Science and Technology in Society *forum*

“Science and Technology in Society: Lights and Shadows”

Inaugural Meeting

November 14-16, 2004, Kyoto
Kyoto International Conference Hall

SUMMARY OF PROCEEDINGS

STS *forum* SECRETARIAT
Sanno Grand Building 419, 2-14-2 Nagatacho, Chiyoda-ku, Tokyo 100-0014, Japan
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November 14, 2004, Sunday

16:00–17:40 Opening Ceremony and Inaugural Session: "Lights and Shadows"

(Part 1)

Session Chair: **Omi**, Koji, *Member, House of Representatives, JP*
Koizumi, Junichiro, *Prime Minister, JP*
Sainsbury, David, *Minister for Science and Innovation, UK*
McKinnell, Henry, *Chairman and CEO, Pfizer Inc., CA*
Okuda, Hiroshi, *Chairman, Toyota Motor Corp., JP*

We must thoroughly examine the roles of science and technology if we are to create a better future, **Koji Omi** maintained. And he pointed to the fundamental concept of the inaugural STS *forum* — that scientific progress has brought about great prosperity while simultaneously raising new ethical, security, and environmental challenges — as a major item on that examination's agenda. Omi said that addressing these challenges would require more than additional scientific advances. Scientists must work in concert with business and government to develop a vision, together with a coherent set of rules, for ensuring true scientific progress while minimizing any adverse side effects. He noted that the STS *forum* works precisely to this end by promoting dialogue between scientists, policymakers, and business people.

Junichiro Koizumi observed that his administration has been a vigorous advocate of science and technology, based on the belief that they are fundamental both to environmental protection and economic development – which, despite the conventional wisdom, are not mutually incompatible objectives. As an example, Koizumi cited his government's program to convert its motorized fleet to low-emission vehicles. While initially expensive, this investment has yielded considerable payoff. Greater corporate investment in low-emission vehicles — particularly hybrid cars — has led to their decreased unit costs, making them more affordable to ordinary citizens. Koizumi noted, however, that despite science's many important benefits, society cannot ignore its dark side. Because the STS *forum* represents the first real attempt to address this duality, the prime minister said, he expressed his sincere appreciation to the forum's organizers and to the opinion leaders from around the world who participate in it.


David Sainsbury

David Sainsbury stated that in the past people believed science would solve all problems of human society. But now they have grown more skeptical as the misuses of science and technology have become increasingly obvious. At the same time, Sainsbury argued, the benefits of science and technology are often underappreciated. Emphasizing that science in the 20th century had greatly improved global health and led to unprecedented economic prosperity, Sainsbury suggested that humankind should adopt a more rational and optimistic view of science. In order to maintain such progress, Sainsbury said, scientists must engage with the public at the beginning stages of technology development. Doing so would permit them to "argue our case in the court of world opinion."


Henry A. McKinnell

Henry McKinnell stated that the STS *forum* was addressing a truly fundamental question, as old as civilization itself: Can growth in human wisdom match the pace of human achievement? In any case, McKinnell stressed that advancements in science and technology have certainly become the flywheel for business expansion. McKinnell cited Thomas Edison as an example of the way in which new technologies create whole new industries, and noted that Edison's formula — inventing, improving, and commercializing a new technology — continues to apply. Today, however, harnessing scientific advancements – and diffusing new technologies from the laboratory to the marketplace — requires a partnership between government, universities, and industry. McKinnell thus expressed his hope that the STS *forum* would help to overcome the cultural and organizational barriers hindering cooperation between the public and private sectors.

Hiroshi Okuda said that while science and technology have served as midwife to modern society — they have been its "lights" — these advances have been paralleled by the "shadows" of environmental degradation and new security threats. In arguing that it is essential for diverse groups to engage in dialogue on such challenges, Okuda cited as example one problem of development: the tension between energy consumption and environmental protection.

Nevertheless, Okuda noted, Japan achieved economic prosperity while implementing a "conservation society" whose nationwide energy efficiency stemmed not only from government regulations but also from the voluntary actions of individuals and corporations. Thus Japan might serve as a model for developing countries, Okuda suggested, and in fact it bears a *responsibility* to promote the growth of conservation societies worldwide.

Hiroshi Okuda

(Part 2)

Session Chair: Yoshikawa, Hiroyuki, *President, National Institute of Advanced Industrial Science and Technology (AIST), JP*
Fursenko, Andrey, *Minister of Science and Education, RU*
Moratti, Letizia, *Minister of Education, Universities and Scientific Research, IT*
Aho, Esko, *President, Finnish National Fund for Research and Development (Sitra), Former Prime Minister, FI*
Thapparansi, Korn, *Minister of Science and Technology, TH*

Hiroyuki Yoshikawa commented on the diversity of the STS *forum*'s participants. It was his first experience, Yoshikawa said, of politicians, business leaders, and scientists interacting as equals. But Yoshikawa cautioned that for such interactions to ultimately be fruitful, experts cannot overstep reasonable professional bounds. For example, Yoshikawa suggested, while a scientist should function not just as a researcher but as a consultant to the greater society, he or she must not confuse personal opinions with objective fact. Otherwise, rather than reflecting the consensus of the scientific community, that individual may be exploited for partisan purposes. Yoshikawa expressed his hope that the STS *forum* would impart greater wisdom to all participants.


Hiroyuki Yoshikawa

Andrey A. Fursenko

Andrey Fursenko acknowledged the lights of scientific advancement, but Fursenko specified some of its shadows as well. His examples of negative consequences of technological progress ranged from genetic engineering, which poses a major ethical dilemma for society, to Internet addiction. All of society's leaders must address such issues to help assure a positive future, Fursenko said, but designers of new technologies have a particularly great responsibility. Fursenko also expressed concern that the increasingly prohibitive costs of R&D might constrain the emergence of new and benign technological alternatives.

Letizia Moratti identified two major problems relating to science and technology. One is the shortage of skilled individuals in many of the scientific and technological disciplines. An example, Moratti said, is the European Union's need for researchers and information– technology (IT) workers. The other problem is the gap between developed and developing countries, which has led to severe brain drain. To formulate solutions, Moratti advocated strengthening the linkages between the scientific community and industry, as well as between industry and developing countries, and Moratti called on governments to help make science a more attractive career for young people.


Letizia Moratti

In describing the sources of Finland's postwar economic success, Esko Aho suggested that the country's growth was largely driven by investments in science and technology coupled with a strong educational system. Aho noted, however, that science and technology cannot produce economic growth all by themselves. To fully exploit the benefits of R&D investments, states must have the ability to undergo rapid structural change. Given the limits of such abilities at present, Aho said, the development of IT has yet to reach the stage of a true technological revolution.


Esko Aho

Korn Thapparansi

Science, if applied correctly, can solve humankind's most urgent problems in the 21st

century, said **Korn Thapparansi**. But although the scientific community does try to pursue such noble ends, most global problems remain *un*solved. One reason, Thapparansi suggested, is that bureaucracies prevent scientists from deciding when and where new ideas and technologies may be applied. Thapparansi called for "partnerships in a world of differences," and, in order to keep all players in the loop, Thapparansi advocated equal and equitable distribution of IT resources to close the digital divide — and, thus, the information divide — between North and South.

