



Science and Technology in Society (STS) forum

Non-Profit Organization



SUMMARY OF PROCEEDINGS Seventh Annual Meeting October 3-5, 2010 Kyoto, Japan

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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:

- **Kaieda, Banri**, Minister of State for Science and Technology Policy, Economic and Fiscal Policy and Space Policy, Government of Japan, JAPAN
- **Nishida, Atsutoshi**, Chairman of the Board of Directors, Toshiba Corporation; Vice Chairman, Nippon Keidanren (Japan Business Federation), JAPAN
- **Chavan, Prithviraj**, Minister of Science, Technology and Earth Sciences, INDIA
- **Holliday, Jr., Charles O.**, Chairman of the Board, Bank of America Corporation; former Chairman and CEO, DuPont (E.I. du Pont de Nemours and Company), USA
- **Friedman, Jerome Isaac**, Institute Professor and Professor of Physics Emeritus, Massachusetts Institute of Technology (MIT); Nobel Laureate in Physics 1990, USA

Koji Omi welcomed participants to the 7th Annual Meeting of the Science and Technology in Society (STS) *forum* held under the theme of “Lights and Shadows of Technology.” He pointed out that since 2004, the number of participants has grown to 1,000, and attendees now hail from 104 countries, regions and international organizations. He said that technology has brought problems such as climate change and nuclear proliferation. These issues cannot be solved by one country alone and international cooperation is essential to tackling the problems facing humankind. Conferences such as the STS *forum* provide a platform for dialogue and discussion that will benefit the future. He stressed that during the 20th century, everyone assumed the earth’s resources were infinite, but it is now evident that they are in fact finite. Omi emphasized that the STS *forum* will focus on what happens post-Kyoto Protocol and on nuclear energy initiatives. Innovation, he said, is the key to solving the problems facing the world and harmony with nature is vital for our well being.

Banri Kaieda said that science and technology have improved our lives, but at the same time progress has negatively impacted humankind. These are the so-called “Lights and Shadows” of science and technology. The Japanese government has placed a high priority on the promotion of science and technology. The Kan administration has developed a “New Growth Strategy” to revitalize Japan and tackle problems head on. The strategy will target “green innovation” in the environment and energy sectors, “life innovation” in the health care sector. He pointed out that Japan is facing an ageing population and a declining birth rate, issues that the rest of humankind will experience in the near future. It is vital to promote the positive aspects of science and technology whilst using human wisdom to control the negative aspects such as global warming, bioethical problems and nuclear proliferation.

Nishida Atsutoshi voiced optimism that the global economy is recovering from the economic crisis and that the recession bottomed out in the first quarter of 2009. But despite this, the world economy lacks the resilience that would ensure sustainable growth. He said the 20th century was driven by a linear vision of development. 21st century growth has come up against the limitations of natural resources and environmental degradation has become a pressing issue. He cited three priority areas: economic growth, the environment and securing resources. Nishida emphasized the need for a clear vision of science and technology and urged the use of basic science to solve problems. He pointed out that it is vital to inspire the younger generations to take an interest in science so that they can aspire to a brighter future. Governments must use their power to create curricula that attract children to science. Toshiba is doing its part by sponsoring the ExploraVision, a science competition that encourages students to create and explore a vision of future technology.

Jerome I. Friedman stressed that the quality of our future will depend on how strongly we support science and technology and how wisely they are used. Populations are growing rapidly and industrialization is spreading as developing nations endeavor to improve their standard of living. But these developments have created enormous challenges for human society. More than 1 billion people are severely malnourished and lack access to clean water. These problems must be overcome and at the same time, food and water must be provided for the world’s fast-growing population, which is expected to reach 9 billion by 2050. The spread of diseases is another issue. The energy needs of industrialized and developing nations must be met, but within the constraints of green house gas emission limitations. There is no single technological “magic bullet” that will solve all our problems, so significant investment must be made in a broad range of science and technology research programs.

Charles Holliday said that it is important for the financial sector to play a role in the commercialization of technology. Bank of America will loan \$20 billion in energy and environmental sustainability technology. Twelve months ago the American Energy Innovation Council was established in the U.S. The council met with U.S. President Barack Obama in June to discuss its energy goals. The council is calling for consistency in government energy policy and an increase in funding from \$11 billion to \$16 billion. It recommended investing \$1 billion in clean technology clusters, another \$1 billion to help entrepreneurs develop energy ideas and \$2 billion to support prototype production and take good ideas past the so-called “Valley of Death.” He expressed confidence that ways to produce clean, cheap energy will be found.

Prithviraj Chavan said that mankind must change course to aim for a better future. The deep “economic divide” has resulted in starvation and migration, both factors that lead to terrorism as well as producing a negative impact on the environment. Jobs and standards of living are important but a broader, holistic approach is needed to cut across national boundaries. Easy access to technology for all must be promoted. Affordable cures for neglected diseases in developing countries and lifestyle diseases in developed countries are needed to counter global pandemics. The Indian government is promoting the documentation and

cataloguing of traditional and herbal remedies via a traditional knowledge digital library (TKDL). This has been translated into 5 languages to prevent the patenting of the knowledge and to promote drug development for all. India has called for open source drug development as a new paradigm. For example, India's Council of Scientific and Industrial Research (CSIR) aims to cure tuberculosis with the cooperation of young researchers. The future of humankind depends on finding universal solutions and increasing access to technology.

11:00-12:00 PLENARY SESSION

101: Innovation as a Driver for Economic Growth

Chair:

- **McKinnell, Henry**, Chairman, Accordia Global Health Foundation, former Chairman and CEO, Pfizer Inc, USA

Speakers:

- **Surapranata, Suharna**, Minister of Research and Technology (RISTEK), INDONESIA
- **Lombard, Didier**, Chairman, France Telecom, FRANCE
- **Ponomarev, Alexey**, Deputy Minister, Ministry of Education and Science, RUSSIA
- **Furukawa, Kazuo**, Senior Corporate Adviser, Hitachi, Ltd., JAPAN
- **Blanco, Herminio**, Founder and CEO, Soluciones Estratégicas; former Secretary of Trade and Industry, MEXICO

Henry McKinnell opened the plenary session by posing a two-part question. The speakers responded from personal experience and sought to provide advice for governments and the private sector on how to encourage innovation. They also suggested ways in which to translate that innovation into products and services that drive growth as well as benefitting humankind.

Suharna Surapranata explained that strategic investment in education has been key in establishing a framework to foster innovative practices in Indonesia. As a result of this government strategy, Indonesia has seen consistent improvements in terms of its global competitiveness over the past few years. This leap has mainly come thanks to a healthier macroeconomic environment and improved education standards. A recent constitutional amendment allocates at least 20% of the government budget to education. This is seen as fundamental in establishing a strong foundation for a knowledge-based society in Indonesia. However, a fundamental challenge remains: to establish strong interaction between, on the one hand universities and R&D agencies who are the technology providers, and on the other, industry and society who are the technology users. The Indonesian Ministry of Research and Technology is particularly aware of this problem and is trying to focus its efforts on bridging the gap in order to facilitate a smooth and sustainable transfer of knowledge between supply and demand.

Didier Lombard spoke specifically about innovation within the telecommunications industry as a driver of economic growth. The information technology sector is entering a new era due to digitalization, expanding access to the internet, and

an increase in network capacities and connectivity. Networks are becoming ubiquitous and telecommunications services are increasingly present in all social and economic aspects of life. User behavior has also shifted as people move from being passive recipients to being active participants. Users now produce their own content through social networks and can create or share information by interacting with others. Various studies point to the positive impact of the deployment of new telecommunications networks on economic growth, job creation and labor productivity. A virtuous cycle for innovation must be put into place depending successively on education, research, development, the deployment of infrastructure and finally, services. Lastly, cooperation must take place on a global level with all actors playing an "open" game.

Kazuo Furukawa noted that global warming, resource depletion, and water and energy shortages threaten the fabric of our societies. In addition, globalization has changed the flow of information, people and capital. The way we work and our lifestyles have undergone dramatic changes. Innovation in information and communication technology will play an increasingly significant role in the areas of health, safety and security. For example, Japanese wristband technology can be used to constantly monitor and record health, activities, sleep and instantly communicate this information to a computer network. This data can then be analyzed and provide information that could lead to the discovery or diagnosis of a certain medical condition. The mission of the information and communication technology industry is to drive such innovation, which could eventually solve some of the most pressing issues facing our world today.

Alexey Ponomarev spoke about the interrelation of innovation and social consciousness as an important aspect of a country's innovation strategy. Russia has been undergoing constant change since the disintegration of the USSR. There have been profound shifts in strategic goals and priorities. The transition to a new social model based on market economy, democracy and personal freedom has left most people simply struggling for a decent life and trying to overcome social destitution. Currently Russia's main goal is economic growth through innovation in five key areas: energy efficiency, medical equipment and pharmacy, strategic information technology, aerospace and telecommunications and finally, nuclear technologies. In order to achieve the desired economic growth, support from society at large is needed and it can only be obtained through encouraging diversity, openness and continuity in education. The Russian government is actively pursuing change in education by supporting universities that open up to foreign faculty, researchers and students. Another priority is to expand R&D activity in universities through the integration of science, business and education. At the same time, curricula aimed at promoting innovation must seek to strike a balance between humanitarian and technical education. For example, they should include socially responsible attitudes towards energy, humanitarian values and ethics in information.

Herminio Blanco suggested that developing countries should maximize the impact of growth and innovation through investment in science and technology. It is essential for developing countries to spend as much as possible on R&D - ideally over 1% of total GDP, he stressed. The logic for this

is based on the idea of increasing returns whereby countries with a high standard of living and a large education budget are more likely to produce a high level of innovation. Another challenge for developing countries is that large amounts of investment in R&D do not necessarily generate domestic employment. Countries that want to achieve the highest level of growth should establish appropriate policies to encourage direct foreign and domestic investment aimed at producing innovations. Finally, the capacity of an emerging country to absorb and assimilate new technologies at a fast pace is another very important factor affecting economic growth.

13:30-15:30 PLENARY SESSION

102: Investing in Science and Technology for Building the Future -- Dialogue among Political Leaders, Scientists and Industrialists

Chair:

- **Kleiner, Matthias**, President, German Research Foundation (DFG), GERMANY

Speakers:

Political Leaders:

- **Ponomarev, Ilya Vladimirovich**, Chairman of Hi-Tech Development Subcommittee, Member, The State Duma of the Russian Federation, RUSSIA
- **Lim, Chuan Poh**, Chairman, A*STAR (Agency for Science, Technology and Research), SINGAPORE
- **Rübig, Paul**, Chairman of Scientific and Technology Options Assessment (STOA); Member, European Parliament, AUSTRIA
- **Iglesias, Enrique**, Secretary General, Ibero-American General Secretariat (SEGIB), URUGUAY/SPAIN
- **Wada, Takashi**, Parliamentary Secretary Economic and Fiscal Policy, Science and Technology Policy and Space Policy, Government of Japan, JAPAN

Scientists:

- **Ernst, Richard**, Professor Emeritus, Swiss Federal Institute of Technology (ETH) Zurich; Nobel Laureate in Chemistry 1991, SWITZERLAND
- **Heuer, Rolf-Dieter**, Director-General, CERN (European Organization for Nuclear Research), SWITZERLAND
- **Nurse, Paul**, President, Rockefeller University; Nobel Laureate in Medicine 2001, UK

Industrialists:

- **Sakurai, Masamitsu**, Chairman, Ricoh Company Ltd; Chairman, Keizai Doyukai (Japan Association of Corporate Executives), JAPAN
- **Cluzel, Marc**, Member of the Executive Committee and the Management Committee, Executive Vice President, Research and Development, Sanofi-Aventis, FRANCE
- **Lynch, Kevin**, Vice-Chair, BMO Financial Group, CANADA

Matthias Kleiner opened the plenary with a call on scientists, politicians and business leaders not to lose their nerve. "In unreliable, risky times we need to promote high-risk research," he said. With the global economy still in a decidedly shaky state, societies need to promote innovative research in

science and technology more than ever. While governments and companies may be tempted to cut back on research budgets when times are tough, the President of the German Research Foundation argued that such short-term thinking could actually end up making difficult situations worse. "Particularly in crises we need investments to generate new ideas," he said.

Richard Ernst warned the plenary that the world could not survive in the long term if it stuck to current models of economic development. "Increasing the wealth of everybody uniformly in order to help the poorest is as inefficient as raising the global sea level for getting a stranded boat afloat in the shallow Baltic Sea!" he said. The Nobel prize-winning chemist argued new paradigms of society were needed, which were not based on the idea of constantly acquiring more material wealth. "Tame your greed and develop renouncement and restraint," he said. He ended his intervention with a quote from Mahatma Gandhi, urging participants to, "be yourself the change you want to see."

Ilya Vladimirovich Ponomarev also quoted a famous historical figure: Karl Marx, whose Communist Manifesto refers to the specter of Communism still haunting parts of Europe. "The ghost is wandering again now. It is not the ghost of Communism but a ghost saying we need a new economic model in favor of all humankind," he said. He added his government was successfully reversing the effects of unbridled free market reforms in the 1990s which saw a huge brain drain away from Russia. His country was now actively supporting measures to encourage home-grown research and was keen to share its knowledge and experiences with other countries. "By coming here we are looking to find joint answers to the problems we are facing," he said.

Masamitsu Sakurai stressed the often repeated maxim that global problems need global solutions. "Global warming is irreversible," he said. "This problem can only be addressed by harnessing the full potential of human wisdom. Science and societies must work together." But new, low-carbon societies could not be simply imposed from the top down by governments he insisted. "Consumers must demand low-carbon goods," he said. And of course companies like his have a role to play by setting "meaningful and advanced goals."

Paul Nurse, another Nobel Prize winner, described what he called the "Eco-system of Innovation" encompassing the business, academic and political communities as well as civil society. Getting these different groups to work together is easier said than done, he argued. "We are dealing with very different cultures who work in different ways and it's very difficult to get these people to work with each other," he explained. One way of improving interaction was to encourage 'permeability' between the groups, for example by making it easier for scientists to move from the academic to the business world and back. This could then lead to increased trust, without which, "science will not thrive."

Chuan Poh Lim explained that Singapore always tried to use periods of economic crisis to re-examine its economic strategies. As a small island with no natural resources, he said his country had chosen to be a knowledge-based, innovation-driven economy. "Singapore should continue to

invest and attract the best talent,” he said, adding that his government had chosen to spend \$16.1 billion on research and development between 2011 and 2015, a sum which amounted to around 1% of annual GDP over the period. The strategy was working, he argued. “My agency alone has enabled 1000 young Singaporeans to pursue research education in top institutions around the world.”

Kevin Lynch argued that the world was heading into uncharted economic territory. “Just as this has not been a typical recession, it will not be a typical recovery,” he said. New global issues like climate change and globalization mean the world is changing fast. “The constant opportunity is ever bigger markets, and the constant challenge is ever more competitors,” he said. Citing columnist and author Tom Friedman, he argued: “If globalization were a sport, it would be a 100 meter dash over and over.” Lynch said that innovation is the oxygen that fuels the star runners. “Our living standards tomorrow will be shaped by how well we establish our innovation architecture today,” he concluded.

Paul Rübig said that the history of the European Union showed that people could do anything if they put their hearts and minds into it. From an original six countries, the EU now counts 27 member states with a total of 500 million inhabitants. The EU understands the importance of investing in research, he insisted. Its latest investment initiative, the ‘seventh framework program’ had double the budget of its predecessor. European research and development could do a great deal to help progress on a number of global challenges, he added. These included efforts to develop more eco-friendly modes of transport and moves to use carbon dioxide as a fuel.

Rolf-Dieter Heuer argued that basic and applied science are inextricably linked. “In my mind you can’t separate the two,” he said. ‘Blue sky’ research came up with revolutionary ideas and concepts that drove innovation, he insisted. Often the potential of a new discovery was not immediately obvious. He explained that in 1989 the field of particle physics was advancing fast in laboratories around the world. The physicists needed a means of transferring documents and data rapidly, so found a way of loading them onto a computer and making them accessible to others around the world. And so, the World Wide Web was born. “How could terms like ‘www.’ or ‘http://’ have been invented by anyone but a physicist?” he joked. He finished by citing the famous British scientist Michael Faraday who, when asked what the use was of his research into electricity replied, “I don’t know but maybe one day you can tax it.”

Enrique Iglesias explained that Latin America had changed dramatically over the past decade and that many countries had experienced sound economic growth. But the region needed to develop mixed economies with a strong science and technology element. “We cannot develop simply because of the prices of our commodities,” he said. He added that many countries had actually managed to use science and technology to improve the agricultural commodities sector. “There has been great innovation in agricultural production and we are now a major source of food,” he said.

