Science and Technology in Society (STS) *forum*

Non-Profit Organization

SUMMARY OF PROCEEDINGS

Sixth Annual Meeting

October 4-6, 2009

Kyoto International Conference Center (ICC Kyoto)

Science and Technology in Society (STS) forum (NPO)
Sanno Grand Building 419, 2-14-2 Nagatacho, Chiyoda-ku, Tokyo 100-0014, Japan
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Sunday, October 4, 2009

Monday, October 5, 2009

Tuesday, October 6, 2009

In this summary, all the names, job titles and functions reflect those current as of the date of the forum; personal titles have been omitted.

Sunday, October 4, 2009

10:00-11:00 OPENING PLENARY SESSION

100: "Science and Technology and the Future of Humankind"

Chair:
Omi, Koji, Founder and Chairman, Science and Technology in Society (STS) *forum*, JAPAN

Speakers:
- **Cicerone**, Ralph, President, National Academy of Sciences (NAS), U.S.A.
- **Kan**, Naoto, Deputy Prime Minister; Minister of State for National Policy Unit, Economic and Fiscal Policy, and Science and Technology Policy, Government of Japan, JAPAN
- **Rezende**, Sergio, Minister of Science and Technology, BRAZIL
- **Shimizu**, Masataka, President, The Tokyo Electric Power Company, Inc.; Vice Chairman, Japan Business Federation (Nippon Keidanren), JAPAN
- **Sophonpanich**, Khunying Kalaya, Minister of Science and Technology (MOST), THAILAND

Koji Omi welcomed participants to the meeting of the Sixth Science and Technology in Society (STS) *forum* held under the theme of "Lights and Shadows of Science and Technology." He referred to U.S. President Obama's statement which said that science is more essential to our lives than ever before. Omi explained that the benefits of science and technology are the "lights." But he also pointed to what he called "shadows" arising from science and technology such as ethical concerns, issues of information security and nuclear proliferation. Omi emphasized the importance of developing the "lights" while controlling the "shadows." Science and technology are not the exclusive domain of scientists and engineers, but concern humanity as a whole. Problems should therefore be addressed through international cooperation. He stressed the need for support and diplomacy in favor of science and technology in developing countries. In addition, despite the current financial crisis, investment in science and technology must continue.

Naoto Kan voiced high hopes for the fields of science and technology under the new Japanese government, noting that Hatoyama is the first Prime Minister in Japan to hold a PhD in engineering. He said his policy is to use science and technology as a basis to stimulate the Japanese economy and contribute internationally to reaching the dual goals of environmental protection and economic development. The "Hatoyama initiative," he said, includes ambitious targets for the reduction of green house gas emissions by all major economies. Japan aims to reduce its own emissions by 25% by 2020, but this will rely on innovative technologies. Japan will also extend more financial and technical assistance to developing countries. Kan spoke of "green innovation," saying that social and economic revitalization can be achieved by developing human resources and creating new business and employment opportunities in "green" fields. By sharing experiences with other countries, Japan can make substantial contributions to building a sustainable society in the world while working towards the twin objectives of supporting economic growth and environmental protection.

Ralph Cicerone suggested that it is possible to deal with the current problems facing the world of science and technology by "avoiding the unmanageable and managing the unavoidable." Six billion people enjoy high standards of living, thanks to the continued progress of science. While science and technology provide services in energy, electricity, transportation, mining and agriculture, worldwide, 80% of this activity comes from burning coal, oil and natural gas. Global climate change caused by human activity is widely recognized. Less obvious but no less important are other factors such as methane build-up, nitrous oxide from fertilizers and a variety of specialty chemicals used in the electronics industry. However, science allows us to monitor the rises in surface air temperatures, water temperatures, sea levels and more intense levels of precipitation. We must predict more reliably and learn about potential destabilizing changes, such as thawing permafrost. With increased knowledge, community leaders and scientists can work to mitigate climate change. The challenge is to see what is coming and to limit those changes by managing the unavoidable.

Sergio Rezende said that Brazil's recent history shows what can be done in developing nations. Previously, Brazil had a small number of scientists and institutions running graduate programs in science were not established until the 1960s. Brazil also relied on foreign technology and yet, just two years ago, Brazil reached self-sufficiency in oil production thanks to its deep sea technology. Now, the number of graduating doctors and research grants is steadily increasing and the country is ranked 13th in the world in the publication of scientific papers. Besides, with a new legal framework, Brazil has worked to establish a 4-year plan with concrete goals. New funding focuses on national science and technology systems and correcting regional imbalances. It also aims to intensify investment in research and development in areas of national strategic interest, and to improve science education and social technologies. New financial instruments have successfully stimulated researchers and promoted initiatives and these have been coordinated with developing countries in order to accelerate recovery. In recent years, Brazil has expanded cooperation in science and technology with countries in Latin America and Africa but cooperation with industrialized nations has not yet reached a satisfactory level. New vision and new values are required to meet the present challenges.

Masataka Shimizu spoke of energy resources and global environmental problems including mass production and mass consumption as negative assets from the 20th century. Such problems may become more serious with the rapid economic growth of developing countries, especially in Asia. He called for a "smart society" with smart supply chains and a smart use of energy. The peaceful use of nuclear energy is a means of providing stable, mass, low-carbon energy at a low cost, but this should come with military nuclear non-proliferation measures. More renewable energies are needed in addition to solar power since it is not a stable source because it is subject to weather conditions. Solutions to power system stabilization such as battery storage systems are needed. In addition, a shift from fuel combustion systems to heat pump systems could reduce total CO_2 emissions in Japan by 10%.

Khunying Kalaya Sophonpanich applauded science that has allowed us to create new and better products and services and deliver these at cheaper prices. Some of the harmful side-effects of science and technology could soon find remedies. We are perhaps even on the brink of great discoveries. But she stressed the need to verify new discoveries and make sure products are safe before they are released onto the market. Thailand hopes to promote an understanding of coming trends in the adoption of technology that it could use with tropical crops, fruits and herbs. Efforts must also be made to familiarize people with science and technology and encourage the study of these subjects. The more advanced our technology is, the more responsible people need to be, she concluded.

11:00-12:00 PLENARY SESSION

101: "Science and Technology for Economic Recovery and Growth"

Chair:
Thomson, Robert, Managing Editor, The Wall Street Journal; Editor-in-Chief, Dow Jones & Company, AUSTRALIA

Speakers:
- **Aoki**, Masahiko, President, International Economic Association, JAPAN
- **Barañao**, Lino, Minister of Science, Technology and Productive Innovation, ARGENTINA
- **Beddington**, John, Chief Scientific Adviser, Government Office for Science, U.K.
- **Hasegawa**, Yasuchika, President & Chief Executive Officer, Takeda Pharmaceutical Co., Ltd., JAPAN
- **Kosgei**, Sally, Minister of Higher Education, Science and Technology, KENYA
- **Kroto**, Harold, Francis Eppes Professor, Florida State University; Nobel Laureate in Chemistry, 1996, U.K.
- **Ramanathan**, Veerabhadran, Director of the Center for Clouds, Chemistry and Climate and Director of the Center for Atmospheric Sciences, University of California, San Diego, INDIA

Masahiko Aoki remarked that the prevailing view of the financial crisis was that it is the result of a global trade imbalance. China and Japan were too reliant on exports for growth and meanwhile, over-investment in Wall Street resulted in excess consumption in the U.S. He said it is necessary to restore the trade balance and boost domestic demand. The U.S., Japan and China boast the world's three largest economies, but each has its own agenda for sustaining economic growth. In China, more than 200 million people have moved out of agriculture. Japan's population ageing problem is looming. In the 1960s, 11 working people supported one retiree. Now it is four to one, and by 2025 the ratio is expected to be two to one. China and other Asian economies will also face this problem. On the bright side, domestic growth will generate demand for renewable energy technology and Japan benefits from engineering expertise in this field. Future leadership must be trained to cope with climate change, he concluded.

Lino Barañao said that regional co-operation in Latin America is necessary to spur growth. Governments also need to increase spending on R & D. He pointed out that the current combined budgets of Latin American nations are comparable to those of single multinational companies. It is critical to improve innovation in productive sectors. Latin America must develop strong international co-operation in science and technology and increase opportunities in this sector. Fostering a critical mass of human and financial resources is vital. He stressed the need for bilateral co-operation to step up food production and support scientific and technological innovations. Latin America faces a two-fold challenge of confronting the energy crisis while trying to boost industrial activity. Biotechnology, nanotechnology and information technologies will develop business opportunities in the region.

John Beddington said demography cannot be ignored as 2009 is the first year that the world's urban population has exceeded its rural population. The demand for food, water and energy is increasing and is expected to rise 50% by 2030. The global population is set to grow to 9 billion by mid-century. Can we feed 9 billion people? As the demand for water rises, it is unlikely to remain a free commodity in the future, as it currently is in many countries. Threats are global but it is important to see that there are regional differences. "Collaboration" is the byword of the future.

Yasuchika Hasegawa said that although there are signs of a global economic recovery, he sees no quick fix to the crisis. He stated the need to change our position from "I to we." He pointed to human responsibility for global warming and the quick spread of the financial crisis. A collaborative response is necessary to meet these challenges. He also said we need to change our behavior from "greed to creed," stressing the importance of integrity over self-gain and warning against the pursuit of quick profits. Governments need to develop regulatory bodies to review products in order to bring them to market quickly. Drug companies must ensure that their products are safe and effective. Advanced nations must support pandemic vaccine development and provide vaccines to developing countries. Governments need to support domestic and international patent applications and help countries that lack patent management systems. We are interconnected as never before and must favor interdependence over independence.

Sally Kosgei said Africa came to the realization that it was affected by the global economic crisis when exports to the developed world and revenue from regional products such as tea, coffee and flour fell. This came at the same time as one of the worst droughts in the Horn of Africa, which has caused crop and livestock failure and famine. As a result, development budgets have been redirected to famine relief. Meanwhile, conflict over water resources has increased between communities. Technology is needed to boost food yields and improve irrigation. She warned against protectionism and the cutting of aid to developing countries. Finally, the loss of jobs and a reduction in the number of health centers continues to cause hardship.

Harold Kroto said big breakthroughs in science and technology will come from left field. He spoke of the need for "uncommon sense" originating in scientific and technological

advances, but warned against "common nonsense" stemming from misinformation. He also warned against corruption in business and economics. Education is vital: every village that has a TV should have access to global knowledge. He stressed the need to bring together the best teachers in the world to create reservoirs of knowledge as well as encourage collaboration among them and promote current efforts to develop education as whole. Access to information will help teachers do a better job. If the business community's strategy had focused on what is best for our children and grandchildren, we would not be in this current ecological and economic mess.

Veerabhadran Ramanathan said we must prepare for a 2-degree rise in global temperatures this century. In the next few decades, more than 800 billion tons of CO_2 will be released. The effects of non-CO_2 pollutants such as methane and black carbon can be observed and monitored. And the technology is at hand to cut these emissions by 30 to 40%. But politics are often a barrier. The situation is not hopeless: ways to curb rising temperatures exist and we can buy time for the planet.

13:30-15:30 PLENARY SESSION

"Special Dialogue with Rupert Murdoch"

Speaker:
Murdoch, Rupert, Chairman and Chief Executive Officer, News Corporation, U.S.A.

followed by

102 "Dialogue among Political Leaders, Scientists and Industrialists"

Chair:
Lee, Yuan Tseh, President Emeritus and Distinguished Research Fellow, Academia Sinica; Nobel Laureate in Chemistry, 1986, CHINESE TAIPEI

Speakers:
- **Bréchignac**, Catherine, President, International Council for Science (ICSU); President, French National Center for Scientific Research (CNRS), FRANCE
- **Espada**, Rafael, Vice President, Government of Guatemala, GUATEMALA
- **Eyton**, David, Group Head of Research and Technology, BP p.l.c., U.K.
- **Nakagawa**, Masaharu, Senior Vice Minister of Education, Culture, Sports, Science and Technology (MEXT); Member of the House of Representatives, JAPAN
- **Nicholson**, Peter, President and Chief Executive Officer, Council of Canadian Academies, CANADA
- **Okamura**, Tadashi, Advisor to the Board, Toshiba Corporation; Chairman, The Japan Chamber of Commerce and Industry, JAPAN
- **Roberts**, Richard, Chief Scientific Officer, New England Biolabs Incorporated; Nobel Laureate in Physiology or Medicine, 1993, U.K.

Rupert Murdoch spoke about education in the United States and pointed to the basic problem that the system does not produce enough students with math and science skills. Children must be exposed to science and math as early as possible. Otherwise they will not possess the basics to pursue advanced studies and will be shut out of decent careers. Competition is increasingly putting a high economic premium on skills which can only be acquired through education. China and India understand this better than other advanced nations. China sets high standards for students and insists these are met. These days, there are no excuses for not educating children.

The greatest strides in world prosperity come from breakthroughs in science and engineering. Of the top five countries in math and science, four are Asian. In contrast, U.S. 15 year-olds came in 30th out of 41 countries in terms of problem-solving, and 38th out of 57 in basic achievement. Furthermore, the U.S. is seeing students drop out of school one or two years earlier than before. Schools should focus on achievement and there are no excuses for failure. A school system that fails our children is a "waste of a human promise." The fact that so many children drop out of school is a moral scandal no one should tolerate. Basic education is the first civil right in any decent society.

Yuan Tseh Lee stressed that continued dialogue between scientists, politicians, and industrialists is very important to overcome problems of competition and collaboration. Science is the language we can use to communicate with nature. But this language is very difficult to understand and only a few specialists can master it. It is imperative that scientific education be made available to everyone, so that the industrialists and politicians of tomorrow are able to understand the dialogue with scientists. Science and technology can achieve much if we continue to improve our dialogue. If Japan can achieve its goals for the environment, there is hope for other societies around the world.

David Eyton said that the solution to future energy demands is contingent on three issues. First, time is running out for oil and gas resources - by 2050 the whole oil and gas industry will have to be restructured. Second is the need to reduce pollution, and to find the trillions of dollars to achieve this. Third, energy, whether renewable or not, puts a strain on resources such as the water supply and land and it is predicted that by 2025, a quarter of the world will live in water-stressed areas. Between 10 and 20% of the global stimulus package has been aimed at the development of sustainable energy sources. It is the role of companies such as BP to find innovative ways forward. Working with university laboratories to research biofuels should provide opportunities and new sources of sustainable and profitable energy. The key is collaboration between research institutes, companies and governments.

Peter Nicholson noted that the world is in transition. The G20 summit in Pittsburgh in September saw the leaders of the world's economic powers come together with the aim of making the G20 the premier forum for international cooperation to combat current world problems. He said that action is necessary but we need to combine action with thinking, research and the sharing of opinions coming from a variety of perspectives. He said: "Something very significant happened in Pittsburgh last week-end." Now is the time to act.

Richard Roberts stressed that science and technology cannot produce a miracle cure for all problems, although they have had a serious impact on some issues. Unfortunately, other problems persist such as poor access to health care. Genetic technology can be used create crops that could feed the hungry and address malnutrition, but political opposition has stood in the way of their introduction in Europe and, more critically, in Africa. We need to choose better politicians, like Nelson Mandela and Aung Sang Suu Kyi, in order to solve the problems of modern society.

Rafael Espada spoke of the need to find a balance between science, politics, and business as a major challenge. He called on scientists to drive changes and stressed that these should be in meaningful areas such as easing human suffering by creating advanced warning systems, tapping wind power and green vehicles. To face our future we must conquer our past. Small steps create giant steps. Let us focus on each day. Let us think of one human race and one place, planet earth.

Catherine Bréchignac pointed out that science is different from technology and therefore, the two should not necessarily be grouped together. Science is knowledge and technology is know-how. Progress requires both of these. The role of the mass media is to educate society, and scientists should ensure the quality of information on the web. We also need to form groups of international experts to work on climate issues. But society must be seen on both a local and global level. It takes too long to arrive at global solutions. A more sustainable world can be achieved if people from different approaches come together in the same place and work to cooperate.