18:30–20:30 Official Dinner

Watanabe, Osamu, *Chairman and CEO, Japan External Trade Organization (JETRO), JP*
Alberts, Bruce, *President, National Academy of Sciences, USA*


Osamu Watanabe

Osamu Watanabe thanked the forum participants for their presence in Kyoto. Watanabe said that it was appropriate for the forum to be in Japan, as the traditional aim of Japanese society is for individuals to lead healthy and comfortable lives. That aim has largely been realized, Watanabe pointed out; Japan is world-renowned for the longevity of its people. For other countries all around the world to achieve that goal too, political initiatives must close the current gap between developed and poor countries. Scientists and business people have crucial roles to play in these efforts, and the discussions in this forum could contribute significantly to them as well.


Bruce Alberts

Bruce Alberts said that science has thrived by generating its own value system, which includes the rejection of dogma, openness to new ideas, and an emphasis on logical arguments. These same values, Alberts said, are also essential to democratic societies. Thus not only is an interface needed between scientists and society but there is a sound basis — and precedent — for such collaboration. Alberts noted that science has already been playing an overwhelmingly positive role in the world — providing the wherewithal, for example, for improved health care and liberation from menial labor — but Alberts acknowledged that scientific advancement casts shadows as well. Advances in science and technology, after all, have also produced environmental degradation and weapons of mass destruction. One important step for moving in the right direction, Alberts argued, is for each nation to have an effective academy, run by scientists and engineers, that can make valuable contributions to society. Alberts noted that on a global scale, the InterAcademy Council already serves as such a repository for scientific expertise. Recognizing the inherent difficulties of scientific-capacity building in some nations, Alberts suggested that many U.S. National Academy of Sciences programs — for example, those that teach elementary-school students scientific values through simple, engaging experiments — can serve as models.

November 15, 2004, Monday

08:30–09:45 Plenary Session: Setting the Tone

This plenary session served to set the tone of the concurrent sessions that immediately followed. It created a framework for leaders from government, industry, and academia to discuss how their three sectors can cooperate to address the "lights and shadows" of science and technology for the betterment of humankind.

Session Chair: Arima, Akito, *Chairman, Japan Science Foundation, JP*
Ergma, Ene, *President, Riigikogu of Estonia, EU*
Murthy, Narayana N. R. *Chairman of the Board and Chief Mentor, Infosys Technologies, Ltd., IN*
Velikhov, Evgeny, *President, Russian Research Center Kurchatov Institute, RU*
Cheng, Jinpei, *Vice Minister of Science and Technology, CN*
Gelsinger, Patrick, *Senior Vice President and CTO, Intel Corp., USA*

Akito Arima

The importance of basic scientific research is often overlooked, said **Akito Arima**. Citing several examples, Arima maintained that no technology could develop without the advancements of basic science. Conversely, Arima regretted that many scientists do not reflect on the implications of their research. They are fundamentally responsible and accountable, after all, for their work's availability to society. Arima said that he is nevertheless optimistic. While technology often creates problems, Arima trusts that society can develop it for human benefit and improvement. "I believe in human wisdom," Arima said.

Ene Ergma

Quoting Immanuel Kant – it is in human nature to "study the sky above us and the moral law within us" – Ene Ergma launched into an explanation of her concerns regarding the role of ethics in science. Ergma pointed out that the public can be misled: for example, although the space industry was developed primarily for military purposes, it has a very positive image because of active public-relations efforts by programs such as the Hubble Space Telescope. Ergma also believes that the global science community should accept greater responsibility for its actions, especially with respect to new technologies. It must consider their possible consequences and then take steps to inform the public of them, given that most people are aware only of what has already occurred, not of what may occur. Meanwhile, with scientists' help, the public should come to see the big picture — the overall, positive role that science plays in their lives — though the attitude of some researchers poses a constraint and may even cause people to believe that science is *not* necessarily devoted to the good of society. Modern scientists, Ergma pointed out, often reject ethics as irrelevant.

Narayana N. R. Murthy

Referencing the conference's theme of "Lights and Shadows" but emphasizing the lights, Narayana N. R. Murthy spoke of the recent developments in information and communications technology (ICT) that today are enriching people's lives. Online public services connect citizens to the government, Murthy said, and they help to provide urgent health care to those who are otherwise without access to it. E-learning offers education to children in remote areas, and Internet- based markets allow farmers to determine optimal selling prices. Murthy also maintained that ICT is a promising resource for sustainable development.

Evgeny Velikhov

Velikhov, Evgeny observed that the 20th century brought a host of new problems: the development of nuclear weapons, which hold mankind in a delicate balance; the growing demands on natural resources; and the increase in stress on humans resulting from economic, social, and governmental change. Seeing many of these problems as the result of the technological "big bang" in which we are living today, Velikhov predicted that this same source — especially improvements in communication technology — will be crucial to mitigating the problems. Technology alone will be insufficient, however. The international challenges we face in the 21st century, Murthy said, require a synergy of science, engineering, and entrepreneurship.

Jinpei Cheng focused on the need for government to maintain public trust in science by guiding, monitoring, and managing research. Cheng said that science's negative impact on society could be minimized through active policy measures, and in that spirit he emphasized the need for international cooperation in science. Cheng also expressed concern at the slow progress in ethics, which often leaves it lagging behind science and technology. To help reverse this trend, he said, "scientists should take responsibility for precaution and risk assessment" and the participants of this forum in particular should become "role models in the promotion of this lofty cause."

Patrick Gelsinger

Patrick Gelsinger predicted that the "digital divide" will be eliminated by 2025, making the Internet accessible and useful to every single person on earth. Acknowledging that this is a difficult goal, Gelsinger outlined three technological trouble spots — in connectivity, accessibility, and infrastructure — that now hinder development. The range of wireless technologies is too short, computers remain too difficult to use, and in order to accommodate all of the people of the world the bandwidth capacity of the Internet must be expanded by a factor of 1,000. On the policy side as well, Gelsinger sees the need for improvements in radio-frequency spectrum regulations, globalized standards, and international education. But Gelsinger believes that these hurdles will be overcame, and that the digital divide will indeed be bridged.

10:15–12:15 First Series of Concurrent Sessions:

The Challenge of Meeting Energy Needs in Developing Countries

Ample, dependable sources of energy are crucial to the sustained development of any economy. How should industrialized countries advise their growing neighbors on best practices in the clean and efficient use of energy?