“Progress in science and technology is no longer linear but exponential”, **Marc Cluzel** highlighted. Thus, we, as scientists,

have a responsibility towards our communities “to translate all that knowledge into concrete health solutions and to accelerate their development once they are discovered, for the benefit of all 6.8 billion people on the planet”. The Executive Vice President of Sanofi-Aventis also stressed that international cooperation and networking are vital when it comes to moving forward in his company’s field. He insisted that with the right approach there are, “unprecedented opportunities,” to be had.

Takashi Wada explained that science and technology form a key element of Japan’s new growth strategy. “It is important to consider how we will invest in science and technology,” he said. Like many other speakers, he insisted that basic research was the bedrock of innovation. He also stressed that links between the academic and business worlds could be improved. “It is important to create an environment where young scientists can move freely between private companies, universities and research institutes.” He added that it is important that ordinary people understand the value of scientific research to their daily lives. “It is essential that citizens as taxpayers understand the necessity of investing in science and technology” he concluded.

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

103-A1: Future of Fossil Energy

Chair:

- **Campbell, Donald**, Senior Strategy Advisor, Davis LLP, CANADA

Speakers:

- **Behrendt, Frank**, Head, Chair for Energy Engineering and Conversion Technologies for Renewable Energies, Berlin Institute of Technology (TU Berlin), GERMANY
- **Cordeiro, Monica Neves**, Superintendent of Gas, Energy Company of Minas Gerais (CEMIG), BRAZIL
- **Durongkaveroj, Pichet**, Secretary-General, National Science, Technology and Innovation Policy Office, THAILAND
- **Püttgen, Hans Björn**, Director and Energy Systems Management Chair, Energy Center Swiss Federal Institute of Technology, Lausanne, SWITZERLAND
- **Tansamrit, Songkiert**, Executive Vice President, PTT Research Institute & Technology Institute, PTT Public Company Limited, THAILAND

The world is facing the prospect of dwindling oil reserves so how can it lessen its dependence on fossil energy? Fossil fuels have been the dominant source of energy for the last century and drove the industrial revolution. Today 80% of global energy still comes from fossil fuels. This will change but it will be a long process.

One panelist quoted a Chinese proverb: “There is no feast that does not end.” Fossil fuels are a finite resource, but remain an important source in the global energy matrix. However, there is no clear, short-term answer to the concern of fossil fuel dependency and participants agreed it will take decades to resolve this issue.

Scientists must find ways to meet the energy needs of the world's 6 billion people. Today half of the world's population - 3 billion people - do not have access to electricity. By 2050 the population will increase by another 3 billion and ways must be found to meet the energy needs of the projected 9 billion people on the planet.

The heat released by burning fossil fuel drives the machinery that generates electricity that powers our society, but the drawback is the release of CO₂. Although the issue of carbon emissions is spurring the transition away from fossil fuels, the transition will be a slow one. Moving away from this form of energy will be expensive and require a great deal of commitment and research. Participants agreed that scientists must make it clear to the public that there are major hurdles to overcome when it comes to developing new energy technologies.

The good news is that for the time being, the world has sufficient reserves of fossil fuels and that there is no immediate shortage of oil. Also, vast reserves of coal are available on all continents and in many countries around the world. Therefore, the geopolitical risks often associated with oil do not apply to coal.

While participants heard that coal is likely to remain a popular energy source in the 21st century, one participant pointed out that some communities in his country rejected the construction of a nearby coal power plant. This was but one case that points to persisting problems with this energy source.

It was agreed that investment is needed to develop cleaner and more flexible uses of fossil fuels. One participant suggested that natural gas is one fossil fuel that is a viable low-carbon energy alternative.

Rich countries need to co-invest with poor countries to develop efficient energy supplies. Africa has huge hydro-power potential that would have a great impact on poverty reduction while also offering low CO₂ emission alternatives. Participants noted that when considering energy options, nations need to consider fossil fuels in relation to living standards and their impact on the environment.

One panellist foresaw a "green industrial revolution" and the start of a "zero" emission energy industry as well as a transition to renewable energy by 2040. It was also suggested that we can look forward to greater fuel efficiency in the airline industry, more teleconferencing to reduce energy use and the development of robotics, which can play a part in reducing CO₂.

Participants suggested it is important look at all aspects of energy use. Developing improved fossil fuel technologies is vital to gaining the public's trust, which in turn is the key to implementing innovations. Politicians need to get involved and make decisions on energy policy. The role of scientists is to offer options to politicians so that they can make informed policy choices.

Oil, natural gas and coal are "The Three Musketeers" one participant said and they are the world's dominant energy sources. The aim is to move beyond them in the next 30

years. Bio-fuels and natural gas for use in cars are some of the alternatives. Increasing reforestation is one nation's idea of how to deal with CO₂ emissions as well as investment in CCS (Carbon Capture and Storage). One participant remarked that storing CO₂ underground might be a good intermediate solution to reducing green house gasses.

One participant expressed skepticism about the chance of finding "the" solution to our energy dilemma. In conclusion, the consensus among participants was that fossil fuels are here to stay and it is vital to use them wisely. The task ahead is to develop the technology that will make fossil fuels environment-friendly.

103-B1: Frontiers in Personalized and Nano Medicine

Chair:

- **West, Steve**, President, MDS Nordion; Chief Executive Officer, MDS Inc., CANADA

Speakers:

- **Carty, Arthur J.**, Research Professor and Executive Director, University of Waterloo Institute for Nanotechnology, CANADA
- **Hayashizaki, Yoshihide**, Director, Omics Science Center, RIKEN, JAPAN
- **Power, Aidan C.**, Vice President, Global Head of Molecular Medicine, Pfizer Inc, USA
- **Stein, Christian**, Chief Executive Officer, Ascenion GmbH, GERMANY
- **Yamanaka, Shinya**, Director, Center for iPS Research and Application (CiRA), Kyoto University, JAPAN
- **Ying, Jackie**, Executive Director, Institute of Bioengineering and Nanotechnology, Technology and Research (A*STAR), SINGAPORE

There is as yet no pure consensus regarding the impact of personalized nanomedicine. However, the genome is the common element which links the two perspectives. Part of this session was devoted to exploring whether there was a convergence of the two themes, which also encompass social and "med tech" aspects. The speakers did not attempt to define but rather to discuss the general trends in genomics and nanotechnology. Health care, prevention and the proactive management of diseases strands are that are common to both themes.

The main issues are changes in medical practice and their effect on the pharmaceutical industry. Alterations in the current health industry structure will be unavoidable. Participants agreed on the need for improved education for doctors, insurers and other industry professionals. Education for the public on new forms of medical care must also be provided. Patient concerns include costs related to diagnostics, treatment and monitoring. Other issues raised by advances in medical science include data security, global standardization and open electronic architecture for medical records. Participants also agreed on the need to examine safety concerns from both nanotech and toxicological perspectives.

Health care systems are undergoing fundamental and

wholesale changes. To deal with metabolic and genome-based predictions regarding diseases, recommendations for patients to make lifestyle changes are likely to become very common. The crucial point regarding personalized medicine is the availability of choice for individuals: to choose freely based upon correct information provided through outreach activities. In addition, national regulations need to be reconsidered as well as the legal frameworks that relate to dosage optimization, treatment monitoring and the phases of clinical studies.

Participants also agreed on the need to develop new approaches to risk sharing when it comes to the development of drugs and treatments. Cooperation among industries as well as between the private sector and the academic researchers must be enhanced. A potential new paradigm has emerged with the advent of innovative technology in the form of induced Pluripotent Stem (iPS) cell research. However, it was noted that iPS cell transplants must be double-checked in order to ensure that cancer risks, for example, are minimized. iPS open the way for regenerative medicine, the establishment of drug screening and the prediction of side effects from treatment agents.

Legal issues came up again on the subject of nanomedicine with participants calling for greater clarity in the regulatory pathways that lead to the authorization of new medical devices. The use of information technology in the medical field will increase along with advances in technology such as cloud computing and smart phones. "Lab-on-the-chip" technology and novel sensor devices are other examples of info-tech uses. Nanofluidics can allow rapid, accurate and automatic diagnostics to take place. As such, today's costly centralized diagnostics systems will eventually be bypassed.

Nanoparticles for the targeted delivery of drugs would reduce monitoring costs and the need to offer "cocktails" to patients. Nevertheless, there must be large-scale testing involving a vast pool of people in order to better understand basic human biology. This could potentially be Web-based, participants heard.

It is predictable that cutting-edge technology will increase the total amount of biomaterials that may be used as treatment agents. The adoption of evidence-based medicine, translational pharmacogenomics, drug delivery and targeted therapy may mean added expenses, and this will provoke a need for changes in people's attitudes.

Participants were reminded that bioethics must also be kept in mind, in particular when it comes to privacy. Personalized medicine means medical practices must be changed and adapted to new realities. Clinical testing involving more "invasive" devices as well as probing into genetic backgrounds are to be expected. The potential misuse of information by insurance companies and other entities is a major area of concern.

Policy issues revolve not only around preventing, treating or curing diseases but also around knowledge-sharing. When it comes to evaluating the costs of new technologies, sequencing machines can now provide case studies in response to the question of how to "cover the bill." Sequencing costs are on

the decrease and capacity is growing steadily. However, the sharing of data and open innovation activities are points of contention. Intellectual property issues, balancing the need to reduce the cost of producing biologics and protecting investment are other areas of controversy.

Utilizing the information provided by bioinformatics could lighten the financial burden of providing medical treatment. Venture businesses and other efforts are likely to help overcome various challenges related to the widespread adoption of personalized and nanomedicine. The future looks bright as participants explored opportunities for industry as well as the potential impact on health economics.

103-C1: New Developments of ICT

Chair:

- **Kaiserswerth, Matthias**, Director, IBM Zurich Research Laboratory, SWITZERLAND

Speakers:

- **Eriksson, Per**, Vice-Chancellor, Lund University, SWEDEN
- **Higashi, Tetsuro**, Chairman, Tokyo Electron Limited, JAPAN
- **Hultin, Jerry**, President, Polytechnic Institute of New York University, USA
- **Kanellos, Leonidas**, President, Hellenic Telecommunications and Post Communication (EETT), GREECE
- **Saracco, Roberto**, Director, Future Centre and Scientific Communications, Telecom Italia SpA, ITALY

Cyber wars and a potentially massive increase in energy use are two aspects of the 'dark side' of the inexorable growth in information and communication technology (ICT), this session heard.

"Computers use up to two per cent of the world's energy. That's as much as commercial air travel," one participant explained. This figure is set to rise as the next generation of "ultra broadband" online services are rolled out around the world. Participants came back again and again to the problem of ICT energy use.

One expert gave the example of a subscriber to a European telephone company who less than two decades ago would have consumed virtually no energy making old-style land line calls. By 2015, that same subscriber is likely to be consuming an ever increasing amount as he or she uses more and more energy-hungry broadband and other communications technologies.

Other participants highlighted a plan to roll out high speed broadband services to every household in Australia that would also require huge amounts of energy to get up and running. One defender of the next generation of internet services insisted that the increased energy use would be offset by savings in travel and other costs. Another argued that as ICTs are powered by electricity, much of the energy they use could come from renewable sources.

Companies that make microprocessors and other ICT hardware components were also trying hard to make their products more energy efficient, it was explained. "Better, smaller semi-conductors will be vital," said one speaker.

Then there was the vexed question of electronic scrap from an industry where it is not uncommon for products to become obsolete in a couple of years. Our societies have begun to address the question of what to do with our end-of-life computers, mobile telephones and other hi-tech gizmos, but far more work is needed.

And participants heard how sources of many of the rare elements used to make components in ICT technology risk running dry unless ways can be found of recycling 'old' hardware.

The session also heard of the danger of 'cyber wars' - deliberate online attacks on a state's IT infrastructure. The US military takes the threat so seriously that it has set up a cyber command to deal with these kinds of threats and similar services exist in other countries. "We have moved into a new theatre of warfare," said one participant.

Another participant pointed out that ICTs had had a devastating effect on traditional media like newspapers and magazines, with thousands of titles closing down around the world. Without the foundation of traditional media, nothing much can grow. "Without established mass media we don't expect that there will be any more alternative media," one participant said.

Other speakers sympathized with the problem, but many argued that new technologies could herald the development of new forms of media. Others added that the media weren't the problem as they were only delivery systems for news. What was important was finding economic models that allowed proper investigative journalism to continue to be correctly funded.

But the session was by no means all doom and gloom. Participants also heard of the huge potential benefits of increased ICT use. Communication technologies are likely to revolutionize further education in the coming decades as universities become cyber campuses with students all over the world. Some institutes have already begun this trend, opening branches in different countries that all offer the same degrees. "ICT will come sweeping through education in the coming years," said one participant.

Other speakers stressed the need to stop and think about the kinds of services that would be delivered on the new ICT infrastructure being rolled out around the world. "We need to address broadband not as a means to an end but as a means for developing targets and delivering services. Broadband development without carrying services doesn't really help the development of a country," said one participant.

The session also heard how the oft cited Web 2.0, which brought us social networking sites like Facebook or the video sharing service YouTube, will soon give way to Web 3.0. "Web 3.0 will be the personalization of information. Your experience will be influenced by what you've just seen," said one speaker.

But what came out of the session above all is that in many areas we simply just don't know exactly where the incredible growth of ICTs will lead us and trying work out our destination in advance is a fiendishly difficult task. "We are addressing a mission impossible, but if it can be done anywhere, it's here," said one participant.

103-D1: Science and Engineering Education for the 21st Century

Chair:

- **Shirai, Katsuhiko**, President, Waseda University, JAPAN

Speaker:

- **Castro Diaz-Balart, Fidel**, Scientific Advisor to the State Council of Cuba, CUBA
- **Mazur, Eric**, Balkanski Professor, School of Engineering and Applied Sciences, Harvard University, USA
- **Shahabudin, Sharifah Hapsah Syed Hasan**, Vice Chancellor, National University of Malaysia (UKM), MALAYSIA
- **Tan, Eng Chye**, Deputy President and Provost, National University of Singapore (NUS), SINGAPORE
- **Ushioda, Sukekatsu**, President, National Institute for Materials Science (NIMS), JAPAN

Disparity in science and engineering education was a recurring theme in this workshop: this meant disparity between the education given to students and the education they required, between the education in developed and developing countries and between genders. As society and technology continue to develop, scientific education methods and content need to develop too, otherwise, new students will not have the education they require to face the future. If these disparities are not addressed, students will move over to other disciplines, with the final effect of stunting scientific and technological innovation.

Current education methods have not evolved at the same pace as society, with most universities using the lecture format supplemented by a set of standard problems for the students to solve. These methods create a passive learning environment, in which grades are the most important aspect. However, the direct competition inherently involved does not foster the ability to interact, work together or allow students to develop problem-solving skills. In the modern age of science, where interdisciplinary research is prized, the graduates of today do not possess the necessary skills to work effectively in society. Introducing talent grooming schemes will help produce graduates who can continue the drive for scientific innovation. Such schemes include students being encouraged to study at different universities around the world, to take up internships at R&D companies and work on volunteer projects.

Disparity between genders is still a large problem in science education, where stereotypes on gender roles create an environment that is not inclusive, leading to low application rates from female students for scientific courses. Participants stressed the importance of creating female role-models in science, both through the media and faculty members, so that female scientists can have a direct influence in guiding students. The building of interactive courses that promote

the ability to discuss and debate science is another area of importance. The implementation of these methods has been found to remove the gender gap in grades in earlier education and encourage a greater number of females to enter higher science and engineering courses. Participants were nevertheless keen to avoid the positive discrimination trap. Work to remove gender stereotypes from education is necessary to create an environment in which everyone can succeed.

One of the great problems facing the developing world is not outdated teaching methods, but outdated information. Without the financial resources to create world-class research institutes, it is difficult for teaching staff to remain at the forefront of their respective fields. This directly impacts on the quality of the education they are able to provide to their students. This problem can only be solved by tackling elitism in education through the creation of a top rate research institute in every country. In this way, developing countries will be able to produce and retain first class scientists and engineers who will have a positive impact on the quality of education that they can provide.

To tackle the current problems in scientific and engineering education, it is necessary to develop new curricula that move away from the lecture-based teaching of the past, where professors teach the way they were taught. There needs to be a move towards methods that foster interaction between students and drive them to go out into the community to solve real world problems. Learning outside the class and using the traditional lecture time like a seminar are found to be very effective in promoting interaction. Encouraging students to enter engineering competitions as part of a group that includes people who study in many different departments is also productive. Other suggestions included teaching liberal arts as part of science courses. Such methods can be employed independent of class size and are likely to foster problem-solving abilities that will be of genuine benefit to students once they graduate, as well as to the community as a whole. Ultimately, participants felt it is important to foster an understanding amongst students that more is learnt through failure than through success.

