Science and Technology in Society (STS) *forum*

Non-Profit Organization

SUMMARY OF PROCEEDINGS

Ninth Annual Meeting

October 7-9, 2012

Kyoto, Japan

Science and Technology in Society (STS) *forum* (NPO)
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Sunday, October 7, 2012

Monday, October 8, 2012

Tuesday, October 9, 2012

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

Sunday, October 7, 2012

10:00-11:00 OPENING PLENARY SESSION

100: Science and Technology for the Future of Humankind

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

Speakers:
- **Tanaka, Makiko**, Minister of Education, Culture, Sports, Science and Technology (MEXT), JP
- **Fioraso, Geneviève**, Minister of Higher Education and Research, FR
- **Holliday, Jr., Charles**, Chairman of the Board, Bank of America Corporation, US
- **Yonekura, Hiromasa**, Chairman, Sumitomo Chemical Co., Ltd.; Chairman, Nippon Keidanren (Japan Business Federation), JP
- **Barañao, Lino**, Minister of Science, Technology and Productive Innovation, AR
- **Friedman, Jerome**, Institute Professor and Professor of Physics Emeritus, Physics Department Massachusetts Institute Technology (MIT); Nobel Laureate in Physics 1990, US

Chairman Koji Omi welcomed the 1,000 participants from 85 countries to the 9th STS *forum* and declared it open. He thanked the supporters and sponsors of STS *forum*. He has travelled extensively this past year and spoken about the 'lights and shadows' of scientific progress. At a time when many countries are experiencing economic and political instability, the development of sustainable scientific and technological solutions to issues such as insufficient food production, poor healthcare, and climate change are crucial endeavors. We now know there are many challenges, and people must be allowed to make their own decisions based on sufficient information. There are no national boundaries between science and technology; nor should there be between the scientific community and the layman. It is to ensure this exchange that STS *forum* brings people together.

Makiko Tanaka welcomed all the participants to Japan and expressed gratitude for the support received after 2011's earthquake. She provided an update on the Fukushima nuclear power station, where preparations are underway to remove the fuel rods. Contamination levels in the soil have been declining, and relevant information will be supplied to the global community on a regular basis. The ethical and environmental aspects of scientific and technological developments are inseparable. She emphasized that there is no country that can deal with these alone.

Genevieve Fioraso started by thanking Chairman Omi for organizing this year's STS *forum*. The use of science for the future of mankind is an 'essential but difficult' subject of discussion, she said, adding that 'the political decisions we are making today are shaping our lives and the lives of our children'. Wealth inequality and resource depletion affects not only developing countries, and new diseases and aging provide challenges even for advanced nations. France intends to develop partnerships between research and industry on a national, Europe-wide, and international level, such as ongoing research into photovoltaic cells in which France and Japan are cooperating. Progress can only be achieved through 'acting local and thinking global.'

Charles Holliday Jr. described how, at a time when many are discouraged by economic and political problems, NASA's Curiosity rover showed the ability of science to breed hope. As important as hope, however, are results. Mr. Holliday himself last year worked on a UN report and the resulting project aimed at, amongst other things, getting electricity to 1.3bn people and replacing millions of potentially lethal cooking stoves. The approach was results-orientated, bringing together companies and over 50 countries in an unprecedented initiative that was co-headed by the Secretary General of the UN and the president of the World Bank. Attention to strategy is admirable, but it is important to evaluate results too.

Hiromasa Yonekura described Keidanren's future city model project, which provides 'new solutions to pressing challenges facing our [Japanese] society', which include rebuilding infrastructure, long-term energy policy, sustained deflation, and declining competitiveness. Galvanizing the private sector is the solution. The December 2010 Sunrise Report provided an action plan for initiatives to expand competitiveness and innovation. Ongoing projects include the future city model project bringing together universities and companies to research sustainability in cities. There are 11 projects underway ranging from future healthcare to advanced urban agriculture.

Lino Barañao discussed the practical application of scientific developments on a global scale. Issues such as food production have reached a critical juncture – between now and 2050 we will consume as much food as we have done in our entire history. Meeting this demand would require an intensification of food production that can only be achieved through technological improvements. Contributions from the social sciences are also vital; our brains are not a 'tabula rasa' but rather the results of 150,000 years of evolution. Research has shown we have no more than 150 friends, the average number of friends on Facebook. Humans need to be 'fully equipped with the scientific background but also with the ethical framework that will guide their actions.'

Jerome Friedman said that science and technology has allowed us to thrive as a species. However, 1bn people remain malnourished; 1bn have no clean water and 40% have no access to sanitation. Beyond this, we are losing topsoil 5 times faster than we can replace it, groundwater is being depleted, and global warming is already causing 150,000 deaths per annum. To avoid such problems, 'as a species we must be compatible with the sustainable world'. Promising new technologies must be introduced as soon as possible in developing countries and there must be investment in infrastructure in these countries – an investment which will bring priceless results for the future.

11:00 - 12:10 PLENARY SESSION

101: Energy and Environment

Chair:
- **Beddington, John,** UK Government Chief Scientific Adviser, Government Office for Science, UK

Speakers:

- **Isaacs, Eric**, President, UChicago Argonne, LLC; Director, Argonne National Laboratory, US
- **Nishida, Atsutoshi**, Chairman of the Board of Directors, Toshiba Corporation, JP
- **Schotman, Gerald**, Executive Vice President Innovation/ R&D; CTO, Royal Dutch Shell plc, NL
- **Yagi, Makoto**, Chairman, The Federation of Electric Power Companies of Japan, JP
- **Zakhary, Nadia**, Minister of Science, Technology & Scientific Research, EG

John Beddington introduced the panel and observed that many of the great challenges of the next 50 years are already determined. The world population will rise by 1bn by 2025. Africa will have 1,000 cities of 500,000 inhabitants each, while Asia will have 500 of 1 million people each. Regardless of what changes happen now, the gases in the atmosphere will determine the climate for the next twenty years. For the future, more energy must be secured and our greenhouse emissions must be reduced. More than anything, we need to engage in a transparent manner with the public, who is often not well informed, and hence worried and suspicious.

Eric Isaacs started by thanking Mr. Omi for starting the forum and Mr. Holliday for his work on the Council of Competitiveness. In terms of technology, future challenges include developing alternative energy sources such as biodiesel and reforming how we distribute and store energy. The success of shale gas shows the potential of technologies that have benefitted from high levels of investment. There is 50% less carbon dioxide in shale gas than in coal and current expansion in its use by the USA is only possible owing to investments made in the 1970s. Similarly, Denmark now derives 25% of its energy from wind power, and offshore wind is a major area of growth. The expansion of these industries shows the benefits of taking a long-term view.

Atsutoshi Nishida explained how, taking 2010 as the base level, energy demands will increase by 80% by 2050, and emissions will increase by 70%. Efficiency in energy supplies and energy saving are therefore vital. Energy policy should be based on a viable mix of energy sources. A hasty switch to unreliable and under-developed sources of alternative energy may cause more damage than good. Carbon recapture is also a process that should be investigated more thoroughly. On the demand side, there needs to be improved efficiency. Building energy management systems, which use ICT to regulate consumption is also vital. Promoting innovation is crucial for all of this, and the STS *forum* is a great opportunity to formulate recommendations for the future.

Gerald Schotman said that the issues facing the world do not depend on any one government or person. The world is facing a 'stress nexus' where the production of food, water, and energy intersect and rely on each other. The estimated growth of the human population to 9bn means more and more consumers. Cooperation and co-innovation is the way forward, and Shell has created partnerships with other companies and environmental NGOs to transform ideas into action. He cited two examples of projects Shell has developed: Pearl GTL in Qatar which does not rely on local water sources, and a joint venture in Brazil which has produced up to 2bn liters of biofuel.

Makoto Yagi apologized for the anxieties that the Fukushima nuclear disaster caused globally, and emphasized how committed the Federation is to ensuring the highest levels of safety in the world. The Japanese government's desire to reduce the contribution of nuclear power to Japan's grid to 0% by 2035 is seen as deeply embarrassing by the industry. He stressed the importance of a good balance between renewable, fossil and nuclear sources of energy. He hopes that the government will not postpone reviewing this decision 'from a practical viewpoint'. Nuclear power is necessary in the light of Japan's very low energy independence and it should be used in combination with other energy sources – including solar power.

Nadia Zakhary drew attention to the fact that Egypt's new government believes that science and technology are absolutely vital for economic growth. Egypt and Japan have very strong links, and several programs exist that allow interaction between Japanese and Egyptian scientists. The Japanese Society for the Promotion of Science has supported science in the Middle East for over 70 years. Much of the work has been in the area of energy security, including research into solar power, photovoltaic cells, wind energy in the Red Sea, nuclear energy, red algae and recycled wastes. In terms of pollution, there is a severe issue with exhaust fumes in Egypt, and research is also being conducted into limiting their impact. Given Egypt's research initiative, with a little reform further cooperation between Egypt and Japan is a win-win situation.