Session Chair: Yoshikawa, Hiroyuki, *President, National Institute of Advanced Industrial Science and Technology (AIST), JP*
Chan, Kei Biu, *Chairman and Managing Director, Surface Mount Technology (Holdings) Ltd., HK*

Foss, Michelle Michot, *Executive Director, University of Houston Institute for Energy, Law and Enterprise, USA*
Hassan, M.H.A., *Executive Director, Third World Academy of Sciences, SD*
Gopalakrishnan, Adinarayantampi, *former Senior Research Associate, Belfer Center for Science and International Affairs, IN*
Zhou, Dadi, *Director General, The Energy Research Institute, National Development and Reform Commission, CN*
Wijkman, Anders, *Member of the European Parliament, SE*

This session placed particular emphasis on the energy needs of developing countries' rural areas. Discussants noted that while the rural poor lack access to national energy systems, untapped local energy sources often exist. These sources, frequently renewable, are especially desirable from an ecological perspective. A major challenge, however, is the link between political (often-nondemocratic) regimes in developing countries and national energy systems, which tend not only to be inefficient but difficult to reform. Discussants noted, however, that achieving the UN Millennium Development Goals would be impossible without meeting the energy needs of developing countries.

A wide array of policy prescriptions emerged during the course of this session. One recurrent theme was the need for industry, government, and academia to focus on energy consumers, as opposed to producers. Participants noted that while manufacturers worldwide often ignore their products' lifetime energy costs, consumers have great incentive to take them seriously. Another proposal was for governments and industry to jointly promote "green manufacturing": through policy guidance and voluntarily adopted standards, industry would fully incorporate environmentally friendly energy usage and disposal into the manufacturing process. The strongest recommendation made by participants, however, was a bottom-up approach for developing countries — entailing cooperation between government, industry, and academia — that would aggregate local energy resources and local energy needs into a national energy plan. More generally, participants urged developed and developing countries to share best practices for energy production and usage; and they called for South-South collaboration on energy technologies uniquely suited to the developing world.

Ethical Aspects of Reproductive and of Therapeutic Cloning

Stem-cell research offers the potential of developing revolutionary therapies for human health care, but not before a variety of "moral" questions are addressed. The latter will be no easy task, however. How do we define ethical standards in an arena made up of groups that represent many different value systems?

Session Chair: Colwell, Rita, *Distinguished Professor, University of Maryland, USA*
Singer, Peter A., *Director, University of Toronto Joint Center for Bioethics, CA*
Yeo, Philip, *Chairman, A*STAR, Singapore*
Desmarescaux, Philippe, *Chairman, Biovision, FR*
Ida, Ryuichi, *Professor, Graduate School of Law, Kyoto University, JP*
McLaren, Anne, *Wellcome Trust/Cancer Research UK Institute, UK*
Hayashizaki, Yoshihide, *Project Director of Genome Exploration Research Group, Genomic Sciences Center, RIKEN, JP*


Rita Colwell

This session's consensus positions included the following: public awareness of the difference between "reproductive" and "therapeutic" cloning should be increased; the realistic benefits of stem-cell research and therapeutic cloning should be communicated to the public; and the global scientific community should present a unified front in speaking out against reproductive cloning. More generally, session participants discussed the disparities between developed and developing nations in technology and health care.

Major recommendations of the panel included: formation of an international body to act as platform for the discussion and dissemination of scientific fact to the public; international support for therapeutic cloning together with an outright international ban on reproductive cloning; and the creation of a global stem-cell bank (not unlike a common blood bank) with attention paid to the need for ethnic diversity. Also much discussed was the need for investment by foreign governments in the development of the Third World, preferably on the level of the Canadian government's recent directive (to devote 5 percent of its research and development spending to general health care systems in developing countries).

The Future of the e-Society

The Internet and the first generation of mainstream online applications are nearing maturity. Where do we go from here?

Session Chair: Ito, Joichi, *President and CEO, Neoteny, JP*
Ahtisaari, Marko, *Head of User Experience, Insight and Foresight, Nokia, FI*
Bishop, *Robert, Chairman and CEO, Silicon Graphics, USA*
Gage, John, *Chief Researcher and Vice President of the Science Office, Sun Microsystems, Inc., USA*
Lim, H.K., *Corporate CTO and President, Samsung Electronics, KR*
Boda, Miklós, *President, National Office of Research and Technology, HU*
Huh, Unna, *President, Information and Communication University (ICU), KR*
Ishizuka, Shigeki, *Senior Vice President and Executive Director, Mobile Multimedia Business Promotion Department, NTT DoCoMo Kansai, Inc., JP*
Seppä, Heikki, *Research Director, Research Professor VTT Technical Research Center of Finland, FI (Rapporteurs)*

John Gage

This session explored challenges related to the ever-expanding impact of information and communications technology (ICT) as mobile-phone and Internet use continues to increase. For example, one participant spoke about the level of ICT penetration in Korea, where two-thirds of households have broadband Internet access and over 70 percent of the population uses mobile phones. She also presented the idea of a "u-life," or ubiquitous life, wherein the proliferation of ICTs allows routine electronic interaction through any device, any time, and anywhere. Other speakers addressed the changing profile of the ICT user and the societal shifts that could occur as ICT penetration approaches 100 percent in developed countries. Problems with the current systems, such as spam email sent to mobile phones, phone-number piracy, and phone-use etiquette, were also discussed.

The consensus of this session's participants was that for new ICT to be successful, it must be fail-safe, offer a high level of security both perceived and actual (now that we've witnessed some of the adverse effects that can accrue from the technology's ready amalgamation of personal information), and have an easy-to-use interface.

The Role of University in Building a Global Knowledge-Based Society

Universities worldwide are in crisis because of their growing inability to meet the demands placed on them in higher education, research, and the creation of knowledge-based societies. How can universities adapt to modern-day realities? Should they reevaluate their relationships with industry and society?

Session Chair: Aperia, Anita, *Professor, Karolinska Institute, SE*
Halliday, Ian, *Chief Executive and Deputy Chairman, Particle Physics and Astronomy Research Council, UK*
Komiyama, Hiroshi, *Vice President, University of Tokyo, JP*
Yoshino, Hiroyuki, *Director and Advisor to Honda Motor Corp. Ltd., JP*
Nguyen, Van Dao, *Chairman, Council of Training and Research, Vietnam National University, VN*
Fronc, Martin, *Minister of Education, SK*
Lotfy, Osman, *Director, Development, Research, and Technological Planning Center, Cairo University, EG*
Abueva, José V., *Founding President, Kalayaan College, Philippines (Rapporteurs)*
Naim, S.T.K., *Consultant, The Organization of Islamic Conference Standing Committee on Scientific and Technological Cooperation (COMSTECH), PK (Rapporteurs)*

Consensus positions among this session's participants were as follows:

- Universities, especially in Europe, are in crisis because they are not changing fast enough to meet the changing needs of society.
- Universities moved to mass education without providing enough specialized, or "tailored," education to meet present-day needs.
- Education-support funds, both from public and private sources, must be judiciously employed so that the cost of education is not a barrier to students.
- It is not clear whether students should be given more freedom in choosing courses or be limited in accordance with strict requirements.
- University/industry collaboration sounds attractive, but it is a myth that universities will get rich from selling their intellectual property and abandoning their primary missions. In fact, technology transfer is a drain on university resources and technology-transfer offices operate at a loss.