103-E1: Sustaining Biodiversity

Chair:

- **Roberts, Richard**, Chief Scientific Officer, New England Biolabs Incorporated, Nobel Laureate in Physiology or Medicine 1993, UNITED KINGDOM

Speakers:

- **Aruffo, Alejandro**, Head Global Research and Development, Syngenta AG, USA
- **Hopper, Stephen D.**, Director, Royal Botanic Gardens, Kew, UK
- **Kada, Yukiko**, Governor, Shiga Prefecture, JAPAN
- **Wambugu, Florence Muringi**, Chief Executive Officer, Africa Harvest Biotech Foundation International (AHBFI), KENYA

Biodiversity is intimately connected to issues such as food security, water security, and quality of life. The increasingly

rapid global loss of biodiversity through direct human influence and the growing effects of climate change is an issue of utmost urgency for the current era.

A growing theme in global biodiversity dialogue is “utilization as conservation”. Numerous practical initiatives, such as the restoration of Lake Biwa in Japan, food security movements in Africa, and even examinations of traditional cultures and the way they interact with their local environments, have illustrated that through careful action, human restoration, and even enhancement, of local biodiversity is possible.

Foremost in this dialogue is the area of food security. Presently about a dozen species make up around 80% of total crop production worldwide. This is a lot of eggs in a fairly small number of baskets - a precarious situation with global climate change looming in the background.

At the same time, growing populations lead to growing demands for food. This means either bringing more land into agricultural cultivation, or making the agricultural land already in use more productive. Biodiversity, especially indigenous species, is an important resource in optimizing agricultural production to local areas across a vast diversity of climates and terrains. This is evidenced in the growing shift in African food production away from introduced crops like barley and towards indigenous crops like sorghum as the continent pursues greater food security.

Water security is another important arena. Besides obvious issues like fish as a source of food and livelihoods, complex biodiversity systems serve as absorbers of nutrients and compounds that would otherwise pollute water sources. Conservation measures at Lake Biwa in Shiga, Japan have shown that the restoration of biodiversity to a lake system and its surroundings, in addition to having benefits in areas like food production or tourism, also garners real success in restoring a polluted water source to its original, potable form.

In all cases, involvement of local stakeholders is integral to success. If local people cannot see the value in local biodiversity, they will not aid in (and may even hinder) its conservation. This may come by optimizing local food production, filtering sources of drinking water, or through economic benefits via eco-tourism, gene-gathering by pharmaceutical companies, direct compensation from private sector actors in exchange for local conservation efforts. Whenever local people can utilize biodiversity and can see a tangible benefit from it, then they will play an active role in protecting the environment.

As we conserve and utilize, we also must catalogue and understand. Not every species has an obvious immediate use. Not every species can be saved from imminent destruction. In these cases, scientists must gather data, preserve it for posterity, and/or evaluate it for future potential use. The value and potential success of resuscitating an extinct species through its DNA is a matter of debate, but the value of recording that DNA is not.

Biobanks and other repositories of information and of physical samples have grown tremendously in recent years. Yet there is so much more information we need to know. There is a pressing need for integration of data – our repositories should

not catalogue only threatened species, but all species in an area, additional information such as historic stock sizes, local inorganic environments as well as organic, and, perhaps most importantly, the complex interactions between different species. Ultimately this should not be just integrated local information, but it must form a comprehensive, integrated, global map of biodiversity. One that, furthermore, is digitized and instantly accessible to a wide variety of actors.

As our knowledge grows, we eventually arrive at a basic philosophical question: should we see ourselves as custodians of the past or as architects of the future? Regardless of our answer to this question, we still have to first preserve our tools before we can think about how to use them in the future. Utilization is an excellent new philosophy in protecting biodiversity, but traditional conservation through terrestrial and marine reserves continues to be of vital importance as well.

103-F1: Developing Human Habitat: Cities

Chair:

- **Yeo, Philip**, Special Advisor for Economic Development, Prime Minister's Office; Chairman, SPRING (Standards, Productivity and Innovation Board), SINGAPORE

Speakers:

- **Camacho Solís, Manuel**, Director, Proyecto Ommega, S.C., MEXICO
- **Imura, Hiroo**, President, Foundation for Biomedical Research and Innovation (FBRI), JAPAN
- **Wong, Man-Kong Peter**, Chairman, Cultural Resource Development Co. Ltd., HONG KONG
- **Yada, Tatsuo**, Mayor, City of Kobe, JAPAN

The discussion focused on the increasingly difficult challenge of developing sustainable and habitable cities around the globe. Participants began by identifying various key challenges that many global cities face as they try to become more sustainable.

Firstly, a growing population and rapid economic expansion place tremendous pressure on a city's infrastructure, including housing, utilities and transportation. Secondly, pollution has worsened in many cities due to rapid industrialization. Some of the effects include rising sea levels, dwindling water resources and extreme weather patterns. Thirdly, in many countries, population ageing is also a consideration when it comes to planning. For example, across Asia, the number of people aged 65 and above will grow dramatically over the next 50 years, from 207 million in 2000 to 857 million in 2050.

One participant stressed the importance of integration when attempting to achieve sustainable development in an urban context. This calls for an integrated approach that aims at not only environmental, but also economic and social sustainability. In addition, consistency of approach is crucial over the long-term if policy is to succeed. Strategies should cut across the many areas of governance and aim to achieve a balance between the current generation's consumption needs and those of future generations. Another point was that economic policies should work for sustainability and not

against it. For example, subsidies for energy and water only encourage over-consumption. It is also vital that the effects of pollution and other environmental impacts be reflected in the price of goods and services.

Another speaker pointed out that it is imperative to ensure that local populations in cities understand their nation's wider development goals and feel that they are an integral part of achieving success. While proper policy and governance can steer a city in the right direction, cooperation from the private sector and the general public is essential in achieving common targets.

It was also noted that there is a global trend of population migration towards the coastlines and urban centers. This presents additional problems when climate change is taken into consideration. Effective city planning must reflect the reality of rising sea levels and unpredictable weather in an effort to mitigate the economic and human consequences of climate change in urban environments.

The discussion focused on the importance of cities and their relationships with local scientists as opposed to how they work at national level. If they work closely with scientists, cities can develop proper policies for sustainable development. While proper policy and strategy are imperative, effective implementation is where real improvement can begin. City mayors have an extraordinary responsibility when it comes to shaping and implementing policy. Scientists are willing to help both locally and on a global scale. However, the two worlds are disconnected. There was consensus among participants that proper lines of communication between scientists and policy makers are necessary, both locally and through virtual and physical networks. One participant spoke of a network of 60 city mayors along the ancient Silk Road from Korea to Turkey. Members collaborate virtually via the internet along with scientists in order to share information and strategies for sustainable city development.

The discussion also touched on the issue of "new" cities which are strategically developed in the vicinity of existing urban centers in order to help ease overpopulation and pollution problems. Strategic planning for these new cities can provide valuable opportunities for experimentation in managing urban challenges, such as transportation, technology and vertical construction issues. Building a city based on a set of values can attract people who share those values, as has been historically seen in cases such as Philadelphia in the USA. New developments should take this into consideration as a potentially cohesive factor.

People move to large cities seeking greater opportunity and a better life. Participants agreed that scientists and those working in the technology sector should take the lead in providing for sustainable urban development instead of being led. Cities and their development hinge on multiple stress factors such as air and water quality, economic opportunity and standard of living. Interestingly, how people actually feel about living in their city is one of the most important indexes that is often ignored when people try to evaluate how "livable" these urban centers are.

103-G1: Science and Technology Diplomacy and International Collaboration

Chair:

- **Bement Jr., Arden**, Director of Global Policy Research Institute (GPRI), Purdue University; former Director, National Science Foundation (NSF), USA

Speakers:

- **Cope, David Robert**, Director, Parliamentary Office of Science and Technology, Houses of Parliament, UK
- **Fruchterman, James**, President and Chief Executive Officer, Benetech Initiative, USA
- **Katori, Yoshinori**, Director General, Foreign Service Training Institute, Ministry of Foreign Affairs (MOFA), JAPAN
- **Tachikawa, Keiji**, President, Japan Aerospace Exploration Agency (JAXA), JAPAN
- **Zuhal**, Rector, University of Al Azhar Indonesia (UAI), INDONESIA

This session examined the relationship between the exchange of science and technology across national borders and the extent to which international collaboration can and is promoting this. Panelists diagnosed challenges and suggested solutions to how cooperation between developed and developing nations could be improved in order to solve common global problems.

Science diplomacy is a relatively new topic and is still an often-misunderstood term. It was noted that some critics point to the fact that science diplomacy is somewhat vague and runs the risk of drawing science into political struggles. On the other hand, the benefits that collaboration can bring in this field were repeatedly highlighted. The question was posed as to whether scientists or diplomats should be setting scientific agendas in the interest of diplomacy.

Several panelists noted that the last few years have witnessed a much greater emphasis on scientific diplomacy and to its discussion. Mentioned by way of example was the fact that the American Association for the Advancement of Science (AAAS) has established a centre for the study of science diplomacy. In addition, the Japanese government has launched a “science and technology research partnership” for sustainable development currently worth ¥51 billion. The year 2009 also saw what may be the first formal collaboration on the subject between sovereign parliaments, with members of the UK House of Commons and the US House of Representatives collaborating in the field of geo-engineering.

Science and technology has become an essential part of foreign relations. Among the main topics discussed, a recurring theme was the extent to which developed and developing nations can cooperate with one another in order to share scientific technology and data, and to achieve mutually beneficial outcomes to current and future world problems.

One area in which international scientific collaboration has been very successful is in the construction of the International Space Station (ISS). This endeavor has brought together more than eleven countries including Japan, Canada, the US and European Union states. Each country brought its

respective expertise and technology to the project in order to build a space station for the benefit of humanity in general and there have been no disputes between member countries in the 25 years of the project.

Data gathered by satellites should be free and open to all nations as much as possible, participants felt. In addition, meta-analysis which combines the results of many different studies needs to be peer-reviewed in order to be useful. Discovery and innovation are advancing at unprecedented rates and more data is being shared than ever before. Shrinking global barriers and an increasingly interconnected world provide an arena in which the opportunities for scientists to collaborate have never been greater. There are many projects that are too complex or expensive for one country to carry out alone and which can only be achieved through multilateral cooperation. Closer collaboration in this area should be encouraged.

Also raised was the fact that science and technology have caused environmental disasters and that there should be greater harmony between science and nature. Many developing countries are very resource-rich and high in biodiversity. Developed nations can bring their experience and technological advantages to bear. They should work hand in hand with resources-rich developing nations to find solutions to global environmental issues. Indonesia was cited as an example of where this has occurred. The country produces large quantities of methane and carbon dioxide as a consequence of its palm oil industry. Close cooperation with Denmark enabled a reduction in CO₂ and other emissions and is an example of successful scientific diplomacy.

Finally, the panel identified access to the knowledge we already have as one of the biggest challenges facing the advancement of scientific progress. Knowledge is unevenly distributed and not uniformly available to all. Access to knowledge should be a global birthright and should not benefit just the top 5-10% of the population. Using science to solve critical problems facing the world today requires access to free and open knowledge. Information is being shared more than before with the open content movement through initiatives such as Creative Commons, Wikipedia and with universities giving away textbooks and course materials for free. The US government is also allowing greater public access to the data and statistics it holds and new ways are being found to the use data that hadn't previously been considered. The current trend towards increasing data sharing should be encouraged.

19:00-20:30 PLENARY SESSION

104: Official Dinner

Chair:

- **Yeo, Philip**, Special Advisor for Economic Development, Prime Minister's Office; Chairman, SPRING (Standards, Productivity and Innovation Board), SINGAPORE

Speakers:

- **Piccard, Bertrand**, Initiator and Chairman, Solar Impulse SA, SWITZERLAND

- **Borschberg, André**, Co-Founder and Chief Executive Officer, Solar Impulse SA, SWITZERLAND

Philip Yeo introduced the two speakers, one of whom, Bertrand Piccard, is the famous aeronaut who completed an around-the-world balloon flight in 1999 (along with Brian Jones). He and André Borschberg established the Switzerland-based company Solar Impulse SA in 2003. The two “pioneers” screened a video presenting the company and outlining their “around the world in a solar airplane” effort. The video showed the work involved in producing the prototype plane, from 3D simulation and design, to testing and success in achieving an overnight flight.

Bertrand Piccard noted that the 20th Century had been an incredible era which saw many “impossible” dreams come true: people scaling Mount Everest, reaching both poles, and flying to the Moon. His paternal grandfather was the first balloonist to reach the stratosphere, and his father was the first person to dive into the Mariana Trench, the deepest point in the sea. Bertrand achieved, with British co-pilot Brian Jones, the first non-stop around the world balloon flight. At the landing just 40 kg were left of the 3.7 tons of liquid propane they had on take-off. If the jet streams had been less powerful, their attempt would have failed for lack of fuel.

Bertrand Piccard then promised himself to fly round the world once again, but this time, without using any fossil energy. The idea of an aircraft powered only by solar energy, capable of flying night and day, had just entered the mind of the Swiss psychiatrist and explorer.

For Bertrand Piccard, the solar airplane project took his vision of the future to a new level: more than just an end in itself, Solar Impulse symbolizes a mindset, an entire philosophy. It demonstrates that the incredible potential of renewable energy of today will allow our society to be much less reliant on fossil energy. And now that this solar airplane has flown night and day without fuel, nobody can go on denying that it is impossible to use the same technology for cars, heating, cooling systems or computers.

The round the world attempt is scheduled by 2013. Bertrand Piccard wants to raise public awareness and lobby politicians, industrialists and the economists to show them everything that can be done with these technologies, and motivate them to change their mindsets. So even after the round the world flight, this airplane will continue to be used as an example of demonstration of environment-friendly solutions.

The plan underwent a feasibility study by the Swiss Federal Institute of Technology in Lausanne (EPFL) and the project was officially launched on November 23, 2003.

The project gained assistance from “partners” such as Solvay, which provided materials for the plane, Omega, which supplied some of the instruments and Deutsche Bank which brings eco-friendly communication tools. In conclusion, Bertrand Piccard expressed his wish to attract partners for the effort in Asia, if possible from Japan.

André Borschberg outlined the fact that the idea of a solar-powered plane had been around for some 30 years. But so

far, solar aircraft have all been flown in daytime - and not even early in the morning or late in the day. Having a solar-cell powered plane cross oceans, flying at night, is an innovative revolutionary concept. In order to achieve this feat, they knew from the beginning that the aircraft would have to be very big to get enough surface in order to have a sufficient number of solar cells and to produce enough energy. At the same time, the aircraft should be ultra-light to save the maximum energy to fly through the night. They had to push the limits of actual technologies in every field. The result is breathtaking: the wingspan of an Airbus A340 (63.4 meters), the weight of a medium-sized car (1600 kilos) which flies with the average power of a small motorcycle!

The first test flight on April 7, 2010 was a success. On July 7, 2010 the plane flew throughout the night solely on electric propulsion using power generated by the solar cells. More altitude was gained during the daytime and therefore less energy was used to fly through the night. The batteries provided enough power to keep the plane flying into the next day.

Bertrand Piccard and André Borschberg also stressed they were not competing with anyone but rather seeking cooperation and support. Asked whether negative impacts of widespread solar cell usage had been considered, the speakers replied that the energy savings and the change in people's mindsets would far outweigh such possibilities.

08:30-09:50 PLENARY SESSION

200: Science and Technology for Global Health

Chair:

- **Varmus, Harold**, Director, National Cancer Institute; Nobel Laureate in Physiology or Medicine 1989, USA

Speakers:

- **Chituwo, Brian**, Minister of Science and Technology, ZAMBIA
- **Nagayama, Osamu**, Chairman of the Board, Representative Director and President, Chugai Pharmaceutical Co., Ltd., JAPAN
- **Singer, Peter A.**, CEO, Grand Challenges Canada, CANADA
- **zur Hausen, Harald**, Professor Emeritus, German Cancer Research Center (DKFZ); Nobel Laureate in Physiology or Medicine 2008 with Luc Montagnier, GERMANY

Harold Varmus opened the session by explaining that improved health care around the world was not just a consequence of development but a goal in itself. "Progress has been achieved as a result of very hard work by very many people in developed and developing countries," he explained. These people came from many different sectors including government bodies, non-governmental groups, industry and academia. But there are still many serious challenges ahead, Varmus added. Changing global demographics in many middle and high income countries where the average age is getting older and people are living longer was forcing the health care community to reassess its priorities, he argued. "A greater burden of illness is attributed to chronic conditions like heart disease," he explained, adding that in these countries, such ailments now accounted for 80 percent of deaths. In the developing world meanwhile, cancers were proving an ever increasing killer he explained, adding that two thirds of cancer deaths occur in low and middle income countries. In other words, there is no 'one size fits' all approach to dealing with global health care. "There's no such thing as simple global health. Every region, every country requires its own approach," he said.

Brian Chituwo explained that he comes from a poor sub-Saharan African country that suffers from a "dual burden of diseases." Infectious diseases are still a major killer but Zambia also has to deal with a rising tide of chronic ailments and conditions like cancer. He explained that he has experienced the frustration of trying to deal with this situation from both the point of view of a practicing surgeon and a minister. When he worked in hospitals he said he was frequently angry when scheduled operations were cancelled because of a lack of resources. "I would ask myself, who is making these decisions?" he said. He found out the answer when he moved into government and was faced with the dilemma of where to allocate extremely modest budgets in the most effective way. Later in the discussion, Chituwo called on drug companies to help countries like Zambia: "Couldn't you reduce prices by maybe five or ten percent? You may not even feel it."