13:30-14:40 PLENARY SESSION

102: Nuclear Safety and Future Development

Chair:

- **Bigot, Bernard**, CEO, Alternative Energies and Atomic Energy Commission (CEA), FR

Speakers:

- **Amano, Yukiya**, Director General, International Atomic Energy Agency (IAEA), JP
- **Cashmore, Roger**, Chairman, United Kingdom Atomic Energy Authority (UKAEA), UK
- **Oshima, Kenzo**, Commissioner, Nuclear Regulation Authority, JP
- **Pershukov, Vyacheslav**, Deputy Director General, Chief Innovation Officer, State Atomic Energy Corporation ROSATOM, RU
- **Raj, Baldev**, President, Indian National Academy of Engineering (INAE), IN

Bernard Bigot thanked Chairman Omi for organizing the STS *forum* and explained that when discussing the long term future of nuclear energy, it is vital to balance the feelings of the population with a realistic approach to energy provision. Reduction in energy consumption is as important as alternative sources of energy. He added that over-reliance on fuel can be a burden on national economies such as France's. We are too numerous a species and too urbanized a civilization to rely entirely on renewable energies, and therefore nuclear power is a vital part of the future. Ensuring a culture of safety and recovering pubic confidence is crucial. The promotion of safety should be an international enterprise: 'Each country should have a sound and comprehensive fuel cycle policy,'

he stressed. Nuclear power 'will continue to play a major role' in the 21st century.

Yukiya Amano opened by identifying the IAEA's activities in the post-Fukushima era, which includes implementing the 2011 Action Plan across the world to ensure the presence of facilities such as fail-safe electricity supplies at all nuclear reactors. It is essential that international agencies maintain their 'sense of urgency' in pursuing their efforts at improving nuclear safety, especially as nuclear output will grow by between 40% and 100% by 2030, fuelled by growth in China, South Korea, India, and Russia. While it must be up to each sovereign nation to determine its own energy policy, international cooperation is a vital part of the nuclear future. The events at Fukushima did not signal the end of the nuclear industry by any means, and the IAEA welcomes the ongoing international debate on the matter.

Roger Cashmore provided an evaluation of nuclear power generation in the UK as a 'case study in how to resurrect' the industry. Although the UK originally intended to reduce the number of its nuclear power stations to one by 2023, various reviews indicated that this policy was incompatible with UK energy demands. As a result of a transparent public discussion, the UK population is broadly supportive of expanding the nuclear power base and increased research and development of nuclear power sources. This will occur under an independent UK regulatory office. Issues of finance remain, as the UK government is unwilling to underwrite new reactors. The 100-year lifespan of these reactors will also necessitate agreement on long-term prices and the management of plants. Concurrently, work on fourth generation reactors, new fuels, and fusion must continue.

Kenzo Oshima thanked the STS *forum* for the opportunity to speak, and paid his respects to Mr. Amano, leader of the IAEA. He provided an update on progress at the Fukushima Daiichi site since 2011. The Japanese Diet's independent report on the incident is probably the most comprehensive, attributing it to human errors that were 'no less' responsible than the tsunami. It also pointed to numerous failures in adhering to various safety standards that could have, in fact, ensured that the power station survived the tsunami. One problem he identified was the misapprehension that nuclear power is inherently safe, as well as the cozy relationship between the industry and the regulator. Learning from the best practices of others was recommended. The IAEA intends to launch its own investigation. The most important lessons are rebuilding Japan's nuclear safety culture and regaining the confidence of the population.

Vyacheslav Pershukov addressed the issue of the post-Fukushima future of nuclear technology. Russia is committed to expanding its nuclear production by a further 30GW by 2030, using technology developed through over 10,000 reactor-years of developmental experience. In order to minimize the potential for incidents like Fukushima, Russia continues to develop sophisticated safety technologies, including integrating new kinds of coolants such as lead-bismuth. Safety assessments are also being bolstered through use of sophisticated computers with processing power in the order of exaflops. In the long term, nuclear fusion could provide a valuable alternative to current fission-based technology, and this potential is being explored by nearly every developed country with a nuclear program.

Baldev Raj discussed the issue of energy consumption in the context of sustainability. Ethics and sustainability are inextricably linked. Furthermore, sustainability can only meaningfully be regarded from a long-term, global perspective. On the subject of nuclear energy, he pointed out that it is the responsibility of both operators and regulators to ensure safety, and that it is vital that all existing generators meet the requisite levels of safety. Provided these are met, there is no reason at all to abandon nuclear power generation. It is also vital that the nuclear industry keeps abreast of the possibilities of modern communications technology, which can often cause anxiety among the people due to its ability to disseminate information rapidly. It is up to the purveyors of nuclear power to present their industry in the most accurate light.

14:50-16:00 PLENARY SESSION

103: Global Health

Chair:

- **Wallberg-Henriksson, Harriet,** President, Karolinska Institutet, SE

Speakers:

- **Hasegawa, Yasuchika**, President and Chief Executive Officer, Takeda Pharmaceutical Company Limited; Chairman of Keizai Doyukai, JP
- **Walport, Mark**, Director, Wellcome Trust, UK
- **Yamanaka, Shinya**, Director, Center for iPS Cell Research and Application (CiRA), Kyoto University, JP
- **Zerhouni, Elias A.**, President, Global R&D, Sanofi SA, US

Harriet Wallberg-Henriksson spoke of the way in which global health has a political and economic impact across borders. Social and economic standards greatly vary around the globe, so new and more effective ways to both deliver healthcare and ensure broad access are needed. 'Global health' is more than simply healthcare – 1bn people lack access to clean water and 2.6bn people lack access to sanitation, giving rise to various health problems and diseases. A major issue in global health is how resources can be consolidated to achieve health equality. Another question is whether major developments in diseases can be anticipated. Current policy makers and experts have a responsibility to society to use knowledge and resources to build a better and safer world, but it is also critical to include the young generation in discussions. The next generation is tomorrow's leaders, scientists, economists and policy makers.

Yasuchika Hasegawa focused on the sustainability challenges facing healthcare systems as life expectancy continues to rise and growing economic development spreads worldwide. Non-communicable diseases are becoming increasingly burdensome in developed and developing countries alike and are predicted to cost the world economy US$47 trillion by 2030. Dealing with these issues requires the continued promotion of well-being programs and preventative medicine, together with a new perspective that sees healthcare as an investment, rather than an expense. Furthermore, a holistic approach involving government, corporations, and individuals is required to generate partnerships and communicate to the public the importance of health - not only for individuals, but

also for the economic prosperity of future generations. As part of this, innovation and ICT will be of critical importance to bring down healthcare costs.

Mark Walport commented that many countries have shared challenges in providing healthcare. Despite great inequalities between nations, a similar challenge exists in addressing the huge inequalities within given countries. Furthermore, diseases respect no boundaries, and human populations are more mobile than ever before. Another major challenge for global health is to avoid getting caught up in thought patterns that neglect other areas such as social science. The rising cost of healthcare is a worldwide issue, but it is also driving innovation. Technology offers the potential for affordable solutions, and many developing countries now also act as major sources of innovation. Knowledge and innovation must be globalized, and health, economic and educational development must be combined. Crucially, however, better regulation is required in areas such as intellectual property and counterfeiting, and incentives must be improved for regulators to ensure that they are truly accountable for their decisions.

Shinya Yamanaka started by discussing the role of scientists in developing new medical technologies, and the drive to make them available to all. Controversies regarding the ethics of embryonic stem cells have limited the access to this technology. However, scientists have recently achieved the development of induced pluripotent stem cells that have the same properties as embryonic stem cells, removing this ethical barrier. The potential of this technology is enormous, but a further issue is how to bring this technology to people in developing countries, regardless of cost. Increasing patenting may be a way to help control the costs of new technologies.

Elias Zerhouni spoke of the issues of duality in global health, such as the differences between the rich and aging world and poorer younger populations in developing countries, and those socio-economic differences within countries themselves. There are also dualities in the nature of the issues that exist within global health, such as infectious diseases vs. non-communicable diseases. All these issues require different approaches and solutions. “Breakthrough innovation” is necessary for diseases without current solutions, but another challenge is that of “systems innovation” - delivery of what we already know in a more effective way. To achieve this, there is a need for efforts beyond the realms of science and technology and a more adequate adaptation of policies. There is also a need for “embedded health” – behavioral change that is embedded in all sectors of an individual’s life.

16:30-18:30 FIRST SERIES OF CONCURRENT SESSIONS

104-A1: Future of Fossil Energy

Chair:

- **Toyoda, Masakazu**, Chairman and CEO, The Institute of Energy Economics, Japan (IEEJ), JP

Speakers:

- **Behrendt, Frank**, Director, Innovation Centre Energy, Berlin Institute of Technology (TU Berlin); International Representative, acatech (National Academy of Science and Engineering), DE
- **Ikeda, Michio**, Director, Executive Vice President, JX Nippon Oil & Energy Corporation, JP
- **Kenny, Brenda**, President and Chief Executive Officer, Canadian Energy Pipeline Association (CEPA), CA
- **Ruehl, Christof**, Chief Economist and Vice President, BP p.l.c., DE
- **Tanguy, Philippe**, Vice President of R&D Programs, Total S.A., FR

The continuing reliance of the global economy on fossil fuels was discussed in some detail. Global economic growth is expected to proceed at 3.1% per annum, along with increasing middle-class consumption and growing urbanization, resulting in a rise in energy demand of between 50% and 100% by 2035. Despite this dramatic growth, fossil fuels may continue to account for as much as 80% of global supply for the foreseeable future. This is partly due to the unreliability of renewable sources caused by growing costs and immature technology. With the development of shale gas in North America, new oil fields in Iraq and offshore in Brazil, the notion that fossil fuels face imminent depletion has receded. However, while production is expected to increase dramatically, soaring demand will ensure prices remain high for the predictable future. Hence it is almost certain that global reliance on fossil fuels for the majority of its energy will continue for more than a generation.