Today's Plagues: Old and New

Some of the diseases that haunted the Old World have reemerged at a time when worldwide medical resources are already overstretched from confronting newer diseases such as AIDS and SARS. What conditions have allowed for this reemergence? How can we detect and control the spread of these diseases before they gain new footholds?

Session Chair: Rubinstein, Ellis, *President, New York Academy of Sciences (NYAS), USA*
Klausner, Richard D., *Executive Director, Global Health, Bill & Melinda Gates Foundation, USA*
Tan, Chris, *President, Calidris R&D, CA*
Imura, Hiroo, *Chairman, Foundation for Biomedical Research and Innovation (FBRI), JP*
Ngu, V.A., *President, Cameroon Academy of Sciences, CM*
Ferguson, *Neil Morris, Professor, Department of Infectious Disease Epidemiology, Faculty of Medicine, Oxford Imperial College, UK*

Ellis Rubinstein

The initial emphasis of this session was on the causes — such as population growth, international trade and travel, and the breakdown of public health systems — of new and reemerging infectious diseases and of their growing resistance to antibiotics. Many speakers lamented the lack of support for research at the fundamental- science level, especially among the wealthy nations. A strong desire was also expressed for more effective methods of developing and distributing vaccines and antiviral drugs.

The session's participants agreed on the immediate need for an effective global health system to provide early detection and containment, and to perform collaborative research, on infectious diseases. The resources for such research should derive from public/private partnerships,

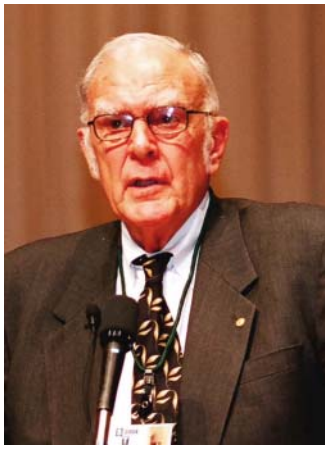
centralized under an organizational structure with a clear prioritization of goals. In addition, funding for research should be shared between countries, with sufficient attention given to problem-oriented research and smaller, riskier projects that have the potential for new discoveries.

12:30–13:30 Working Lunch

Panel Discussion "The Question of Sustainability"

Session Chair: Inoguchi, Kuniko, *Professor of Political Science, Faculty of Law, Sophia University, JP*
Rowland, Sherwood F, *Donald Bren Research Professor of Chemistry and Earth Systems, University of California at Irvine, Nobel Laureate [Chemistry 1995], USA*
Lee, Yuan Tseh, *President, Academia Sinica, Nobel Laureate [Chemistry 1986], USA*

In pursuing sustainability, countries need to share knowledge, Kuniko Inoguchi said. We can't afford to make the same mistakes over and over. In that spirit, Inoguchi spoke of the need for SOS ("Solution-Oriented Science") and stronger civil-society involvement in the sciences. Because we need policy solutions toward which science may be directed, Inoguchi said, civil society must put forward priorities, ideas, and questions to be answered. This should be a strongly inclusive process, in which regional balance is sought and solutions are shared.



Sherwood F. Rowland

"You can't talk about sustain- ability if you have some parameter that's increasing [seemingly] forever," Sherwood F. Rowland said. That parameter is global population, which keeps on growing and is not expected to stabilize until the middle of the 21st century, when it will have reached 9 billion. This means that room must be made for 3 billion more individuals within the next 50 years, Rowland noted, which also includes the question of how to distribute GNP among the earth's people. A related problem is the inevitable impact on global climate. Rowland said that annual CO_2 emission per capita is about 1 ton per person worldwide, though the amount varies considerably from country to country (the US averages 5.1 tons per capita, for example, while India's average is 0.2). Most countries will not be aiming for particularly low emissions, however, as there is not enough GNP for the current population, Rowland said. Thus they are looking to *expand* GNP, which requires a lot of energy, which in turn leads to global climate change — and a global problem.

Reflecting on the changing historical relationship between humans and their environment, Yuan Tseh Lee pointed out that the earth used to be huge — that is, humans had little effect on it. Since the industrial revolution, however, the earth has become increasingly limited as the effects of human activity have grown more intense, influential, and global in reach. Responding to this problem, Lee asserted, means nothing less than harmonizing the relationship between humans and nature. His technological solution is solar energy, but this can only be developed through new social thought and organization. Scientists and scholars need to work in community, Lee said, becoming a "global village" for the beneficial use of science and technology.

Yuan Tseh Lee

14:00–16:00 Second Series of Concurrent Sessions:

The "Promise" of Clean Energy

Through international cooperation, we can find ways of meeting the energy needs of our growing economies while achieving the goal of reducing our impact on the earth's environment.

Orbach, Raymond L., *Director, Office of Science, Department of Energy, USA* (Session Chair)
Hennicke, Peter, *President, Wuppertal Institute for Climate, Environment and Energy, DE*
Goldemberg, José J., *Secretary for the Environment, State of São Paulo, BR*
Kaya, Yoichi, *Director General, Research Institute of Innovative Technology for the Earth,(RITE) JP*
Jacometti, Jack, *Vice President, Global GTL Development, Shell Gas and Power, UK*
Sasaki, Mikio, *Chairman, Mitsubishi Corp., JP*
Mohri, Mamoru, *Executive Director, National Museum of Emerging Science and Innovation, JP (Rapporteurs)*
Duca, Gheorghe, *President, Academy of Sciences of Moldova, MD*

The overarching theme of this session was that addressing global energy needs requires a comprehensive approach on the part of both developed and developing countries. Discuss- ants agreed that clean energy sources have great potential, and that renewables' share of global energy consumption has in fact steadily risen in recent years. Policy incentives could further enhance this trend, particularly because the unit cost of renewables tends to decrease as consumption expands. But discussants also agreed that renewables alone cannot solve the world's energy needs. The supply of some renewables, such as hydro- power, is limited; while other sources, such as wind and solar, are unreliable. Thus participants sought to embed renewables in the larger concept of decarbonization—reducing the CO_2 output associated with energy production and consumption. Achieving environmentally acceptable levels of atmospheric CO_2 would require a 50-to-60-percent decrease in global carbon emissions by 2050. Session members recognized, however, that lowering global carbon emissions while simultaneously expanding energy production will pose a

Raymond L. Orbach

major challenge to developed and developing countries alike.

A number of recommendations resulted from this session. In general, discussants agreed that no source of energy should be reflexively discounted — countries should exploit an array of renewable and nonrenewable energy sources. While acknowledging dissenting opinions, session participants largely concluded that nuclear energy should be thoroughly reexamined, and that it may be necessary for large developing countries like China and India. Another recommendation was to alter the incentive structure of energy markets so that developing countries would be motivated to pursue renewable energy sources over fossil fuels and so that individuals in developed countries would be motivated to reduce energy consumption. Such a system of incentives would lead the consumer price of energy to account for CO_2 intensity and energy-resource constraints. Lastly, discussants proposed a number of technological mechanisms for reducing global CO_2 emissions. In addition to renewables, other instruments cited for achieving decarbonization included carbon sequestration, synthetic fuels, clean coal technology, and electric/hybrid cars.