Osamu Nagayama said there was no question that science and technology had contributed to improving global health care. "Since 1980 molecular biology and biotechnology have rapidly advanced," he said, noting the recent success in mapping the human genome at the beginning of this century. But now is not the time for complacency. "In developing countries rare and infectious diseases are becoming more and more serious," he said. Drug companies like his are treating the problem as a priority, but industry cannot meet the challenges alone. "Governments need to support and improve infrastructure, educate young scientists and fund research," he said. Above all, cooperation is needed between all stakeholders in the developed and developing world, he argued. "No single company or nation can do everything on its own."

Peter Singer described how the concept of Grand Challenges could be used to tackle major health care problems in different parts of the world. He described a Grand Challenge as, "a specific critical barrier that can be removed to significant effect for global health." Identifying and overcoming these challenges must be a collaborative effort, he insisted. It should bring together public bodies, private foundations, business and academia. Above all it should be flexible, allowing different alliances and collaborations to develop depending on the challenge. "It represents a kind of 'operating system' for development innovation. Innovation saves lives," he said.

Harald zur Hausen outlined the particular challenges the world faced in the fight against cancer. "There are close to 13 million new cases of cancer occurring every year," he explained. This is partly a result of population ageing in high and middle income countries, where cancer is primarily a disease of elderly people. But it is also causing serious problems in low income states. Rates of cervical cancer among women in certain developing countries are of particular concern. The Nobel laureate said the health care community needs to think carefully about how best to tackle cancer. Over-reliance on drugs and treatment is not necessarily the best option he said. "Primary prevention is the most cost effective method. Screening can reduce the incidence of cervical cancer by 70 to 80 percent."

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

201-A2: Challenges and Solutions for Renewable Energies

Chair:

- **Bamberger, Yves**, Scientific Advisor of the Chairman and CEO, Electricité de France (EDF); Member of the French Academy of Technologies, FRANCE

Speakers:

- **Al-Hinai, Hilal Ali**, Secretary General, Research Council of Oman, OMAN
- **Colombani, Pascal**, Chairman of the Board, Valeo, FRANCE
- **Kojima, Nobuaki**, executive vice president, global environment business development group Mitsubishi Corporation, JAPAN

- **Kirloskar, Vikram**, Vice Chairman Toyota Kirloskar Motor Private Limited (TKM), INDIA
- **Mesot, Joel**, Director, Paul Scherrer Institut (PSI), SWITZERLAND
- **Panigoro, Hilmi**, Chairman Commissioner Pt Medco Energi Internasional Tbk, INDONESIA
- **Vieau, David**, President and Chief Executive Officer, A123 systems, Inc., USA.

This panel discussed and debated the outlook and viability of renewable energy in order to lessen the global dependence on fossil fuels, which will also help reduce the negative impact on the environment. The time frame covered was 2010 to 2030, because beyond that, the “crystal ball gets a little cloudy,” as one attendee remarked.

Renewable energy sources have huge potential but they are not perfect: the debate on how useful they are must be rational, not passionate. In some nations with no traditional energy networks, renewable energy is bringing electricity to people. The world has a chance to introduce more renewable energy sources – but it needs a global vision of the order of putting “a man on the moon.”

While developed nations must focus on energy conservation and on alternative energy sources, developing countries must also focus on energy conservation in order to meet their own energy needs. A participant proposed a program of international cooperation to help developing countries define solutions and implement energy conservation. Developing countries often lack qualified personnel with expertise in renewable energy, so the solution is to boost vocational training programs to meet the need for skilled workers. More globally, renewable energy development requires a long-term time frame that is not compatible with the short-term nature of politics.

Fuel-cell development is progressing. Fossil fuel is cheap and easy exploit, so fuel cells need to compete with this market reality. The production and distribution of hydrogen required for fuel cells is an issue that has not yet been adequately addressed. Creating hydrogen takes energy, so the use of solar cells in the hydrolysis process is one answer if the cost becomes low enough. Some participants pointed out that hydrogen is not the right solution for safety reasons.

One participant remarked that all automobiles will need to be electrified to some degree. The development of advanced battery systems is the key to achieve this. The market share of hybrid vehicles is projected to reach 30% of all new vehicles by 2020. The drawback to purely battery-powered cars is their limited range, which will restrict them to suburban areas.

Why invest in renewable energy sources? Renewable energy, one participant emphasized, is going to be very competitive in the near future. The cost of solar power, for example, has dropped in the past few years from 40 cents per kWh to 25 cents per kWh. As oil prices are rise, the cost of renewable energy decreases. Japan for example spent \$190 billion on imported oil in 2008, and this figure projected to rise to \$459 billion by 2030.

One benefit of renewable energy, such as biomass, is the

possibility of electrifying rural villages. But the key is to develop stand-alone biomass power plants that can be built in rural areas.

One participant underscored the fact that electricity grids are not properly designed. “Smart” electricity grids need to be created to better manage peak loads. Transmission can be vastly improved by implementing super-conductivity technology, which “should be brought into the game.” Waste energy from power plants can be captured and then used to heat homes.

Renewable energy faces a hurdle: the so-called NIMBY (not in my backyard), or the reluctance of communities to adopt it. So government must get involved to educate people about the benefits of renewable energy. It was also stressed that the public must be given accurate and trustworthy information.

Investment in energy storage systems is needed so that power from wind turbines, for example, can be stored and then used when needed.

Finally, trade barriers must be avoided and renewable energy technology must be made available to all. But: “Being green is not enough, it has to be cheap,” concluded one participant. There is “no time to lose - every minute counts.”

201-B2: The Science of Aging

Chair:

- **Komiyama, Hiroshi**, Chairman of the Institute, Mitsubishi Research Institute, Inc, JAPAN

Speakers:

- **Correia de Campos, António**, First Vice Chairman of Scientific and Technology Options Assessment (STOA); Member, European Parliament, PORTUGAL
- **Dolphin, David**, Chair, Genome British Columbia, CANADA
- **Ganten, Detlev**, Summit President, World Health Summit, GERMANY
- **Nilsson, Björn, O.**, President, Royal Swedish Academy of Engineering Sciences (IVA), SWEDEN
- **Sies, Helmut**, Vice President, Lindau Nobel Laureate Meetings, GERMANY
- **Staudinger, Ursula**, Vice President and Dean, Jacobs Center on Lifelong Learning and Institutional Development, GERMANY
- **Watters, Jack**, Vice President, External Medical Affairs, Pfizer Inc, USA

This session examined the human condition of getting older, its social and practical consequences and how science can make a contribution to combat its negative effects. Panelists discussed a series of issues ranging from the causes of ageing, its economic and social ramifications and how society will and should adapt to take into account an ageing population. The aim is not just to live longer, but to achieve good health in old age. Participants noted that there are many fallacies and common age-related stereotypes and suggested a number of ways in which science and medicine can bring about change in this field.

The improvement in human life expectancy in many countries today is a natural outcome of better medicine and education, especially of women. Although to date population ageing is a phenomenon mainly in developed nations, developing countries such as China will soon face a similar situation. It is commonly asserted that our societies are heading for an economic ageing disaster. Participants suggested this may not be correct and ageing can create many unique opportunities and challenges that science and technology will need to address.

The process of ageing has both genetic and non-genetic components. Recent evidence shows that nutrition is an element and advantage can be derived from caloric restriction. There have been breakthroughs regarding which molecules govern the process of ageing. Molecular switches that modify our gene pattern resulting in the transformation and survival of an organism are now known. It was pointed out that although we derive energy from oxygen, it is a double-edged sword in that oxidative damage has serious consequences for ageing.

Participants also noted that vascular system complications are a common cause of ageing and death. Vascular health and the study of the skin are both very important areas in the science of ageing. Another factor is exercise. People who exercise at least three times per week have brains that perform at a demonstrably younger level of cognition than those who do not. It was mentioned that last year was the 150th anniversary of Darwin's theory of evolution by natural selection. Yet the idea of including evolutionary thinking into medicine is relatively new. We as humans may be stuck with our evolutionary history but we are not stuck with our medicinal or biological systems.

A recurring theme was the economic and societal consequences that ageing populations will bring. A participant pointed out that perhaps more than half of the children born today could reach the age of 100. Another participant voiced the view that some people born today may in fact live forever. Over the next 25 years, the number of people in the European Union over the age of 65 will grow by 2 million a year. All this will place severe strains on global pension systems and payouts. Current retirement ages in many Western countries are no longer sustainable. A recent economic study in Sweden recommended raising the retirement age to 72, and something of that sort will have to be considered in many societies around the world. People will need to work and pay into the system for longer than ever before. This is an area in which science and technology can help. Developing mixed teams of young and old people who are in competition with one another is just as important as the more traditional practice of mentoring.

One problem was identified as the negative image and stereotyping of the elderly in general. It was argued that these negative images actually shorten people's lives and individuals who view age negatively live on average seven years less than those who don't. The idea that cognition reduces with age is not necessarily true either. There needs to be a re-organization in our societies and workplaces to reverse or slowing age related decline.

Finally, the panel identified five major areas of research as key to the study of ageing. Firstly, physical aspects such as vascular ageing, muscular weakness, protein damage and nutrition. Secondly, social and economic research relating to national health care systems, the societal impacts of migration and the importance of financial resources for quality of life. Thirdly, the environment of ageing - from housing to assistive devices. Fourthly, healthy ageing: the monitoring, maintenance, promotion of health and well being of elderly people. Finally, 'user' involvement: how older people can have a say in the decision making process regarding the questions associated with ageing. Ultimately, dealing with the challenges and opportunities an ageing society presents will have to involve a multi-disciplinary approach embracing the social sciences as much the medical and technological fields.

201-C2: Business and Social Transformation enabled by ICT

Chair:

- **Hegarty, John**, Provost, Trinity College, Dublin, IRELAND

Speakers:

- **Atichartakarn, Suebpong**, Senior Vice President, Office of the President, Bangkok Bank Public Company Limited, THAILAND
- **Binh, Truong Gia**, Chairman, FPT, VIETNAM
- **Hara, George**, Ambassador, United Nations; Group Chairman and CEO, DEFTA Partners, JAPAN
- **Harayama, Yuko**, Deputy Director, Directorate for Science, Technology and Industry (STI), Organization for Economic Co-operation and Development (OECD), JAPAN
- **Patel, Ketan**, CEO, Greater Pacific Capital, UK
- **Whitney, Chris**, Director, Data Center Design for Cloud Computing Lab, Hewlett-Packard Lab Singapore, USA
- **Wold, Anders**, CEO, Global Ultrasound, GE Healthcare, UK

The all pervasive influence of information and communication technologies (ICTs) was ever present during this session. But as one participant explained at the outset, the aim of the workshop was not to assess where ICTs are now but where they may lead society in the future. "The intention is not to think about today but to focus on tomorrow," he said.

It was agreed that with such a wide-ranging subject, there was a risk that the session might simply skim the surface. "There is a danger of not getting into any depth on anything," said one speaker. Nevertheless, all participants agreed that the subject certainly merited discussion.

Many participants referred to 'Generation Y', young people in their twenties who have grown up with ICTs, the internet and social networking services like Twitter and Facebook. "Whole communities are organizing around these networks. A single twitter can circle the globe in an hour. Universities are full of young people who do not see any barriers," said one speaker. "Young people going to work in ICT companies today have a completely different relationship with technology than the

generation that went before them,” said another.

The way this generation of thinkers is likely to use ICTs to create new business, social and scientific models and paradigms was a central theme. One speaker explained how the rapidly expanding economies of China and India were poised to grasp the creative opportunities offered by ICTs. “In many ways we’re about to move to a “beyond ICT” era. The technology’s out there now. The most fundamental issue is what we do with it,” he said.

China and India were already grasping the potential of ICTs and that process is set to continue, another participant said. “Silicon Valley in the USA is going to feel the challenge from 50 new Silicon Valleys that have been set up in China and a dozen or so ICT hubs in India,” said one speaker. The two countries were also feeling the social effect of ICTs. For example, one participant pointed out that in China, “government control on information is slipping away and as it does, the people’s voice is being heard through the social networks.”

There is also a dark side to online social networking services as people’s private personal data can end up in the hands of private companies, government bodies and other organizations. “ICT is powerful and invisible. It gets hold of you and does not let go. It provides people with freedom but it can also reduce privacy and serve tyranny. It’s a great destabilize in society” said one speaker.

The service sector is also keen to keep exploiting the potential of ICTs in the future. The banking sector is keen to use new technologies to develop bespoke banking services, tailor-made to individual customers’ needs. “In the future the bank will be really close to you through your mobile phone or social networks,” said a speaker.

ICTs can also help to create new business models for the developing world. One participant explained how information technologies are being used to develop socially aware companies in countries like Bangladesh and Nigeria. These firms donate up to 40 percent of their profits to local not-for-profit groups that help local people. Another participant said that while such schemes are laudable, they would get nowhere if they were not economically viable.

Many participants agreed on the fact that when it comes to creating new ICT opportunities in the developing world, simply repeating the experiences of rich countries is not an option. As one speaker said: “We need to find new business models. The developed world’s models are limited.”

Another participant returned to the theme of profitability when it comes to new ICT services in emerging economies. “If we are to develop services, someone must pay for them, even if it is only a small amount. That is the way to make new ICT models viable,” he said.

Everyone agreed that making the changes needed to usher in a new ICT era will not always be easy. Said one participant: “Change can be painful. People like what they are used to and don’t always want to try new ideas. It’s very difficult to change the way we do business.”

201-D2: Collaboration among Academia, Industries and Government

Chair:

- **Dijkgraaf, Robbert**, President, Royal Netherlands Academy of Arts and Sciences (KNAW), NETHERLANDS

Speakers:

- **Amirinia, Hamidreza**, Scientific Advisor to the President, Chairman, Technology Cooperation Office, IRAN
- **Aragão de Carvalho Filho, Carlos**, President, National Council for Scientific and Technological Development (CNPq), BRAZIL
- **Arigoni, Fabrizio**, Head of Nestlé Research Tokyo, Nestlé S.A., ITALY
- **Camacho Solis, Manuel**, Director, Proyecto Omega, S.C., MEXICO
- **Chi, YoungSuk**, Vice Chairman and CEO, Science & Technology, Elsevier Inc., USA
- **Derian, Paul Joel**, Group Vice President in Charge of Research & Technology, Rhodia, FRANCE
- **Fortier, Suzanne**, President, Natural Science and Engineering Research Council of Canada (NSERC), CANADA
- **Gergils, Håkan**, CEO, Ecofin Invest AB, SWEDEN
- **House, Chuck**, Executive Director, Media X at Stanford University, USA
- **Inoue, Akihisa**, President, Tohoku University, JAPAN
- **McGagh, John**, Head of Innovation, Rio Tinto, Plc., AUSTRALIA
- **Nomakuchi, Tamotsu**, President, National Institute of Advanced Industrial Science and Technology (AIST), JAPAN

This session looked at how links between industry, the academic world and governments could be strengthened. Participants asked what kinds of bridges can be built between the three sectors and tried to identify over-arching issues of common concern. As part of this process, it was important to take young peoples’ views into account, the session heard. Industry also had a role to play in promoting cooperation at various levels.

Trying to balance the academic world’s need for the freedom to publish with industry’s need for competitive advantage through intellectual property control is an ongoing challenge. Very careful management of such issues is required. Constant dialogue must be maintained to keep abreast of changing situations. Identifying business opportunities and coordinating research with manufacturing capabilities are required for delivering workable technology solutions. “Policy transfer” as a means of building stronger links was also suggested.

Encouraging academics to work in industry can produce effective results. They gain a greater understanding of how industry works and companies benefit from outside input.

Participants also highlighted how ventures such as public-private partnerships and groups of businesses with particular specializations, known as ‘competency clusters’, could help reinforce links between industry, academia and government bodies.

An effective knowledge-based economy requires extensive consultations based on new strategic developments and thorough evaluation. In addition, increasing requests for access to knowledge, expertise and new talent are having a major impact on the teaching environment in many universities. Participants also heard of the need to improve access to information for small and medium-sized enterprises.

The status of developing countries was also discussed, with a number of models for collaboration suggested. The “triad” model of having academia, industry and government work closely together was considered the model of choice, although some participants reminded the session that “one size does not fit all.”

Merging industry, academia and government bodies to form a “hybrid” organization in certain situations was suggested as a way of spreading risk through enhanced intellectual property protection and the sharing of profits. However, some participants from emerging economies said that intellectual property protection was considered secondary in some states. Institutes or laboratories attached to universities were suggested as another way of building links between the different sectors.

It was also agreed that any successful and lasting relationships between academia, industry and public bodies had to be built on credibility and trust.