Masaharu Nakagawa discussed the new Hatoyama cabinet in Japan and its priorities for the budget in the areas of child rearing, the promotion of science and attention to environmental issues. Hatoyama declared a revolutionary 25% reduction in emissions by 2020. With many obstacles to overcome, this will be difficult to achieve, but it is natural for Japan to bear a heavy burden if it is serious about being a world leader in environmental preservation. Nakagawa suggested a combination of private and public funding for science and technology and the possibility that the cost of market research could be covered by private funds.

Tadashi Okamura said there is a sense of stagnation in Japanese society. We must match the innovativeness of the 20th century. Science and technology have moved towards more specialized research, rather than on meeting needs. This is a roadblock to research. To overcome problems we must involve a wide range of participants, integrate the liberal arts with the sciences, and introduce ordinary people to science. The role of the government is to take a leadership position and develop a vision.

16:00-18:00 FIRST SERIES OF CONCURRENT SESSIONS

103-A1: “Building a Post-Kyoto Protocol”

Chair:
Komiyama, Hiroshi, Chairman of the Institute, Mitsubishi Research Institute, Inc., JAPAN

Speakers:
- **Alatas**, Sharifah Munirah, Lecturer, National University of Malaysia, MALAYSIA
- **Asrar**, Ghassem, Director, World Climate Research Programme, U.S.A.
- **Botti**, Jean, Chief Technical Officer, European Aeronautic Defence and Space Company (EADS), FRANCE
- **Incer Barquero**, Jaime, Special Advisor to the President on Environmental Affairs, NICARAGUA
- **McBean**, Gordon, Chair of the Board and Chief Executive Officer, Canadian Foundation for Climate and Atmospheric Sciences, CANADA
- **Patel**, Ketan, CEO, Greater Pacific Capital, U.K.

Several key issues must be assessed to bring about real advances in climate change solutions. For example, both observation and evidence-based models point to significant increases in CO_2 levels and ocean acidification, affecting food sources from the sea and causing glacial melting. Because the rate of change in the environment has increased significantly, there is less time to develop responses. Addressing the root causes of these problems and developing strategies to minimize the effects of ongoing environmental change are critical. These strategies should be institutionalized and governments should make policy decisions to deal with climate change issues.

Mitigation and adaptation cannot be separated and therefore economic considerations, food security, energy, transportation, etc. must all be weighed up. At the same time, the benefits of a comprehensive climate education system should be explored. A new Kyoto Protocol that can facilitate decisions at regional level needs to be designed and implemented.

Knowledge of climate systems is necessary to reduce our vulnerability to and prevent dangerous changes that affect food production and economic development. Some 75% of disasters are due to climate hazards and if present trends persist, these will become more severe. Combining initiatives such as the Kyoto Protocol and the World Conference on Disaster Reduction will lead to better, more integrated solutions. It could also help bring about a greater understanding of the real-world effects of these changes, further driving national decision-makers to take the Copenhagen initiatives seriously.

Developing countries are looking to technology as a means for survival. Central American countries such as Nicaragua are repositories for much of the world’s biodiversity and as such, act as a buffer to changes in the world climate. Ongoing strategic alliances are being formed to protect fertile land and prevent environmental degradation. Yet, structural poverty and insufficient scientific and technological knowledge about agriculture and the environment are significant challenges to development in the region. Policies must change to provide alternative approaches to land cultivation and food production as well as to promote education for the sustainable and profitable use of forests and the protection of biodiversity.

The divergence in the political and economic objectives of the United States, the EU, India, China and Japan must be addressed. China and India will not give up on profitable production and trade based on Western economic models

unless they are provided with real alternatives to using carbon fuels. If there are no scientific breakthroughs that allow nations to make increases in GDP without burning fossil fuels, agreement on climate change initiatives will remain elusive.

The issue of profitability needs to be fully integrated into the debate on climate change. Creating new and green technologies such as solar and wind power can positively affect a company's bottom line. This includes managing the impact of production on the environment. However, some people in the private sector are still skeptical of warnings and want to see more precise data on climate change to ensure that current predictions are correct.

Some countries such as Malaysia are consistent in collecting greenhouse gas data and religiously report their emissions. While no country is perfect, it is necessary for all nations to continue to meet the goals of each of their commitment periods. At the same time, they must continue to work on increasing public awareness. Cutting consumption is also important and some need to learn that they cannot have their cake and eat it too.

The adoption of post-Kyoto Protocol measures is a must. While some permanent climate changes must be accepted, mitigation is still necessary. A holistic approach is needed to face the current challenges, in particular in terms of food security and water resources.

Our fundamental behavior and value systems must be re-examined. We need both scientists and non-scientists to provide education on limiting over-consumption. Recent literature mistakenly presents Copenhagen as a replacement for the Kyoto Protocol instead of explaining that it is a continuation of its ongoing initiatives.

103-B1: "Infectious Diseases"

Chair:
Fidler, Armin, Lead Adviser, Health Policy and Strategy, Human Development Network, The World Bank Group, AUSTRIA

Speakers:
- **Gubler**, Duane, Director, Program on Emerging Infectious Diseases, Duke-NUS Graduate Medical School, Singapore, U.S.A.
- **Omi**, Shigeru, Professor, Jichi Medical University, JAPAN
- **Orozco**, Esther, President, Institute of Science and Technology of Mexico City, MEXICO
- **Wasunna**, Monique, Head, Africa Liaison Office, Drugs for Neglected Diseases initiative (DNDi), KENYA

This session explored many aspects of the present state of infectious diseases in the world and their remedies, both scientific and social. In the early 1980's, there was an impression amongst infectious disease specialists that the field was drawing to a close: they believed that they were on the brink of solving the problem. However, the world has since experienced outbreaks of HIV/AIDS, H5N1, SARS, and others in what one panellist described as an "alphabet soup" of viruses.

Most recently, the outbreak of H1N1 has caused widespread alarm across the world and mobilized health resources. A panellist mapped the history of influenza, from descriptions by Hippocrates, through to mutations among pigs and major outbreaks in countries like Mexico. But widely-publicized infectious diseases like influenza are not the only deadly ones. Diseases such as dengue hemorrhagic fever were mentioned, and one panellist pointed out that as many as 500,000 people per year die of neglected tropical diseases.

There were several suggestions regarding how the world might improve its approach toward tackling infectious diseases. Speakers expressed a broad spectrum of opinions on the importance of vaccination, new technologies and other "hard" approaches to disease prevention. While panellists stressed there is too much emphasis on technological solutions, others suggested progress is being made regularly and quickly in several fields related to infectious disease. This includes progress in the genetic modification of insects, the decontamination of vehicles, and new antigen vaccination technology. Nevertheless, several participants cautioned against over-reliance on technology. Global strategies, including disease surveillance and financial incentives to produce cures were suggested as effective tools.

Building awareness was another major area panellists sought to emphasize. Working with media to raise public awareness of the risk of diseases and their prevention strategies can be effective. Notable successes include efforts to encourage hand washing among kindergarteners in Japan. But communication strategies can also backfire. On case was mentioned of a scare surrounding an H1N1 outbreak in an African country, which turned out not to be as virulent or dangerous as reported. The panic was worse than the infection, a participant said.

Economic growth and exponential increases in population numbers have lead to increasing urbanization which has, in turn, allowed diseases to spread further and faster than ever before. Globalization has meant increasing international transportation of people, animals and commodities, and has thus changed previous patterns of localized outbreaks. Now, within days of first discovery, a disease can spread across the world, with disastrous implications on global security and commerce.

Furthermore, the implementation of vastly improved technology is being hampered by financial considerations. Bird influenza vaccine technology, developed several years ago, allows doses to be produced more cheaply and efficiently. But unstable demand and expensive set-up costs make marketing it unfeasible at present. Market concerns and other issues often mean there is a 15-year time lag between the development of a new vaccine and its introduction in low-income countries.

Nevertheless there have been several success stories. Japan's low incidence of swine flu deaths has been attributed to its exposure management, Tamiflu stockpiling and public awareness. In addition, polio has been all but eradicated thanks to an adequate mobilization of resources.

Much remains to be done to improve the world's response to infectious diseases. More risk-taking in both financial and technological approaches was suggested. For example,

antigen technology could allow the immunization of ten times more people, but this could result in statistically higher side effects. However, other than improvements to scientific and social strategies, one of the biggest challenges is to integrate both. We have been battling some viruses for centuries and have developed newer, stronger weapons for the fight, but it is imperative that we incorporate the tools that we have in order to continue our progress. "It's common sense," said one panelist.

103-C1: "New Development of Communications"

Chair:
Ito, Joichi, Chief Executive Officer, Creative Commons, JAPAN

Speakers:
- **Crawhall**, Robert, President and Chief Executive Officer, NanoQuebec, CANADA
- **Laudouar**, Jérôme, Chief Executive Officer, France Telecom Japan Co., Ltd., FRANCE
- **Overbeek**, Edzard, President and Chief Executive Officer, Cisco Systems Japan, NETHERLANDS
- **Saracco**, Roberto, Director, Future Centre and Scientific Communications, Telecom Italia SpA, ITALY

With the tremendous developments in communication in recent times, we now have fast, large volume and cheap ways of exchanging information. In terms of improving education, communications technology can have a significant impact. Since the rate of communications development is so fast, the education system can barely keep up with how the public, especially school age children, use these new tools.

One clear way in which education can be improved involves changing the system within current structures. New devices, such as e-books, can be used as effective tools in the classroom. An e-book reader costs as much as one year's worth of books, but has the advantage that it makes reading a more interactive experience, as relevant links, videos and notes can be incorporated easily. Interactive technology in the classroom must be used to improve how information is presented.

One of the main areas debated in this session was how communications networks will evolve. With new technology, higher demands and new markets are forming and the onus is on the communications companies to innovate so that they can stay competitive. New methods for video conferencing mean that users feel they are having a face-to-face conversation. These developments are aimed at providing the new "killer" communication method while reducing the cost to the consumer.

One of the current needs is to make the Internet available for everyone, everywhere, at any time, with sufficient bandwidth. To achieve this, the way that the networks are constructed will have to be rethought. A constant wireless network throughout a town or city would require the number of cells to be increased 10-fold. This is not achievable by any one company, and businesses will have to work together and with private individuals to establish a high density of small, energy-efficient cells. For this to work, vertical roaming and more flexibility between companies are necessary.

The Internet will also continue to evolve. Companies now understand that we do not need a 'net of things', but rather a 'net with things'. One example given was that Apple provides about 85,000 applications, most of which were developed by the general public. Traditionally, these were not seen as valuable by companies, as they made no money. However, if the customer finds value in them, communications companies that work effectively to offer them to their clients will have a huge role to play in the future. Regulation may be necessary to allow new ideas to take off, so they have a chance to grow before they come fully into the public domain. Caution will be needed to make sure that IP is respected, to promote free and fair competition.

These developments do not necessarily imply increased complexity. In fact, companies see it as their social responsibility to make communication easy and provide simple, cheap technology useable by all. For example, in Africa, where there can be problems with infrastructure, solar power has been used to feed the system and make sure there are no communication breakdowns.

It is not possible to see how communications and the Internet will evolve, how companies will change to deal with the future demand, or even what will be the next communication method. Although the future as a whole remains unpredictable, it looks bright for the communications industry.

103-D1: "Science and Engineering Education"

Chair:
Carty, Arthur, Research Professor and Executive Director, University of Waterloo Institute for Nanotechnology, CANADA

Speakers:
- **Arzt**, Eduard, Scientific Director and Chairman, Leibniz Institute for New Materials (INM), GERMANY
- **Gast**, Alice, President, Lehigh University, U.S.A.
- **Kanpolat**, Yücel, Chairman and President, Turkish Academy of Sciences (TÜBA), TURKEY
- **Pifer**, Marilyn, Senior Program Manager and Senior Technical Advisor, U.S. Civilian Research & Development Foundation, U.S.A.
- **Watkins**, Alfred, Science and Technology Program Coordinator, The World Bank Group, U.S.A.

This session on Science and Engineering education examined several key issues regarding methods of ensuring an adequate supply of highly qualified scientists and engineers in order to drive the knowledge based economy as the world recovers from a global recession. Panellists diagnosed challenges and suggested specific solutions for both developed and rapidly developing economies.

Among the main topics discussed, a recurring theme was the need to boost enrollment in universities and increase the attractiveness of science careers. Improving science literacy is imperative to ensure that students, parents and the general

public are enthusiastic about it and its contribution to society. Additionally, efforts must be made to adjust the science and engineering curricula to recognize changing paradigms as is has become clear that scientific research is increasingly cross-disciplinary and collaborative. Scientific innovation requires an appreciation of commerce and entrepreneurship and the curricula must teach these skills. Universities must be able to adapt their curricula and pedagogy in order to address future needs and rapidly emerging technologies such as nanotechnology, which will impact all sectors of industry and society. Finally, increased opportunity is essential for practical application through work terms, internships and international exchanges is essential. This will broaden the educational experience and training of students who will be required to bridge the gap between the fundamental and applied schools of science and engineering.

The scientists and engineers who can lead us into the coming decades are not the anti-social specialists of yesteryear, but rather, interdisciplinary risk-takers. They are good communicators who understand social implications and global market trends. In order to produce scientists and engineers who approach problem-solving in this way, we must educate children at an early age and "infect" them with the science and technology gene. Physical and mental freedom, as well as freedom from negative influences such as targeted corporate advertising, is paramount in nurturing this scientific gene in children. Teaching children the vocabulary of chemistry, physics and biology at an early age is important but emphasizing the role that science plays in our daily lives is essential. We should encourage students to conduct their own research and experiments as early as possible. Scientific role models are essential for young children to help spark an interest in science.

At university level, a multi-disciplinary curriculum is necessary to develop scientific leaders who are broad thinkers and creative integrators. Scientists and engineers well versed in the social sciences are able to apply solutions to society's needs whether the issue is global warming, an energy crisis or a health-care problem. Additionally, students must be pushed into having hands-on experience, to take risks and to learn through failure. Educating scientists and engineers as global citizens is also paramount as most of our future challenges are global and interconnected. Language skills, internships, and cultural experiences are a start. Real global understanding can be achieved by encouraging students to apply theory to work projects abroad in topics such as energy conservation, agriculture and microfinance.

Developing countries are experiencing a growing demand for education in science and engineering. However, there is not enough faculty to meet this need. Also highlighted was the problem of faculty from developing countries trained abroad who face rejection when they return to teach in their home country. To overcome this problem, a system of reintegration would be helpful. In addition to quantity, the quality of faculty is also a concern. The Internet and online media are vital resources for providing teachers in developing countries with top quality and tested educational material. Finally, international university partnerships between developed and developing countries should be encouraged as long as the social and economic needs and goals of developing countries are kept in focus.

103-E1: "International Reconciliation of IPR"

Chair:
Straus, Joseph, Emeritus Scientific Member, Max Planck Institute for Intellectual Property, Competition and Tax Law, GERMANY

Speakers:
- **Chi**, YoungSuk, Vice Chairman, Elsevier Inc., U.S.A.
- **Kilama**, John, Director, Kilama International Consulting Group, LLC, U.S.A.
- **McCormack**, Stuart, Managing Partner and Head of Intellectual Property Group, Stikeman Elliott LLP, CANADA
- **Minami**, Koichi, Deputy Commissioner, Japan Patent Office, JAPAN
- **Stein**, Christian, Chief Executive Officer, Ascenion GmbH, GERMANY
- **Wilbanks**, John, Vice President for Science, Creative Commons, U.S.A.

While Intellectual Property Rights (IPR) have become the subject of growing debate and awareness, those in the IPR area have fielded criticism of these rights and faced difficulties in managing the infrastructure of IPR, especially regarding patents.