The expansion of fossil energy reserves is representative of innovation within the industry. The refinement of shale gas technologies may increase accessible world gas reserves as much as twofold. Similarly, the rapid expansion of oil extraction technologies in the USA and Canada has resulted in these two countries having the biggest growth in oil production in the world since 2005. Such success is also indicative of the value of an open and dynamic investment mechanism. It was also pointed out, however, that the expansion of such technologies will require adaptation to local conditions and may run into widespread opposition from various sources. Furthermore, the water used in the ‘fracking’ process requires processing afterwards, which increases costs. Regarding coal, given that every 1% increase in combustion efficiency results in a 3% decrease in carbon emissions, the improvement in combustion efficiency in some industrialized nations can be as high as 50%. This has both economic and environmental benefits.

The geopolitics of fossil fuels continues to be a source of concern and interest. The period since the fall of the Soviet Union has seen unparalleled international energy exchange – as was shown by Japan’s ability, post-Fukushima- to import large amounts of liquefied natural gas from as far as West Africa at relatively short notice. Also important is the growing reliance of China on Middle Eastern energy sources, and the potential of North American energy independence driven by shale gas. Both could overturn the political status quo. Beyond this, events such as the Arab Spring – which are both unpredictable and dramatic – may cause further instability, reminiscent of the energy crises of the 1970s. In terms of domestic politics, it is vital for energy producers to find the ‘right energy in the right place at the right time’. Despite the huge presence of fossil fuel companies in Canada (22% of its mercantile activity is in this sector), the interests of these companies can look very remote to citizens, who are also extremely averse to the idea of risk in energy production. This can in turn have a major impact on exploring new kinds of

technology, such as Ontario's moratorium on fracking. Much higher standards of transparency are required for all players in the field, including critics.

Many participants expressed concerns over climate change, and observed that the greatest growth in recent fossil fuel output had been in one of its least polluting forms, natural gas. The majority of participants, however, emphasized that energy efficiency was the most promising strategy for negating the environmental impact of energy production. One panel member expressed the belief that instead of relying on morally persuasive arguments, efficiency should be promoted by emphasizing its economic benefits. On an individual level, the increasing efficiency of engines (current 1.5 liter engines that produce up to 180 horsepower will be able to produce as much as 300 in the near future) could reduce the massive impact of the motor industry on emissions. One other method of increasing energy efficiency is through localized energy generation, which is not only more efficient in dealing with waste heat but can survive major disruptions like earthquakes. A further area of discussion was carbon capture and storage, which currently has several promising but as yet expensive technologies. A participant pointed out that China is one of the few countries that has a mandatory carbon footprint reduction policy that applies to all factories

104-B1: Frontiers of Personalized Medicine

Chair:

- **Roberts, Richard**, Chief Scientific Officer, New England Biolabs Incorporated; Nobel Laureate for Physiology or Medicine 1993, US

Speakers:

- **Es Sabar, Karimah**, President and Chief Executive Officer, Centre for Drug Research and Development (CDRD), CA
- **Krieger, José E.**, Professor of Genetics & Molecular Medicine, Heart Institute (InCor) University of São Paulo – Medical School, BR
- **Meeker, David**, President and Chief Executive Officer, Genzyme Corporation, US
- **Puente, Jorge**, President, Asia Pacific-Canada Region, Oncology Business Unit, Pfizer Inc., US
- **Syrota, André**, President, Inserm (National Institute of Health and Medical Research), FR
- **Tsutsumi, Kazuhiko**, Executive Officer, Vice President, Corporate Research and Development, Mitsubishi Electric Corporation, JP
- **West, Steve**, Chief Executive Officer, Nordion (MDS Inc.), CA

The discussion centered on how to achieve personalized medicine despite competing interests. From the commercial perspective, the development of personalized medicines is challenging because of the difficulty in making profit from drugs that may only benefit a very small sub-section of society. From the patient's perspective, personalized drugs are highly desirable owing to numerous potential benefits including the early identification of susceptibilities to particular diseases, increased drug efficacy, and reduced side-effects.

With regard to costs, affordable solutions are yet to be attained. Where technologies have been developed such as full-genome sequencing, they remain prohibitively costly for the majority of society and what is more, the interpretation of results remains challenging. The development of personalized health technologies in this area is greatly restricted by the enormous funding required to bring basic scientific research through to clinical development and to market. There are high failure rates during this process, and the private sector bears the burden of much of these costs. This expenditure can run into millions of dollars and cannot be absorbed if the market for the drug is not large enough.

Tackling cost issues requires a major change in the present way things are done. Currently there is a duplication of costs at international level, and the need for individual institutions to secure funding tends to inhibit knowledge sharing and collaboration. Better policies are needed in the area of clinical development, as well as improved infrastructure and investment in order to make drug development more affordable. This might be achieved in part through public-private partnerships. The regulatory platform also needs to evolve in order to speed up the innovation process, and regulators must work together more efficiently to avoid costly duplication. Innovation in stem cell technologies, for example, may also help to speed up clinical trials. Combining diagnostics and therapeutics is another way of dealing with cost issues, though reimbursement frameworks are yet to catch up with this approach. Some people argue that it is up to industry to create value in new technologies.

The need for collaboration was also raised, as personalized medicine converges in many different areas and poses new challenges to society. Scientists must collaborate with both politicians and civil society.

Stakeholders who stand to gain from personalized medicines also need to share in the costs of its development. Wider access to healthcare for all, economical issues, and social acceptance are important considerations. Ethical and legal issues, such as the implications of being able to predict susceptibility to ill health and the problems of developing new technologies that may be unaffordable to many, must also be considered. These issues must be anticipated in advance if personalized medicine is to continue progressing. Personalized medicine may however help to leverage change for re-engineering healthcare systems.

From a technical perspective, the promises of personalized medicine will only become reality through a robust, research-based approach. However in the case of rarer diseases, it can be problematic because a good understanding of the disease origins can be hard to achieve with only a small population pool from which to draw data. New systems are required that can handle data in a timely and integrated fashion. The bioinformatics needed to change the way diagnostics and disease prevention is carried out represents a huge task. Many technical issues still exist, and going from genome sequence to making predictions is complicated due to the influence of other complex factors such as the effect of micro-organisms present within an individual.

104-C1: New Frontiers in Innovation

Chair:

- **Yeo, Philip**, Chairman, SingBridge International Pte. Ltd. and SPRING (Standards, Productivity and Innovation Board) Singapore, SG

Speakers:

- **Arakawa, Yasuhiko**, Director of Institute for Nano Quantum Information Electronics; Director of Nanoelectronics Collabor, The University of Tokyo, JP
- **Isaacs, Eddy**, Chief Executive Officer, Alberta Innovates - Energy and Environment Solutions (AI-EES), CA
- **Parker, Richard**, Director of Research and Technology, Rolls-Royce plc, UK
- **Saracco, Roberto**, Director, Future Centre and Scientific Communications, Telecom Italia SpA, IT
- **Wince-Smith, Deborah L.**, President & CEO, Council on Competitiveness, US
- **Zelinsky, Alexander**, Chief Defense Scientist of Australia and Chief Executive, Defence Science and Technology Organization (DSTO), AU

Collaboration between governments, universities, investors, researchers and inventors is required to bring an idea from the research laboratory to the marketplace.

Although government policies are generally enacted from the top down, it is important to have systems in place that ensure active engagement at all levels. The millions of potential inventors who fuel innovation are the most important element in such systems, and the "maker's movement", which uses technologies like new 3-D printing facilities (cited by many as a promising innovation fuelling new technology), should prove to be a tremendous boon to many educational and research institutions. Some speakers also mentioned that one of the most important things government can do to support innovation is to provide a well-articulated vision for how collaborators should work together. Korea was named as a model for forging government-led innovation policy.

Institutions must recognize that it is not enough just to have the idea. It must be carried through to application. A good example of the difference between having a brilliant idea and bringing it to full fruition is the difference between Joseph Swan and Thomas Edison. While Swan obtained the first patent for a light bulb, Edison was able to successfully market the invention. Many speakers mentioned that a proper appreciation of the length of the process required to bring an idea to fruition is crucial, with a general consensus that it takes approximately 20-30 years. Educational institutions need to focus on the final stage, and entrepreneurship, as much as the initial research and development, which until now has been the primary focus.

Another important issue influencing innovation is financial backing, from both the private and public sectors. Brazil's BNDES was cited as a successful example of government collaboration in scaling up fledgling businesses. Financing becomes increasingly crucial during the transition from a startup to a medium-sized business. Government regulation making it difficult to go public was mentioned as an issue, and ways in which governmental agencies can assist with advice and direction were also brought up. One member stated that not only do startup businesses need information and guidance, in fact, they often don't know what they need. Governmental organizations must step in to provide this information. In response to a question regarding how countries with less-developed capitalization systems could encourage financing, it was suggested that larger companies already present in that country's market could be a viable source of funding.

The discussion also touched upon the role of intellectual property in the inventive process. The emphasis should be less on "ownership" and more on agreements that incorporate each player's role and desired use for the technology in a symbiotic way. For example, universities want to expand their research, while industry wants to manufacture and sell products. It was pointed out that endowments given to universities from appreciative companies benefitting from the institution's research are a large source of revenue for the universities.

There was a general consensus that the desire to keep information secret in order to gain a competitive advantage stifles innovation. Participants also expressed the view that, while there are several areas where companies necessarily are competitive, such as sales, in many others, it would be more advantageous to collaborate in fields such as safety, environmental protection and reliability. All the participants agreed that collaboration could spur advances in renewable energy and resource technologies in mutually beneficial ways.

Attitudes toward failure in the innovation and learning process should be modified in many cultures. It was noted that institutions need to resist the vilification of failure, and reward risk-taking both culturally and monetarily, to encourage more of a "learn-by-doing" approach.