201-E2: Sustaining Forests

Chair:

- **Winter, Alan**, President and CEO, Genome British Columbia, CANADA

Speakers:

- **Luers, Amy**, Program Manager of Environment and Vulnerability Mapping, Google Incorporated, USA
- **McBean, Gordon**, Chair of the Board and CEO, Canadian Foundation for Climate and Atmospheric Sciences (CFCAS), CANADA
- **Nobre, Carlos Afonso**, President, The International Geosphere - Biosphere Program (IGBP), INPE Brazil, BRAZIL
- **Suzuki, Kazuo**, President, Forestry and Forest Products Research Institute (FFPRI), JAPAN
- **Western, David Jonah**, Chairman, African Conservation Center (ACC), KENYA

Forests provide a great number of benefits to humankind and other species of the planet. They shelter biodiversity, store and purify water, protect us from natural disasters like floods and landslides, provide a great variety of economic products, serve as important cultural resources, and perhaps above all, they act as the planet's lungs, taking in CO₂ and outputting oxygen on a tremendous scale.

Deforestation is a two-fold blow for the earth – it is not just a source of greenhouse emissions through the burning and decomposition of cut plant matter, it also represents a loss of carbon sink – so it is imperative that the global community react immediately to stop deforestation from progressing

further.

The forests themselves are also in danger from the very climate change they could help prevent - perhaps far more than we realize. Rising temperatures bring new threats, like wildfires and the proliferation of pine beetles currently rampaging across the forests of British Columbia. Changing climates will result in changing ranges of ecosystems – but this may not be as simple as some think. Other factors like soil composition do not alter as easily as temperature zones. Forest biomes may face tipping point thresholds. For example, it has been estimated that should the Amazon suffer deforestation exceeding 40% of its total area, the basic Amazon biome may shift away from rainforest towards something more savannah-like.

What do we need to prevent further deforestation? Do we have the tools to protect our forests through evidence-based action?

In the realm of science and technology, monitoring methods have improved significantly with increasingly detailed satellite data, organized through tools like the Google Earth Engine. Ground-based efforts to quantify ecosystem services are also taking off with initiatives like the Natural Capital Project's InVEST. In terms of guidelines and policies, there is the UN-REDD program (“Reducing Emissions from Deforestation and Forest Degradation”), though it alone is not considered to be nearly enough.

Revolutionary new paradigms are needed, especially in developing countries. The economic gains local people derive from deforestation, for example in Brazil, are actually quite small (though vital to their lives) – small enough that an international consortium of some sort could probably provide equal compensation. But that would not solve the root problem. The real challenge is in providing a new economic model to replace the one that led to deforestation in the first place. The poor people of the world always have aspirations towards development and these should not be denied. At the same time, the development path originally taken by the West is not necessarily a good example to follow.

Solutions will require the intensification of local agricultural productivity and innovation in terms of new products obtainable from forests as well as new ways of compensating the local inhabitants for good forest management. More people can actually lead to less erosion and less deforestation if better agriculture is practiced and the people realize the value of the local forest resources and take charge of them themselves. One heartening development is the “Parks Beyond Parks” initiative in Kenya where there is now more biodiversity in the community-run park areas than in the national parks.

Major new knowledge creation and education initiatives are needed within the countries of the forests themselves. So is the establishment of science and technology centers in the tropics and other developing areas.

This applies not only to countries with mega-forests but to everywhere else. Countries with smaller, marginal forests (coastal, mangrove, highland, etc.) are often those facing the most danger. Moreover, local pastoral communities

often depend highly on these limited forest spaces for water security, culture heritage, and forest products.

It is now essential to reconsider how the value of forests is measured. Even if it were somehow possible to measure the total economic value of CO₂ absorption, watershed control, disaster mitigation, and all the myriad forest products, there would still remain the question of the cultural and spiritual value of forest areas.

It has become clear that a holistic systems approach is absolutely vital to planning a future in which humankind can thrive together with its forests. Such an approach must take into account not just economic but also cultural concerns. A long-term view is needed that considers the quality of life of our grandchildren and not just the tempests of election cycles. A multi-lateral, multi-cultural, multi-agency approach would foster collaborative action. Above all, a holistic approach must encompass issues ranging from population, health, energy, climate change, biodiversity, water, and food that have often been treated separately in the past but are in reality intimately connected.

201-F2: Developing Human Habitat: Water

Chair:

- **Zehnder, Alexander**, Scientific Director, Alberta Water Research Institute, Alberta Innovates - Energy and Environment Solutions (EES), SWITZERLAND

Speakers:

- **Chua, Soon Guan**, Assistant Chief Executive, Public Utilities Board (PUB), Singapore's National Water Agency, SINGAPORE
- **Desmarescaux, Philippe**, Chairman, BioVision; Vice President, Scientific Foundation of Lyon, FRANCE
- **Patry, Gilles**, President and CEO, Canada Foundation for Innovation (CFI), CANADA
- **Xia, Jun**, Hydrology and Water Resources Specialist, Chinese Academy of Sciences, CHINA

This discussion revealed the complexity of water issues in our rapidly globalizing world. Water is necessary for human survival and is a critical resource for industry, economy and society. Participants actively discussed what science and technology can do to help mitigate water problems and considered under what circumstances proper policies can be effectively implemented.

A human being can survive without food for weeks or even months but cannot live without water for long, sometimes less than two days. In addition to quantity, the quality of water is critical for human health. In a disaster situation, water is often the first thing lacking. The infrastructure through which water is distributed to a population in a city or village is essential.

Some large cities like Singapore have no natural aquifers or ground water, making water resource management a huge challenge. Rapid urbanization, over-population and pollution, as well as natural catastrophes like drought and flooding all complicate the issue of water management. By investing in water technology and adopting a long-term,

integrated approach to water, Singapore was able to develop a diversified and sustainable water supply system. This has become a model for other countries.

It was also noted in the discussion that while technological solutions to water management exist, water issues must be seen in a socioeconomic context if effective solutions are to be found. Advanced membrane technologies (microfiltration, reverse osmosis and ultraviolet disinfection) have improved the cost-effectiveness of supplying clean water. However, proper government planning and political will are necessary to apply these new technologies. In addition, broad ranging communication programs are needed to educate the general public about water usage and conservation. Governments can begin to develop appropriate and sustainable solutions if they approach water issues as a complete and integrated range of issues, from supply to consumption.

"Understanding the person who is drinking the water is imperative," one participant added. Each country or region has a different environment and conditions that affect the way water is managed. Therefore unique solutions must be developed locally. In Australia for example, water conservation has become a part of the culture as children are taught the value and necessity of this resource. In other countries, water is in such abundance that it is free and often wasted. Populations in some developing countries who lack supplies are forced to use bottled water for drinking, despite a lack of comprehensive laws regulating quality or standards.

One speaker noted that proper pricing is necessary in order to encourage private companies to invest in developing water systems. Citizens will not value a resource if it is free and perceived as infinite. In the developed world, many water infrastructures are old and poorly maintained and water is wasted through leaks and corrosion. The security and vulnerability of water processing facilities and infrastructure in some countries is also a concern.

The existence of state-managed monopolies in some nations was cited as a challenge in maintaining an efficient water supply. Bringing the private sector into the equation means that competition is introduced and efficiency in water transportation and supply is improved.

Participants concluded that a local, integrated and systematic approach to water supply management in conjunction with public education are essential for the optimal use of existing water technologies. The management of the demand and consumption of water as well as a fundamental change in our water-intensive methods for waste disposal are vital areas of focus that are needed to ensure the sustainability of water in the future.

201-G2: Role of Media in Science & Technology and Related Policy Issues

Chair:

- **Alberts, Bruce M**, Editor-in-Chief, *Science*; Professor of Biochemistry and Biophysics, University of California, San Francisco, USA

Speakers:

- **Corbeil, Suzanne**, Director of Global Outreach Initiative, Perimeter Institute for Theoretical Physics (PI), CANADA
- **Kawai, Maki**, Executive Director, RIKEN, JAPAN
- **Kharrazi, Kamal**, Head of the Founding Committee and President of the Board of Trustees, Institute for Cognitive Science Studies, IRAN
- **Latour, Almar**, Editor-in-Chief, The Wall Street Journal Asia, NETHERLANDS
- **Schütte, Georg**, Permanent State Secretary, Federal Ministry of Education and Research, GERMANY

The increase in new media, in which data is instantly available through the internet and 24-hour news channels, has fundamentally changed the way in which the public accesses information. Journalists are under pressure to produce stories on much shorter time scales, which directly limits their ability to check their sources and facts. Studies have shown that only 12% of published scientific stories were researched in full, with most journalists relying on second-hand information. The internet has also led to a rise in user-provided information that can easily be mistaken for fact.

The problem is how to move accurate scientific information into the public domain. This is imperative so that people can understand the important issues that are facing humanity. This is crucial because if the public is well informed, it is in a position to directly affect policy makers and drive change in political thinking.

Gone is the time when respected news outlets were almost viewed as the “voice of God.” Nevertheless, there remains a very important role for media outlets in the public education of science. Factual accuracy is vital in science reporting. However, there appears to be traffic jams in the flow of information at the intersection between science and the media. With so much information, and some of it factually incorrect, journalists must act as a “common sense filter” for the public.

One panelist spoke of a science centre that was created as a place for journalists to check their sources and facts while also acting as an outlet for scientists to move their stories into the public domain. Other examples were also cited of the media forming links with universities and research institutes to ensure greater scientific accuracy of their articles.

The onus is not on the media alone. Scientists must learn that when they want to educate the public on scientific matters, they cannot present the information in the same way as they would for a scientific journal. A scientific story must become personally engaging, current and directly relevant to a newspaper’s audience. To take this further, a scientific story has to present not only facts, but also a ‘dream’ to the public. This may not always sit well with the scientists and the way they work, including the gradual progress, teamwork and peer reviewing that goes into a piece of writing destined for publication to a scientific audience.

In their desire to see more science in the media, scientists must nevertheless be careful not to ‘over-promise.’ For example, if the people are bombarded by news of cures for cancer, they will become cynical when these cures do not appear. The

public places a premium on depth and reliability in the articles they read. Journalists who write these articles need to know where to go to obtain credible information and this is why it is important to facilitate the forming of personal relationships between scientists and journalists. This would bring scientific spokespeople to the fore who can give respected, informed opinions on the important issues of today.

The media can have a great influence on the path that government policy will take, through its ability to shape public opinion. It may even have more power than that. One panelist even raised the question: what are the impacts of the media on the development of our brains and minds, including those of our children? There was a general agreement that youth is a very important target for scientific media, as such media could be instrumental in developing an interest in science amongst the younger generation. One suggestion was for media outlets to create an archive of online articles tailored for younger audiences. This could then be attached to core courses taught to students, relating to subjects such as energy, which could then spark an interest in basic science subjects. The creation of a knowledgeable, interested generation who can respond to and push for new government policy would change the way that government and science interact.

12:30 – 14:00 PLENARY SESSION

202: Working Lunch - Building a Post-Kyoto Protocol World

Chair:

- **Töpfer, Klaus**, Director, Institute for Advanced Studies Climate, Earth System and Sustainability Sciences (IASS), GERMANY

Speakers:

- **Brudermüller, Martin**, Member of the Board of Executive Directors and President, Asia Pacific Regional Division, BASF SE, GERMANY
- **Bucaille, Alain**, Senior Vice-President, Research and Innovation, Areva Group, FRANCE
- **Matsumoto, Hiroshi**, President, Kyoto University, JAPAN
- **Ramadorai, Subramanian**, Vice Chairman, TATA Consultancy Services Limited (TCS), INDIA
- **Romero Hicks, Juan Carlos**, Director General, National Council for Science and Technology (CONACYT), MEXICO
- **Sakakibara, Sadayuki**, Chairman of the Board and CEO, Toray Industries, Inc.; Vice Chairman, Nippon Keidanren (Japan Business Federation), JAPAN

Klaus Töpfer opened the discussion with an overview of progress made since the Kyoto protocol was signed in 1997 in the very building where this year’s STS forum was taking place. There was no getting away from the fact that more could have been done, he suggested. “It took eight years until the Kyoto protocol entered into force and even then the United States was not a partner,” he said. Efforts to move the Kyoto process forward at 2009’s meeting of signatories in Copenhagen had effectively stalled, he added. The meeting “was not a great success. It didn’t produce a Kyoto style agreement,” said the former German environment minister. Later in the discussion Töpfer argued that he didn’t expect

2010's meeting of signatories in Cancún, Mexico to produce a binding agreement either. But this was not necessarily a disaster. What mattered in Cancún was restoring some of the confidence that had been lost in Copenhagen. "If you can do this, you are already doing a great job," he said.

Martin Brudermüller shared his thoughts on the Kyoto protocol while outlining his predictions for the future of global agreement on climate change. He is convinced that there will be no globally binding agreement in the coming years and that we are even further away from having an agreement on precisely what needs to be done and who should be responsible for it. Despite being aware of the action needed, it is unlikely that countries like China and the United States would accept national sacrifice with harsh economic repercussions that would hamper growth. Looking forward, the focus should be on defining global rules for monitoring and verification as well as coming to an agreement on a global CO₂ price. Additionally, defining international labeling standards would allow consumers to compare the efficiency and carbon footprint of the products and services they buy. Innovation in science and technology is the lever as it will help improve the efficiency of our industries, one step at a time.

Hiroshi Matsumoto stated that although it is clear what must be done to stop climate change, this feat would require drastic social and industrial change on a global level. Many countries however are neither aware of the necessity to change or prepared to implement new policies. He noted the environmental problems that affect the earth affect the entire human race, at global, national and local level. He said that there is a paradox because humans continually seek stability and security in a constantly fluctuating world. Simply put, the earth is not in trouble because it has always undergone changes. It is the human race and modern society that are in trouble. Ultimately, science and technology will help us adapt to our changing climate but we must also deepen our understanding of our predicament by understanding our own desires. Effective mitigation of climate change can be achieved through a combination of technical, systemic and social measures.

Subramanian Ramadorai discussed the role of governments and business in mitigating climate change post-Kyoto protocol. Counter intuitively, he stated that the key to success in mitigating climate change lies with our corporations, not government. While government charts the national agenda and the focus areas, it is industry that translates this into action. If corporations build momentum, government will feel the pressure to support them with the right regulatory environment. He also noted that progressive corporations could take a leadership role by building robust economic sustainability as well as balancing out the ecological and economic components. In addition, corporations should contribute to improving the performance of both industry and communities with regard to their impact on the environment. They can take the lead in adopting and promoting new technologies that optimize resource allocation and low carbon options. He also suggested that solutions could be found in the world's collective, cumulative wisdom and traditionally sustainable customs. These need to be respected, valued and blended with modern day advances in science and technology as we strive to find solutions for climate change.

Sadayuki Sakakibara agreed that science and technology are key to mitigating climate change. However, he focused on the importance of what he called the "lifecycle perspective" when assessing products. The lifecycle perspective seeks to assess the environmental impact of a product for its entire lifecycle, calculating the net CO₂ emitted during production, through usage and after disposal. He also cited carbon fiber as an alternative material for aircraft, automobiles, wind turbines and reverse osmosis membranes. He expressed hope that by implementing a full lifecycle approach along with innovations in science and technology, emission reductions can be achieved at a global level in a way that is compatible with global economic growth.

Alain Bucaille explained that current research on climate change has meant that the debate has been reduced to two specific issues: choosing the best way of giving a value to carbon and then convincing world governments to agree to negotiate on this value. However, he argued that the topic should be extended to bring public opinion on board, starting with the OECD member countries. He added that countries should look beyond their own political specifics and integrate their commitments to various international treaties into their constitutions. In addition, all economic and financial sectors should be involved in the discussions and they should recognize that emission permits and carbon taxing are only part of what is required. In conclusion, it is clear that the technologies for solving the climate change issue exist or are highly likely to exist by 2015, and their costs should amount to less than the equivalent of 18 months worth of growth. The key question is how to define a system that fosters their implementation.

Juan Carlos Romero Hicks voiced his expectations from the Mexican federal government's perspective, for the upcoming COP16 to be held in Cancun, Mexico. Thus far, each meeting has been a stepping stone towards progress, with transparency, mutual trust and coordination continuously improving between host and participant nations. For COP16, the Mexican proposal is focused on building trust via inclusive, open dialogue while convening in small groups and focusing on substance not legalities. It is also the role of facilitators to press for agreements and not just chair discussions. He also cited 5 key issues for progress on climate change: a shared long-term vision, mitigation and adaption strategies, technological innovation and effective financing in the form of a fund for pooling public resources. While results for COP16 are highly anticipated, they can take many forms, running the gambit from an ambitious legally-binding agreement, to a simple reconstruction of mutual trust. "The challenges ahead are great but our will must be even greater".