Patent harmonization has never been attained as yet but perhaps this is because information technology rights, genetic material and business methods are all different and should be treated independently. Furthermore, topics that provoke strong debate and relate to culture and ethics such as stem cell research, are unlikely to ever attain harmonization. Significant cultural differences preclude reaching a consensus on issues such as what is "patentable subject matter."

Key questions for debate are how broadly and in what direction we should harmonize. Most people agreed that while total harmonization is perhaps impossible, targeted areas for harmonization are. For example, bringing together small groups with a common interest and focus toward a specific goal would allow people to agree on how to treat intellectual property within that group.

Harmonization is further complicated by the problems of understanding what IPR is and why it is valuable. While developed countries are constantly involved in discussions on the subject, developing countries may have little, if any, understanding of the concept.

For example, the U.S. created a property ownership system long ago, which resulted in creating huge economic opportunities. But in many developing countries, the concept of intellectual property ownership is not always so straightforward. Some societies lack legal ownership systems and even if they exist, those systems are not organized with the idea of creating economic advancement. Consequently, IP is not seen as important. Unfortunately, it seems IPR then becomes a subject for debate only among developed nations. This is another key in understanding why IPR are so difficult to harmonize. Participants felt work is needed to bring these lesser developed nations into the arena and involve them in the debate.

Other important questions regarding factors for harmonization included determining what is patentable, creating a definition of what is known as "prior art" and deciding whether to implement "first to file" or "first to invent." Most participants agreed that a universal grace period should be instituted.

Two further problem areas affecting harmonization are workload and duplication. For example, Japan has attempted to tackle this by developing three pragmatic measures that involve bottom up, grass roots approaches in a specific response to the growing need for work sharing. One is an institutional framework for inter-office collaboration via the Patent Prosecution Highway (PPH) for speed, cost saving, and quality control. The second measure facilitates inter-office collaboration via an advanced industrial property network (AIPN). Third are administrative arrangements for timely examination to promote inter-office collaboration, called JP FIRST, a fast information release strategy. As a result, first priority is given to applications under this system, which can then be approved within 30 months of the filing date.

Standards-based licensing is another way to encourage voluntary harmonization. A standards-based licensing system makes licenses available to for uses outside of their core field. These inter-operable licenses make many things possible, especially for tools and products where several elements are often combined to make an item. Such licensing also decreases transaction costs and establishes norms for software and cultural works.

Lastly, the panel discussed the issue of enforcing IPR. Without enforcement, patents are worth nothing. This is critical as human society integrates globally. Because many developing countries continue to struggle with ignorance, disease and poverty, they need assistance in developing new products. As we move forward in the area IPR, worldwide efforts must be made to create a legal system in which IPR can be enforced and practiced by all. Patenting should exist to serve innovation, not the other way around.

103-F1: "Collaboration between Academia and Industries"

Chair:
Kao, John, Founder and Chairman, Institute for Large Scale Innovation (ILSI), U.S.A.

Speakers:
- **Dolphin**, David, Chair, Genome British Columbia, CANADA
- **Guinot**, François, Honorary President, National Academy of Technologies of France (NATF), FRANCE
- **Haour**, Georges, Professor of Technology and Innovation Management, IMD, SWITZERLAND
- **Kitazawa**, Koichi, President, Japan Science and Technology Agency (JST), JAPAN
- **Melo**, Lucia, President, Center for Strategic Management and Studies in Science, Technology and Innovation (CGEE), BRAZIL
- **Teeri**, Tuula, President, Aalto University, FINLAND
- **Williams**, Peter, Chancellor, University of Leicester; Treasurer and Vice President, Royal Society, U.K.

The age-old question of collaboration between academia and industry seems "innocent enough" as a topic, but it soon became clear in this session that it is in fact pivotal and that the gap between the two worlds remains. Participants agreed that is was no longer appropriate to talk about building "bridges" between the two since this is restrictive: a bridge is at best a two-way road only, at worst, a one way street. These days, it is preferable to take a broader view, and in order to provide environments in which academia and industry can benefit from each other while making the most of innovative ideas, it is more useful to think in terms of creating "eco-systems."

Others like to think of it as an "open research concept" in which multiple partnerships are built between scientists, regulators, business leaders and consumers. Another way of approaching the issue was to think of "distributed innovation".

In order to do so, it is important to develop a strategy that is appropriate to the local culture, environment and economy. A multi-faceted approach, while more complex, is much more productive and conducive to bringing together two worlds which in most countries, whether developed or not, are often at odds. It has become necessary to invent or re-invent new multidisciplinary structures which could also help nurture greater understanding and mutual respect between the two.

A particularly innovative example was cited in which a technical institute, business school and university of art and design were merged to create a single body and provide a wide open space for interaction and innovation. This is the sort of environment in which a "value chain" can come into being, linking people together on a collaborative platform. The facility also includes an empty building where "knowledge exchange" can take place in which students, scientists, designers and business leaders come together, also with people from the outside world, and work for a period of time on a given project.

It was noted that this exemplary institution is the product of a specific government policy and this led participants to agree that the role of government is crucial in any approach, in particular in developing countries where scientific institutions and universities are often young and need support. Government policy toward its academic institutions also plays a crucial role and their room for manoeuvre and ability to interact with industry can be deeply affected if members of the academic staff are in effect civil servants of the public sector. The government can play a very constructive role, in particular by providing seed funding or grants to help innovative ideas make the transition between the university and research environment into the business and commercial world. These days, venture capitalists are too far upstream and reluctant to fund start-ups. Bespoke venture capital or special funds are needed but meanwhile, governments can also provide funding for research in industries.

On the subject of funding, participants considered the issue of "curiosity-driven" or basic research versus "commercially-driven" research and agreed this was an increasingly artificial distinction. Between the two lies solution-oriented research and this is what is likely to capture the interest of industry which could indeed provide funding, as some corporations already do.

While it is clear that every nation is different, overall, developing countries are today potential sources of innovation. However, they continue to need support from initiatives such as peer-to-peer scientific mentoring and the setting up of sustainable research facilities. Participants suggested that donor countries could write research funding into their overseas development aid plans.

Finally it was agreed that while strategy, funding and innovative structures are needed to bring academia and industry toward mutually rewarding relationships, skills are required too. There are as yet no norms defining technical transfer specialists. But these new skills are needed in order to manage the process and the transition from academic research to industrial and commercial applications.

103-G1: "Future Cities"

Chair:
Rubinstein, Ellis, President and Chief Executive Officer, The New York Academy of Sciences (NYAS), U.S.A.

Speakers:
- **Dutkiewicz**, Rafał, Mayor, City of Wrocław, POLAND
- **Ebrard Casaubón**, Marcelo Luis, Mayor, City of Mexico, MEXICO
- **Imura**, Hiroo, President, Foundation for Biomedical Research and Innovation (FBRI), JAPAN
- **Meier Wright**, Julie, President and Chief Executive Officer, San Diego Regional Economic Development Corporation, U.S.A.
- **Ou**, Chin-Der, Chief Executive Officer, Taiwan High Speed Rail Corporation (THSRC), CHINESE TAIPEI
- **Yuki**, Fumihiko, Vice Mayor, City of Kyoto, JAPAN

This session focused on the important challenges facing the world's cities. Over half of the world's total population now lives in cities. According to a UN report, the global urban population will increase from 3.3 billion to 5 billion by 2030. Nearly every city will grow. The world has seen an increase in the number of mega-cities which are defined as metropolitan areas with a total population of more than 10 million people. In 1950, New York was the world's only mega-city. As of 2009, there were 26 around the globe.

Among the many challenges that must be faced are the effects of climate change, access to clean water and health issues such as new flu viruses. But as problems arise, cities will also be the main laboratories for finding the answers. Science and technology must be at the center of these solutions. And it is in mega-cities that most of the cutting-edge science and technology developments are taking place. One participant pointed out that if a city is an exciting place to reside then talent will flow in. "Cities are clusters of brain power," remarked another participant.

One major question among participants was how to boost economic growth. One answer is to move towards a knowledge-based economy. Investment in science and technology is also essential to growth but it is not a matter of how much is put in, but how it is carried out. It is imperative for city policymakers to build bridges between the science, private and public sectors.

One way to boost growth suggested by a participant is the establishment of bio-science institutes for medical and pharmaceutical research. Breakthroughs in medical science can help drive a city's economy.

Spending on urban freeway infrastructure now makes little sense in most large cities where land is in any case scarce. Another issue is that energy consumption will grow, so it is vital to develop new sources of power and this requires scientific and technological innovation.

Participants heard of one city's solution to combating climate change: the production of bio-diesel from discarded cooking oil. In this project, waste cooking oil from homes is collected and then refined to create eco-friendly fuel for city buses. This technology is now being provided in some cities in Indonesia. In another example, one participant stressed his city's investment in electric and hybrid municipal vehicles. Another is town is re-developing its center so that residents can live closer to work and avoid long commutes

Many participants remarked that city governments are able to move faster in implementing policy than national governments, which move too slowly to address the challenges we face. One participant pointed out the need to engage policymakers so that they can formulate sound decisions. It was suggested that by building networks, cities can help each other.

Despite the problems facing overgrown cities, urban centers nevertheless have a positive role to play by providing jobs while also promoting tolerance, driving technology and fostering talent. However, one major threat is the economic imbalance that can develop between urban and rural dwellers.

Finally, city planners also must take into account risk management systems, such as strengthening building codes and implementing routine emergency drills for such disasters as earthquakes. As a result of climate change, coastal mega-cities face greater risks from natural disasters so planners must work to foresee and mitigate the dangers as far as possible.

19:00-20:30 **104 Official Dinner**

Chair:
Serageldin, Ismail, Director, Library of Alexandria, EGYPT

Toast:
Hayashi, Yasuo, Chairman and Chief Executive Officer, Japan External Trade Organization (JETRO), JAPAN

Speaker:
Ernst, Richard, Professor Emeritus, Swiss Federal Institute of Technology (ETH) Zurich; Nobel Laureate in Chemistry, 1991, SWITZERLAND

Yasuo Hayashi noted that JETRO had supported the STS *forum* from the beginning, then raised a toast to its health and future prosperity.

Ismail Serageldin described how science had progressed since the time of Imhotep in Egypt 5,000 years ago, and spoke of the introduction of the word "scientist" into the English language. He referred to the "lights and shadows" of scientific progress and mentioned global warming and environmental change as instances of "shadows." He spoke of the many stages in the journey from information to wisdom and lamented the lack of wisdom in the world today.

Richard Ernst said that science and technology are neutral tools. How we use them is what matters. He made a plea for more responsibility in science, calling on scientists to forego the promise of financial gain in favour of personal liberty and freedom of mind. He said that competition among scientists for prizes, publication deals and university rankings is an imposition coming from the free market, which, he pointed out, had failed us badly last year. Research without the education to disseminate it is a "luxurious waste of resources." He suggested the creation of an international agency for global resource management, but added that sadly, our current system of selfish nation states, industries and individuals would not allow it to come into being. Science and technology are the keys to our future, but we must take care not to lose our humanity. Science and technology are only tools. Humanity is what is needed to ensure they are used properly. Scientists have a special responsibility to educate the public not only on research but also on humanity. Scientists at universities help shape the leaders of tomorrow.

A number of issues were raised in the question-and-answer session that followed, including transparency in scientific research, education in mathematics, access to science as a basic human right, and the relative merits of problem-based and curiosity-based science. On the subject of education, Ernst mentioned the Internet as an effective educational tool, but was sceptical about television. He also expressed the view that religious education does not necessarily interfere with science and mathematics, but stressed that religious answers should not be given to questions that belong in those fields. He called for more scientists in the classroom, right down to primary schools. Ernst added that the reason why scientists are not recognised for the art that they love and pursue, and the reason why the sciences do not attract more students is that scientific papers do not reflect the humanity of their authors. Scientists should work to incorporate more humanity into their papers but at the same time remain cautious about not diluting their scientific content.

Monday, October 5, 2009

08:30-09:50 PLENARY SESSION

200: "Science and Technology for Global Health"

Chair:
Castell, William, Chairman, Wellcome Trust, U.K.

Speakers:
- **Berkley**, Seth, President and Chief Executive Officer, International AIDS Vaccine Initiative (IAVI), U.S.A.
- **Makani**, Julie, Clinical Research Fellow and Group Head, Nuffield Department of Clinical Medicine, University of Oxford; Senior Lecturer, Muhimbili University of Health and Allied Sciences, TANZANIA
- **Montagnier**, Luc, President & Co-founder, World Foundation for AIDS Research & Prevention; Nobel Laureate in Physiology and Medicine, 2008, FRANCE
- **Noyori**, Ryoji, President, RIKEN; Nobel Laureate in Chemistry, 2001, JAPAN
- **Watters**, Jack, Vice President, External Medical Affairs, Pfizer Inc, U.S.A.
- **West**, Steve, President, MDS Nordion, CANADA
- **Yamanaka**, Shinya, Director and Professor, Institute for Integrated Cell-Material Sciences (iCeMS), Kyoto University, JAPAN
- **Zerhouni**, Elias, Senior Fellow, Bill & Melinda Gates Foundation; former Director, U.S. National Institutes of Health (NIH), U.S.A.

William Castell noted that many Americans do not have health insurance although the U.S. spends 16.8% of its GDP on health care. Japan spends 9% its GDP but because of the longevity of its population, costs are expected to spiral upward. Everyday, 30,000 children in the world die of curable diseases, and someone dies of AIDS every 10 seconds. Global warming is causing the spread of tropical diseases such as malaria and dengue fever into developed urban areas. In addition, counterfeit medicine is a bigger industry than patented drugs, but the amount of funds put into the fight against counterfeiting is far inferior. Hard work is needed to promote innovation and efficiency to bring safe, affordable health care to all. This is not something that countries can achieve individually. Health agendas must be reshaped under the banner of one world, one medicine, one health.

Elias Zerhouni said that progress in medical research has been made in the last 10 years through increased awareness, public support, science and technology and the efforts of a growing number of private foundations supporting global health. However, these efforts are insufficient. Disparities resulting from population growth are on the rise. For example, in the next 15 to 20 years, the number of unemployed males aged 15 to 30 will rise to over 1 billion globally; this will cause instability in many nations. Furthermore, although the amount and availability of scientific knowledge has increased rapidly, the amount of knowledge per capita may have decreased. The application of science and technology is necessary to achieve the Millennium Development Goals. The global shortage in the health workforce must be addressed by reinforcing education and training. Scaling up intervention, sharing common knowledge and encouraging research and

partnerships are important steps toward better health care and social change.

Ryoji Noyori explained that the propagation of science has had a huge impact on society. In the developed world, life expectancy has risen from 45 to 80 years. This has been brought about by many scientific and technological developments, including in drug design. However, diseases such as flu, cancer and AIDS remain incurable, so the battle continues. Expectations are high for genome-based drug design, and people need to come together from many different areas of scientific research with knowledge from fields such as chemistry, mathematics and computer science to provide personalized medicine. In order to further these developments, new education systems are necessary to train people in multidisciplinary research for drug design.

Shinya Yamanaka warned against growing global health challenges, specifically those stemming from population ageing in Japan. Great achievements in modern medicine are expected to lead to a significant increase in the number of seniors in Japan. As a result, age-related problems such as cancer, diabetes, and cardiac disease will cause a rise in health care costs.
New technologies, such as those involving induced pluripotent stem cells (iPS), can be used to produce cells and tissue for patients and it is now possible to predict the side effects of medications. Both basic and applied sciences such as those involving iPS must be funded to promote advances in the medical sciences.

Luc Montagnier focused on the potential solutions to the immediate health problems affecting the world. More work needs to be done on active disease prevention, instead of focusing simply on the cures. Two steps will make this possible. First is innovative technology, such as nanotechnology, which could allow the events that precede disease to be investigated, along with changes in DNA that cause cancers. Second is behavior change among the general public as well as doctors and policy makers. Doctors need to work with patients before they are sick, providing advice and mild preventative treatment, instead of intervening only when an acute problem occurs. Politicians need to provide funding for research and enact legislation that rewards those who provide preventative treatment, as well as educational initiatives that promote preventative treatment as a priority and provoke a change in the mindset of the public. With new technology and changes in attitude, we can combat global disease.