Ethical Aspects of GM Crops for Developing Countries

Genetically modified (GM) crops' enhanced abilities to endure environmental stresses — such as drought, pests, and poor soil — have resulted in much higher yields and the capacity to feed more people. However, the long-term health effects of consuming GM crops have not been fully tested and therefore are not well understood. Under these circumstances, what are the ethical ramifications of allowing the world's people to eat such foods?

Session Chair: May, Robert, *President, The Royal Society, UK*
El-Beltagy, Adel, *Director-General, International Center for Agricultural Research in the Dry Areas (ICARDA), EG*
Wambugu, Florence, *CEO, A Harvest Biotech Foundation Int'l (AHBFI), KE*
Guillou, Marion, *President, Institut National de la Recherche Agronomique (INRA), FR*

The main issue brought up in this session was the need for general debate about questions of safety, vulnerability to invasive species, creation of less-diverse farmlands (given the increased efficiency of mono cultures), and other concerns that have entered the public consciousness regarding the proliferation and consumption of GM crops. The session also focused quite intently on the implications of applying GM technology to combat hunger in Africa.

While the prime concern of session participants was that the Third World benefit from advancements in life science — mention was even made of promoting a one-class world in which all nations benefit from new knowledge — the session's strongest recommendation was to apply the same safety standards in developed countries and Third World countries. In other words, we must avoid exportation of substandard/untested technology to countries that are so in need of aid they cannot in good conscience pick and choose which technologies to use. In that spirit, one of the session's discussion groups proposed that the EU work in partnership with developing countries to improve the local infrastructure, particularly promoting the participation of interest and pressure groups that may work together with governments to define the countries' needs. This same mechanism can then be used to formulate proactive financial measures in the developing countries that enable them to fulfill those needs.

Robert May

The "e-Developing" World

Will "e-technologies" help Third World countries overcome obstacles to development? Can these digital technologies even help them leapfrog ahead — develop faster than traditional societies have been able to do in the past? What are the specific needs of developing countries in terms of e-technologies?

Session Chair: Newton, Richard, *Dean of the College of Engineering and the Roy W. Carson Professor of Engineering, University of California, Berkeley, AU*
Lu, Hong Liang, *Chairman, CEO and President, UTStarcom, USA*
Kalil, Thomas, *Special Assistant to the Chancellor for Science and Technology, University of California, Berkeley, USA*
Gannes, Stuart, *Executive Director, Media X, Reuters Digital Vision Fellowship Program, Stanford University, USA*
Gelsinger, Patrick, Senior *Vice President and CTO, Intel, USA*
Freeman, Peter, *Assistant Director, National Science Foundation, USA*

Fully aware that information and communications technologies (ICTs) have become commonplace in developed countries, this session aimed to explore the economic feasibility — the potential usage and markets — for ICTs in developing countries. Some session participants believed that current business models could never be profitable when serving a population with little disposable income; others either felt that alternative ways might exist for making ICT useful and profitable in developing nations, or they were already in the business of delivering ICT services there. Critics tended to see investment in developing nations as a charity, or an R&D project, or perhaps as a head start into a fledgling market. Proponents

cited examples of a single Internet connection allowing hundreds of people to ask medical questions or query information services that provide weather forecasts and accurate crop values, thereby demonstrating areas of high demand in developing nations.

In an informal vote taken of the participants, about 60 percent thought that governments are the greatest hurdle to delivering ICTs to developing countries, while 40 percent felt that corporations must change their attitudes in order for services to become available. There was unanimous agreement, however, that to fully understand the problems of the "e-developing world" it is important for conferences to also include people from the developing world — only a few were present at this one.

From Brain Drain to Brain Gain

The wealthiest and most open economies have always attracted the best talent. What actions can be undertaken, both by industrialized countries and developing countries, to accept the inevitability of such movement and turn brain drain into brain gain?

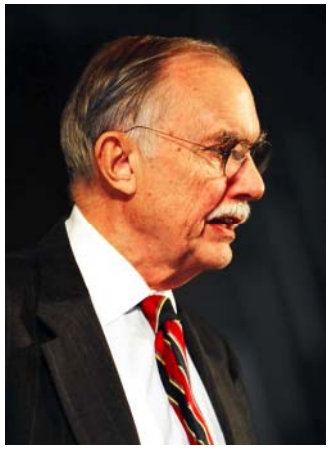
Session Chair: Serageldin, Ismail, *Director, Library of Alexandria, EG*
Allende, Jorge, *Member of the Chilea de Ciencias, Instituo de Ciencias Biomedicas (ICBM), CL*
Bismuth, Pierre, Vice President of Global Personnel Practices, Schlumberger Ltd., FR
Gago, José-Mariano, *President, Laboratorio de Instrumentacao e Fisica Experimental de Particulas (LIP), PT*
Zakri, A.H., *Director, Institute of Advanced Studies, United Nations University, Malaysia*
Goldin, Daniel S., *NASA Administrator (1992-2001), USA*

Brain drain is a natural function of human survival; people migrate to escape poverty and adverse living conditions. This is especially true of educated people, in that education provides freedom. Countries suffering from brain drain should therefore take steps—such as improving quality of life, allowing greater research flexibility, and giving young researchers more research opportunities—in order to retain their educated citizens. Similarly, the creation of centers of excellence can allow countries to concentrate their resources and reduce talent outflow; and they can make S&T more attractive to women by developing more female instructors and other professionals who may act as role models.

Science for a Safe and Secure Society (Against the Intentional Spread of Infectious Diseases)

The threat of bioterrorism not only exists but is growing. How can the international community cooperate to contain this threat?

Session Chair: Plate, Nikolay, *Vice President, Russian Academy of Sciences, RU*
Atlas, Ronald M., *Dean of the Graduate School, University of Louisville, USA*
Branscomb, Lewis M., *Professor Emeritus, Public Policy and Corporate Management, John F. Kennedy School of Government, Harvard University, USA*
Falaschi, Arturo, *Director General, The International Centre for Genetic Engineering and Biotechnology (ICGEB) , IT*
Sharma, Manju, *former Secretary to the Government of India and former Advisor to the Ministry of Science and Technology, IN*
Han, Seung-soo, *President, The 56th Session of the United Nations General Assembly, KR*



Lewis M. Branscomb

This session covered two main topics. The first was that infectious-disease research, for all its benefits, also makes bioterrorism a greater concern. New knowledge of pathogenic organisms, after all, can be used for malevolent intent. Participants noted, however, that many countries are not seriously concerned about this issue and would therefore be underprepared should they actually experience a bioterrorist attack. While participants agreed that infectious-disease research must continue, especially on diseases that afflict developing countries, they also recommended that the scientific community, as the holder of the most detailed knowledge on this problem, has the obligation to advise nations on effective ways to meet bioterrorism threats.