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

203-A3: The Nuclear Energy Option

Chair:

- **Rubbia, Carlo**, Scientific Director, Institute for Advanced Sustainability Studies (IASS), Potsdam; Nobel laureate in Physics 1984, ITALY

Speakers:

- **Fuller, Jack**, Chairman, GE Hitachi Nuclear Energy, USA
- **Kondo, Shunsuke**, Chairman, Japan Atomic Energy Commission, JAPAN
- **Lelli, Giovanni**, Commissioner ENEA (Italian National Agency for New Technologies, Energy and the Environment), ITALY
- **Suzuki, Atsuyuki**, President, Japan Atomic Energy Agency (JAEA), JAPAN
- **Zerbo, Lassina**, Director, International Data Centre (IDC) Division, Preparatory Commission for the Comprehensive Nuclear Test-Ban Treaty Organization (CTBTO PrepCom), BURKINA FASO

The panel debated the future of nuclear energy. While interest is growing in renewable and alternative energy sources, nuclear power remains a key option as world demand for energy grows. However, safety and security issues must be addressed if it is to become more widespread.

Why invest in nuclear energy? The answer is that the world's population is rising and nuclear power must be considered to meet the demands of growing numbers of people who will all want to "live the good life." In addition, nuclear power has the advantage of replacing coal-fired power plants, cutting the release of greenhouse gases.

At the dawn of the nuclear age in the 1950s it was hoped that nuclear power would someday supply cheap and abundant energy for all the people on earth. That dream has not come true, and today only a small percentage of the world's energy comes from nuclear power. Yet interest is growing again and many countries are eager to exploit this energy source.

Nuclear power faces serious and pressing issues - in particular the safe disposal of waste, plant safety, and the development of new technologies, such as fusion reactors.

The three "R"s of nuclear energy are: Repository, or the storage of radioactive waste; Recycling, and Reprocessing. One participant said recycling is on the verge of being viable and will "eat up" plutonium.

How can nations be assisted in the developing nuclear power? Most newcomers face great financial difficulties in building the reactors, so monetary and technological assistance are needed to help these countries in the endeavor. This international cooperation should, in turn, help them adhere to and abide by international non-proliferation frameworks.

Will the nuclear-power industry be able to shake off public concerns over the risks? Will there be a renaissance of nuclear energy? Because of nuclear accidents such as Chernobyl and Three-Mile Island, public anxiety over the safety of nuclear energy must be addressed. If another bad accident occurs it may set the industry back by 20 years, a participant warned.

The safety and security of radioactive waste is also a great worry. It is therefore vital to show the public that the technology exists for the safe management of waste. Transparency and education initiatives are crucial in order to gain public trust. Public awareness campaigns are important in order to ensure that people receive accurate information and understand the

benefits of nuclear power. "If people are not informed, they are not involved," said a participant. The consensus was that the nuclear industry has not done a good job of educating the public.

The development of new nuclear technology is a long-term process that requires international co-operation to bring about fruitful implementation. Investment in R&D will be crucial to the development of the next generation of nuclear-power systems. Strong national energy policies are needed to promote nuclear energy.

One threat is the menace of terrorism. Nuclear materials are one of the most dangerous substances when it comes to the terrorist threat. In addition, non-proliferation treaties must be ratified to curb non-civilian or potentially aggressive uses of nuclear power.

Another danger comes from nuclear waste, so international control mechanisms are vital to safeguard the radioactive material. Disposal is a key challenge and geological disposal, or burial deep underground, is one answer. No country has come up with a good solution for handling radioactive waste, so global cooperation is mandatory. A nuclear waste repository on each continent was offered as a solution to avoid the dangers of ocean shipping.

Some 440 nuclear plants exist in the world, and it is estimated that an additional 150 gigawatts of nuclear power will come online by 2020. Although the cost of building nuclear facilities is much higher than other types of power plants, they last 60 years and the operational costs are low. Thorium was suggested as a cheaper and safer nuclear fuel alternative because it is not a fissile material, which would reduce the problem of disposal. This could boost nuclear power use and help meet the global demand for energy without contributing to the release of greenhouse gases.

203-B3: New International System to Fight Infectious Diseases

Chair:

- **Hacker, Jörg**, President, German Academy of Sciences Leopoldina, GERMANY

Speakers:

- **Chen, Chien-Jen**, Distinguished Research Fellow, Genomic Research Center, Academia Sinica, CHINESE TAIPEI
- **Farrar, Jeremy**, Professor of Tropical Medicine, Director, Oxford University Clinical Research Unit in Vietnam, UK
- **Hamid, Eisa Bushra Mohamed**, Minister of Science and Technology, SUDAN
- **Lewanika, Mwananyanda**, President, Zambia Academy of Sciences, ZAMBIA
- **Taneepanichskul, Surasak**, Dean, College of Public Health Sciences, Chulalongkorn University, THAILAND

The session opened with a graphic explanation of why the fight against infectious diseases is such a pressing issue for the global community. "In the middle ages, the bubonic plague took five years to spread across Europe from Italy to

Scandinavia. Last year, H1N1 went round the world in five days," said one speaker referring to the outbreak of so-called swine flu that affected countries across the world.

In today's interconnected, global village, distance is no longer the natural barrier to infection it once was. A person infected with a disease can board a plane in Japan and half a day later be on the other side of the world. In the age of globalization, goods bearing potential pathogens are permanently moving around the planet.

In addition, climate change means many diseases are beginning to migrate beyond the areas with which they are traditionally associated. "I was recently speaking with a French health care expert who was very worried about cases of dengue fever being reported in southern France," said one participant.

In such a situation the need for effective, coordinated measures to tackle the spread of infectious diseases seems more pressing than ever. But for many speakers, the system is still patchy and poorly linked up. One participant went so far as to say that the World Health Organization (WHO), the UN body responsible for coordinating international health policy, was "not fit for purpose."

Speakers argued that the WHO could be overly bureaucratic and lacked the ability to act swiftly and decisively when health crises loomed. It also tended to plan to fight the last pandemic to strike the planet rather than trying to anticipate the one to come. The reaction to the 2009 swine 'flu pandemic was an example of this. "We prepared for a bird 'flu that would come out of Asia and be nasty. What we got was a pig 'flu coming out of Mexico and it was mild," remarked one speaker.

Many participants felt that the reaction to the swine 'flu pandemic was actually relatively successful, but also pointed out that the H1N1 crisis was not entirely unexpected. "We shouldn't forget that we've spent a lot of time preparing for influenza," said one speaker.

Other participants argued that the response to H1N1 had been very impressive because the pandemic affected rich countries such as the USA and many European states, which were prepared to fund the measures needed. When outbreaks of infectious diseases threaten poorer nations, the reaction is not always as exemplary, argued a number of speakers.

This needs to change, they said. Coordinated action to tackle pandemics effectively is in the interest of both the developed and the developing world, several speakers agreed. "The chain is only as strong as the weakest link," said one participant, adding that "the recent experience of HIV and AIDS, SARS and the H1N1 virus shows that there is a thin line between domestic and international health problems."

Other speakers said a radical overhaul of the way the global community tackles infectious disease pandemics must be undertaken. "Needs assessment is vital and we also require a global revision of the surveillance system for pandemics," said one.

Another participant said that much better coordination is

needed between the WHO and the UN Food and Agriculture Organization (FAO), which handles many animal health issues. Recent pandemics like bird and swine flu have shown graphically how infectious diseases can affect animals and humans alike. "Working on the link between animal and human health is still a problem," said one speaker, adding that better coordination between the UN bodies would go some way to redressing the issue.

The question of coordination was cited repeatedly as the key for improving the fight against infectious diseases. But in order to be really effective, this process of exchanging information needs to be widened beyond traditional actors like the WHO and national public health authorities. "In developing countries the issue of public/private partnerships is important," said one participant, arguing that in the right context, the private sector can provide some important links in the chain of protection against pandemics.

Other participants added small, local drug companies could link up with big multinational firms to create what he called, "new systems" for fighting infectious diseases. One speaker summed up the general mood. "Sound surveillance systems require the mobilization of all resources," he said. As the session closed, all participants agreed that there was still a great deal of work that remained to be done.

203-C3: Security in the Age of ICT

Chair:

- **De Biase, Luca**, Science/Technology Chief Editor, Il Sole 24 Ore, ITALY

Speakers:

- **Asthana, Atul**, Vice President Global Standards, Research in Motion (RIM), CANADA
- **Cohen, Jay**, Principal, Chertoff Group, USA
- **Dzinotyiweyi, Heneri**, Minister of Science and Technology Development, ZIMBABWE
- **Naik, Praful**, Executive Director, Chief Scientific Officer, Bilcare Limited, INDIA
- **Piou, Olivier**, CEO, Gemalto NV, FRANCE
- **Riera Madurell, Teresa**, Member, Committee on Industry, Research and Energy (ITRE); Member, European Parliament, SPAIN
- **Saito, William**, Professor, National Graduate Institute for Policy Studies, JAPAN

This session examined the threats to security and society posed by the Internet and the proliferation of connected global networks. Panelists discussed a series of issues arising from the threat of cyber attacks and discussed how risks could be mitigated and controlled. The potential seriousness of the cyber threat was emphasized while a distinction was drawn between the civilian and military spheres.

The Internet is not secure and nor is it likely to be in the future. At present there are no software-only solutions to security problems. The recent cyber attack on Estonia was mentioned as a turning point when people woke up to the reality of the Internet as a potential theatre for warfare. Cyber-terrorism as a part of conflict is no longer the stuff of science fiction: it is

likely and carries a high level of consequence. Examples of cyber threats becoming reality include an attack carried out on a power generation facility in South America that caused power loss for ten days. There was also an incidence of external electronic manipulation of a certain country's stock market. Panelists raised the question of what trade-offs would have to be made to provide protection and whether threats can be averted and yet allow the same levels of freedom that we enjoy today.

The World Wide Web, through the Internet, has transformed itself from being an information source to something that has become a part of everyday life. It is becoming less secure, personal data is being stolen more frequently and identity theft is becoming a greater problem than ever before. Some of the potential current and future risks discussed included the possibility of an outsider taking control of a network and disrupting services that depend on that network. Examples include smart grids, meters and power generation. And as we become more connected, the possibility arises of killing someone by denying them the medical treatment they rely on was suggested as another example. The risk associated with being held to ransom through a compromised network was also raised.

A recurring theme was personal identity. The issue of how an individual's electronic identity and privacy can be protected is vital. Protection against information and computing technology threats must be seen as a public good. It is incumbent upon governments to learn what the threats from ICT are today and protect against them. There are ever-increasing opportunities to conduct cyber crime and with this come rising costs. An urgent solution must be found to the problem of data security and privacy. The right balance must be struck between freedom of information and security and the level of danger that we are willing to tolerate.

Financial and personal transactions across the web are increasing all the time. E-government is also an enormous growth sector. Through these mechanisms a cyber attack could cause serious disruption to a country. In the future as networks and vital systems in all countries become integrated further still, enemy domination could occur not only through traditional means but also at cyber level. Different security requirements both in military and civilian life need to be established. The raising of these multi-faceted concerns at international level through an organisation such as the United Nations would give the issue the recognition it desperately needs.

Finally, the panel suggested the creation of an Internet equivalent of the World Health Organization (WHO), a "cyber-WHO" dedicated to Internet health and safety so that it can become a sustainable resource for mankind. Such an organization could address many of the problems of today. Although this would not solve the problem of cyber war between states, the vast majority of issues that people are concerned about at civilian level could be addressed and mitigated. Often computers can be remotely checked for viruses and threats using the internet. Many users or organizations often don't even realize when they have been compromised. The solutions to remedy and repair many of these problems already exist but cannot at present be

implemented due to legal limitations. In the same way that the WHO mobilizes teams in response to an outbreak of swine flu, a "cyber-WHO" could mobilize teams and resources for affected computer systems. Internet safety and security will require international cooperation. Data flowing across political and national boundaries raises serious issues of jurisdiction, control and enforcement. The Internet is borderless and does not observe national boundaries. No one country can fully control its own Internet security and this issue should be addressed at international level.

203-D3: Transforming Universities for the 21st Century

Chair:

- **Córdova, France A.**, President, Purdue University, USA

Speakers:

- **Abouleish, Ibrahim Ahmed**, Founder and Chairman, SEKEM Group, EGYPT
- **Chaudhuri, Subhasis**, Dean, International Relations, Indian Institute of Technology, Bombay (IIT-B), INDIA
- **Huber, Bernd**, President, Ludwig-Maximilians-University (LMU) of Munich, GERMANY
- **Natera, Angélica**, Program and Development Officer, Harvard University, USA
- **Rock, Allan**, President and Vice-Chancellor, University of Ottawa, CANADA
- **Seike, Atsushi**, President, Keio University, JAPAN
- **Wiesel, Torsten Nils**, President Emeritus, Rockefeller University; Co-Chair, Board of Governors, Okinawa Institute of Science and Technology (OIST); Nobel Laureate in Medicine or Physiology 1981, USA

This session focused on transforming academic institutions in the 21st Century through knowledge bases that can be shared globally. Diversity, interdisciplinary activities and sustainability, were judged to be keys to the transformational process. Several ideas were put forth, such as "commoditization" of education and the systematic adoption of "best practices." Participants also suggested the use of Internet technology to help improve economic viability and strategic planning. It is also important to motivate all the stakeholders in universities into supporting the transformational process.

Changing teaching practices by adopting "best practices" in order to strengthen education at universities entails encouraging faculties to increase their own skill levels and show willingness to submit to assessments and adopt new goals. This is likely to be a challenge. Reference was made to an earlier session on science and engineering education, which emphasized the need to ensure students are better prepared for the outside world. Shrinking public budgets for education means that new models are needed to attract future funding.

Four transformational changes are foreseen: internationalization, engagement in the community, further "interdisciplinarity" and the democratization of universities. Involvement in the commercial world and collaboration with industry and government are additional driving forces behind transformation. Nevertheless, it is important not to lose sight

of the basic role universities play as educational institutions and research centers in the community.

Several possible solutions for transformation were suggested. One recent Japanese model strives towards originality and creativity with emphasis on faculty and student interactions with the local community, and on communication and languages.

Also discussed was the idea that a scientific perspective could be taken when looking to transformation. This means discovering a problem, offering a hypothesis to explain the situation, verifying the hypothesis and reaching a conclusion.

The issue of intellectual property at universities was another point of debate and in this context, the role of universities in disseminating technology was considered to be vital. Moreover, there is a need to maintain balance between teaching the basics to enable students to think on their own and imparting skill sets so that graduates are “employable.” Aspects of professional and continuing education were other points considered.

Participants looked at the structure of newer universities, both “broad-based” and specialized, and noted a clear trend towards smaller institutions, focusing on “excellence.” Accreditation and global standardization require consideration in order to establish equivalences between curricula, credits and degrees worldwide.

Universities in developed countries are facing reduced pools of local applicants owing to ageing populations and other trends and increasingly look to developing countries as promising new markets. They are forced to compete to attract young talent from abroad which is leading to greater development of their “brand” image. At the same time, the benefit of this phenomenon is the internationalization of what were once fairly parochial institutions.

203-E3: Sustaining Oceans

Chair:

- **Taylor, Martin**, President and CEO, Ocean Networks Canada (ONC), CANADA

Speakers:

- **Henocque, Yves**, Theme Leader Nature & Society of Prospective and Scientific Strategy, Ifremer (French Research Institute for Exploitation of the Sea), FRANCE
- **Imawaki, Shiro**, Executive Director of Research, Japan Agency for Marine-Earth Science and Technology (JAMSTEC), JAPAN
- **Iskandar, Marzan Aziz**, Chairman, Agency of Assessment and Application of Technology (BPPT), INDONESIA
- **Russom, Semere**, Minister of Education, ERITREA
- **Yamagata, Toshio**, Dean, School of Science, The University of Tokyo, JAPAN

This is the second year the STS *forum* has featured a session solely focused on oceans. Last year’s session identified as major issues ocean biodiversity and declining

fish stocks, ocean acidification, sea-level rise, and coastal zone management. It included a discussion of the need for advances in ocean observation systems to understand, predict, and mitigate the negative effects of ocean change.

The focus of this year’s session was on how to create stronger linkages between science and policy.

Speakers presented projects and spoke of specific issues and initiatives such as a network of data collection instruments, the study of the El Nino Southern Oscillation, and the informative case study for conservation presented by a pristine coastal environment. They also discussed challenges and issues with the global status quo for ocean science and policy.

Three key terms emerged repeatedly in the discussions: “interdisciplinary”, “international”, and “integrated”.

An interdisciplinary approach integrating diverse knowledge and technologies is essential to attain greater understanding of the oceans as complex integrated systems. The approach should encompass physical and chemical oceanography and marine biology, coastal ecosystem and deep ocean studies, as well as the socio-economic dimensions related to the human factors that impact ocean systems. Without this kind of overall vision, it is difficult to formulate clear, overarching plans of action that can be presented to policy-makers.

There is still a great deal we do not know about the oceans. International collaboration can play a key role in gathering the massive amounts of data needed to fill these vast gaps in knowledge. Cooperative initiatives between nations have already produced successful results on a number of projects ranging from studies of ocean currents to climate variation predictions and the deployment of tsunami warning systems. Many more such collaborations will be needed in the coming years.