Jack Watters said the aspiration is to provide good health care around world using all resources and disciplines. One of the first lines of defense against disease is education. This is particularly true in the areas of the world with significant gender disparity, which leads to health disparity. This must be addressed. In the pharmaceutical industry, there are significant gaps in R & D. The introduction of innovative evaluation tools to assess the safety and efficacy of new drugs could eliminate the need for costly clinical trials. This would mean faster production and a reduction in the R & D bottleneck. “A healthy world is a prosperous one and prosperity leads to stability,” he concluded.

Steve West expressed concern about the disparity in care standards in different regions and countries of the world. Many governments are not meeting expectations or fulfilling basic health care rights. Some 80% of innovation in medical research occurs in either academia or clinical settings and governments must actively support it. Governments worldwide must also devise public policies and provide effective reimbursement and investment. They must also back and provide incentives for the commercialization of medicines. Public-private partnerships for joint research and development should be devised to attract government funding and commercial partners.

Julie Makani discussed ways in which cures for genetic illnesses such as sickle cell disease, could be found. The burden of inherited illnesses is huge, with 275,000 children born every year with sickle cell disease. Estimates suggest that it costs 25% of an African government’s health care budget to provide the life-long care necessary for sickle cell suffers. Through research into the human genome, cures can be found. She proposed three ways in which this research can progress. First is an increase in research funding. Second is addressing the issue of inequities and sharing the benefits of research. Third is the establishment of centers of excellence. This progression would make it possible to “train, retain and attract brains back to Africa.” If pharmaceutical companies could recognize the benefits of sickle cell research, through which new tools in the battle against malaria and HIV may be found, more investment might follow.

Seth Berkley stressed the importance of global partnerships for accelerating the growth of critical knowledge and the production of tools to combat poverty-related diseases. Focused research and investment have resulted in more drugs to fight AIDS than those for all other viruses combined. Better prevention tools are needed to mitigate the effects of AIDS. Current AIDS remedies only reach 30% of affected populations. If an AIDS vaccine were produced and widely distributed, this would allow a diversion of resources towards combating other diseases. Public-private partnerships in product development have also dramatically increased the number of drugs for neglected tropical diseases. Large pharmaceutical companies are also contributing with their own not-for-profit neglected disease units. Science and technology are necessary for solving some of mankind’s greatest problems and novel types of partnerships and financing are necessary for creating a world without AIDS.

10:20-12:20 SECOND SERIES OF CONCURRENT SESSIONS

201-A2: “Alternative Energy for Transportation”

Chair:
King, Julia, Vice-Chancellor, Aston University, U.K.

Speakers:
- **Nandy**, Marc-Oliver, Director and Vice President, Service & Parts Division, Mercedes-Benz Japan Co., Ltd., GERMANY
- **Okamoto**, Kazuo, Vice Chairman and Representative Director, Toyota Motor Corporation, JAPAN

- **Oliva**, Patrick, Corporate Vice President, Michelin Group, FRANCE
- **Püttgen**, Hans Björn, Director and Energy Systems Management Chair, Energy Center, Swiss Federal Institute of Technology Lausanne (EPFL), SWITZERLAND
- **Riisgaard**, Steen, President and Chief Executive Officer, Novozymes A/S; Chairman, EuropaBio, DENMARK
- **Tak**, John, President and Chief Executive Officer, Canadian Hydrogen and Fuel Cell Association (CHFCA), CANADA

Science and technology must solve the problems that have surfaced as the result of developments in the field of transportation in the last century. At the same time, viable region-specific options must be provided for a new and growing generation of global consumers. One-fourth of the oil consumed since its discovery has been used up in the past 10 years. Solutions to steep increases in energy demand must be explored and progress must be made to produce viable, clean energy alternatives that can come on stream fast.

Due to the relatively short life-span of cars, the auto industry can serve as a model of quick and clean energy implementation and evolution. The number of cars on the road is expected to double to approximately 2 billion by 2030, yet a 50-80% reduction in emissions will be necessary. The current options of battery electric, hybrid, hydrogen fuel cells and bio fuels all require investment, and they are not without problems. The urgency of the current situation requires efforts to move forward with global initiatives in Copenhagen and intervention by all governments to influence prices of the new generation of clean cars and boost demand.

Energy consumption must be reduced from current levels and at the same time, governments must consider the needs of their regions and weigh up the relative merits of different sources of alternative energy. The current electric vehicle energy consumption of 60-70 kilowatt hours (kwh) per 100 km must drop to below 25 kwh per 100km. Countries such as China aim to produce 50-70 million light weight, short mileage vehicles by 2020. The usefulness of alternative fuels, new power trains and new engines such as flex fuel engines must be assessed and developed to meet individual regional demands.

Decarbonizing electricity generation using renewable and nuclear energy sources instead of coal is key and each nation must consider appropriate energy alternatives to reduce their carbon footprint. All-electric energy solutions are good for countries such as Switzerland, because nations such a these have many renewable sources of electricity generation. Poland and Italy rely more on coal for their electricity and need diversified alternative energy technologies.

Alternative energy technologies, such as hydrogen fuel, have already been adapted to a range of industrial applications. In the case of hydrogen, 3 million tons are currently produced every year and proper codes and standards have been established. It is up to automakers to embrace these technologies. Japan is already embracing solar, wind, hydrogen and fuel cell technologies to meet its evolving energy demands and China has shown strong interest in these technologies.

Second generation biofuels, which are produced from cellulosic material and agricultural waste, will be a key source of energy that will overcome the controversy surrounding first generation fuels created from crops such as sugar, corn, etc. These fuels can be made available by 2015, as they have been tested with current systems in combustion engines which burn gasoline blends. Modifications to these engines can lower CO_2 emissions by 80 to 100%.

A dominant alternative energy source will not emerge soon. Various technologies such as electric and hybrid vehicles and hydrogen fuel cell, synthetic fuel and biofuel will be available to help reduce CO_2 emissions and meet energy demands.

Companies and nations are working hard to meet current technological demands. Strong partnerships such as those that have led to the development of 1,000 hydrogen stations built across Europe are an example of the kind of infrastructure that will be needed for creating zero-emission systems. Reasonable pricing, partnership with energy producers, government support and international cooperation will lead to both a paradigm shift in how we move around and the reinvention of the automobile.

201-B2: "New Development in the Genome Era – Applications in Personalized Medicine"

Chair:
Fineberg, Harvey, President, Institute of Medicine of The National Academies, U.S.A.

Speakers:
- **Hayashizaki**, Yoshihide, Director, Omics Sciences Center, RIKEN, JAPAN
- **Herrling**, Paul, Head of Corporate Research, Novartis International AG, SWITZERLAND
- **Lindpaintner**, Klaus, Head of Roche Genetics and Director of Molecular Medicine Laboratories, F. Hoffmann-La Roche Ltd., AUSTRIA
- **Mehta**, Viren, Managing Member, Mehta Partners LLC, U.S.A.
- **Winter**, Alan, President and Chief Executive Officer, Genome British Columbia, CANADA
- **Yamazaki**, Tatsumi, Executive Vice President, Member of the Board, Chugai Pharmaceutical Co., Ltd., JAPAN
- **Yang**, Huanming, Director, Beijing Genomics Institute, Beijing/Shenzhen, CHINA

Personalized medicine is not a new field and should not be intimidating, as doctors have always endeavored to create the best treatment programs for individual patients. Now, however, with genomics, they have more tools to focus their care "in a more targeted way."

Genomics may be an answer to the question raised by one speaker: "How do we extend useful life that is worth living?" Since the word "genomics" was coined in 1986, the cost and efficiency of genetic sequencing has fallen precipitously. Widely different numbers were quoted for the current price of sequencing a human genome, but it was generally agreed that a reasonable short-term cost goal would be US $1,000. One speaker mentioned a US-based Chinese scientist who, using

new equipment, claimed that he could achieve sequencing at a cost of as little as US $100.

It is possible to obtain information from a genetic sequence and make it useful to medicine, but we are in the process of finding out how. Preventative medicine, cancer diagnosis and infectious diseases were mentioned as the three fields in which genomics could be most applicable.

Traditionally, the prevailing concept of genomics has been to sequence the genome of a patient and used it as a basis to prescribe treatment. Recently, efforts at sequencing pathogens and diseases have become more prominent and offer a different approach to prevention and treatment. Among promising projects which could contribute invaluable information are: sequencing the genomes of type II diabetics along with a control group; sequencing the genomes of mosquito-borne dengue fever patients; and using genomics to track the progression, transmission and mutation of H1N1 influenza during the upcoming winter Olympics.

Ethical concerns were also debated. Technology and science have "galloped ahead" of the concept of responsible use. It was pointed out that even if a person were to explicitly agree to make their own genetic code public, doing so would also expose much of the genetic code of their immediate family. Improving the quality of life and preventing disease are noble goals, but the question was raised as to whether they could be taken too far, perhaps offering unfair enhancements to memory or physical ability. Also, since we have historically discriminated against one another on the basis of race, gender or religion, one speaker wondered whether a genetic sequence might not become another factor for intolerance. "No topic has a more intimate sense of personhood," he said.

Avoiding these pitfalls will require open discussion and smart regulation. Regulation must be thought out "with respect to what we're trying to accomplish by regulating," in order to avoid irresponsible legislation. We must invite health authorities to be part of the decision-making process, but at the same time, they must be educated into developing criteria for the successful integration of personalized medicine.

There was a consensus on the urgency of education: if the public does not understand what genomics can offer, it cannot benefit from the innovations in personalized medicine. The public outcry against genetically modified organisms in the food industry was mentioned as a failure of public education. In order to make sure genomics escape the same fate, the science must be shown to be safe, useful and effective.

With such a young and rapidly evolving field, we can only speculate about what the future will bring to the "language to talk with life." Ideas on how to remedy to allergies using genomics were brought up. One speaker suggested that in the near future, genomics could have more impact on the quality of life than IT, and suggested that it could allow the application of Moore's Law to health. By 2020, there may be genomics wards in hospitals where patients get their genome sequence scanned before diagnosis with the goal of "matching the right drug to the right patient at the right time."

For personalized medicine to live up to its potential in our lives, it will require many innovations not just in genomics, but also in carbohydrate analysis, cell-cell interaction and proteomics. One participant revealed that he had his own genome sequence scanned, and that it did not affect his life in any appreciable way. Another speaker said that genomics was being "oversold," and that "expectations are outpacing the reality."

201-C2: "Robotics and Humans"

Chair:
Kanade, Takeo, Director of Quality of Life Technology Center (QoLT), Carnegie Mellon University, JAPAN

Speakers:
- **Bajcsy**, Ruzena, Professor, University of California, Berkeley, U.S.A.
- **Hollerbach**, John, Professor, University of Utah, U.S.A.
- **Mařík**, Vladimir, Head of Department of Cybernetics, Czech Technical University in Prague (CVUT), CZECH REPUBLIC
- **Sankai**, Yoshiyuki, Professor, University of Tsukuba, JAPAN
- **Terwiesch**, Peter, CTO, ABB Group, GERMANY

This session was designed to discuss the ways in which robots and robotics can enrich human life and as well as exploring the boundaries necessary to control risks and maintain human dignity. Early robots were developed around 50 years ago and were first introduced in the automobile industry. By the end of 2008, there was a total of 6.8 million robots in use. Robotics have now reached the point where they are about to become extremely influential in everyday life, similar to developments in IT some 30 years ago. This raises many questions for the future: what are the opportunities for robotics to enhance the quality of life? What are the risks of robotics and how can robot-robot and robot-human interaction be improved?

Many different ideas were suggested on how these inventions can improve the quality of life. In the medical field, numerous different applications are already in use. Robots are being used to give physicians greater accuracy and precision in what they do. Through the use of telesurgery, a specialist surgeon is able to perform surgery on a patient in one part of the world while he or she is in another location. Systems are being developed to aid with rehabilitation. For example, the muscles of patients with spinal injuries can be stimulated using computer chips, allowing more effective therapy.

Population ageing is an issue in many countries and robots could play an important role in the care of the elderly. In an effort to combat loneliness, robots could provide an interactive presence that can be asked questions and respond. At the other end of the spectrum, children who are left at home being babysat by the television could have a robot nanny that could provide active education. But this kind of robot-human interaction can also have negative implications. It may not be psychologically healthy for someone to have a robot that looked like a dead relative, one participant suggested. Worse will be the potential, and unfortunately inevitable, use of humanoid robots in the pornographic industry. Whatever

the intention, great care is needed to make sure that people from all backgrounds are involved as robotics become part of everyday life.

Regarding risks, the first is physical safety. Traditionally, risk prevention has involved the construction of barriers and shutting down machines at the first sign of trouble, but now there is a need for more dynamic, close contact interaction. Robots are being programmed to be aware of their surroundings so that they can slow down and maintain production and safety simultaneously.

Other issues are emerging. Advanced robots can access the Internet and communicate with others without human intervention and can therefore gather a substantial amount of data about an individual. This raises privacy issues: we might not know how much robots really know about us. These are questions that will require continuous attention to ensure that effective solutions are developed.

New software means there are increasing opportunities for robot-robot and robot-human interaction. In some cases, the contact distance between humans and robots is being reduced to zero, as in robotic limbs. We need to think about how much ability we have to override the robot, and in reverse, how much control over us we should give it. These boundaries are important to define, because if a pedestrian is killed by a robot-controlled car, who is to blame? Robots also need to be put in a position where they can interact and share information to work together. In industry there are teams of robots work together, which is something that could be integrated into society.

Developments in robotics may mean we need to define what is a human and what is a cyborg. The Olympics, for example, may have to clarify its rules. A robotic exoskeleton may allow a paraplegic to walk… In anticipation of what is a promising field, there is a need to train a new generation of robot engineers who are sensitive to our future requirements. What ever happens, the field of robotics has an enormously exciting future.

201-D2: "Brain Drain, Brain Gain and Brain Circulation"

Chair:
Wiesel, Torsten, President Emeritus, The Rockefeller University; Nobel Laureate in Physics, 1981, U.S.A.

Speakers:
- **Anzai**, Yuichiro, Professor, School of Open and Environmental Systems, Keio University, JAPAN
- **Benmokhtar Benabdellah**, Rachid, Executive Vice President, Fondation MAScIR (Moroccan Association of Science, Innovation and Research), MOROCCO
- **Dzinotyiweyi**, Heneri, Minister of Science and Technology, ZIMBABWE
- **Eichler**, Ralph, President, Swiss Federal Institute of Technology (ETH) Zurich, SWITZERLAND
- **Lam**, Khin Yong, Associate Provost, Graduate Education & Special Projects, Nanyang Technological University (NTU), SINGAPORE
- **Ramamurthy**, V.S., Chairman, Indian Institute of Technology, Delhi (IITD), INDIA
- **Zich,** Otto, Chairman of the University Council, University of Salzburg, AUSTRIA

In this session panelists discussed their varied opinions on the global issues of "brain drain", "brain gain" and "brain circulation." One of the overarching conclusions of the debate was that in today's world, brain drain and brain gain are just two sides of the same brain circulation coin. In our increasingly technologically interconnected and internationally mobile world, the movement of educated talent must not be viewed in the short term. The reality is that when scientists or engineers see opportunity in other country or in other sectors they are quick to seize them and move.

Rather than governments attempting to prevent emigration and brain drain, the debate focused on ways to encourage international cross-pollination and work to develop attractive educational and business opportunities. Economic development and innovation are driven by a globally minded, mobile workforce that is a direct product of international migration.

The debate then explored to how policies must be enacted to take advantage of the benefits of migration. Governments should develop policies in order to nurture the "push and pull" effect by which students are pushed to work and study abroad and are later presented with opportunities in their home country which pull them to come back home. In this regard, visa and immigration restrictions are an area in which governments must be flexible.