The second topic dealt with the moral and ethical issues facing individual researchers in potentially contributing to bioterrorism. There was a general consensus that the scientific community must make it clear that the development of bioterrorist weapons is unacceptable. "We will not engage in the misuse of life sciences" must become the credo. Broaching the problem of whether or not to monitor individual researchers, participants suggested that the biological community should accept responsibility for what is occurring in its laboratories. In partial fulfillment of that obligation, life scientists must establish a globally accepted code of ethics; and of prime importance in upholding this code is an active relationship between science, government, and society.

16:00–18:00 Concurrent Plenary Sessions:

"Nanotechnology: Promises, Promises"

After witnessing many overhyped new technologies, the public has understandably greeted nanotechnology with a bit of well-earned skepticism. How can the scientific community educate members of the public so that they may appreciate the wondrous new directions in which this technology will take us?

Session Chair: Kishi, Teruo, *President, National Institute for Materials Science, JP*
Bai, Chunli, *Vice President, Chinese Academy of Sciences, CN*
Nakamura, Michiharu, *Executive Vice President and Executive Officer, Hitachi Ltd., JP*
Roco, Mihail, *U.S. Nanoscale Science, Engineering and Technology, and Senior Advisor, National Science Foundation (NSF), USA*
Tokura, Yoshinori, *Professor, University of Tokyo, JP*
Braach-Maksvytis, Vijoleta, *Director, Commonwealth Scientific and Industrial Research Organization (CSIRO), AU*
Connolly, Mark S., *Vice President, R&D, DuPont Performance Coatings, USA*

In introducing this session and its speakers, Teruo Kishi said that "lights and shadows" apply not so much to science — knowledge is fundamentally neutral — but to technology, which can be used in beneficial or harmful ways, and sometimes both. This applies no less to nanotechnology, whose so-called shadows will depend on the uses we make of it. Kishi noted that he is optimistic about the positive effects of nanotechnology, but that the scientific community will still have to be very careful in its use.

Chunli Bai stated that nanotechnology is basically a positive endeavor that should gain the public trust, but at the moment the public doesn't have enough knowledge of what nanotechnology is, much less of its presumed effects on society. Bai stressed that the scientific community should get involved in outreach efforts that bring a better understanding of nanotechnology to the average person. Such actions will be more effective, Bai added, if coordinated with government and industry. These kinds of partnerships should already exist, in fact, to assure the very development of nanotechnology and its bright future.

Michiharu Nakamura described the importance of nanotechnology for Japan, which has carried out research in this field Nakamura added that a lot of researches concerning nanotechnology and nanoscience have been produced in Japan for the last four decades so as to be well positioned for the Industrial Revolution of the 21st century. So far, the Japanese government has overseen most of the nanotechnology studies, in cooperation with several scientific bodies, but Nakamura added that universities have extremely important research roles to play, via academic nanotechnology centers, to secure breakthroughs both scientific and societal. Meanwhile, nanotechnology is becoming a high priority for Japanese industry, which seeks to apply it in diverse fields — IT, medical, and environmental, for example. Actually, a strong collaboration now exists between government and industry. Called the Nanotechnology Business Promotion Initiative, its efforts have been communicated to the public by means of the Nanotech Summit. Nakamura cited some of the initiative's recent achievements, and called for research efforts to ensure that the societal implications of nanotechnology will be overwhelmingly positive. Any "shadows" should be minimized through rational risk-management strategies, for example, or information-exchange programs (which also promote international cooperation and solidarity).

Mihail Roco noted that the financial costs of nanotechnology R&D are very high, but so are the expectations of the international community. The technology's profound potential consequences include redefinition of material structures, development of new and transformative tools, and major social effects. Nanotechnology's implications could be so great, in fact — arguably, it may even be capable of modifying the natural world — that the next few years must largely be devoted to health and safety studies. Roco expressed confidence, however, that as long as we proceed ethically and with conscientiousness regarding social and environmental impact, nanotechnology could very much improve human abilities and our way of life.

Yoshinori Tokura divided nanotechnology applications into three main areas: mechanical, chemical, and electrical. With closer looks into the elementary structures of materials, Tokura believes that many remarkable properties will soon be found and exploited in each of these areas. Tokura believes that to excite and comfort the public about nanotechnology, and thus to secure its support, research successes should be well publicized and scientists should disclose their ambitious research goals for the future.

Vijoleta Braach-Maksvytis described her approach to nanotechnology as "taking something very familiar and looking at it in a different context." Unlike most other scientists, Braach-Maksvytis regards nanotechnology from the applications perspective — determining where needs exist for technological improvements and then applying available technologies to fill those needs. The question Braach-Maksvytis asks with regard to nanotechnology is: At what point does it become imperative? For example, Braach-Maksvytis points out that with India's new economic growth, every year there will be 35 million more children attending school, who will need 35 million more sets of books, computers, paper, pencils, and more. Nanocomputers and e-books could be invaluable in efficiently meeting their needs without undue material and environmental disruption. By similarly projecting our future needs in other areas as well, we may discover other useful applications. Nanotechnology is not something that people should fear, Braach-Maksvytis said, because it will offer great benefits to society in the future.

Mark S. Connolly cited a number of nanotechnology examples, including UV-resistant paint coatings and dent-proof plastics, to show that it already affects diverse aspects of our lives yet remains largely invisible. Because Connolly basically considers nanotechnology to just be the natural extension of current research in materials science, Connolly sees no reason why the public should be wary of this branch of science. Indeed, nanotechnology may be a

source of numerous benefits — reduced material consumption, reduced waste, and reduced energy use, all of which are essential factors for sustainability. Because public trust is a critical requirement for these and other explorations of nanotechnology to continue to thrive, Connolly called for efforts to keep people informed that this field is safe and environmentally friendly. In that way, they may continue to support nanotechnology research and development efforts through their taxes, fully expecting valuable new products and services in return.

"Science and Technology: The Central Role in National Strategies"

In this session, speakers reported on their country's science and technology strategies for the 21st century.

Session Chair: Leshner, Alan, *CEO, American Association for the Advancement of Science (AAAS), USA*
Tanahashi, Yasufumi, *Minister for Science and Technology Policy, JP*
Kleiber, Michal, *Minister of Science, PL*
Taha, El-Zubeir Bashir, *Minister of Science and Technology, SD*
Park, Ky-Young, *Advisor to the President for Information, Science and Technology, KR*
Yakushiji, Taizo, *Member, Council for Science and Technology Policy, JP*
McSweeney, Barry, *Chief Science Advisor to the Government, Head of Delegation of the Government of the Republic of Ireland, IE*

Alan Leshner

Alan Leshner compared this forum's theme of "dark" and "light" to two other diametric opposites in science and technology—cost and benefit—and he spoke of the tensions that derive from human beliefs and value systems. As science advances, Leshner said, people not only start asking whether progress in the sciences helps or hurts them but also whether certain things ought to be known at all. To illustrate the point, Leshner cited the examples of stem-cell research and the sequencing of the human genome, which may lead to a better understanding of human origins and personality traits, among other things, but also strike a little too close to home for some people. The closer science gets to the study of personal issues, Leshner said, the more we strive to control it because we are afraid of what we might hear. This means that scientists can no longer simply explain their science and leave it at that, said Leshner. They must engage in deeper dialogue on its societal implications, and governments' national science policies accordingly need to assure that new technology is applied in a socially beneficial manner. Along the way, Leshner added, world governments must help build national science capacity and improve the general public's science literacy.