As the competition for limited resources escalates, the chance of intensified conflict, including that initiated by non-state actors, increases the need for security applications surrounding emerging technologies. Additionally, many of the inventions developed for security purposes are on a dual path since they are often later adapted for civilian use. Among the most promising of these "dual path" endeavors are autonomous systems, which could be used for unmanned search and rescue operations, and 3-D printing technology, which could be used for on-site fabrication in isolated locations. New military technologies could also include performance enhancing drugs. This of course raises ethical issues.

104-D1: Collaboration among Academia, Industries and Government

Chair:

- **Kobayashi, Yoshimitsu**, Representative Director; Member of the Board, President and Chief Executive Officer, Mitsubishi Chemical Holdings Corporation, JP

Speakers:

- **Abdul Hamid, Zakri**, Science Advisor to the Prime Minister of Malaysia, Malaysian Government, MY
- **Bazergui, André**, Special Advisor to the President & Chief Executive Officer, Consortium for Research and Innovation in Aerospace in Quebec (CRIAQ), CA
- **Edwards, Russell D.**, President, Nichicon (America) Corporation; Operating Officer, Nichicon Corporation, US
- **Mackay, Martin**, President of Research & Development, AstraZeneca Plc, UK
- **Mello, Luiz**, Director of Technology, Vale S.A., BR
- **Revellin-Falcoz, Bruno**, President, National Academy of Technologies of France (NATF), FR

The world faces many problems such as the depletion of energy and water resources. The best solution is global innovation to tackle our common problems. Strong and effective collaboration is the key to the future. It is therefore important to define the roles of stakeholders in the collaborative process.

The challenges facing each nation of are of global importance. Individual governments must demonstrate the political leadership necessary to achieve common goals. One participant spoke about Malaysia's strategic plan to achieve developed country status by 2020 through the use of science and technology. Important targets are high income, sustainability and inclusiveness. The Malaysian government has launched this development initiative centered on collaboration among academics and industries. It was recognized that there are areas where a developing country may not have the resources or technical expertise necessary to achieve developmental goals, and in such cases, collaboration at international level can be crucial.

Paradoxically, some of the innovations of the past have created some of the problems facing the world today. One company representative spoke of the way in which collaboration is used to solve some of these problems. This has led to many important innovations including a "level 3 quick charger" that charges 80% of a vehicle's battery in just 30 minutes and the development of cost-effective alternative energy supplies. Universities should continue to provide excellence in education while passing new ideas to businesses to develop. Meanwhile, businesses should continue to pursue new avenues for collaborative endeavors. It is also important that governments recognize their duty to society by supporting innovative projects which are geared to enhance the lives of people.

Participants discussed the need to radically modify the way we envision and plan for the future. We must focus on long-term solutions to the problems facing our world. There is a source of difficulty, however, stemming from the fact that governments are not permanent. A possible solution is for countries to establish national strategy plans for research and innovation that transcend political boundaries. France is cited as an example where this has been achieved. Governments must better coordinate efforts to improve partnership between companies and academia.

The session heard a report of a successful collaborative project called the Consortium for Research and Innovation in Aerospace in Québec (CRIAQ). The CRIAQ Forums, which have been held biennially since 2002, have launched a number of projects that have attracted funding and other support from companies. CRIAQ further secured a grant from the Valorisation-Recherche-Québec (VRQ) which enabled a successful project launch in 2004. At present, the Consortium has 100 projects worth $112m at different stages of completion. CRIAQ promotes and facilitates collaboration on environmental issues affecting the aircraft industry. The overwhelming success of their projects is testament to what can be achieved through strategic collaboration.

There is hope that innovation will accelerate to meet some of the health challenges facing the world. The session heard of the work of a pharmaceutical company to find solutions to some health issues. Innovative Medicine Initiatives is a European collaborative project aimed at tackling the problem of antibiotic resistance. One speaker proposed the use of herbal medicines as a possible solution. The fact that companies can now begin to work together despite a competitive economic environment is an indication that they are becoming more aware of the benefits of collaboration.

Sustainability and environmental issues should be important concerns for industries, participants heard. Companies seek returns on their investments, while governments are responsible to their constituents. Governments must act as a catalyst to bring about more meaningful collaborations and provide incentives targeting long-term goals to improve people's quality of life and protect the environment.

104-E1: Oceans

Chair:

- **Roy, Craig**, Deputy Chief Executive, Science, Strategy and People, Commonwealth Scientific and Industrial Research Organisation (CSIRO), AU

Speakers:

- **Djamaluddin, Ridwan**, Deputy Chairman, Natural Resource Development Technology, Agency for the Assessment and Application of Technology (BPPT), ID
- **Taira, Asahiko**, President, Japan Agency for Marine-Earth Science and Technology (JAMSTEC), JP
- **Woodruff, David**, Director, Sustainability Solutions Institute, University of California, San Diego (UCSD), US

The oceans are changing, and the changes are far more frightening than a glance at current policy-making and public dialog might imply.

Rising temperatures disrupt ocean ecosystems, but this is only the beginning. Acidification resulting from the absorption by the oceans of 26% of the CO_2 humanity emits each year, is a separate and additional issue to temperature changes. It threatens all forms of sea life that build shells as well as some types of plankton and corals that play critical roles in entire ocean food chains. Disruptions of these systems would have devastating effects on the many people around the world who depend on the seas for a large portion of their protein intake – for example, in countries like Indonesia where it accounts for more than 60%. Sea levels are rising year by year, and although this may be only an annual 2-3 mm at present, there are indications to suggest the ultimate rise may total 5 or even 10 meters. Faced with the fact that 1/3 of the world's population lives within 100km of the coasts, if such rises continue, estimates of inevitable migrations start at 200 million affected people and go up from there.

Why have ocean issues not gained as much attention in policy-making and public consciousness as atmospheric climate change?

One significant challenge is incomplete knowledge. Scientific understanding of the oceans has vastly increased over the past two decades, due in significant part to satellite data and supercomputer modeling. However, there is much that is yet unknown, especially regarding deep ocean circulation, the resilience of oceans to climate change, acidification and temperature changes. Also unclear are the locations of tipping or breaking points, and macro scale interactions between

biological and chemical processes with physical processes. As the oft-repeated saying goes, we know more about the surface of Mars than we know about many areas of the oceans. While satellite monitoring technology has given us a great deal of information about the ocean surface, the average depth of the oceans is 4km, and gathering observational data throughout the thousands of meters of water column is a significant hurdle. Organizations like JAMSTEC and NOAA do excellent work each year to overcome this knowledge gap, but to tackle the issue with the urgency appropriate to the magnitude of the threats will require significantly more concentrated effort and funding.

Another challenge is the question of communication. While comprehensive scientific knowledge is a work in progress, in general terms, scientists know the issues and know what steps can be taken to do something about them. The challenge is to convey that information to the general public and to policymakers. Participants suggested transforming appeals from primarily intellectual talk of CO_2 levels and seemingly minute changes in temperature and ocean acidity to more emotional imagery that non-scientists can easily comprehend – such as dramatically rising sea levels, vanishing coral reefs, and threats to ocean food sources. Ocean issues must be integrated into general climate change policy and awareness.

It was noted that over the years, the International Panel on Climate Change (IPCC) has produced an unprecedented body of integrated research concerning climate change and atmospheric science, and moreover, it has enjoyed considerable success in raising awareness of the issue and framing the global debate. Despite being an international issue of major urgency, the oceans have no such overarching effect. An IPCC-like body focused on the oceans could tackle both the scientific challenge of vast integrated assessment and the social challenge of presenting the issues in a way that are easily accessible for policy makers and the general public.

However, participants mentioned many steps that can be taken immediately in terms of mitigation and adaptation. Ocean surface conditions could be used as an easily accessible global way of measuring progress on greenhouse gas emissions. What is more, oceans are also a resource in which everyone has a stake. Coastal ecosystems, especially mangrove forests, tidal marshes and sea grass meadows that sequester significant amounts of carbon and provide buffering services against storms can be protected and even restored. Likewise, marine fisheries ecosystems can be managed to protect and ultimately enhance populations of live species. R&D in sustainable marine energy sources such as wave, tide, offshore wind, and thermal and salinity gradients can be promoted and supported. Perverse subsidies that promote excessive coastal development or fishing activities at the cost of other benefits like tourism, ecosystem services, food production, and so on should be reformed.

Participants also discussed geoengineering solutions, but urged extreme caution in considering such approaches. Some warned that of the most common and well-developed ideas, such as injecting large quantities of sulfur aerosols into the stratosphere, might impact climate change but do nothing to solve major ocean issues like acidification, which result primarily from CO_2 concentrations.

104-F1: Developing Human Habitat: Smart Cities

Chair:

- **Onishi, Takashi**, President, Science Council of Japan (SCJ), JP

Speakers:

- **Goldstein, Rose**, Vice-Principal, Research and International Relations, McGill University, CA
- **Lim, Neo Chian**, Chief Executive Officer Singbridge International Pte Ltd., SG
- **Murai, Yoshihiro**, Governor, Prefecture of Miyagi, JP
- **Rinnooy Kan, Alexander**, President, Social-Economic Council (SER), NL
- **Rubinstein, Ellis**, President and Chief Executive Officer, New York Academy of Sciences (NYAS), US

There was unanimous support among participants for the further development of smart cities, yet what exactly the term ‘smart city’ means was a different matter. One speaker commented that the uncertainty over what ‘smart city’ means is proof that the concept is still in its infancy. While some saw the smart city as primarily synonymous with the concept of an efficient city supported by technology, others viewed a smart city as an urban space that is actively designed to support the quality of life of its inhabitants. Still others emphasized that a smart city is a place that is fundamentally green – designed to lower its carbon foot print.