In the private sector, industry partnerships with international research institutions are vital in promoting brain circulation. Policies need to be developed so that local employment agencies can help job seekers identify opportunities at home that are suitable for nationals who have studied or worked abroad. Entrepreneurship must be encouraged and salaries in developing countries must be attractive in order to entice talent back. In addition, flexible appointments can help attract talent to return, if only in the short term. International consulting companies should endeavor to identify and hire local talent that has had the benefit of experience abroad.

Universities and schools must develop programs that encourage students to study abroad in cultures different from their own. By collaborating to develop academic affiliations with both local and international institutions, universities can provide opportunities to students early in their careers so they can make informed decisions. If a country is suffering from brain drain, in the short term, it would be beneficial to spend money on developing faculty and creating faculty fellowships and grants. The Humbolt Research Fellow is an example of a grant that encourages brain circulation and creates a global network with lifelong mentoring and engagement.

In conclusion, brain circulation and international mobility are here to stay and must be encouraged and managed effectively with the involvement of government, academic and private sectors. Policies must approach global migration strategically with an eye on the long term in order to develop their own push and pull forces. Observing the strategies used

by developed countries that attract talent can serve as a guide for developing countries hoping to participate fully in global brain circulation into the future.

201-E2: "Science and Technology Diplomacy and International Collaboration"

Chair:
Goel, Anita, Chairman and Chief Executive Officer, Nanobiosym Diagnostics, Inc., U.S.A.

Speakers:
- **Cunningham**, Patrick, Chief Scientific Adviser to the Government of Ireland, IRELAND
- **Djelić**, Božidar, Deputy Prime Minister, Government of Serbia; Minister of Science and Technological Development, SERBIA
- **Fedoroff**, Nina, Science and Technology Adviser to the Secretary of State, U.S. Department of State, U.S.A.
- **Hara**, George, Group Chairman and Chief Executive Officer, DEFTA Partners; IIMSAM Ambassador, UN ECOSOC, JAPAN
- **Katori**, Yoshinori, Ambassador for Science and Technology Cooperation, Ministry of Foreign Affairs (MOFA), JAPAN
- **Kharrazi**, Kamal, Head of the Founding Committee and President of the Board of Trustees, Institute for Cognitive Science Studies, IRAN
- **Rothschild**, Henri, President and Chief Executive Officer, International Science and Technology Partnerships Canada Inc. (ISTPCanada), CANADA
- **Schütte**, Georg, Secretary General, Alexander von Humboldt Foundation, GERMANY
- **Swati**, Muhammad, Minister of Science and Technology, PAKISTAN

There is a growing respect in the world for scientists today. Whereas the historical role of scientists was to pave the way for diplomatic activity, now countries actively look to build partnerships using science and technology as a tool to structure those relationships. Science can serve as an effective channel to build bridges between people, governments, countries -- and of course, scientists themselves.

How and why to build these bridges were the main topics of discussion in this session. Naturally, there can be collaborative agreements among countries, but unless scientists and funding are made available for them, efforts will remain fruitless. One example of successful collaboration connecting people is a program in the U.S. that brings hundreds of young scientists to work in government bodies. Another is a fellowship opportunity for senior scientists.

Even with funding, collaborations fail if they do not have a common goal. The advantage of science is that it is a field in which honesty prevails. Science also strives to acheive a secure exchange of knowledge. Small countries such as Serbia, however, face basic questions such as identifying strategies of how to play with the "big guys." Furthermore, these countries need to be able to distinguish between "those who are policy takers, not makers."

While national self-interest can sometimes promote collaboration with others, there is a need to achieve a balance between competitive self-interest and funding in partnerships. Funding is crucial and is an increasing concern in these lean financial times. There are still great chunks of capital available in the world such as the Gates and Wellcome Foundations that can be tapped with the aim of generating returns and benefit society. Unfortunately, however, these are rare examples.

Establishing an international fund to create wealth was suggested in which percentage of the profits of the world could be deposited. Such a large, international fund could provide money to help address issues such as health care and climate change.

In addition, there was a consensus on a need to establish a solid international science and technology council, although it was recognized that there are cultural, political and financial obstacles to building collaborative, international partnerships.

One participant pointed out that in Japan, science and technology diplomacy contributes to the national interest with what was called "soft power," which can be used to further ties with other countries, especially in Asia.

Despite poor diplomatic relations between some countries such as Iran and the U.S., scientists must continue to work together. In this way, and thanks to the power of individuals, science and technology can progress in spite of diplomatic hurdles. It was suggested that innovative investment in science and technology education could even help to counter terrorism threats.

Finally, one participant suggested using venture capitalism and entrepreneurship to create bridges to cross boundaries. Such varied partnerships and collaborations can work to overcome obstacles as long as the players focus on a common goal. As the role of scientists continues to change, it is critical to reconsider how they work within and outside the worlds of science and technology.

201-F2: "Role of Media and Others in Communicating Science and Technology"

Chair:
Campbell, Philip, Editor-in-Chief, Nature, U.K.

Speakers:
- **De Biase**, Luca, Science/Technology Chief Editor, Il Sole 24 Ore, ITALY
- **Kuroda**, Reiko, Professor, The University of Tokyo, JAPAN
- **Lenzen**, Dieter, President, Free University of Berlin, GERMANY
- **Lim**, Chuan Poh, Chairman, Agency for Science, Technology and Research (A*STAR), SINGAPORE
- **Pontin**, Jason, Editor-in-Chief and Publisher, Technology Review, published by MIT, U.K.
- **Yaari**, Menahem, President, Israel Academy of Sciences and Humanities, ISRAEL

Participants immediately sought to get away from the mutual criticism, constructive or not, that often dominates debates about the media in scientific circles and steer the discussion toward creative and pragmatic ways to approach the question. One over-riding theme was the need to help scientists communicate better, not only to the media but the general public. Journalists are in this sense professional intermediaries, but with the boom in the use of new media, scientists need communication skills, not only to tell the world about what they are doing, but also to make themselves more accountable – to their constituencies within universities, research centres and the like, and to those paying for the research. This could be the university itself, funding agencies or the tax payer.

Another reason why it is important for scientists to communicate effectively is because science's "major output" are predictions and forecasts, and very often these a matter of immediate concern for citizens at large. No less important is the "science for policy" aspect of what scientist do, since it can have a direct impact on government policy and therefore needs to be communicated broadly. Clear communications on the part of scientists are also important in order to respect the public's right to know and to uphold transparency.

Overall it was acknowledged that communications training for scientists is crucial and that it is important to start working with young scientists early so that they become effective communicators. One institution has launched a multidisciplinary course in science interpretation which aims to foster communication skills in parallel with a deep understanding of science. Scientists often labor under an "ethos of modesty," are not trained as writers or speakers and few have media strategies. In certain countries, however, funding agencies are now demanding communications plans as an integral part of a research funding package. This is likely to become increasingly prevalent as funding agencies and governments need to be able to explain why they are spending so much on money research.

With or without training, many scientists are using new media and there is a real boom in scientific blogs. While some are seen as successful in their outreach, new media as a whole suffers from a lack of accountability. Learning was described as a "fuzzy" process and overall, the Internet and blogs were seen as positive forces that can draw attention to scientific work. However academic and peer assessment remains crucial and in that sense scientific academies cannot be replaced when it comes to giving credibility to new ideas.

In that respect, traditional media still has a role to play and scientific journals remain key vehicles for communicating the activities of the scientific community. However, the relationship between scientists and journalists is often "ambiguous" with a degree of fear on both sides: the scientist is worried that the journalist will not understand and therefore misrepresent what he or she is doing, and the journalist will be uncomfortable with any uncertainty surrounding the work. Journalists can play a useful role in questioning why and how large sums of money are being spent, and they can also "legitimize" the work by ensuring that it is better understood by the general public.

In conclusion, there was consensus around the idea that universities should train scientists in how to communicate directly and encourage them, for example, to hold regular briefings with members of the media. While accepting that uncontrolled blogs, websites and social networking channels carry risks, direct communication through new media by scientists, including online conferences, needs to be encouraged.

In the end, and in particular on sensitive subjects such as stem cells or health issues, a hybrid model is perhaps the best solution, blending new media with the old way of doing things such as going out to meet the public and stakeholders. In all cases, scientists should remember who the target audience is and tailor the message accordingly.

201-G2: "Issues and Opportunities in Space Science and Technology"

Chair:
Dordain, Jean-Jacques, Director General, European Space Agency (ESA), FRANCE

Speakers:
- **Kendall**, David, Director General, Space Science, Canadian Space Agency (CSA), CANADA
- **Malo**, Joseph Otieno, President, Kenya National Academy of Sciences (KNAS), KENYA
- **Sackett**, Penny, Chief Scientist for Australia, AUSTRALIA
- **Sweeting**, Martin, Director, Surrey Space Centre, University of Surrey, U.K.
- **Tachikawa**, Keiji, President, Japan Aerospace Exploration Agency (JAXA), JAPAN

Participants from five continents took part in this forum to debate the issues and promises of space science and technology. All agreed that space activity is a high-risk and expensive endeavor that nevertheless should be supported as it brings great benefits to humanity.

Space exploration is vital to fuel scientific and technological innovation. Earth mapping and GPS devices help us find our way. Satellites contribute to the understanding of weather and the environment and help us manage resources such as water, fisheries and agriculture, among many other benefits.

In addition, the space industry provides career opportunities for the younger generation and prevents a brain drain of a nation's scientific talent. Exploration also holds the hope of finding life outside the Earth. Such a discovery may not be far off, and we should prepare for it.

"Space tells us that we live under the same sky, and that we live on the same fragile earth," said one participant. "We are living in interesting times in space activities," remarked another. Space science can also show people that the Earth has a future.

This year marks the 40th anniversary of the moon landing. It was a historical moment and was one nation's technological triumph. But today, international cooperation and a pooling of resources is critical in order to share the cost and risks

of space science. Over 50 governments now support space science, with more coming on board. A solution to the high price tag is for countries to develop and build smaller satellites that fit within their budget limitations.

Participants agreed that restrictions on space science data imposed by some countries must be lifted. It is essential that all nations deposit data into a global pooling center in order to promote the free flow of information.

Human space flight is hazardous. The environment is dangerous and the distances are great. Governments and society have a low risk tolerance when it comes to people in space. One participant said the answer is the involvement of the private sector in the commercial development of space exploration.

The premise behind the X Prize is an example of how to "escape the box we are in," one participant pointed out. The Ansari X PRIZE was a space competition in which a $10,000,000 prize was offered for the first non-government organization to launch a reusable manned spacecraft into space twice within two weeks. Today's financial climate and political decisions limit us to low earth orbit, and it will take the involvement of private business to send humans to the moon and beyond.

Several participants argued there is too much emphasis on human space flight. Instead, we must focus on Earth-observation satellites as this unites countries in common research. They recommended that nations rearrange their space budgets and put more money into Earth satellites. Participants concluded that Earth observation, private investment and open access to data are the keys to space science development.

12:30-14:00 WORKING LUNCH

202: "Science and Technology for the Environment"

Chair:
Goldin, Daniel, Chairman and Chief Executive Officer, The Intellisis Corporation; former NASA Administrator, U.S.A.

Speakers:
- **Batterham**, Robin, President, Australian Academy of Technological Sciences and Engineering; Group Chief Scientist, Rio Tinto Ltd., AUSTRALIA
- **Brudermüller**, Martin, Member of the Board of Executive Directors, BASF SE, GERMANY
- **Chidambaram**, Rajagopala, Principal Scientific Adviser to the Government of India, INDIA
- **Rowland**, F. Sherwood, Donald Bren Research Professor of Chemistry and Earth System Science, UCI; Nobel Laureate in Chemistry, 1995, U.S.A.
- **Sakakibara**, Sadayuki, President, CEO and COO, Toray Industries, Inc.; Vice Chairman, Japan Business Federation (Nippon Keidanren), JAPAN

Daniel Goldin spoke of the position of planet Earth in the universe noting the rare and optimal conditions it offers to sustain life. It is relatively free from radiation from supernova explosions and safe from black holes. The distance from the sun is such that temperatures are manageable, and the magnetic field around our planet shields us from solar radiation and space debris. He deplored the fact that so little was being done to protect it, adding that carbon and greenhouse gases have built up to devastating levels. Natural disasters are more frequent and violent than before. "A wake up call for humanity," is needed, he said. Some problems can be offset with the advent of new technologies and new forms of energy but in many cases, political considerations stand in the way. The complexity of the problems facing the earth does not mean they are impossible to solve, however.

Robin Batterham made three main points, the first being that globally, we already know what direction we must move in to support innovation in climate science. The environment is not a perfect laboratory: it is complex, chaotic and constantly changing. Time must not be wasted in arguing about global or regional models. Definitive action is required at local level. The second point was that we must speed up research to reach significant breakthroughs. Technology does not evolve in a Darwinian fashion in which only one successful design survives. Rapid change can occur when technologies are joined together across disciplines. Finally, trans-national and trans-disciplinary collaboration is essential for progress. Dramatic innovation does not come as the product of an individual mind but from the ability to harness the prowess of numerous individuals.

Martin Brudermüller described his worldview as a chemist, seeing it as he does at molecular level. But the mega-trends affecting population, urbanization, energy and mobility also shape our future, he added. Chemistry works to find solutions to these challenges. For example, in order to meet the world population's demand for food, a yearly 2.8% increase in production is needed, but we have averaged only 1%. Loss of arable land, soil and water challenge our ability to produce food, but new technologies could provide some answers. Genetically modified plants allow us to grow more crops on the same land or in dryer climates. His research in Berlin involves millions of plant metabolic profiles and observing their reactions to genetic modifications or stresses. Genetic modification has already enhanced the viability of many important crops: corn, soy, cotton, canola… But genetically modified organisms are not always readily accepted. For example, it took 13 years to obtain E.U. approval for the Amflora potato, which contains only potato genes. He called for more effort to resolve what he described as the "errors in translation" between reality and public understanding. Researchers must also develop strong partnerships with companies to overcome some of the hurdles inherent in biotechnology, such as long development periods.

Rajagopala Chidambaram explained that the problems affecting the environment such as deforestation, global warming and climate change are complex and numerous and must be integrated with economic strategies. Mitigation technologies can help developing countries raise their quality of life index and help increase the use of indigenous renewable energy sources. More efficient technologies such as nuclear energy production can also help. Altruistic collaboration in research and innovation can support technological and

scientific developments and help address issues related to global health and climate change.

Rowland Sherwood spoke of the need to build awareness among the general public of the problems of greenhouse gases and global warming. He used a recent U.S. Supreme Court decision defining CO_2 as a pollutant, to illustrate convincing arguments: a rise in CO_2 from 315 ppm in 1958 to 390 ppm in 2009 has been accompanied by a rise in global temperatures. Scientists believe that the two phenomena are related. This connection can be used to demonstrate to non-scientists that global warming is real and dangerous. In answer to a question on how we might utilize available models and databases for environmental predictions, he expressed faith in our current models. However, the way we define regions still needs refining and consequently, it is not yet possible to accurately predict how climate change will affect small areas.

Sadayuki Sakakibara said we need to make environmentally efficient products and assess their overall impact on the environment taking into account their entire lifecycle. By quantifying the amount of CO_2 a product releases into the environment throughout its lifetime, it is possible to determine clear benchmarks in order to drive innovation in this field. Toray Industries is currently developing two environment-friendly technologies: carbon fiber, a construction material used to make lightweight airplanes, automobiles and large-scale windmills and a membrane used to purify drinking water. Both are part of Toray's strategy to develop sustainable products and services.

14:20-16:20 THIRD SERIES OF CONCURRENT SESSIONS

203-A3: "The Nuclear Energy Alternative"

Chair:
Moniz, Ernest, Cecil & Ida Green Distinguished Professor of Physics and Engineering Systems, Massachusetts Institute of Technology (MIT), U.S.A.