Yasufumi Tanahashi

Yasufumi Tanahashi cited the enactment of the Science and Technology Basic Law in 1995 as evidence of Japan's desire to establish itself as a science-and technology-oriented nation. The first Basic Plan under this law led to 17 trillion yen of government investment in science and technology from FY1996 through 2000. Then, in 2001, Japan formed the Council on Science and Technology Policy to serve as the lead agency for formulating the country's policies and strategies in science and technology, as well as for guiding the government's annual resource allocations for their promotion. Further, in a move intended to increase government investment in the sciences to 1 percent of the GDP by 2005, the second Science and Technology Basic Plan set 24 trillion yen as the goal of the public scientific and technology sector during the FY2001-2005 period. This plan, Tanahashi said, involves prioritization of investment in order to promote high-quality research, and also the reform of what Tanahashi called a "National Innovation System" to increase competition and promote industry-academia- government collaboration.

Michal Kleiber spoke of the "public's right to know," noting that the Polish government has attached great importance to the public dissemination of scientific information. For example, it promotes "science days," during which all public television channels focus on the broadcasting of scientific information, and the establishment of science festivals in many major cities. Kleiber also described how the Polish government works with scientists themselves. Its grant system, Kleiber said, has become an object of intense competition, enabling government to support only the highest-quality research. Kleiber also spoke of plans to refine the Polish tax system so that the private sector has greater incentive to invest in science (industry currently accounts for one-third of total funding), and of the government's aim to increase public investment to 3 percent of GDP by 2010.

El-Zubeir Bashir Taha lamented that Sudan's reduction of public funding in the sciences has had a negative impact on science education, as have forces well beyond that country's control. The expanding globalized labor market strips developing countries of 85 percent of their skilled workers, Taha said, though it does result in some transfer of technology through expatriated nationals. Taha also put forth the idea that in the borderline areas of science, such as the study of human consciousness, the "dichotomy between science and spirit may not be as sharp as is commonly perceived." Taha explained that science in Sudan is closely tied to a religious emphasis on the preservation of human life. Widening this concept to a global scale, Taha called for more science education, international dialogue, and a "global coexistence" marked by peace and stability.

Ky-Young Park said that the Republic of Korea, in response to the 1997 economic crisis in Asia, has adopted

a new model of growth that emphasizes innovation rather than higher production per se. The country's policies for creating a national innovation system now include elevation of the Ministry of Science and new incentives for collaborative R&D among small enterprises, medium-sized firms, and startups. In addition, the ROK government has sought to spur the development of regional R&D clusters, and will assist in the marketing of new technologies. Park also emphasized government's role in promoting cooperation between business and academia and in attracting students to the sciences.

Barry McSweeney characterized Ireland's science and technology policy as a common-sense approach in which science is harnessed to help business operate in a sustainable and responsible manner. This policy has had excellent results, McSweeney said, serving as a stimulus for four decades of rapid economic growth. McSweeney noted that Ireland's government recently committed 2.5 billion euros to basic research in biotechnology and ICT, and that this pattern of R&D spending reflects its decision to invest in specialized technologies. McSweeney observed that Ireland has benefited from a higher proportion of science and technology graduates than other OECD [Organization for Economic Cooperation and Development] countries — 20 percent of 20- to 29-year-olds — compared to an OECD average of 10 percent. To attract additional scientific expertise, the Irish government intends to establish a seven-year plan for postdocs that guarantees a tenured professorship or permanent research position.

19:00–21:00 Special Buffet Dinner: "Experience Kyoto"

Master of Ceremony: Kuroda, Reiko, *Professor, Department of Life Sciences, Graduate School of Arts and Sciences, University of Tokyo, JP*
Yamada, Keiji, *Governor of Kyoto Prefecture, JP*
Masumoto, Yorikane, *Kyoto City Mayor, JP*

November 16, 2004, Tuesday

08:30–09-30 Plenary Session

Rapporteurs reported on yesterday's morning and afternoon concurrent sessions.

Session Chair: Kurokawa, Kiyoshi, *President, Science Council of JP*
Oxburgh, Ronald, *Non-Executive Chairman, The "Shell" Transport and Trading Company p.l.c., Member of the House of Lords, UK*
May, Robert, *President, The Royal Society, UK*
Campbell, Philip, *Editor-in-Chief*, Nature, *UK*
Branscomb, Lewis M., *Professor Emeritus, Public Policy and Corporate Management, John F. Kennedy School of Government, Harvard University, USA*

In introducing this panel, **Kiyoshi Kurokawa** quoted former U.S. President Franklin D. Roosevelt: "The test of our progress is not whether we add more to the abundance of those who have much, it is whether we provide enough for those who have little."


Kiyoshi Kurokawa

Ronald Oxburgh cited some of the major points of the sessions on energy:

- Developed countries are "addicted to the drug" of fossil fuels," and they are its biggest users as well. Eighty percent of the world's energy is consumed by only 20 percent of the population.
- Time is critical for developing countries, because they will not be able to use the currently available cheap energy sources for very much longer, as these sources are dirty.
- We have 30 to 40 years to avoid serious CO_2 emissions damage. Extreme climate changes and sea-level rises will mostly affect developing countries.
- Renewable sources of energy are stable sources, but are not yet competitive on price.
- If the costs associated with CO_2 from fossil fuels increases, the use of fossil fuels will decrease.
- Coal and nuclear energy are viable sources of energy for developing countries and can be developed without the help of developed countries. In that case, however, environmental impact will be more severe.


Ronald Oxburgh

"Time is of the essence," Oxburgh emphasized. "This not an academic exercise to be carried out on an academic time scale." If we miss this opportunity to help developing countries "get it right" with their energy development, we will not get another chance. We need a project, Oxburgh said, that is similar to the U.S. mission to put a man on the moon. That is, much of the available technology and manpower was concentrated in order to solve a very difficult problem in a short time. Such an effort needs to be applied as well to the energy crisis in developing countries — a problem that is "much, much, much" more important.