One speaker expressed the view that far too often, cities are either places that are easy to live and play in, or easy to work in, but are rarely spaces where you can do both. As such, the urban experience needs to be seen holistically, providing the foundations for a multifaceted space, reflecting the way people work and live. More recent smart city developments in Northern America, such as Montreal, have tried to focus on a balance between a scientific approach of efficiency and a more creative and social approach built on culture. However, such a dual tactic is incredibly difficult to achieve without adequate backing from both the state and the private sector. Finding ways to unite the goals of both sides is particularly challenging. Extensive work needs to be done to help all parties understand the substantial benefit that comes with putting the citizen at the center of the urban experience. Smarter, better planned urban spaces can lead to decreases in green house gas emissions, by, for example, shorter journey times and the right infrastructure for public transport.

A participant emphasized the need for cities to take greater care in designing the space to be more responsive to the needs of the city’s inhabitants. Japan, for example, has an aging population and so there is need to make cities more user-friendly for the elderly. The disaster stricken areas of northern Japan provide an opportunity to rebuild cities more efficiently by putting the people at the heart of the projects.

In contrast, others spoke of technology as the defining feature of a smart city. Technology here is seen as the backbone to increased competition, livability and sustainability. This can range from building smart grids to reduce energy needs, or high density buildings to allow more people to live comfortably in a smaller space. Technology will lead to a more livable urban environment.

One speaker stressed that the definition of the smart city needs to be clearer, as 'the broader the definition becomes, the more diluted it gets.' For some, the emphasis should be on the European idea of smart cities, which defines them as urban spaces that work hard reduce their carbon foot print – net zero carbon emission buildings, better energy networks, or more efficient transportation systems. Further reference was made to the importance of maintaining commitment from both the public and private sectors. Curitiba, a town in southern Brazil, was praised as a noteworthy example of successful city planning, where an independent research institute was set up in 1965 that oversaw the development of the city. Now, with its many large parks and Brazil's most used public transportation systems, it is ranked as one of the most livable places in the country. However, this could not have been achieved without the leadership of a central figure and a strong long-term vision, sustained with short-term actions.

While views differed on what is the single most important aspect of a smart city (human-centered urban planning, technology, and green), all the participants agreed that a smart city must be a place that is livable, efficient, and sustainable. Participants furthermore agreed that the only way to achieve this is by ensuring the support from both the public and private sectors. One potential way to achieve this is for separate cities to work more closely together in developing joint policies, giving such endeavors more clout and encouraging private enterprises to buy into the ideas. For example, one speaker suggested that the Tohoku region of northern Japan could create a shared administration to enable the area to define a more unified, efficient and targeted regional policy.

104-G1: Science and Technology Diplomacy and International Collaboration

Chair:

- **Rübig, Paul**, First Vice-Chairman of Science and Technology Options Assessment (STOA); Member European Parliament, AT

Speakers:

- **Boucher, Richard**, Deputy Secretary-General, Organization for Economic Cooperation and Development (OECD), US
- **Campbell, Donald W.**, Senior Strategy Advisor, Davis LLP, CA
- **Moriguchi, Yasutaka**, Vice Minister of Education, Culture, Sports, Science and Technology (MEXT), JP
- **O'Reilly, David**, Group Scientific Director, British American Tobacco Plc., UK

Science, which depends on cooperation and collaboration between people, does not always sit well with diplomacy, which requires caution and care. So why do countries conduct science and technology diplomacy? The reason is that questions surrounding the environment, energy and health are all transnational issues, and national solutions are simply not sufficient. At the same time, technological change has enabled collaboration in unprecedented ways. This has resulted in a high level of interest in science diplomacy, meetings and conferences in recent years. One recent example of this was a conference at Britain's scientific fellowship, the Royal Society, which resulted in a highly recommended paper entitled "New Frontiers in Science Diplomacy".

Science and diplomacy can interact in different ways. There is a distinction between 'diplomacy for science' – diplomatic initiatives to achieve successful scientific programs, such as the Large Hadron Collider, the Intergovernmental Panel on Climate Change, and space programs – and 'science for diplomacy', where scientific cooperation is used as a way to deepen ties between countries. An example of this is a recent agreement between Canada and Japan.

Scientific dialog often continues between countries even when other relations have been broken off. This can be positive for both scientific research and diplomacy. The European Organization for Nuclear Research (CERN) in its early days was a good example of how scientific cooperation can precede and enable more general diplomatic cooperation. Today, Synchotron-Light for Experimental Science and Applications in the Middle East (SESAME) brings together researchers from Arab nations like Jordan and Egypt along with others from Israel, the Palestinian Territories and Iran, all working together. It is important to ensure that scientific research in developing countries like China is integrated into the existing global scientific dialog instead of being perceived as in being competition with it.

Greater attention is being paid to how to conduct big international scientific projects effectively. The OECD has recently concluded a study examining how best to organize collaborative research to identify cross-border capabilities and share costs. Flexibility on the part of governments and scientists is increasingly recognized as highly important. Also crucial is agreeing an appropriate balance between protecting intellectual property rights and disseminating the results as widely as possible.

A major issue under discussion was the movement of scientists around the world. One recent trend is the migration of scientists to countries and research institutions in the Middle East and Asia which are providing massive funding for scientific research. Japan, for example, is paying not just for Japanese researchers to go abroad, but also for foreign researchers to come and work in Japan. At the same time, funding issues and visa restrictions are making international scientists less likely to remain for their entire careers in countries like the United States. While this is often viewed as a problem (especially in the countries concerned), it was pointed out that the resulting international networks are drivers of global scientific collaboration in themselves.

Also discussed was the role of international coordination between scientists and governments to address educational mismatches between the skills taught in national education systems and the skills required by employers. Since many new initiatives for development come from technologies enabled by academic research (such as distance learning and telemedicine), science diplomacy must also focus on building frameworks to enable the flow of insights from science into technology and from academia into the private sector.

A major issue in the discussion was the potential for discomfort among scientists due to a feeling that their research might be 'used' for political ends. For scientists, diplomatic outcomes are often incidental to their scientific aims. In the 'dance' between evidence-based policy and policy-driven evidence, there must be some mutual flexibility, and the private sector also needs to be involved. The Institute for Environmental

Negotiation at the University of Virginia, for example, is using science diplomacy as a way to bring together stakeholders in both science and industry to find a way for tobacco companies to work collaboratively with independent researchers.

International scientific dialog has been around for a long time. The Royal Society in Britain had its first Foreign Secretary in 1723, 59 years before the British government itself appointed one. Science and technology diplomacy is increasingly important and has a vital role to play in promoting both science and diplomatic relations in the future.

19:30-21:00 PLENARY SESSION

105: Official Dinner

Introduction by:

- **Barañao, Lino**, Minister of Science, Technology and Productive Innovation, AR

Speaker:

- **Eurnekián, Hugo**, Vice President, Corporación América, AR

Lino Barañao welcomed the guest speaker, who was there to introduce one of the most ambitious projects in Latin America – a tunnel to connect Argentina and Chile, which in his opinion will 'probably change the geopolitical landscape of the region'.

Hugo Eurnekián emphasized that infrastructure is everywhere, underpinning every daily activity. Consider a glass of water, or the speaker's tie. These everyday objects are not just raw materials assembled through production. They required transportation, energy and communication capacity. Infrastructure improves our quality of life, connecting us to schools and hospitals, providing clean water and sanitation.

In Latin America, there is a huge gap between existing and desired levels of infrastructure. In order to achieve GDP growth over the next 15 years at a sustainable rate of 4.5%, investment in infrastructure would have to reach 5% of GDP. Today that rate stands at 2%. To achieve a quality of infrastructure equivalent to the most developed countries in Asia, the investment required would be 8% of GDP. That investment alone would not be sufficient, however, because just as important as the physical infrastructure (the hardware of an economy), is a set of political policies to provide an appropriate economic framework (its software). Part of this challenge is to develop regional integration in Latin America. Europe has an inter-regional exchange of 80%, Asia 50%, and Latin America just 20%. Greater integration of Latin America is essential to develop value chains and stronger industry. It would bring a more robust and balanced economy which relies less on primary exports, reducing vulnerability to price fluctuations in primary goods markets. Greater regional integration, together with better roads, ports and airports would also enable greater integration with global markets.

Annual infrastructure investment in Latin America fell from 4% in the 1980-85 period, mostly from the public sector, to just 2% in 2007-2008, mostly from the private sector. This achievement by the private sector has not fully replaced public sector investment and is insufficient to meet the needs of the area. Flaws in financial markets are also a problem. The public and private sectors must assume the roles and risks for which they are best suited.

Geographically speaking, there is a colossal logistical bottleneck in the region. South America is divided by the Andes mountain range, an enormous natural barrier, making traffic flow between the Atlantic and Pacific coasts of the continent extremely difficult. A solution comes in the form of a private initiative, the Bioceánico Aconcagua, a railway and tunnel linking the thriving metropolises of São Paulo, Santa Fe and Buenos Aires and the agricultural land around Córdoba to Santiago and Valparaíso in Chile. This area covers 70% of South American GDP and 50% of the population of region.