Speakers:
- **Arima**, Akito, Chairman, Japan Science Foundation, JAPAN
- **Bamberger**, Yves, Director, Research and Development, Electricité de France (EDF), FRANCE
- **Bouchard**, Jacques, Special Adviser to the Chairman, French Atomic Energy Commission (CEA), FRANCE
- **Castro Diaz-Balart**, Fidel, Scientific Advisor to the State Council of Cuba, CUBA
- **Kondo**, Shunsuke, Chairman, Japan Atomic Energy Commission, JAPAN
- **Shu**, Frank, Distinguished Professor, University of California, San Diego (UCSD), U.S.A.
- **Velikhov**, Evgeny, President, Russian Research Center, Kurchatov Institute, RUSSIA

Rising global energy demand will require a significant increase in power generation this century and nuclear energy will become a necessity to meet this demand. It is estimated that nuclear power generation will have to increase three-fold in the long term. However, there are obstacles in the way.

Technological and scientific progress should lead to safer and more efficient nuclear power. New non-linear and microscopic schematic models can be used to extend the lifespan of new and existing plants to 60 years or more. A five-point hexagonal structure encompassing safety authorities, utilities, vendors, national and local politicians and citizens could help in the decision making process. This includes the conception, funding and construction of nuclear power plants.

In this respect, international information-sharing will become increasingly important. For example, the governments of Japan, France, the U.S. and Germany would benefit, as well as other nations, from sharing information. To this end, it is important to consider establishing international bodies to address the various aspects of nuclear energy.

Nuclear power will play a central role in the debate and efforts to combat climate change, but safety assurances will be necessary before the technology can become more widespread. Japan has declared its intention to cut emissions by 25% in 10 years. Discussion on the nuclear option must begin at Copenhagen. Overall, the question needs to be actively addressed by the members of the G20 and discussions should involve the IAEA in order to identify and verify the peaceful use of nuclear technology around the world. Other important issues for debate include: creating adequate waste disposal and management systems and ensuring safeguards against the dangers of natural disasters such as earthquakes. The optimization of existing technologies and safeguarding the fundamental principles of non-proliferation will be key issues in discussions on the options aimed at tackling climate change.

Current renewable energy sources are unlikely to be sufficient to replace fossil fuels in the immediate owing to high costs and problems of adequate production levels. The gap between energy supply and demand is expected to widen as early as next year with a possible 30% gap by mid-century. While the high cost of nuclear energy is still a consideration, new nuclear resources could reduce the strain on current energy technologies. Meanwhile, developing new nuclear technologies such as molten salt reactors, reprocessing and breeding uranium-238 and converting thorium are crucial avenues that should be investigated and developed for the generation of safe, abundant and clean sources of energy.

Practical solutions are critical to provide nuclear energy for developed and emerging nations. Fast reactors could lead to a reduction in nuclear waste. Improvements in the nuclear fuel cycle, and specifically waste management, are essential. The issues of recycling and disposal must be further explored in order to manage the spent plutonium that will accumulate over the next few decades.

Finally, nations that are willing to safely implement nuclear technologies should not be denied access to nuclear power. All nations, especially emerging countries, will depend on secure and stable energy sources for economic development. Cuba, for example, has developed power infrastructures, rehabilitated inefficient power distribution grids and implemented wind and solar energy strategies to cope with energy shortages. In short, all emerging nations will need unrestricted access to energy alternatives, including nuclear power.

203-B3: "GMOs and Innovation for Food, Fiber and Fuel"

Chair:
Campbell, Donald, Senior Strategy Advisor, Davis LLP, CANADA

Speakers:
- **Bhumiratana**, Sakarindr, President, National Science and Technology Development Agency (NSTDA), THAILAND
- **Buchanan**, Gale, Dean and Director Emeritus, College of Agricultural and Environmental Sciences, University of Georgia (UGA), U.S.A.
- **DiNicola**, Natalie, Director, International Development Partnership, Monsanto Company, U.S.A.
- **Lewanika**, Mwananyanda, President, Zambia Academy of Sciences, ZAMBIA
- **Riba**, Guy, Deputy Director General in Charge of Scientific Programs, Resources and Assessment, INRA, FRANCE
- **Wildeman**, Alan, President and Vice-Chancellor, University of Windsor, CANADA
- **Winnacker**, Ernst-Ludwig, Secretary-General, HFSP (Human Frontier Science Program), GERMANY

This session explored trends related to the present and future of genetically modified organisms (GMOs). The world's population currently stands at 6.8 billion, but is set to climb to 9 billion by 2050. Climate change will have profound effects on food and water supplies. Cultivation for biofuels and other non-food crops is likely to increase competition for arable land. GMOs were described as the most appropriate method of providing food for the growing population while conserving valuable natural resources.

Although the majority of the scientific community has embraced the idea of GMOs, public opinion is not as accepting. Resistance remains an issue and it often affects policy. Several examples were cited of countries banning or refusing GMOs. The public remains troubled by fears about the health, economic and environmental effects of new technology.

One speaker pointed out that this is a normal reaction. GMOs and biotechnology are controversial, but so were cast-iron and steel ploughs, the motorized tractor, and the hybrid seed. But agricultural innovations such as these have provided us with the means to sustain society. Without a comprehensive education system accompanying new technology, we may see more negative reactions to GMOs like the recent ban on Monsanto's MON810 maize in Germany. One participant pointed out, however, that the European Food Safety Authority had stated that this decision to ban was "not scientifically justified."

Although several issues affect public opinion of GMOs, there was strong sentiment that the situation could be eased by improving the performance of the GMOs themselves. One speaker told the story of the "immediate benefit" of another technology that was eagerly adopted – cellular phones in remote villages – simply because its usefulness was instantly clear, unlike planting genetically modified crops. Another speaker agreed that as soon as the advantages of GMOs become clear, they will be more readily accepted throughout Europe. On the other hand, a more proactive approach which would include assessing the ecological and social impacts of GMOs and keeping citizens and legislators informed could help counter current antipathy.

Participants heard that there could be dramatic economic repercussions if GMOs are not accepted. Europe's agricultural market could fall behind. Without the advantages of these new crops, European food production could be overtaken by other regions that allow GMOs.

Furthermore, GMOs have been wholeheartedly embraced in other sectors, even in regions that shun genetically modified crops. For example, insulin produced by recombinant DNA technology has been in use around the world for years, allowing some people to suggest that here may be a double-standard for GMOs when it comes to food and medicine.

GMOs can offer new varieties of plants resistant to insects and adverse growing conditions. For example, drought-resistant crops require less water to thrive. Other developments in GMOs, like golden rice, provide enhanced nutritional profiles for staple foods. One panellist spoke of on-going research into converting non-legumes into nitrogen-producing plants, which could eventually provide a stable and bountiful source of protein.

Another important issue was market dominance in the field of GMOs. Currently, a few large firms control almost the entire market. One speaker described this as "not a problem," providing market dominance does not become a market-controlling monopoly. Some GMO-producing firms use their strength to seek public acceptance of GMOs. One firm was mentioned as running a massive charity project under the slogan "producing more, conserving more, and improving farmers' lives."

Several participants expressed concern that the ongoing debate regarding the legislation of GMOs would remain divided into the pro and con camps only. There was a general consensus that regardless of whether GMOs become as pervasive as some believe, they still have much to offer science and the world. One speaker warned that we must "not let the argument become 'GMO, yes or no.'"

203-C3: "ICT, Privacy and Security"

Chair:
Sahin, Kenan, President, TIAX LLC, U.S.A.

Speakers:
- **Adly**, Noha, Director, Information and Communication Technology (ICT) Department and the International School of Information Science (ISIS), Library of Alexandria, EGYPT
- **Asthana**, Atul, Vice President Global Standards, Research in Motion Limited, CANADA
- **Hamada**, Junichi, President, The University of Tokyo, JAPAN
- **Higashi**, Tetsuro, Chairman and Chief Executive Officer, Tokyo Electron Limited, JAPAN

- **Saito**, William, Professor, National Graduate Institute for Policy Studies, JAPAN
- **Seshadri**, Premkumar, Senior Corporate Officer and President, Corporate Sponsor - Asia Pacific, HCL Technologies Limited, INDIA

The science fiction world portrayed in George Orwell's "1984," in which Big Brother is always watching, has now become reality. We live in a world in which video cameras follow our every move, our e-mails are scanned to provide targeted advertising, and search engines remember every website we visited. What is more, there is a general feeling that this will only increase in the future. This session looked at ways to protect privacy and increase security in a world where the invasion of both is automated in networks themselves.

Privacy is a particularly sensitive issue for many people who fear their personal information will leak into the public domain. Since the 1970's, privacy has been thought of as the right to control information about yourself. Companies hold a huge volume of information about us. As the internet expands, so does the amount of information companies can learn about us. And so privacy shrinks.

Privacy has been identified as a human right by the United Nations, but people need to play a more active role in how they protect it. A solution may lie in making clear decision on what data it is acceptable to release. Furthermore, people must be made more aware of their rights. In the context of acceptable norms, it is up to the individual to decide what level of privacy here or she requires.

It was suggested that the younger generation have very few cares about their privacy. Many write blogs and upload photos on the internet. Some way this attitude will change in the future when the information that they have released on the internet is accessed by people making decisions about their future, for example hiring for a job. It was recognized that there are still boundaries that this generation does not want to cross. It will be interesting to see how this attitude develops with time, and if there will be a point when the younger generations no longer think about privacy at all.

The subject of security revolves around two ideas: key management and authentication. Regarding authentication, passwords have been used for a long time, but methods have become much more complex as this was found to be limiting. Now with the use of biometrics, people can be identified with great accuracy, but the information taken for these authorization purposes leads to new issues of privacy. Another example is in business collaboration. People need to be able to trust the security of the flow of their information so that they are able to effectively work in partnership. Leaks can be disastrous and destroy a company's competitive edge. Collaboration between businesses would be impossible without secure information transfer. The volumes of information being transferred and stored are so large that we need to think about who stores and controls the flow, and how long the lifecycles need to be so it remains protected.

Hacking and fraud mean that ideas designed to help society can end up being used for crime. For example, a system that is designed to look after elderly people by following their movements inside the home and alerting someone if they fall could be used by criminals to rob them.

Singapore is implementing a system enabling hospitals to share medical records, allowing more effective patient care. However, this system brings up many privacy and security issues. Often it is a case of "today's solution is tomorrow's issue." Finding the optimal balance between benefit and risk is the key.

The science fiction fantasies of the past have become science fact, bringing topics like privacy and security into sharp focus. This area is so complex, that simple guidelines cannot help in such a fast-evolving world. A case by case approach in a local but also global setting is probably most effective. Equally, personal responsibility is a crucial factor, but it needs to be supported by national and international laws as well as technical solutions.

203-D3: "Role of Universities"

Chair:
Schiesser, Fritz, President, ETH Board - Swiss Federal Institute of Technology (ETH) Zurich, SWITZERLAND

Speakers:
- **Alghatam**, Mohammed J. K., Chairman, Bahrain Centre for Studies and Research (BCSR), BAHRAIN
- **Gudmundson**, Peter, President, Royal Institute of Technology (KTH), SWEDEN
- **Hepburn**, John, Vice President Research, University of British Columbia (UBC), CANADA
- **Huber**, Bernd, President, Ludwig-Maximilians-University (LMU) of Munich; Chairman, League of European Research Universities (LERU), GERMANY
- **Koke**, Tatjana, Minister of Education and Science, LATVIA
- **Osterwalder**, Konrad, Rector, United Nations University, SWITZERLAND
- **Shirai**, Katsuhiko, President, Waseda University, JAPAN
- **Ushioda**, Sukekatsu, President, National Institute for Materials Science (NIMS), JAPAN

Universities in our modern world must be flexible and collaborative in order to educate students to become global citizens as well as encourage research across disciplines in both fundamental and applicable sciences. The panelists identified three major trends that characterize the changing state of the modern university. Firstly the boundaries between disciplines are becoming increasingly blurred as learning and research become more and more collaborative. Secondly, technology has changed the educational landscape as modeling and computer simulations permeate into all areas of research. Finally, internationalization is the way forward as universities become increasingly culturally diverse and globally connected.

It was noted that along with the boundaries between culture and disciplines, the local identity and "brand" of traditional institutions is also becoming blurry. Universities must strive to maintain a distinct brand and character while integrating globally. This is particularly true of public universities which

are expected to have a national identity and cater to national needs.

Additionally, modern universities must take the lead in upholding the triangle of education, research and innovation. The reality is that many universities are still quite conservative in this respect. It is well known that the capacity to carry out curiosity and passion-driven research is the driving force of discovery. Universities require autonomy and freedom to conduct research in the fields where student and faculty interests lie, but at the same time do so with an understanding of the practical needs of society. Research agendas must be defined in close interaction with non-academic parties in business, industry, government and society at large. Full benefit can only be achieved when universities and society are closely linked, communication pathways are open and mutual trust exists.

Sustainability was another key topic in the discussion. Universities must strive to play a leadership role in sustainable development and energy conservation. By pursuing environmentally friendly initiatives, universities are able to save money and reduce operating costs. Involving students in the innovation process means universities are able to tap into a reservoir of creativity and give students the opportunity to grapple with real world applications. Involving students in creating a sustainable institution is likely to produce graduates who can drive similar transformations in society.

On a fundamental level, a university must be able to organize a complex body of knowledge into channels of education and research. It should be an organization that combines student education in a research environment while being firmly grounded in the needs of society, government and business. Autonomy is important for nurturing creativity but a competitive environment and horizontal hierarchy are also essential for fostering excellence.

In short, universities must be competitive yet autonomous, transnational, multi-disciplinary, innovative, sustainable and coordinate research effectively with business, industry and society. In order to confront the global problems of the 21st century, universities must take the initiative to drive change and put forward proposals on how to address issues such as global health, climate change and sustainable development.

203-E3: "The Ocean Frontier"

Chair:
Kennel, Charles, Distinguished Professor Emeritus, Scripps Institution of Oceanography, University of California, San Diego (UCSD), U.S.A.

Speakers:
- **Delaney**, John, Professor of Oceanography and Jerome M. Paros Endowed Chair in Sensor Networks, University of Washington, U.S.A.
- **Knowlton**, Nancy, Sant Chair for Marine Science, The Smithsonian Institution, U.S.A.
- **Nepstad**, Tore, Managing Director, Institute of Marine Research (IMR), NORWAY
- **O'Dor**, Ronald, Professor, Dalhousie University, CANADA
- **Suyehiro**, Kiyoshi, President and Chief Executive Officer, IODP Management International, Inc. (IODP-MI), JAPAN
- **Taylor**, Martin, President and Chief Executive Officer, Ocean Networks Canada (ONC), CANADA

Seventy-one percent of the planet is covered by oceans. However, since few people aside from oceanographers witness the changes happening in the sea, most of us are unaware of the problems. Oceans absorb half of the CO_2 in the atmosphere and this is now causing the acidification of sea water. As a result of changes in the sea, a huge proportion of ocean life has died or is under immediate threat of extinction. It is also understood that there is a direct correlation between the health of the oceans and the growth of vegetation on land, meaning that the rhythms of the ocean are linked to the production of food.

With the rapid loss of ocean species, the reality is that a massive extinction may be imminent. The question we face is how to manage these changes. In addition, unknown factors must be considered, such as the possible effects of new species entering the ecosystem.

Participants discussed the need to create gene banks and a DNA database as soon as possible. Freezing organisms would permit the storage of some genes for the potential reconstruct of these organisms in the future. Norway, for example, has already started a gene bank.

Until now, we have only been able to explore the top 10% of the ocean. Here, the big fish have disappeared, the water is becoming more acidic and surface water temperatures are rising. One challenge is to consider ways to restore the balance. Another challenge is the deep ocean, 75% of which has yet to be chartered. Predictions indicate that oceans will undergo decreases in oxygen and changing current patterns. These phenomena as well as sea creatures – from bacteria to whales – need to be better understood.