The open sharing of information across international boundaries is no less vital. Whenever possible, this should not be limited to scientific data sharing, but also include translation into information and knowledge modules to facilitate research and exchange in ways that support policy applications. At the same time, it is important to uphold the principle that the core competence and key role of the research community is to inform and not create policy.

Furthermore, integration and international collaboration must be pursued not just among the scientific disciplines but among their associated international bodies as well. The different international organizations and treaties which deal with various aspects of the oceans all too often progress in parallel with insufficient cross-fertilization.

An especially important area in need of international multi-sectoral cooperation is the governance of the fisheries. Policies aimed at promoting the long-term sustainability of fisheries demand detailed information over time on the complex interactions between climate and ocean changes resulting from the combined effects of natural and human forcing factors.

On a final note, while it is clear that integration is imperative

to pursuing comprehensive knowledge and effective ocean policies, strong leadership is needed for integration to become reality. On a positive note, some national ocean strategies are emerging that demonstrate the types of synthesis and creative approaches required.

Participants closed the session by suggesting the creation of an international body to champion ocean issues and to frame and focus ocean policies. It could be similar to the Intergovernmental Panel on Climate Change (IPCC) in size and scope. This body would be tasked with key ocean science and policy communities together to integrate existing data, identify priorities for further research, and expedite knowledge translation and exchange to advance ocean policies globally.

203-F3: Developing Human Habitat: Adaptation to Climate Change

Chair:

- **Kennel, Charles**, Distinguished Professor Emeritus, Scripps Institute of Oceanography, University of California, San Diego (UCSD), USA

Speakers:

- **Brotto, Maria Theresa**, Senior Official, Consorzio Venezia Nuova, ITALY
- **Gaur, Vinod Kumar**, Distinguished Professor, Indian Institute of Astrophysics, Bangalore, INDIA
- **Hüttl, Reinhard**, President, acatech (German Academy of Science and Engineering), GERMANY
- **Ruto, William**, Minister of Higher Education, Science and Technology, KENYA
- **Watkins, Alfred**, Science and Technology Program Coordinator, The World Bank Group, USA
- **Yaari, Menahem**, President, Israel Academy of Sciences and Humanities, ISRAEL

The discussion on how science and technology can help human society adapt to our obviously changing climate was varied in scope and a highly attended session at the STS *forum* this year.

The scientific and technological innovations of the last century have given rise to unprecedented success in human development leading to a tremendous increase in global population, expected to be about 9 billion by 2050. These innovations and the industrial revolution they generated resulted in the exploitation of natural resources in order to sustain economic development. But, as a result of the over-exploitation of resources, environmental degradation has led to climate change, of which we are only beginning to feel the negative effects: unpredictable and hazardous weather, droughts or floods leading to food shortages.

There was consensus that immediate action at a grassroots level is necessary in order to mitigate as well as adapt to the effects of climate change. One speaker noted that, “due to the inertia of natural factors on climate dynamics, we cannot expect that a regulation of the global temperature can be achieved through mitigation alone.” The development and implementation of adaptation strategies is equally important.

Another speaker noted there must be a mechanism to develop “greater appreciation by the industrialized nations of the need to support the developing nations in managing the effects of climate change”. In addition, he noted that though developing nations are hardest-hit by climate change, they did not share in the benefits of the industrial revolution.

One speaker explained the need to both mitigate and adapt to climate change at the same time, noting that the effects are usually highly localized and have an impact on all levels of society, industry and commerce. Careful monitoring of global systems has helped compile data and develop scientific models. However, these models are uncertain and care must be taken not to present this information as fact. The effects of climate change vary depending on location and efforts should be made to study locally-developed solutions and adaptations. This knowledge should also be shared as widely as possible.

Since adaption to climate change cannot be successful without the engagement of those impacted in local communities, many speakers endorsed the urgent need to develop “Knowledge Action Networks.” These are managed social networks that link global science, technology and policy communities to local initiatives. This grassroots approach “creates a two-way flow of information, knowledge and methods between local communities, scientists, opinion leaders and decision makers, and their regional, national and global counterparts.”

These networks would be relatively inexpensive to establish and would be designed to have scalability, so that they might evolve into more complete systems in due course. In addition to funding, what is required in the initial formation of a Knowledge Action Network is a “vision and need that inspires committed participation by the individuals and institutions whose expertise is needed”.

In summary, a localized yet globally connected grassroots approach involving both mitigation and adaptation strategies is necessary to confront the effects of climate change. While it might seem like an enormous challenge, algorithmic integration of independently generated efforts around the world through Knowledge Action Networks can help speed up the process of adapting to climate change and all its regional social and cultural impacts. Every person and entity has a role to play in solving this problem.

203-G3: Perspectives from Young Scientists on Science and Technology in Society

Chair:

- **Winnacker, Ernst-Ludwig**, Secretary-General, Human Frontier Science Program (HFSP), GERMANY

Speakers:

- **Bordoni, Simona**, Assistant Professor, Environmental Science & Engineering, California Institute of Technology, USA
- **Costales Cordero, Jaime**, Assistant Professor, Center for Infectious Disease Research, Pontificia Universidad Católica del Ecuador, ECUADOR

- **Descrovi, Emiliano**, Postdoctoral Student, Materials and Microsystems Laboratory, Politecnico di Torino, ITALY
- **Eggleton, Benjamin**, Director, Institute of Photonics and Optical Science, University of Sydney, AUSTRALIA
- **Emori, Seita**, Chief of Climate Risk Assessment Research Section, Center for Global Environmental Research, National Institute for Environmental Studies, JAPAN
- **Managi, Shunsuke**, Associate Professor, Graduate School of Environmental Studies, Tohoku University, JAPAN
- **Marwala, Tshilidzi**, Dean, Faculty of Engineering and the Built Environment, University of Johannesburg, SOUTH AFRICA
- **Soljagic, Marin**, Associate Professor, Physics Department, Massachusetts Institute of Technology, USA
- **Stevens, Molly**, Professor and Research Director, Biomedical Materials and Regenerative Medicine, Imperial College London, UK
- **Xiong, Qihua**, Assistant Professor, School of Physical and Mathematical Sciences, Nanyang Technological University (Singapore); Fellow, National Research Federation, CHINA

This workshop was organized with the support of the Japan Society for the Promotion of Science (JSPS), in collaboration with the New York Academy of Sciences (NYAS). It brought together ten young scientists from around the world to discuss five important points that relate to the careers of the new generation. A wide range of delegates, including a Nobel laureate, joined this lively workshop focused on how to support young scientists in their ambitions.

Early career independence for young scientists was the first issue discussed. It was agreed that mentoring was important and should begin at high school level and continue beyond that. This mentoring should not focus on scientific work alone, it is also important to teach students and young researchers how to apply for their own funding. This would help ensure they do not remain tied to the research themes of their supervisor's funding. It is also important to connect young scientists to academies of science, even on fixed-term positions, so they can be in a position to promote their own research.

The need for female mentors for female students was also discussed. Young female students need to have a woman faculty member to act as a role model and mentor and also offer career and scientific advice. The current generation of young female scientists does not have this, but awareness of the issue has grown and the hope is that future generations will benefit from the lessons learnt. With the human resources now in place, it should become easier to attract young female students into a career in science.

It was generally agreed that collaboration in science is implicitly international. Therefore, it is important that from the undergraduate and graduate levels, young scientists should experience studying abroad in order to further their careers. The links they form and the independence they gain can only be of benefit. However, participants noted that it can be difficult for some people to adapt to life abroad and sometimes there is no infrastructure in place for students to take up these

opportunities. Some schemes are in place to address these problems. For example, in Europe it is possible to switch between universities without extra cost to the student or the government. This allows an internationalization of the student body and a broadening of its scientific horizons.

Strong differences exist in the various scientific cultures around the world, and such factors, along with economic conditions, result in both brain gain and brain drain. The problem of brain drain can be especially acute in developing countries, where students are sent abroad to study but then do not return home. Various ideas were voiced, including improving local scientific institutes and offering the top talent generous grants to return home. Also discussed was the idea of attaching a legal requirement to return to funding for overseas research. This was seen as dangerous by some, as it may result in people not leaving at all. But the truth remains that improving research institutes and economic conditions in some developing countries could take a long time.

Another issue concerned scientists living as a couple and it emerged that provisions varied drastically between different institutions and different countries. Even if there are facilities on offer, these tend to be very expensive if they are of a high standard. This, among other things, can prove to be a barrier to dual-career couples. One participant noted that even where salaries are high, there were still problems that lead to a disparity between sexes in science. It was concluded that creating the right conditions to help dual career couples would be of benefit to everyone.

Career prospects are important for all young scientists. With the USA generally offering the best salaries and most generous funding, many young scientists have long looked to America as an option on their career path. Participants in this workshop, however, did not seem to feel that not working in the USA would be a massive hindrance to their scientific careers. Many participants from Europe and Asia had worked in the USA, then returned home to successful careers.

Another suggestion to help the mobility of young scientists was to standardize tenure rules. The movement of young scientists was seen as very important, since it allows ideas to spread. Improved working methods penetrate into institutions and have a positive impact on conditions globally.

16:50-18:00 PLENARY SESSIONS IN PARALLEL

204-A: Impacts of ICT on Economy, Society and Quality of Life

Chair:

- **Kagermann, Henning**, President, acatech (German Academy of Science and Engineering); former CEO, SAP AG, GERMANY

Speakers:

- **Brzustowski, Thomas A.**, Chair of the Scientific Advisory Committee, Council of Canadian Academies, CANADA
- **Grünberg, Peter**, Scientific Staff at IFF-Institute, Forschungszentrum Jülich (Research Center Jülich); Nobel Laureate in Physics 2007, GERMANY

- **Ormala, Erkki**, Vice President, Nokia Corporation, FINLAND
- **Harris, Parker**, Co-Founder and Executive Vice President, Technology, Salesforce.com, Inc., USA
- **Tomita, Tatsuo**, President, Fujitsu Laboratories Limited, JAPAN
- **Vijaya Kumar, Ivaturi**, Chief Technology Officer, Wipro Limited, INDIA

Henning Kagermann opened the plenary session by pointing out that the impact of ICT on the global economy cannot be underestimated. Networks are getting faster and the speed of innovation is accelerating in every ICT-related field. Growing consumption, the expansion of services and the convergence of many different technologies are several trends he sees in ICT. Huge business opportunities are foreseeable in the ICT sector. Social networks are one example. Who could have predicted that Facebook would grow to have 500 million users? The questions are: is the impact of ICT different in different regions, and is the digital divide growing or shrinking? The next revolution will be in “smart everything” technology.

Tatsuo Tomita explained that Fujitsu is investing heavily in R&D and is aiming for a human-centric networked society. Cloud computing and mobile communications are the two areas of greatest growth potential. Cloud computing is the future core technology that holds limitless computing power. It will allow small companies to tap into advanced computing resources which will help them expand their business. ICT will aid in protecting the environment and in stimulating the growth of commerce and business. By 2030, 1 person in 3 in Japan will be over the age of 65, and ICT will aid in addressing the needs of an ageing society.

Thomas Brzustowski pointed out the economic importance of the user side of the ICT sector, where social processes often determine the rate at which impacts actually appear. He used the quotation “Students are to ideas what mosquitoes are to malaria,” to introduce the fact that many characteristics of ICT make it particularly fertile ground for student innovators. He called ICT the “young people’s sector,” because many of the most prominent technology companies in the world were started by students - Apple, Dell, Google, H-P, Microsoft and RIM, for example. And he expects the flood of innovation to continue in the future, particularly in social media.”

Erkki Ormala remarked that ICT in Europe is doing very well and there are great opportunities in the sector. The European Commission is supporting ICT because it sees it as a way to boost economic growth. In the future, mobile access will be the primary way in which people use the Internet. Nokia is working on understanding the impact of ICT on such areas as finance, health, education, society, etc. Nokia sees finance as one exciting area of growth for ICT. Some 1 billion people have a cell phone but do not have a bank account. Mobile banking is now a fast-growing area. ICT-based education is another area of great potential that can help students in the developing world. Africa is a fast growing market with great opportunities for Nokia, which has experience helping children in South Africa learn math via mobile Internet connections.

Nobel laureate **Peter Grunberg** observed that the amount of energy consumed in air travel and the power needed to run

the world’s computers is the same. He sees the growing use of teleconferencing as one area of ICT that can save energy by mitigating the need for air travel, which has increased exponentially over the years. Advances in ICT, such as Skype, are enriching our lives.

Parker Harris sees the Internet as a force of democratization that allows to everyone access data easily and cheaply. His company, Salesforce.com, is connecting people and businesses with a Facebook-like service. Savings from Salesforce.com’s system are passed on to customers. Facebook is “flattening the world” by allowing greater connectivity, and Salesforce.com is doing the same for business. He wondered why business software was not as easy to use as, say, eBay or Amazon. So his company built its service to be just as user-friendly. His company caters to all clients, large or small. Salesforce.com is active in giving back to society by allowing employees time off to help their favorite charity.

Ivaturi Vijaya Kumar said that ICT has been a “fix for the last mile” in telecommunications in India. It benefits the nation’s agriculture and has also proven helpful in improving health and in boosting the growth of rural banking via mobile technology. He also sees ICT assisting in the promotion of clean energy use.

204-B: Food, Nutrition and Population

Chair:

- **Serageldin, Ismail**, Director, Library of Alexandria, EGYPT

Speakers:

- **Greenwood, M.R.C.**, President, University of Hawaii System, USA
- **Kurokawa, Kiyoshi**, Professor, National Graduate Institute for Policy Studies, JAPAN
- **El-Beltagy, Adel El Sayed Tawfik**, Chair, International Dryland Development Commission (IDDC), EGYPT
- **Wambugu, Florence Muringi**, CEO, Africa Harvest Biotech Foundation International (AHBFI), KENYA
- **Hassan, Mohamed Hag Ali**, Executive Director, The Academy of Sciences for the Developing World (TWAS), SUDAN
- **Ongkili, Maximus**, Minister of Science, Technology and Innovation (MOSTI), MALAYSIA

Ismail Serageldin opened the session by highlighting some of the major issues regarding population, health, and food production. Some 1 billion people go hungry on a regular basis in the world today. Yet projections indicate that in the discomfortingly near future there will be 2.5 billion more mouths to feed. How on earth will we feed them? Production needs to vastly increase while still using approximately the same amount of land and water. The growing consumption of more calorically dense foods (animal protein requiring large amounts of feed) strains production and introduces obesity and other lifestyle diseases, including in the developing world. What is the role of governments in this picture? What is the role of scientists?

M.R.C. Greenwood insisted that if there is one word we should take home from this session, it is “convergence”. Broad themes have appeared repeatedly in this conference – climate change, water conservation, energy, biodiversity, population, health, communication – and all converge around one issue: food production. Climate change affects land fertility and therefore the type of crops can be grown. Energy needs drive the conversion of agricultural land to uses like biofuel crops, furthering pressure on land under food cultivation. Water shortages and water quality issues plague us regularly. The number of people suffering from obesity and other lifestyle diseases grows by the day. Food consumption patterns must change to become more sustainable and healthier, lowering the pressure both on our bodies and on the planet. Herein lies an opportunity for a great new alliance: physical and energy scientists should create a joint forum together with health and climate experts with food as its core the issue.

Kiyoshi Kurokawa spoke about issues of health and nutrition, especially among children. If the nutrition needs of very young children are not met at the right time, i.e. in first two years, their development – including brain development – can be irreparably damaged. There are many solutions: from working on health of the mother, to providing supplements and nutritionally enhanced crops. The private sector has especially high potential in this regard. Given that food companies already deliver products to people in developing areas on a daily basis, it is easy for them to incorporate CSR initiatives to add extra nutrients to already widely consumed foods like yoghurts, or to deliver nutrient powders and the like directly to the people. On the other end of the spectrum is the worldwide obesity epidemic and the growing numbers of other lifestyle diseases. Creative solutions like ‘Table For Two’ a Japanese NGO initiative, could be put forward such as linking “healthy menus” in the developed world with nutrition programs in the poorest countries. For example, if someone orders a “healthy menu” item at a restaurant, 20 cents would be donated to a nutrition program in a poor country in Africa.

Adel El Sayed Tawfik El-Beltagy deplored the fact that the world is not being managed in a sustainable manner. Resilience is being lost because all too often the knowledge discovered by scientists is not being put to use. Climate change threatens to displace 200 million people worldwide, particularly pastoralists. Their movement is likely to result in political upheaval and disruption. Some 60% of people in the developing world depend on agriculture for their livelihoods. A new paradigm of agro-management is necessary for their survival. Local assessments of ecosystems and the effects of climate change upon them are needed. Agriculture needs to become dynamic and knowledge-based. The know-how of the developed world must be made available to the developing world. Let us share and apply what we know, and commission studies into that which we do not.