At present, crossing the mountain range is the weakest link in the logistic corridor, so an effective solution will have an enormous impact. Developing the project requires state-of-the-art solutions including a 52km tunnel, one of the longest in the world. The new crossing will cut travel time by more than two thirds, and transportation capacity will increase from 5m tons per year to 77m tons – a 15-fold increase. The project will be carried out in a flexible manner, divided into 3 large stages to be executed in sequence as demand grows. The system will be 100% electrically powered, reducing energy consumption by 82% and leaving a positive carbon footprint. From a legal standpoint, such a landmark project will necessarily trigger reform of regulations, laws and customs processes. This will strengthen the framework of integration, as has already happened with the bilateral treaty between Argentina and Chile in 2010, which established the organization of a special bi-national entity for this project. When it was ratified by both countries, it became the first bi-national entity in the history of Chile.

This project has been take underway for more than 5 years so far, with an international consortium including companies from Chile, Italy, Japan and Argentina. This international cooperation has resulted in optimal engineering design utilizing the latest technology. Behind this process is a complex interweaving of relationships between science, companies, entrepreneurs and politics united behind a common purpose.

Participants viewed a video illustrating some of the logistical challenges of the project and the tremendous rewards its completion will bring to the region. Construction is now well under way.

Monday, October 8, 2012

08:30-09:50 PLENARY SESSION

200: Enhancing Innovation - Dialogue among Political Leaders, Scientists and Industrialists

Chair:

- **Kagermann, Henning**, President, acatech (National Academy of Science and Engineering), DE

Speakers:

Political Leaders:

- **Durongkaveroj, Pichet**, Secretary General, National Science Technology and Innovation Policy Office, TH
- **Goodyear, Gary**, Minister of State for Science and Technology, CA

Scientists / Academics:

- **Chameau, Jean-Lou**, President, California Institute of Technology (CALTECH), US
- **Van den hove, Luc**, President & Chief Executive Officer, IMEC, BE

Industrialists:

- **Chubais, Anatoly**, Chief Executive Officer, OJSC "RUSNANO", RU
- **Uchiyamada, Takeshi**, Vice Chairman of the Board, Toyota Motor Corporation, JP

Henning Kagermann stated that there is no universal blueprint for innovation, but the presented three positive examples that innovators can learn from. The software industry shows the virtue of not overprotecting knowledge, and the value of CEOs who champion innovation. From Germany's experience of building innovation programs, it is clear that legislation has acted as a catalyst. Also important is the democratization of innovation by which many groups in society have been part of the process. From a pan-European perspective, it has become clear that working with large groups of people with disparate interests – such as business and politicians – is often harder, but the rewards can be great.

Pichet Durongkaveroj stressed that while innovation provides opportunities for mitigating many global challenges, the field needs to be open, encompass all areas of concern and benefit from worldwide cooperation. In general, more drugs are approved for high profile diseases such as HIV/AIDS and malaria than for other "neglected" illnesses like tuberculosis, typhoid and dengue fever. Policies such as public-private-people partnerships and youth-focused development are vital to ensure a suitable interface between innovation, the market, and social concerns. There are some examples of successful inclusive innovation, such as the Bill and Melinda Gates Foundation's activities in Thailand, but these need to become more widespread.

Gary Goodyear emphasized the Canadian government's commitment to education in science, technology, engineering, and mathematics, and provided an overview of ongoing research commitments. Current efforts are focused on attracting and retaining talent, supporting excellence, marketing developments, and building infrastructure. Investment in science is also part of a program of economic stimulus. Of the G7 countries, Canada has the uppermost level of higher education expenditure on research and development as a percentage of GDP. Underlying all this is a vital need for collaboration, between companies and researchers, and between countries.

Jean-Lou Chameau provided a university-based perspective on knowledge, innovation, and talent. Universities are no longer restricted to particular campuses. Institutions such as Caltech can now extend their networks globally via modern communication systems. The ability of academic institutions and academics to pioneer and innovate cooperatively is crucial to achieve broad common goals. It also serves to defray the rising costs of big science. Intellectual and creative freedom – 'entrepreneurship of the mind' – can also produce what is seemingly useless knowledge that eventually becomes the cornerstone of new technologies. For their part, research universities should be mindful of contemporary global challenges and seek to provide game-changing solutions to apparently intractable problems.

Luc van den hove spoke of a model for open innovation practiced by the Interuniversity Microelectronics Center. Even fierce competitors work together in research as a way to offset the high costs of research and development in this field. Open innovation works in three directions. Producers, manufacturers, and companies that use semiconductors are encouraged to work together to create a route for rapid marketization, while developers such as universities also contribute according to their strengths. In addition, international cooperation is promoted, as is apparent in IMEC's staff of over 70 nationalities.

Anatoly Chubais identified the most significant ongoing global concerns as climate change, exponential population growth, and the threat of resource deficits (eg. metal consumption topping 20bn tons per annum recently, from 0.6 tons in 1900). Innovators must start to refine usage of new hydrocarbon nanomaterials such as graphene, which is 20 times stronger than steel, to create more efficient resources for construction. Global problems require global solutions, and so high tech competency must not be restricted to developed nations. Megascience projects are needed to promote development, and megabusiness projects are needed to transfer new technologies to emerging markets.

Takeshi Uchiyamada discussed the diversification of energy provision for motor vehicles, with an emphasis on the development of hydrogen. As it stands, electric vehicles have low running costs but, due to large battery requirements, have limited cruising ranges and take time to recharge. Fuel cell vehicles, in contrast, refuel in as little as 3 minutes, but require hydrogen stations which are still few and far between. Hydrogen is produced in large quantities, but distribution will require a further expansion of the infrastructure. However, charging centers may eventually become as ubiquitous as current gas stations – Japan is expected to have as many as 100 by 2015. The energy network of the future will likely be an interaction between renewable energy, the hydrogen grid, and the electrical power grid.

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

201-A2: Challenges and Solutions for Renewable and Transitional Energies

Chair:

- **Somerville, Chris**, Director, Energy Biosciences Institute (EBI), Professor, University of California Berkeley, US

Speakers:

- **Atwater, Harry**, Howard Hughes Professor and Professor of Applied Physics and Materials Science, California Institute of Technology (CALTECH), US
- **Darchis, François**, Senior Vice President, Member of the Executive Committee, Air Liquide Group, FR
- **Denhoff, Eric**, President and Chief Executive Officer, Canadian Hydrogen and Fuel Cell Association (CHFCA), CA
- **Hato, Hideo**, President, New Energy and Industrial Technology Development Organization (NEDO), JP

Renewable energy technologies that seemed a distant prospect only 10 years ago are now looking quite viable, with some having arguably already crossed that line.

Biofuels have expanded tremendously over the last 10-15 years, with annual global output approximately equivalent to the total fuel use in Germany over a year. With projections of continued growth at about 8% per annum, they are arguably the most rapidly expanding energy sector. Many concerns exist regarding land use, in particular the conversion of forests and other natural ecosystems to monoculture crop systems in competition with food crop. This is especially true for first generation biofuels like corn-based ethanol. Proponents admit there are good and bad ways to use any technology, and suggest looking to Brazil and its sugarcane-based ethanol for a more successful example. They point with enthusiasm to next generation biofuels that will produce ethanol from cellulose (essentially the bodies of plants as opposed to their fruits, seeds, or tubers). This would eliminate competition with food crops and open possibilities of much more sustainable, less carbon intensive land use. A major USDA study suggests there may be enough sustainably harvestable and “waste” biomass produced every year in the US to make 130 billion gallons of ethanol annually. Biofuels may not be able to cover all of the country’s transportation needs, but could cover between one-third and one-half by 2050.

Fuel cells have seen major gains as well, though widespread deployment remains a few years off. Between 2005 and 2012, Fuel Cell Electric Vehicles (FCEVs) increased in range capacity by 135% (to more than 550km), in power by 30% (to 70-100kW), in top speed by 20% (to 165km/h), and doubled in durability (to 2500 hours of operation). All these statistics compare well with average gasoline automobiles. Moreover, hydrogen consumption averages 1kg/100km and hydrogen can be purchased for around 7€/kg, also suggesting possibilities of competitiveness for fuel price. The most common way of producing hydrogen is from natural gas. Carbon sequestration during this process is reportedly not too costly, so it is unsurprising to see that natural gas companies are expressing serious interest in the technology. Meanwhile, programs like the “Blue Hydrogen Initiative” encourage production using renewable technologies. The difficulty is in the development of new delivery infrastructure, i.e. building networks of hydrogen refueling stations which remains a major endeavor.

There is interest from both the public and private sectors, however, and governments like Germany and the Netherlands are cooperating with companies such as Toyota, Hyundai, and Mercedes-Benz to establish demonstration sites involving both cars and refueling stations. Hyundai, for example, has committed to launching 1,000 FCEVs between late 2012 and 2015. Another possible way for governments to jumpstart the technologies is by changing over their fleets of buses and government vehicles to FCEVs.

On the subject of fuel cells, a participant pointed out that there are at least two commercially successful applications already: fork lifts and backup/auxiliary power generation. This is especially used in the telecoms industry for remote installations, where the resilience of the technology keeps communication grids running in the event of disasters.

Regarding electricity generation, the photovoltaic industry has been undergoing violent swings in recent years due to complications involving European subsidies, silicon shortages, low cost loans in China, to name but a number of issues. These have lead to sudden imbalances between production capacity and demand. However, overall, the picture is quite good, with 30 gigawatts of new PV capacity installed around the world in 2011, and present PV electricity generation reaching between 2-4 times grid parity. Within 3 to 5 years the industry is expected not only to recover, but do so transitioning into next generation technologies with improved efficiencies and reduced costs. Many think the technology is very close to a tipping point as it is, with the developments in artificial photosynthesis technology hinting at a bright future indeed.