A transformative phase has been reached in the ability to study the ocean floor. Whereas previously nothing was known about the sea floor, the "invisible has been made visible" through fiber-optic cables. Robots continuously monitor, measure, image and test, and we can now map the sea floor.

Two important projects were highlighted in this session. The first is a program established by the Canadian government who invested CAD 120M to develop observatories for the ocean floor. This was possible with additional international collaboration. France installed the basic fiber optic cable nodes, Germany helped identify sites, while Japan and the U.S. supported the technology.

Another innovative project tracks sea life via satellite. Twenty-three different species and 3,000 animals have been tagged so far. Tagging provides information about marine physics and how animals use the ocean. The tags last up to 20 years so animals can be observed over an extended period.

With a greater understanding of the oceans, better management of food sources will be possible, along with monitoring fish catches and refining fishing techniques. Furthermore, the U.N. has called for an intergovernmental panel to regularly address such key issues.

How will we expand our knowledge in the future? In much the same way that seismologists predict earthquakes: by monitoring fault zones under oceans over the long term and tracking fish behavior as short term indicators.

In the meantime, social scientists must help raise awareness so the public can begin to realize the importance of the crises facing our oceans. Scientists must work to deepen their understanding of ocean ecosystems to fully gauge the problems. It has been said that "We are destroying species we don't even know about" on earth, and we are only beginning to understand what happens under the sea. But even if we know what is happening, can we do anything about it?

203-F3: "Proposals from Young Scientists"

With the support of the Japan Society for the Promotion of Science (JSPS) and in collaboration with the New York Academy of Sciences (NYAS).

Chair:
Kurokawa, Kiyoshi, Professor, National Graduate Institute for Policy Studies; Chairman, Health Policy Institute, Japan, JAPAN

Speakers:
8 STS *forum* 2009 Future Leaders

Under the leadership of eight outstanding international young scientists and in the presence of two Nobel laureates, this session worked in groups that sought to address four key issues facing young scientists today: empowering young scientists to succeed; establishing improved networks for young scientists; envisioning the next frontiers in science and technology and engaging the social responsibilities of science and technology.

Several suggestions on the question of how to empower young scientists were put forward. Good mentors were seen as crucial, and not only from the academic field. Industry could also provide valuable mentors but either way, the important thing is that they should be passionate about the work of the young scientist as well as flexible, since he or she would need to make calls on their time. Funding was the second important issue which affects many aspects of the life of a young scientist, and it came up repeatedly. These days, many grants are awarded on a competitive basis and young scientists are up against older, more experienced and better known figures. Special funds targeted specifically at young scientists should be set up.

By way of introduction, the first group also raised the issue of mobility of young scientists and the dilemma they face in terms of contributing to "brain drain" or "brain gain." In some countries, funding for study abroad is tied to an obligation to return home after. This was not seen as a good idea and participants felt young scientists should be allowed to study what they want where they want. Without being coercive, some countries have taken initiative to attract their young scientists back home by providing the equipment and facilities they need to continue their work. A related issue that could deter young scientists from the developing countries from returning to their home country is access to cutting-edge technology. Here too, nations need to provide high tech-facilities, and that includes access to the Internet which is still very expensive in some places.

Networking and how this can benefit young scientists was the focus of another group's work, although this too was an over-arching concern. It is particularly important and valuable in multi-disciplinary fields. Young scientists need to be able to network, communicate and exchange with scientists who from different countries, languages and generations on a worldwide scale. What is needed is funding. Japan, the U.S. and the E.U. provide some support, but on the other hand, it means scientists come under greater pressure to publish more. Young scientists, who often have other jobs, need more time and cannot necessarily step up their output. Young scientists would benefit from special budgets to allow them to engage in networking independently. Start-up funds, however, are very difficult to come by, in particular to built the infrastructure they need for their networks.

In terms of moving towards the new frontiers in science and technology, the most important challenge is how to make inter-disciplinary science work. The same problem comes up in other environments, such as industry, and often it simply boils down to the people involved. It cannot be solved from a top-down approach. The key is to set a common target around which people can coalesce. Another question was what kind of science and scientific workforce are needed in the developing world, and how can these be sustained? One of the answers was to relocate knowledge, not people.

On the subject of engaging the social responsibilities of science and technology, the role of scientists is clear in terms of their work as educators in universities or research institutions. Helping the new generation learn is a "pillar" of social responsibility. Intrinsically, scientists are also role models in that they uphold ethics and integrity. Another role for young scientists is in helping policy makers come to decisions. A suggestion was that young scientists could create a network or association in order to come together, join forces and develop a "manifesto" or global priority list on, for example, the efficient use of resources.

The STS *forum* was seen as an excellent umbrella under which such a "club" could be created. The forum is also an exceptional opportunity for young scientists to inter-act with their seniors. The young participants in this session felt it was an invaluable opportunity to gather energy, inspiration and homework to take back with them. In conclusion, this session wished to see a two or three-fold increase in the number of young scientists at the forum. The creation of an association or academy of their own should be encouraged so they can speak with a common voice. "It will be heard," concluded a senior participant.

203-G3: "Sustainable Water Supply"

Chair:
Zehnder, Alexander, Scientific Director, Alberta Water Research Institute; former President of the ETH Board, Swiss Federal Institute of Technology (ETH), SWITZERLAND

Speakers:

- **Chitradon**, Royol, Director, Hydro and Agro Informatics Institute, Ministry of Science and Technology (MOST), THAILAND
- **Eggen**, Rik, Deputy Director, Swiss Federal Institute of Aquatic Science and Technology (Eawag), SWITZERLAND
- **Faruqui**, Naser, Director, International Development Research Centre (IDRC), CANADA
- **Young**, Mike, Executive Director, Environment Institute, The University of Adelaide, AUSTRALIA

The management of water resources is a multi-faceted concern facing the planet. This session debated the issues of provision of potable water for a growing population, pollution mitigation as well as flood and drought risk management.

As population numbers rise, so too does the demand for water. How is the world going to provide this vital commodity to billions more people? There is a risk that water scarcity could trigger conflicts. It is estimated that some 2.5 billion people are without clean water. India, for example, is now forced to "mine" for ground water with deep drilling to meet the needs of its people.

A participant suggested that a "blue revolution" is needed in water infrastructure investment to boost supply and quality. We "need cash flow to make the water flow," another added. One problem is that water is free in many countries, which means there is little incentive to invest in its management. Countries must put a price on it to spur private business to put money into developing water systems. Installing water meters, for example, is an efficient method to start charging users.

Pollutants such as arsenic, fluorides, pesticides as well as water-born diseases, pose a threat to supplies. Governments must establish barriers between sewage systems and municipal reservoirs. The chemical industry must switch to making bio-degradable compounds in order to prevent water contamination.

People can do a lot to protect the water supply if they are aware of the problems. Public education is key. For example, citizens need to be made aware that if they use pesticides in their gardens, the chemicals will contaminate the water system.

It was pointed out that nanotechnology can be a useful tool in the desalinization and purification of water. Other ideas to improve water conservation include increasing the number of drought-resistant crops and installing drip irrigation to limit waste. One promising trend in several developing countries is the recycling of household water for crop irrigation in rural communities.

More than 350 floods and droughts occur every year. Regions with weak governance are at greater risk, and it has become evident that governments must make plans to prepare for and mitigate such disasters.

Many participants agreed that politics and water don't mix. Scientists need to find ways to talk to and convince policymakers about the importance of their water science in order persuade them to make the correct decisions and avert crises.

In summary, participants said solutions to water management include a "massive need for education," charging for water, transparency in water management, and finding the political will to look for solutions and follow through with concrete action.

16:50-18:00 PLENARY SESSIONS IN PARALLEL

204A: "ICT for Future Society"

Chair:
Smarr, Larry, Founding Director, California Institute for Telecommunications and Information Technology (Calit2), U.S.A.

Speakers:

- **Declerck**, Gilbert, Executive Officer, IMEC, BELGIUM
- **Gopalakrishnan**, S. Kris, Chief Executive Officer and Managing Director, Infosys Technologies, Ltd., INDIA
- **Jenkins**, Tom, Executive Chairman & Chief Strategy Officer, Open Text Corporation, CANADA
- **Jung**, Edward, President, CTO and Founder, Intellectual Ventures, U.S.A.
- **Kosonen**, Mikko, President, Finnish Innovation Fund (SITRA), FINLAND
- **Meyer-Krahmer**, Frieder, Permanent State Secretary, Federal Ministry of Education and Research, GERMANY
- **Sasaki**, Hajime, Executive Advisor, NEC Corporation, JAPAN

Larry Smarr opened the session with a brief overview of the state of Information and Communication Technology (ICT) and its role in climate change. The manufacture, power usage and disposal of ICT products creates emissions that are projected to triple by 2020. But on the other hand, ICT can become a "low-hanging fruit that can help us" in areas such as improving energy efficiency.

Gilbert Declerck said microelectronics and nano-electronics are the building blocks of tomorrow's high-tech society. The energy sector has seen the development of ultra-low power electronics and of energy harvesters leading to so-called wireless autonomous transducer systems. Improvements in photovoltaic technology will lead to more cost-effective and more efficient silicon-based solar cells. Very powerful semiconductor and nano-electronics technology, which was developed and is still being developed for microprocessors and memories, will be used in a broad range of sensors, transducers and actuators. This will lead to a number of new solutions and applications in the fields of health care, mobility and green energy.

Kris Gopalakrishnan discussed how we can manage and control IT systems as computing power grows and networks become increasingly complex. Today more than 2 billion people are connected through the Internet, and it is estimated that by 2020, up to 100 billion devices will be linked. This will create a need for new software applications. System

complexity, the volume of software and the application of information technology in products and services will increase exponentially.

Tom Jenkins discussed the impact of ICT on society. He pointed to the widening generation gap between young and old concerning Internet use. Older people tend to rely on newspapers and the telephone to communicate while the younger generation uses social-networking sites to keep informed. In response, Canada recently held a nationwide forum including the worlds of business, government and academia to discuss this trend and its impact on a country's culture. It was found that only 5% of information in libraries is available in digital form, which means many children cannot access it. He said it is imperative that governments build capacity and hire young people to help close the Internet generational gap.

Edward Jung said ICT's contribution to society is in bringing about innovation. He discussed the founding of his company, Intellectual Ventures, and its focus on helping inventors bring their ideas to market. The company has established a network to manage inventors in universities and companies and boasts more than 27,000 inventions under management in such areas as medical devices as well as in energy and consumer electronics. Great inventions are only half the solution, he said. Convincing others that an invention is worth pursuing is the other half of the battle.

Mikko Kosonen discussed Finland's past as a forerunner in IT innovation, but he said that its lead had declined due to the country's lack of a shared commitment and vision to the modernization of society. A closed ICT world makes the development of new products and services nearly impossible. Addressing this requires strong political leadership and cooperation with the private sector. The problem is not technology but leadership and the implementation of solutions. Finland relies on a top-down hierarchy, but the solution is to put citizens at the center and develop new services for them based on an open way of addressing issues.

Frieder Meyer-Krahmer dicussed ICT's role in society and the areas in which it can solve problems, such as in energy supply. He said public research policy takes a supply-side approach, but neglects the demand side. Simplistic answers do not help, he said. He recommended a far more holistic approach that brings together research, science and ideas with lifestyle and infrastructure.

Hajime Sasaki talked about how ICT contributes to economic development. ICT applications promote the accumulation of human capital through training, education and access to information that together boost economic growth. He also mentioned the global ranking of ICT infrastructure, applications and security. Japan is number one in terms of infrastructure, Singapore is tops in applications and Denmark is best in security. The world is now recovering from an economic downturn. Our mission is to improve the productive use of technology in order to accelerate growth.

204B: "Challenges of Funding Science and Technology" - *Viewpoints of Funding Agencies / Universities / Research Institutes / Industries*

Chair:
Rietschel, Ernst, President, Leibniz Association (WGL), GERMANY

Speakers:
- **Bement, Jr.**, Arden, Director, National Science Foundation (NSF), U.S.A.
- **Fortier**, Suzanne, President, Natural Science and Engineering Research Council of Canada (NSERC), CANADA
- **Kleiner**, Matthias, President, German Research Foundation (DFG), GERMANY
- **Makarow**, Marja, Chief Executive, European Science Foundation (ESF), FINLAND
- **Morales Carazo**, Jaime, Chairman, National Research Council of Science and Technology (CONICYT); Vice President, Government of Nicaragua, NICARAGUA
- **Nomakuchi**, Tamotsu, President, National Institute of Advanced Industrial Science and Technology (AIST), JAPAN
- **Phillipson**, Eliot, President and Chief Executive Officer, Canada Foundation for Innovation (CFI), CANADA

Ernst Rietschel said that the greatest weakness in the science sector is that it does not produce its own funding. Instead, it must turn to government, society, and industry. He defined the two basic approaches to be examined in this session: bottom up, and top down. The differences and consequences of each relate to originality, quality and relevance. The challenge is to find a balance between the two approaches.

Carazo Morales spoke from the point of view of "third world" countries where economic resources are scarce. While he acknowledged that science and technology are powerful vehicles for understanding and bringing people and nations closer together, countries such as Nicaragua can barely meet the minimal, essential requirements for economic survival. As a result, there is a serious lack of resources for science and technology. Whereas the U.S. devotes US $ 1,000 per capita to science and technology, for example, Nicaragua spends just US $ 0.05. There are no other resources devoted to the development and promotion of science and technology.

Tamotsu Nomakuchi said that the investment principles used by the National Institute of Advanced Industrial Science and Technology (AIST) are based on the bottom up model and arise from the spontaneous ideas of researchers. Research needs to be grounded in strategies, industrial technologies, and "road maps." He pointed to the importance of international standardization in areas such as biofuels and their environmental evaluation – from production to consumption. AIST continues to carry out numerous research projects in such in areas. AIST's management policy includes ensuring that the fruits of state-of-the-art research are disseminated around the world.

Eliot Phillipson, noted that today society is far more knowledgeable about the role of science and expects it to meet the challenges we are facing. Governments also understand

that in a knowledge-based economy, science is the foundation for progress. The Canada Foundation for Innovation's (CFI) objectives are to increase Canada's capacity, and to promote networks, job creation and innovation. A majority of funds are disbursed on the basis of institutional priorities. CFI has established a different approach to research funding, working with institutional applicants rather than individual researchers. CFI's evaluation of applications includes assessment but also, to a degree, consideration of the potential benefits to Canada. CFI funds only 40% of a project so the partner institution must fund the other 60%.

Suzanne Fortier, President of the Natural Science and Engineering Research Council (NSERC) of Canada said it balances the bottom up and top down approaches to research funding to mobilize science and technology to Canada's advantage with a focus on creative, talented people. It also recognizes that Canada must do more to use innovative ideas to meet global challenges. NSERC researchers must demonstrate they are creative, competitive and leaders in their field. The NSERC aims to be a magnet for talent and gives people the freedom to research while providing stable funding for cutting-edge and high risk research.

Marja Makarow felt that a major challenge today is in establishing collaborative funding for research. She stressed that public investment must bring returns to society through concrete benefits. The National Research Council of Science and Technology was created on behalf of its member organizations. She noted that international collaboration between funding organizations is increasing and added that multilateral research programs need more consideration and suggested that awards should be opened up to non-residents. Finland in the early 1990's is an example of how a country in economic recession was transformed into a nation with a knowledge-based society thanks to systematic investment in education and industry.

Arden Bement Jr. spoke on the subject of funding for universities. He explained that the National Science Foundation (NSF) uses both top down and bottom up strategies. The NSF works with both the public and private sectors as well as bodies such as the Gates Foundation. The NSF engages in 3,000 international collaborative projects and has programs that support innovative research in the developing world. Exchanges are based on a partnership in which each side pays for its share. It is a unique time for the NSF since it is receiving more support from Congress as the US attempts to stimulate the economy through scientific programs. This additional support will be used to meet research needs as well as to help support job creation. The NSF attempts to fund the best and most exciting research as seen by scientists themselves since it feels strongly that they are best judges of what good science is.