Florence M. Wambugu addressed the subject of what biotechnology and genetically modified crops can contribute to African food security. The continent still imports 25% of its cereals, and the only net exporter of food is South Africa. Malnutrition and starvation are everyday issues in many regions. Increasing and enhancing food production are of the utmost importance, and in this, biotechnology can be extremely effective. In Africa, four crops in particular stand

as exemplary: nutritionally enhanced sorghum, banana, cassava and golden rice. Sorghum in particular shows great promise – it is drought resistant, heat resistant, grows well in arid climates, making it very well adapted to some regions of Africa, but in its natural state, it is nutrient-poor and difficult for humans to digest. Genetic modification adds significant nutritional value and better digestibility while maintaining the characteristics that make it a robust agricultural crop. Intellectual property around genetically modified organisms is not a simple discussion and can only be approached on a case-by-case basis. Royalty-free schemes are essential for poor farmers, and in these scenarios, charity by corporations is highly encouraged.

Mohamed Hassan reiterated the importance of science and technology, especially biotechnology, in addressing the food security issues that affect the world’s poor. In addition to biotechnological innovations such as drought-tolerant maize and pest-resistant sweet potatoes, there is a need to improve university-level education in low-income and least-developed countries. More local faculties of agricultural science are essential for building intelligent bridges between centers of science and farmers. Furthermore, academies of science must acknowledge the important roles they play in organizing science to address issues of global significance. An excellent example of this is former UN Secretary General Kofi Annan’s request to the InterAcademy Council to investigate how best to help African agriculture and boost food security.

Maximus Ongkili spoke of the role of government in promoting science. Governments must drive solutions informed by scientific evidence. But they must first believe that science and technology themselves offer a solution. Unfortunately, judging by national science budgets, that does not seem to be the case. Too often, the first budgets to be slashed in hard times are R&D programs. Yet the same governments insist that we must innovate to escape recession. Governments themselves must innovate - they must invest more in science and formulate national science policies; they must establish more local science institutions, and take care not to neglect natural and social sciences in doing so. They must protect intellectual property rights lest they damage incentives to innovate. Finally, they should reward scientists for important contributions.

08:30-09:25 PLENARY SESSION

300: Key Messages from Concurrent Sessions

Chair :

- **Goldin, Daniel**, Chairman and CEO, Intellis Corporation, USA

Rapporteurs:

- **[A] Kitazawa, Koichi**, President, Japan Science and Technology Agency (JST), JAPAN
- **[B] Rietschel, Ernst**, Past-President, Leibniz Association (WGL), GERMANY
- **[C] Kleiber, Michał**, President, Polish Academy of Sciences (PAN); Senior Advisor to the President of the Republic of Poland, POLAND
- **[D] Imboden, Dieter**, President, EUROHORCS (European Heads of Research Councils), SWITZERLAND
- **[E] Campbell, Philip**, Editor-in-Chief, Nature, UK
- **[F] Sackett, Penny**, Chief Scientist for Australia, AUSTRALIA
- **[G] Palis, Jacob**, President, Brazilian Academy of Sciences (ABC), BRAZIL

Daniel Goldin opened the session by saying that he had been struck by the incredible energy and commitment of participants at this year's forum. "I've become a lot more optimistic as a traveler on this planet as a result of my involvement with this conference over the years," he said. Like many other participants, he thanked STS *forum* founder Koji Omi for his vision in creating the event. He then quickly handed the floor over to the rapporteurs from the forum's seven tracks.

Koichi Kitazawa explained that one of the key findings of his track was that fossil fuels are here to stay, at least for the time being. "Transition away from fossil energy is necessary but it can't be achieved quickly," he said. Renewable energy sources had potential and were becoming more competitive all the time, but they were not yet ready to supply all our energy needs. "The problem is cost. Current sources are heavily subsidized and can't compete with fossil fuels," he said. It was also very clear that the world should increase its use of nuclear energy. Obviously this should be done with maximum respect for environmental concerns, safety and nuclear non-proliferation agreements. Finally, he concluded that while different states and regions would need to adopt different energy solutions, international dialogue was crucial.

Ernst Rietschel spoke of recent advances in human genome research that were revolutionizing modern medicine. "Not so long ago it took two years to sequence a genome. Soon we could be talking about two minutes or two seconds," he argued. Easy, fast access to genetic data could enable countries to completely re-think their public health systems, shifting the emphasis away from treatment to prevention of diseases. But these huge steps forward also posed major ethical questions. He also sought to debunk many myths about the 'crisis' of the world's ageing populations. People are definitely living longer, but this is not necessarily a bad thing. "Societies with ageing populations are more and more creative," he said. He also

stressed the need for greater international cooperation to fight infectious diseases.

Michał Kleiber explained how information and communication technologies had become almost as important a part of our infrastructure as water or electricity supply systems. "It's virtually unthinkable to address any global or local challenges today without referring to ICTs as essential enabling technologies," he said. ICTs offered huge potential for ending economic and social disparities in the world, he continued. But they also threw up new challenges. People were still wary about using the internet because of fears about cyber attacks, phishing or the safety of their private data. These issues needed to be addressed, he said. The growth of the internet was also throwing up new technical challenges. As demand for internet services increased, notably delivered to mobile devices like smart 'phones, new infrastructure would have to be rolled out around the world, requiring serious investment and co-ordinated planning.

Dieter Imboden stressed the fact that greater cooperation between government, industry and academia is needed if we are to reap the full benefits of progress in science and engineering. "How do we go from universities to the real world?" he asked, summing up one of the key questions that arose repeatedly in his track. One answer was to realize that nobody can act alone. When companies, universities and government bodies manage to cooperate, they are nearly always more effective than when they act in isolation. But achieving this cooperation was often easier said than done. He also warned against trying to develop 'one size fits all' models for organizing research. "There will always be different solutions for different situations," he said. Finally he stressed the need to encourage more women and young people to become involved in science and technology, fields that are still dominated by middle-aged men.

Philip Campbell said there was no getting away from the fact that we have so far failed to tackle seriously any of the major environmental threats facing the planet. "The news is bad," he said bluntly. Efforts to reduce biodiversity loss have failed, the world's forests are still shrinking, albeit slightly more slowly, and global warming is as big a concern as ever. But amid all of the doom and gloom, there was a glimmer of hope. Certain grass roots projects, for example efforts to clean up Japan's lake Biwa, have shown that it is possible to reduce biodiversity loss. There are similar local initiatives in Eritrea and Brazil. But such efforts would come to naught without some serious new thinking on environmental issues. The good news was that STS *forum* is an outstanding place to come up with these ideas. "There is ground for movement rather than paralysis and hope rather than despair," he said.

Penny Sackett explained that development of human habitat was critically dependent on a number of factors including adaptation to climate change, water supply, and the managements of urban centers. The latter is particularly important since the world's population is becoming rapidly urbanized. "We're told that in China alone we'll be looking at the equivalent of ten new Shanghais over the next ten years," she said. "There are no perfect solutions, we must begin with our best knowledge and accept we won't always get it right." One thing was clear however. Without cross-border and cross-cultural cooperation on the challenges of urbanization, we will almost certainly get it wrong, she suggested. Sackett

said her track backed “systems thinking” to address issues of urbanization in a holistic and interconnected way. To do this properly, social and natural scientists would need to work together. “As humans, we are part of the system. That’s why social sciences are so important. We must understand ourselves. And in the end,” she added, “quality of life for citizens around the world is the measuring stick by which our actions will be judged.” she said.

Jacob Palis stressed the need to encourage young people to take up careers in science and technology. He argued that scientists had made progress in using the media to explain the way they work, but that more needed to be done. It was important to explain that a career in science and technology could be rewarding and challenging. But he also warned against the scientific community promising more than it could deliver to potential new recruits. One way of encouraging young researchers to stick with science was by allowing them to develop their own fields of research as early as possible. “Passion is the main way of encouraging people to do a good job. The young should be audacious. There should be freedom of research,” he said. Palis suggested the creation of academies of young scientists in countries that have an academy of science as way of mentoring scientists as they start out on their careers. There was also a pressing need to encourage more women to take up a career in science and technology, he said.

10.45-11.45 PLENARY SESSION

302: Energy for Future

Chair:

- **Yoshikawa, Hiroyuki**, Director-General, Center for Research and Development Strategy (CRDS), Japan Science and Technology Agency (JST), JAPAN

Speakers:

- **Beddington, John**, Chief Scientific Adviser, Government Office for Science, UK
- **Minster, Jean-François**, Senior Vice President Scientific Development, Total S.A., FRANCE
- **Okamoto, Kazuo**, Vice Chairman and Representative Director, Toyota Motor Corporation, JAPAN
- **Stigson, Björn**, President, World Business Council for Sustainable Development (WBCSD), SWEDEN
- **Westwell, Steve**, Chief of Staff, BP p.l.c., UK

Hiroyuki Yoshikawa called for a sustained commitment to energy research. Around the world, large scale energy distribution systems have been supplemented with smaller installations to bring energy to remote areas. There has been a change of focus away from governments, and companies are working for high efficiency while people are more conscious of their energy sources. However, seen on a global level, these efforts seem like “random work.” Scientific research into new energy sources is too fragmented, and there is no communication between groups. This means that the knowledge gained has not spread throughout the scientific community. He also highlighted communication problems between society and the scientific community, stating that it must improve to shape the direction energy policy takes in the future. Investment must also be seen as an effort made by society, and not simply in terms of money.

John Beddington stated that with current predictions, the global population is set to rise to 8.3 billion by 2030 and 9 billion by 2050. The increase in energy demand is projected to be around 85% above 2007 levels by 2050, if no measures are taken mitigate population growth. If the emissions that energy production creates continue at current rates, there could be a global rise in temperature of 4°C by the end of the century. As global warming progresses, he believes extreme climate events will become more frequent, so will problems relating to food, water supply and crop production. New technology makes it possible to decarbonize power supplies, and this technology is the future of energy production. The British government targets an 80% reduction in carbon emissions, using measures that include off-shore wind farms. As part of a unified effort, this type of national level solution will lead toward a global solution to this global problem.

Jean-François Minster said that the global need for energy will increase as the population rises. It is estimated that an annual increase in energy production of 1% is required to meet these demands. This may not seem like much, but considerable investment is required. Business and technological innovation is needed to provide affordable and reliable energy sources. Energy systems must be transformed to cope with the impacts of climate change, due to the pressure this will put on resources. These systems must be integrated and a continuous evolution of the “system of systems” must take place to allow new technology to be embedded. More resources need to be spent on energy efficiency research. The energy decisions made for the next decade will impact on the next half century. A roadmap for technology must be developed, where the cost and efficiency of systems are seen as paramount when building the energy systems of the future.

Kazuo Okamoto discussed the need for new energy sources in transportation. There are concerns about the security of oil, as the growth in demand is not matched by the pace of discovery. To solve this problem, fuel economy must be improved and alternative sources developed, with the constant aim of zero CO₂ emissions. This must take into account CO₂ creation during production as well as vehicle emissions. He predicted a future where electric vehicles are used for short distance travel and hydrogen powered vehicles for mid-to-long distance journeys. He pointed out that Toyota has introduced hybrid cars to Japan, the USA and Europe. Toyota also plans to introduce an electric car to the USA in 2012 and is developing a hybrid fuel cell planned for 2015.

Björn Stigson stated that the green race has started globally. There is competition for countries and companies to provide efficient solutions and the winners of this race will be in a position to dominate the global economy of the future. The result will be a sustainable world that benefits all. By the year 2050, it is estimated that 85% of the world’s population will live in developing countries. As these countries focus on poverty reduction and improvement in the quality of life, high energy demands will lead to more pollution. He believes that most of the technology that is needed for low carbon solutions for energy supplies already exist, but that deployment is currently too slow. Barriers are being created by a lack of supporting regulatory frameworks and proper energy and carbon pricing. To move forward, private-public partnerships are necessary to lead the drive for energy efficiency. He closed by saying that we must “build partnerships to create a sustainable world.”

Steve Westwell expressed his deep regret for the loss of life and the devastation caused by the oil spill in the Gulf of Mexico. He said that BP had accepted responsibility and mobilized a clean-up effort involving 3 million feet of boom and 7,000 vessels. This event highlights the risks involved in trying to secure future energy sources. Major consumers were looking to reduce demand, but nevertheless future energy sources must possess key qualities: sufficiency, security and sustainability. Although renewable energy sources and nuclear energy will be important in the future, greater focus on natural gas is important. There is sufficient natural gas to supply 60 years of demand, and with BP's "unconventional" gas, which is taken from previous untappable areas, there will be supply for much longer. Biofuels will also be an important source, supplying 10% of energy demands by 2030. However, correct choices of crops that do not affect food supplies or the ecosystem are necessary. He summarized by saying that BP remains committed to a sustainable future. The company is making progress towards more sustainable fuel supplies and is painfully aware of the damage caused recently. It will learn its lesson from this and strive to meet its obligations to the world.

11.45-12:30 PLENARY SESSION

303: What Should We Do Now

Chair:

- **Castell, William**, Chairman, Wellcome Trust, UK

Speakers:

- **Pandor, Naledi G. M.**, Minister of Science and Technology, SOUTH AFRICA
- **Hasegawa, Yasuchika**, President and CEO, Takeda Pharmaceutical Company Limited, JAPAN
- **Lee, Yuan Tseh**, President Emeritus; Distinguished Research Fellow Institute of Atomic and Molecular Sciences, Academia Sinica; President-Elect, International Council for Science (ICSU); Nobel Laureate for Chemistry 1986, TAIWAN
- **Omi, Koji**, Founder and Chairman, STS *forum*, JAPAN

William Castell pointed out that this is the third time he has attended the STS *forum* and he thanked the extraordinary commitment and vision of Koji Omi. The STS *forum* is not just a place for frank and open dialogue but also a venue where people with common goals can come together and seek solutions. Basic research, as well as an increase in interdisciplinary studies, is vital to improving society. The world is increasingly falling behind on the challenges of reducing CO₂ emissions. Our cultures must work to mitigate climate change. He suggested the creation of an "STS Kyoto Prize" - to be awarded annually in the field of sustainability. Castell expressed the hope that in a few years the award could become as important as the Nobel Prize.

Naledi Pandor said the STS *forum* is an important intellectual gathering where a great deal of ground was covered. In Africa, the development of human resources in science and technology is a critical priority. These are fundamental fields when it comes to resolving problems in Africa such as poverty, sustainable agricultural production and raising education standards. One of Africa's weaknesses is its failure to convert

research into things of commercial value. She added that the forum needs to recognize that the future lies with the young and that more attention should be paid to supporting developing countries. Pandor concluded by saying that participants need to return home with a set of solutions gained from the forum and to translate these into concrete action.

Yuan Tseh Lee has attended every STS *forum* since 2004. In those 7 years, the conference has discussed many important issues, but climate change stands out as the most pressing. There is little time left to take real measures to address this concern. If unchanged, current policies will result in enormous disruption by the end of the century. Renewable energy is needed, but it will not be enough to mitigate the impact of climate change. People must transform the way they live. How much climate change is safe? The answer is each person can emit no more than 3.5 tons of CO₂ per year, and atmospheric carbon should be no more than 350 ppm in order to stop temperatures from rising by more than 2 degrees Celsius. This boundary ought to be respected but it is already exceeded. How can mankind shift to a lifestyle that only produces 3.5 tons of CO₂ per year? It does not have to mean a life of poverty. If correctly applied, science and technology can help us reduce CO₂ emissions while leading us to a richer, healthier and happier life. It is crucial to create a society that is in harmony with nature.

Yasuchika Hasegawa remarked that while economic growth is stagnant or slowing in many of the developed nations, exceptional growth is occurring in Brazil, Russia, India, and China. Science and technology, combined with the power of commerce, is lifting millions of people out of poverty in the emerging and developing countries. There are, however, hundreds of millions more who await such benefits. Rapid change in the focus of science and technology spending has occurred in recent years. Private sector research investment in the developed nations has long focused on the needs of middle income and wealthy consumers in western markets. Products made for low-income consumers were often stripped down versions of higher end products developed for first-world countries. However, the rise of emerging markets is leading to a promising new approach for science and technology investment by the private sector, which is progressively meeting the needs of the broader human population.

Koji Omi closed the 2010 edition of the STS *forum* and expressed his appreciation to all the participants for their contributions. Sustainability was the main theme discussed at this year's conference. The Earth's resources are not infinite, but are finite, and sustainability is now vitally important. It is regrettable that no climate-change agreement was reached at Copenhagen, so it is crucial that nations establish a framework on this issue. The development of solar and biomass energy production is needed to reduce CO₂. Nuclear power is capable of providing energy on a large scale, but the prevention of nuclear proliferation must be addressed. Science and technology have become so advanced that some people think humans can control nature. But we must live in harmony with the environment. The STS *forum* has grown from a conference to a movement that has made visible achievements in the world. One of the purposes of the STS *forum* is to deepen ties and friendships among participants. They are the first to aspire for a bright future for generations to come.

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.