Wind energy was not a key topic, but the general consensus was nevertheless quite positive with mention of 40 gigawatts of capacity having been installed worldwide in 2011. One of the long-understood challenges of wind and solar energy is their inconsistency, with peaks potentially exceeding demand and stressing existing grids and troughs failing to meet demand. Correspondingly, there is great interest in technologies that can balance and buffer these swings. One such idea resides in smart grids and smart cities. Among other advances, “smart” systems could store excess energy in peak production times in batteries, heated water, hydrogen, etc. to be released when needed. Various demonstration sites are under implementation around the world, such as NEDO’s collaborative project with the Hawaiian government on Maui Island.

Two competing paradigms for the future of energy production emerged during the discussion. One philosophy envisions a future of highly localized, “smart” generation, exemplified by things like PV production on rooftops, minimization of transmission distance and associated energy losses, small (5-30 MW) power plants located close to urban centers, and district heating using waste heat or excess electricity from peaks. The other holds a vision of a hugely powerful, much-upgraded transmission grid that could even connect across continents, balancing inconsistencies and allowing concentration of renewable power generation in areas of the world richest in the relevant resources.

201-B2: The Science of Aging

Chair:

- **Komiyama, Hiroshi**, Chairman of the Institute, Mitsubishi Research Institute, Inc.; President Emeritus, The University of Tokyo, JP

Speakers:

- **Berger, Geneviève**, Chief Research and Development Officer, Unilever NV, FR
- **Breton, Guy**, Rector, Cabinet du recteur, University of Montreal, CA
- **Ricquier, Daniel**, Vice-President Foreign Secretary, Academy of Sciences of France, FR
- **Staudinger, Ursula M.**, Vice President and Dean, Jacobs Center on Lifelong Learning and Institutional Development, Jacobs University Bremen, DE
- **Ugrumov, Mikhail V.**, Advisor to the President of RAS on International Scientific Cooperation, Presidium of the Russian Academy of Sciences on Foreign Affairs, Russian Academy of Sciences (RAS); Head of Laboratory, Institute of Developmental Biology RAS, RU

This is the third time that there has been an STS *forum* session focusing on aging. Life expectancy has increased significantly over the last centuries, at present reaching over 70 years in most developed countries. The session addressed the question of how to create a healthy aging society.

One speaker talked about the link between obesity and aging. It is estimated that in the 100 years between 1950 and 2050 the number of people over 60 years will have reached 2 billion. Aging is often accompanied by pathologies such as cardiovascular disease, cancer, neurodegenerative disorders and metabolic diseases. Obesity is very common among younger people and therefore it tends not be associated with aging. In developed countries, more than 50% of the population is overweight and 30% is obese. It is also a rapidly growing epidemic in the developing world. Amongst the elderly, obesity is a factor of risk and disability. It can accelerate aging and increase the likelihood of arterial hypertension and diabetes in people over 65. Possible solutions to treating obesity in older people will include drawing on the progresses that have been made in the prevention and treatment of obesity in young people, while tailoring strategies to meet the specific circumstances of the elderly.

Another speaker emphasized the effects of neurodegenerative diseases, such as Parkinson's and Alzheimer's, amongst the elderly. The number of people with these illnesses is expected to rise over the next 20 years, which will lead to a significant increase in treatment costs. There is a need for more preclinical diagnosis and preventive therapy. More generally, these problems need to be approached holistically and through international cooperation.

The rise in life expectancy has in part been a major achievement in public health. These efforts must continue to maintain healthy societies and keep lowering morbidity rates. Mention was made of a study by Voelcker-Rehage to test the effect of physical activity on cognitive functioning that was published in the journal 'Frontiers in Human Neuroscience' in 2011. It confirms that regular physical exercise helps reactivate and improve brain function.

Food and personal care also play an important role in fostering a healthy aging population. Diet, pollution and other external factors coupled with internal factors such as stress levels affect the way in which people age.

An important question is how do we deal with research in aging: do we focus on individual organs? Pharmaceutical intervention looks at specific organs affected by aging. However, there is need for a more holistic approach to the science of aging, rather than this 'single organ approach'.

A participant stated that aging in the face can be affected by our general health condition, for example, higher blood sugar levels and genes can contribute to wrinkles and other physical signs of aging. Healthy skin aging and other aspects of growing old well can achieved through educating people on how to live better. Some dietary supplements successfully help skin repair, but there overall, there is still need for companies to be better poised to help build a healthy aging society.

Aging is a universal and constant process: we start aging at conception. We need to use knowledge to promote wellness as well as to engender cultural and policy changes. Age-related diseases, the decline in autonomy and mobility affecting ever growing numbers of people will have a social, cultural and economic impact which all countries will have to face at some point. Research can provide some of the answers to many of these age-related issues. The science of aging should not be seen as the science of sickness. It is the interaction of different complex factors that help us understand aging. We can do much to achieve healthier aging societies. A better understanding of aging will change the way we live. Preventing some of the problems that lead to disease and deterioration in aging people should be a primary goal.

201-C2: Nanotechnology for Electronics and Photonics

Chair:

- **Yeh, Nai-Chang**, Professor of Physics, California Institute of Technology (CALTECH), US

Speakers:

- **Chang, Ching-Ray**, Dean, College of Science; Professor, Department of Physics, National Taiwan University (NTU); President, Asia Union of Magnetic Societies, CHINESE TAIPEI
- **Ferrari, Andrea**, Professor of Nanotechnology, Engineering Department, University of Cambridge, IT
- **Higashi, Tetsuro**, Chairman, Tokyo Electron Limited, JP
- **Noda, Susumu**, Professor, Department of Electronic Science & Engineering, Kyoto University, JP
- **Suter, Ulrich**, President, Swiss Academy of Engineering Sciences (SATW), CH

There could be as many as 200 quintillion transistors in the world by 2015, and 'many of us carry in our pockets what a decade ago would have been a supercomputer'. However, as we approach the limit of our ability to miniaturize technology, the era of 'faster, cheaper, better' processors is coming to an end. Techniques such as heterogeneous integration, more sophisticated mounting, and alternative systems of interconnectivity may enable a growth in power that transcends Moore's law, but for the next 3-5 years, there appears to be no mass-marketable alternative to silicon technology.

In the field of nanoelectronics, the cost of manufacturing has decreased as functionality has increased, while the use of nanomaterials such as graphene means that structures can be assembled on an atomic level. At this scale, quantum effects and energy dissipation become major concerns. New architectures of information processing are being explored. Another experimental technology is the manipulation of the spin of electrons (as opposed to the charge), resulting in a new field known as spintronics. Spintronic devices have the advantages of being both stable and easy to scale down, but for now the next generation will probably be hybrid silicon devices. However, achieving a low signal-to-noise ratio and high process flow efficiency remain challenging. Furthermore, the mass production of nanoscale materials remains challenging, and the industrial viability of materials needs to be explored further. There are also numerous other applications for nanomaterials beyond the realm of electronics – for example, the inclusion of graphene flakes in lithium batteries enhances their capacity. One speaker, however, warned of unreasonable expectations associated with the development of 'wonder materials', and emphasized the need for thorough research.

The interaction of light and matter is the essence of photonics. One participant expressed the belief that processing functions can and will be efficiently carried out by nanoelectronics, while energy transmission can be achieved more effectively through photonics. Another participant suggested that the nanoscale interaction between human requirements and the photon will be one of the most important trends of the 21st Century. Photonic technologies will have an impact on areas as diverse as medicine and energy generation. Photonic crystals, with internal structures similar to semiconductors, allow light waves to be manipulated in a similar way to electricity. These already exist in nature, for example in the blue morpho butterfly, but man-made materials will have many applications. Nanodevices based on materials including 2D and 3D photonic crystals, have potential uses in photovoltaic cells and in the conversion of light energy into electricity, with the obvious implications this has for solar power generation. Beyond this, the next 10 years may also see integrated electronic-photonic devices.

The plasmonic responses of electrons in metals are one fruitful area of nanotechnological research. This has applications in communications, photovoltaic cells, and batteries, amongst others. Indeed, the development of light emission inhibiting materials in general could result in LEDs with efficiency approaching 100%. Work is also proceeding on devices such as germanium avalanche photodetectors. In the longer term, strong confinement of photons could provide a new technique for data storage that is both extremely high capacity and efficient. The refinement of light inhibiting materials could have a profound impact on the efficiency of solar panels. Technical issues include the fact that that the optical properties of a material may change with size, as well as difficulties in reliable mass fabrication.

One participant described how even relatively small nations with limited resources can maximize their contributions to the field through effective intra and international cooperation. It is imperative to ensure that there are common scientific safety standards. These are also required industry-wide standards are also required to regulate the usage of nanotechnology in consumer products such as makeup. While nanotechnology has the potential to be of great benefit to the human race, such as through creating body-monitoring devices to optimize medical treatment and other 'wearable' applications, it is vital that scientists and engineers be vigilant in keeping the public well informed on developments in the field. The public may yet turn against the technology, as reactions to nanotechnology accidents in China have shown. One participant also emphasized that approaches to nanoscale research should take into account the practical applications of the items produced, and issues of cost and marketability. In terms of production, multi-functionality is a vital element of successfully bringing this technology into the mainstream.

201-D2: Science and Engineering Education for the 21st Century

Chair:

- **Dijkgraaf, Robbert**, Director and Leon Levy Professor, Institute for Advanced Study (IAS) in Princeton, NL

Speakers:

- **Chi, YoungSuk**, Chairman, Elsevier Inc., US
- **Eichler, Ralph**, President, Swiss Federal Institute of Technology (ETH) Zurich, CH
- **Kobayashi, Makoto**, Professor Emeritus, High Energy Accelerator Research Organization (KEK); Nobel Laureate for Physics 2008, JP
- **Ponomarev, Alexey**, Vice President, Industrial Cooperation and Public Programs, Skolkovo Institute of Science and Technology, RU

The importance of science and engineering in solving the major problems facing society is increasing. Interest from students and enrollment are also up. The challenges facing science education are twofold. Funding rewards research instead of teaching in higher education, and social science and liberal arts disciplines are under-emphasized in the typical curriculum.