Regarding the sessions on ethics, **Robert May** paraphrased Charles Dickens: "These are the best of times; these are the worst of times." In many ways, right now is the best time to be alive. Food is cheap and abundant, life expectancy has increased, and health care is very good. But it is also the worst of times as we increasingly suffer "the unintentional consequences of technological advancements." Socialism failed, May said, because it did not tell the truth about economics, while capitalism is failing because it has not told the truth about

the environment. Consider, for example, the planet's decreasing biological diversity. The extinction rate today is the highest since the last great mass extinction. "Science opens doors," May acknowledged. But "we must decide together" which doors we might want to open and which ones to keep shut. And we need to roll up our sleeves and begin making decisions and taking action immediately. "We must move beyond these days of exciting and agreeable talk to one that produces recommendations and results," May concluded.

In reporting on the ICT sessions, **Philip Campbell** made the following points:

- Problems associated with the Internet are often attributed to immaturity — not only to youth of the medium but to the young people who populate it.
- There is not enough education about making decisions.
- There has been a conspicuous absence of anthropologists and sociologists at the STS *forum*.
- Internet governance is very important. Too much control is given to those who set up the businesses that develop, maintain, and search the Internet. "Who controls my domain name, controls my destination," Campbell said.
- We must find imaginative ways of providing business opportunities in developing countries — for example, micro-capitalism (such as a woman in a small village selling Internet time by the minute).
- Campbell strongly recommended publishing Richard Newton's summary of the session titled "The 'e-Developing' World."

In reporting on the security sessions, **Lewis Branscomb** made the following points:

- Infectious diseases cannot be addressed just locally. Individual countries need the help of the global healthcare community.
- A crucial matter is "the gross inequity of the effect of infectious diseases" in the world: poor people suffer from infectious diseases much more than do wealthy people.
- We need to have "ethically based education at all levels."
- The STS *forum* should create a statement that seeks acknowledgement from the UN and other governing bodies.

09:30–10:30 Plenary Session: "Science and Society"

This plenary session discussed the science community's responsibility to maintain the public's trust.

Session Chair: Noyori, Ryoji, *President, RIKEN, Nobel Laureate [Chemistry 2001], JP*
Laughlin, Robert B., *President, The Korea Advanced Institute of Science and Technology (KAIST), Nobel Laureate [Physics 1998], USA*
Gros, François, *Honorary Permanent Secretary, Academie des Sciences, FR*

Ryoji Noyori noted that in the past, humankind survived by overcoming challenges posed by nature. Today, however, the fate of humanity is in human hands. Unchecked human activity has led to environmental degradation and will ultimately bring about cultural decline, Noyori said. To avoid such a tragedy, scientists must strive to develop technologies truly needed by society. Noyori defended scientists, however, from accusations of irresponsibility. Inspiration rather than planning often generates new and unintended discoveries, Noyori said, and while these discoveries may pose moral dilemmas, the scientist does not willfully challenge society's ethical norms. Noyori asserted that despite its "shadows," science is critical to society. Scientists and others, especially politicians, must work together so that these shadows are minimized.

Ryoji Noyori

Robert B. Laughlin

Robert B. Laughlin observed that the lights-and-shadows motif of the STS *forum* captures the dilemma of scientists branded by the Frankenstein myth. But Laughlin argued that action, rather than knowledge, defines good and evil. Society needs knowledgeable individuals, Laughlin said, not only to oversee worrisome things ("shadows") such as nuclear weapons but also to produce the "lights." Laughlin expressed concern that that the biotech revolution has, for many nonscientists, reinvigorated the Frankenstein myth. In society's responses to such fears, Laughlin said, the negative externalities of biotechnology should be addressed through law rather than the suppression of science. Laughlin stressed that policymakers, not technologists, bear responsibility for ensuring that advances in biotechnology conform to societal norms.

François Gros noted that society views science with a degree of dualism. On the one hand, science is viewed as a tool for solving global problems such as hunger and disease. On the other hand, many people do not believe that scientific knowledge itself is inherently valuable — that is, the benefits of basic research are often underappreciated. Thus Gros voiced concern at the increasing knowledge gap between scientists and society at large, and Gros called for new methods of teaching science at the

François Gros

elementary and secondary levels to help bridge this gap. Gros also advocated a "shadows" dialogue that would comprise multiple international forums. It would bring together diverse groups, including average citizens, to discuss the negative externalities of scientific progress and what might be done to reduce or, where possible, eliminate them.

11:00–12:00 Closing Plenary Session

Global cooperation between government, academia, and industry can secure for humankind the best of what science has to offer.

Session Chair: Friedman, Jerome I., *Professor, MIT, Nobel Laureate [Physics 1990], USA*
D'Aubert, François, *Minister Delegate for Research and New Technologies, FR*
Salama, Amr Ezzat, *Minister of Higher Education and Minister of State for Scientific Research, EG*
Nishimuro, Taizo, *Chairman, Toshiba Corp., JP*
Omi, Koji, *Member, House of Representatives, JP*

François D'Aubert noted that popular fear of science has grown alongside humankind's heightened ability to manipulate the living world. Complicating this problem is the fact that the benefits of science have been distributed unevenly within and across nations. D'Aubert urged collaboration between scientists and other actors in society, as well as "democratic confrontations" and lively debate within the scientific community itself. D'Aubert also expressed his hope that STS forum participants would ultimately see fit to create a planetary ethics committee.

Amr Ezzat Salama

Amr Ezzat Salama proposed that scientists adopt a code of daily ethics to minimize the shadows resulting from their work. This code would emphasize honesty, cooperation, and objectivity. In noting that science–and– echnology capabilities are unevenly distributed across nations, Salama maintained that developing nations need assistance in building such capacity. This would require a new vision that replaces the current dynamic of technology transfer and brain drain. With that end in mind, Salama asked STS forum participants to consider how to maximize the benefits of international science and technology cooperation.

Taizo Nishimuro suggested that the private sector can no longer follow the single model of producing more at lower costs. Instead, enterprises must balance profits with a sense of social obligation. Likewise, scientists and engineers must act to fulfill society's needs, and conduct their activities with regard to ethical norms. In that spirit, Nishimuro called for industries, governments, and educational institutions to promote lifelong learning among

Taizo Nishimuro

members of the workforce. Nishimuro also identified the STS *forum* as the beginning of a global network for addressing the role of science in society. To expand this network, Nishimuro urged participants to exert their influence on colleagues not present. Lastly, Nishimuro observed that society accepts and nurtures science only when science demonstrates its value to society.

Koji Omi

Koji Omi asserted that the STS *forum* marked a new page in human history — that the forum's lively exchange of thoughtful views would serve as a building block for enhanced understanding and respect between the science–and–technology community and the rest of society. Omi suggested that the fate of society would in fact depend upon how effectively humankind addresses the "lights and shadows" of scientific progress. In developing such new paths for the future, Omi maintained that partnerships among governments, industry, and the scientific community would be essential. He remarked that three major themes had emerged during the course of the STS *forum*: global warming represents a pressing threat; foreign assistance to developing countries should include science–capacity building; and science and technology should be used to enhance human security. In closing, Omi announced that the STS *forum* would reconvene in Kyoto in September 2005.

12:00–13:00 Farewell Buffet Lunch