Matthius Kleiner, President of the German Research Foundation (DFG) said that both bottom up and top down strategies are needed to drive society and address challenges with great ideas. These ideas can only come as a result of academic freedom and excellence. Scientists need to have the freedom to pursue research with their own methods. There is sometimes too much pressure to produce quick returns. DFG uses a mix of bottom up and top down strategies. Science, he said, is not an instrument of policy but is a third power that comes addition to politics and economics.

Tuesday, October 6, 2009

08:30-09:25 PLENARY SESSION

300: "Key Messages from Concurrent Sessions"

Chair:
Colwell, Rita, Distinguished University Professor, University of Maryland and Johns Hopkins University, U.S.A.

Speakers:
- **[A] Yoshikawa**, Hiroyuki, Director-General, Center for Research and Development Strategy (CRDS), Japan Science and Technology Agency (JST), JAPAN
- **[B] McKinnell**, Henry, Chairman, Accordia Global Health Foundation; former Chairman and Chief Executive Officer, Pfizer Inc, U.S.A.
- **[C] Eriksson**, Per, Vice-Chancellor, Lund University, SWEDEN
- **[D] Matsumoto**, Hiroshi, President, Kyoto University, JAPAN
- **[E] Hunter**, Howard, President, Singapore Management University (SMU), U.S.A.
- **[F] Hassan**, Mohamed, Executive Director, The Academy of Sciences for the Developing World (TWAS), SUDAN
- **[G] Yeo**, Philip, Special Advisor for Economic Development, Prime Minister's Office; Chairman, SPRING Singapore, SINGAPORE

Rita Colwell stressed the importance of the STS *forum* in bringing together heads of state, scientists and industrial leaders to confer and achieve a common understanding and shared principles of action for the benefit of human kind. Complexity, not simplicity, has been an underlying thread. She quoted the famous axiom: "When we tug at anything in the universe we find it connected to everything else."

Hiroyuki Yoshikawa pointed out that while the central issue in the Kyoto Protocol was global warming, the "new Kyoto Protocol" will focus on regional disasters and their relationship to climate change. Experience since the Kyoto Protocol has shown that innovation and adaptation are necessary to deal with a changing climate. The demand for nuclear power as a clean energy sources raises safety concerns and problems of public acceptance. Now is the time for new technologies to prevail over "modern" technology. For example, while oil, gas and coal are the main sources of energy today, the near future will provide power derived from wind, biomass, and many other sources. What is needed is adaptive technology so that local people have ways to apply high technology to regional problems. Furthermore, there is a need for a new type of discipline he called "sustainability science."

Henry McKinnell started by saying that the idea of "One World" is now a reality. We continue to grapple with questions such as: "Can we feed 9 billion people by 2050?" At the same time, we have seen dramatic progress in areas such as new surveillance technology, new vaccines and screening methods in health care. McKinnell proposed some strategies of his own for dealing with the world's problems. First, we need to understand issues but not let them interfere with our progress. We should not lose sight of some successes, such as advances in AIDS relief. If people concentrate on "doing what they can with what they have," others may join in. Investment is needed in science and technology in the field of healthcare and it is important to talk about health rather than sickness. Debate, not bans, is what is needed on the subject genetically modified foods. We must talk about prevention, not treatment. Although we are at war with viruses, bacteria, and food shortages, we are not at war with each other. The future is very exciting, so let us focus on the lights, to inspire change in the shadows of science.

Per Eriksson recognized that there are difficulties in keeping up with the rapid changes in ICT. E-books, videos and the internet have all changed our behavior. We immediately turn to these communication tools for answers to questions rather than using more traditional experiential methods. More open innovations are needed such as Apple's iTunes. Privacy for young people is an issue as they want to be open and connected. A balance must be found between that and security. Advances in robotics have led to serious questions such as "What defines a human?" and "Where do we draw the line between humans and robots?" We must consider how we will deal with certain situations: if a computer-controlled car has an accident and kills someone, what do we do?

Hiroshi Matsumoto talked about the problem of too few young people studying science, technology and mathematics. If this trend continues, prosperity will suffer. How do we ensure an adequate supply of scientists and engineers? To boost enrollment in science and technology and increase their attractiveness, we must stimulate interest in science at a young age. Teaching methods that focus more on experiential learning to encourage creative thinking would spark greater interest in science and technology. Meanwhile, brain drain is a problem particularly for developing countries because of a lack of employment options and low wages in these countries. Brain drain can be combated by providing grants for people to study abroad while ensuring they have the incentive to return to opportunity and a secure work environment.

Howard Hunter talked about diplomatic barriers to international collaboration in science and technology including political and social conflicts and the division between rich and poor nations. Regarding intellectual property, he stressed that in the developed world there are pragmatic ways to deal with IP but translating these to other countries and cultures can be difficult. Copyright, trademarks and patents are important in the commercialization of IP. Regarding the "ocean frontier," the concern is how little most people know about this large area of the earth's surface. Better ways to convey information are needed, and so is public policy to protect and develop the oceans.

Mohamed Hassan stated that although it is said that scientists are not good communicators, one way to overcome this is for scientists to use the Internet to reach non-science based audiences. Universities should take a greater role in training scientists in how to publish their findings and develop a strong public voice. Communications courses should be an essential part of education in science and technology. A wider focus is needed to help young scientists so they can have a forum of their own at national, regional and international levels. A funding scheme should be designed and young scientists should be encouraged to participate in forums such as this.

Philip Yeo spoke of urban development, saying that as towns grow into mega-cities they raise issues of sustainability, energy demand, effective transportation and public safety. City governments can move faster than national governments on these issues as they have better knowledge of local and regional needs. Space science has provided us with useful technologies such as GPS earth mapping and satellites to help manage water. The problem with space research is its high cost, so international cooperation is necessary. Water is another global problem. In order to maintain a sustainable water supply, purification technologies are needed, as is research into ways of incorporating these technologies. But what is needed most to avert a water crisis is political will.

10:45-11:45 PLENARY SESSION

302: "Science and Technology for a Sustainable Future"

Chair:
Clark, Megan, Chief Executive, Commonwealth Scientific and Industrial Research Organisation (CSIRO), AUSTRALIA

Speakers:
- **Aoki**, Satoshi, Chairman and Representative Director, Honda Motor Co., Ltd., JAPAN
- **Bednorz**, J. Georg, IBM Fellow Emeritus, IBM Zurich Research Laboratory; Nobel Laureate in Physics, 1987, GERMANY
- **Khlunov**, Alexander, Deputy Minister of Education and Science, RUSSIA
- **Kobayashi**, Makoto, Professor Emeritus, High Energy Accelerator Research Organization (KEK); Nobel Laureate in Physics, 2008, JAPAN
- **Russell**, Alan, Director, McGowan Institute for Regenerative Medicine, University of Pittsburgh, U.K.

Megan Clark opened the session by introducing some of the issues which industries, nations and individuals face in our increasingly interconnected world. Sustainability and food security are key examples. In order to keep up with population growth, over the next 50 years, we will need to produce as much food as we have ever produced in history. Unlike in the past, the landscape has changed and we must face this challenge while we struggle with soil and water quality, climate change, urbanized populations and highly limited resources. Scientific and technological innovation will be crucial in reaching some of the breakthroughs we will need to confront some of these issues.

Satoshi Aoki stated that when he joined Honda in 1969, some of the company's engineers were reading reports about the impact of pollution on children. Ever since, Honda engineers have been striving to create cleaner technology. In line with these objectives, the Honda Civic was the first car to satisfy the U.S. Clean Air Act on engine performance alone. Currently Honda is working on comprehensive, clean technology for the whole lifecycle of the car. This includes work on the development of bio-fuel, hybrid, and fuel cell technology. Currently, Honda has a very competitive hybrid car, and more models will be released next year. Research is on-going into producing bio-fuels from the inedible parts of plants, in order to avoid pressure on food sources. In addition, there is work on new fuel cells that can be powered by solar energy. Honda's research is not limited to the development of cars. The company has produced robots that are able to help those with weak leg muscles to walk. It has also developed machines that can be controlled only with the mind. He ended by saying that Honda still has the same objectives as when he joined in 1969: "To leave blue skies for our children."

Georg J. Bednorz explained how science and technology have radically changed the lives of people living in developed countries. Access to cheap energy and the misconception that our resources are unlimited has given rise to a dangerous illusion. In order to create a sustainable society and stable social systems, diverse trans-disciplinary collaboration, a well-educated society and multilateral communication are imperative. The IBM Zurich Research Laboratory is hosting 300 researchers from over 38 different countries who are collaborating with leaders from the developing world and are researching crucial sustainability topics based on the needs in their countries. Once common goals have been identified, interdisciplinary research can be focused in order to form an international community creative enough to solve many of the large sustainability problems we face.

Alexander Khlunov believes that in the 21 century, we will no longer be thinking about energy conflicts between countries, but rather conflicts between us and our children. They may look weak now, but our children are the people who will defeat cancer and develop thermo-nuclear energy. Through its so-called Foresight project, Russia is looking into how its neighbors will have a sustainable energy supply in the future. He believes that the best way forward is with thermo-nuclear energy. In Russia, new innovative technology is being developed as part of a combined research project to build a thermo-nuclear reactor. Such reactors will be possible by the year 2050, but for this project to continue, it is important to ensure that science research is integrated into the education system, so that the next generation of scientists will be able to continue this work. The main task is to formulate national and international policies for science to create the smoothest possible path for scientific evolution.

Makoto Kobayashi emphasized the importance of basic research from a generic and fundamental standpoint. His organization, the Japan Society for the Promotion of Science (JSPS) works to provide grants to support scientific research in social, technical and human science. Industry is strongly motivated to support application-driven science to solve global issues such as climate change, resource shortages and epidemics. However, more resources must be used to fund curiosity-driven research in basic science in order to drive innovation forward in unexpected ways. Science and technology research must be viewed over the long term - a period of at least 100 years in order to create a sustainable future.

Alan Russell discussed the dangers that we currently face from biological weapons of mass destruction. He emphasized that these weapons have been tested and can be deployed covertly in such a fashion that their origin remains unknown. In addition, they are much easier to produce, smuggle and deploy than nuclear weapons. Mutual destruction - the

deterrent inherent in nuclear weapons - does not apply to biological weapons. If an anthrax vaccine were required for the whole of the U.S., at current rates, it would take 160 years to complete production. We need to create a bio-defense network. A global network that could allow scientists to work effectively together would make it possible to produce a global vaccine in only a few months after the first detection of a disease. This is currently politically difficult. But if centers of cooperation were established, it would become possible protect the world against biological weapons. It would also become easier to help those without adequate medical care.

11:45-12:30 CLOSING PLENARY SESSION

303: "What Should We Do Now?"

Chair:
Friedman, Jerome, Institute Professor and Professor of Physics Emeritus, MIT; Nobel Laureate in Physics, 1990, U.S.A.

Speakers:
- **Lu**, Yongxiang, President, Chinese Academy of Sciences (CAS), CHINA
- **Mimura**, Akio, Representative Director and Chairman, Nippon Steel Corporation, JAPAN
- **Omi**, Koji, Founder and Chairman, Science and Technology in Society (STS) *forum*, JAPAN
- **Palis**, Jacob, President, Brazilian Academy of Sciences; President, The Academy of Sciences for the Developing World (TWAS), BRAZIL

Jerome Friedman introduced the session's theme, asking: "What shall we do now?" This is a crucial question because the threats our world faces require urgent action. We are exceeding our resources and damaging the ecosystems on which we depend. We need to address these problems that threaten to cause havoc. Tropical forests are being cut down, with many species of flora and fauna permanently lost as a result. Maritime fisheries are collapsing, and "the list goes on," he said. These are symptoms of a serious crisis. The answer is greater investment in research to counter these threats. Progress has been limited because of fear of damage to economic growth. An international agreement is needed, and there is a chance it will be reached at the Copenhagen Climate Conference. Opponents should be aware that everyone will suffer from a collapsing environment. Political leaders must have a sense of urgency to act and counter global warming to avert a catastrophe. "We must find a path to establish harmony with nature," he concluded.

Yongxiang Lu began by outlining several common challenges of our modern world, including the financial crisis, economic shrinkage, and pollution of our air, soil and water. With the world's population set to reach 9 billion by the middle of the century, we can expect that these challenges will only grow, and none can be solved by any one country alone. Globalization has built links between us, so that solutions must be global. Alleviating energy shortages and pollution will require advances in conservation and efficiency, accelerating the search for renewable energies and advancing nuclear technology. To prevent disease and improve health for people across the world, especially in developing countries, we must continue to advance in science. Cooperating to live up to our global responsibilities will involve fighting against protectionism. We will need to work together to build a global capacity to combat epidemics, predict and warn about natural disasters, prevent terrorism and the proliferation of nuclear weapons. New technologies should be shared. We must use our sense of ethics and morality to narrow the education between gap between developed and developing countries, as well as between rich and poor. Developed nations should take responsibility and share their knowledge with developing countries.

Akio Mimura stated that only science and technology can save the world. The Kyoto Protocol has been effective in raising awareness on the issue of global warming, but CO_2 emissions continue to rise. The agreement contained several problems: there were no suggested cuts in CO_2 emissions, the targets were political, and it failed to provide incentives for breakthrough technological developments to cut CO_2. The next protocol must include provisions to ensure all nations act in a responsible manner. Developed nations should be required to make cuts. We must improve energy efficiency and switch to energy sources that emit less CO_2. Technology and long-term commitment are necessary to make this happen. The Japanese steel industry has sent energy efficiency teams to steel mills in India and China to help. But breakthrough technology in the industry is still vital and it takes time and money to develop innovative technology.

Jacob Palis suggested that we cannot wait a minute longer to become greener in all sectors of human activity. Science and technology are pivotal in overcoming threats to our survival. Brazil has developed a plan for the Amazon region, to preserve the environment while developing a sustainable economy for the local population. But even despite some major advances, much more needs to be done, including more research. The good news is that the devastation to the Amazon rainforests is decreasing. But no destruction at all is the goal, and we are far from it.

Koji Omi began by expressing his deep appreciation for participants' contributions to making the *forum* successful, and for their opinions and insights on the future of humankind. He summarized Statement of Sixth Meeting of the STS *forum*, stressing the need for a new post-Kyoto Protocol framework, in which all countries will participate. Investment in science and technology must be maintained as a remedy for the financial crisis. Clean energy is essential, and advances in nuclear technology, under anti-proliferation safeguards, will be necessary. Japan and other countries have begun to engage in science and technology diplomacy. Fair, and if necessary, protected reporting is needed on "lights and shadows" of science and technology. We must change our economic behavior and our daily lives to reflect the fact that our world is finite. Science and technology are so advanced that some people believe we can control nature. However, we must not forget that we are all part of nature and must live in harmony with it. It is to that end the STS *forum* was created, not just for scientists and engineers, but also for journalists and policymakers - as a human network.

The Science and Technology in Society (STS) *forum*, inaugurated in November 2004, holds an annual meeting starting on the first Sunday of October every year, in Kyoto, Japan. The meeting is aimed at creating a global human network based on trust and providing a framework for open discussions regarding the further progress of science and technology for the benefit of humankind, while controlling ethical, safety and environmental issues resulting from their application: “The Lights and Shadows of Science and Technology.” In seeking to ensure further progress in science and technology throughout the 21st century, it is necessary to keep possible risks under proper control based on shared values, and to establish a common base for promoting science and technology.

Because international efforts as well as concerted efforts between different areas to address these problems are essential, the forum gathers top leaders from different constituencies: policymakers, business executives, scientists and researchers, media - from all over the world.

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