The ongoing global recession has hurt the delivery of science and technology education around the world. Science is expensive. As budgets shrink, obtaining long term funding for projects becomes more difficult. Funders prefer projects with short term value. The reduction of resources also forces scientists and researchers into to concisely and simply explaining the value of their research to decision makers. As the language of science becomes increasingly specialized, the average person's understanding of the importance of science and its effect on their lives diminishes. Public outreach is needed to explain the impact of science in layman's terms. One institution did an excellent job of explaining the importance of discovering the Higgs boson through a series of videos on YouTube.

Many participants also expressed concern about how research results, not teaching results, are used to evaluate professors' performance. This system practically rewards them for not wasting time and energy teaching. One participant noted that the training to teach at the university level often includes absolutely no pedagogical training, and that there are no systems for supporting best teaching practices as there are for research.

One of the failings of modern science and engineering education is its inability to include more interdisciplinary

studies. But how should they be promoted? Which social sciences at which level would be best? Some applauded the US system of broad-based education at the undergraduate level, then moving on to more specialization for advanced degrees, while others thought students should focus on an area of expertise from the start with experience of working on interdisciplinary teams later. Most participants agreed that the teacher should facilitate student participation, and a few favored an approach in which the individual student would have access to multiple learning styles, including the prevalent lecture system. Some participants also expressed the hope that advances in technology allow students to learn scientific fundamentals in less time, enabling them to expand and diversify their studies.

Participants also discussed how the changing role of technology would affect the classroom. Increases in access to information can result in decreased attention spans, and there was some disagreement about the extent to which information technology can be applied to the understanding and synthesis of information -- as opposed to simply enabling more access to information. Sinking money into hardware and technology for students will not necessarily lead to better performance outcomes. The learner must do something, and not just regurgitate information. If the expansion of communication technology is used to improve synthesis, or free up time for the teacher to facilitate higher level learning activities, it could be beneficial.

Some participants felt that tackling the “grand challenges” facing the world would require an interdisciplinary approach that most current science and engineering education programs now lack. For example, knowledge of a local culture is necessary in order to create livable and sustainable cities. There was a consensus that teachers should do more to instill an understanding of science’s role in society, and that expanding the role of the liberal arts into the curricula would help. Several participants emphasized that the cultural and sexual diversity of the student and faculty bodies, as well as the diversity of disciplines taught to science and engineering students, was instrumental in giving students the broad range of skills necessary to work well on multidisciplinary teams after they graduate.

Another area of concern was industry’s reluctance to provide careers for students who pursue education up to doctoral level. It was recommended that universities avoid overly specific labels for the graduate’s area of expertise, such as robotics, and that potential employers focus more on the graduate’s ability and resourcefulness to complete his or her research than on their particular field of expertise. One participant questioned whether the difficulties faced by doctorate holders in finding employment were because they were over-specialized or because they lacked other competencies not related to their field of expertise.

201-E2: Water

Chair:

- **Hüttl, Reinhard**, President, acatech (National Academy of Science and Engineering); Scientific Executive Director, German Research Centre for Geosciences (GFZ), DE

Speakers:

- **Abe, Koichi**, Senior Vice President, Toray Industries Inc., JP
- **Desmarescaux, Philippe**, Founder, BioVision FR
- **Eggen, Rik**, Deputy Director, Swiss Federal Institute of Aquatic Science and Technology (Eawag), CH
- **Hatta, Gusti Muhammad**, Minister of Research and Technology, Ministry of Research and Technology (RISTEK), ID
- **Lowry, Don**, President and Chief Executive Officer EPCOR Utilities Inc., CA
- **Zehnder, Alexander J.B.**, Scientific Director, Alberta Water Research Institute, Alberta Innovates – Energy and Environment Solutions (EES); Former President of the ETH Board, Swiss Federal Institute of Technology (ETH), CH

The discussion began with an overview of some major challenges. The global concerns for water include ensuring that drinking water is clean, fresh and free from pathogens and contamination. This also includes that enough water exists for agriculture and industrial production, that ecosystems and biodiversity are correctly maintained, and that water balances are managed so that areas at risk from drought or flooding can be identified and measures implemented. Many of these issues are however becoming increasingly challenging, as huge population growth strains water supplies for drinking and agriculture and demand for industrial processes grows. Although the millennium development goal relating to water may be met with regard to drinking water, sanitation remains a huge problem with around 700m urban dwellers still going without.

Addressing the challenges relating to water is extremely complicated due to the size and multi-factorial approach required. More efficient ways of managing water and water resources are required, and approaches must account for the fact water is not required for just one approach. Integrated water resource management (IWRM) is an important strategy, and requires using a coordinated method that addresses numerous challenges affecting water such as climate change, population growth, land use and urbanization. In addition to this, the cross-cutting areas of water monitoring and water research must be considered together. Tackling issues of incomplete provision and exchange of data between monitoring systems and regions also must be addressed. At the same time, societal aspects must be incorporated into the overall approach, and academia, government, industry and civil society must all be involved in the process.

Another important approach to dealing with some of the challenges related in relation to water is implementing the findings emerging from science and technology. The development of new on-site technologies is required to improve efficiency in water use, such as better toilet systems. Waste water may also be re-used and converted into a product with value, due to the nutrients and energy contained in waste which are typically lost. More efficient treatment of waste is also necessary due to the role waste water plays in causing eutrophication and algal blooms in water systems, which in turn is harmful to ecosystems and results in the death of fish. Technologies such as RO membranes and special water purification tablets exist to desalinate and decontaminate water, but political administrations need to be motivated in order for technologies to be efficiently implemented. The

fragmentation of utilities poses a problem, since in general, fewer larger infrastructures are less expensive to develop and maintain than many smaller systems. In poorer countries, there is a need to provide access to robust technologies that can be used in remote places by people with no technical background.

A large proportion of the discussion also centered on conceptions of water treatment and how this affects trade and pricing. Water is generally perceived in a more emotional than intellectual manner, and this generates resistance to viewing it as something that can be traded and priced according to its value. Failure to price water according to the costs of providing it and maintaining infrastructure results in chronic underinvestment in infrastructure and enormous deficit. In the US, for example, $1tn is required to address the deficit. Government subsidies for water are also dangerous and fail to improve efficiency or competition, and ultimately are paid for by consumers anyway in the form of taxes. Water should be priced appropriately and the way in which water provision is perceived must be changed.

Education about water is also important – politicians should understand the real costs of water, and all sectors of society must also understand the value of water. In this way, behaviors relating to water may also be modified to reduce wastage. Ownership of water should also be created, as the current lack of it stops people from taking responsibility for its maintenance.

201-F2: Developing Human Habitat: Adaptation to Climate Change (RCC4)

Chair:

- **Kennel, Charles**, Distinguished Professor Emeritus, Scripps Institution of Oceanography, University of California, San Diego (UCSD); Senior Advisor, Sustainability Solutions Institute, US

Speakers:

- **El-Beltagy, Adel, El Sayed Tawfik,** Chair, International Dryland Development Commission (IDDC), President of the Governing Board, International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM), EG
- **Kasuga, Fumiko**, Vice President, Science Council of Japan (SCJ), JP
- **Taniguchi, Makoto**, Program Director, Core Research Hub; Head of Division of Research Development, Center for Coordination, Promotion and Communication, Research Institute for Humanity and Nature (NIHU), JP
- **Tremewan, Christopher**, Secretary General, Association of Pacific Rim Universities (APRU), NZ

Participants came from a diverse range of cultures and disciplines, reflecting the gravity of climate change both socially and environmentally. It was felt that climate change can be tackled in two primary ways – by either mitigating greenhouse gases or by finding new methods of adapting to the changing circumstances. Certainly focus thus far has tended towards mitigation, ever since the severity of climate change was officially recognized at the United Nations Framework Convention on Climate Change in 1992. Since then, the scientific community has come to understand that while CO_2 emissions, particularly from burning fossil fuels account for 60% of greenhouse gas emissions, the rest - up to 40% - are derived from other sources, such as methane. This raises the question as to whether the discussions have been unjustifiably skewed towards combating CO_2 production, particularly with recent findings showing that even if we are able to dramatically lower CO_2 levels overnight, it would take decades, if not centuries, for it show any meaningful effect. It might be more advantageous to concentrate on reducing the remaining 40% of greenhouse gases first.

Although moves are being made across the globe to cut emissions, it is looking increasingly unlikely for warming levels to stay below the targeted “under 2 degree increase” by 2050. This will have substantial impact on the melting of the icecaps at both poles, causing rising sea levels. With rising water levels looking ever more unavoidable and around a quarter of the world’s population living in coastal areas, ways need to be found to adapt to the changing circumstances. First attempts have been made, such as the recent project to save Venice from rising sea levels.

Rises in sea levels do not only represent an erosion of habitable land and the displacement of millions of people, it also poses the risk of salt water leakages into fresh water supplies, rendering it undrinkable. One participant expressed the need to use these findings as an impetus to push research into desalination technologies.

Another participant looked at the issues of global warming, resulting temperature rises and flooding from the perspective of the impact on human life. Not only are food supplies affected, but also bacteria and infectious diseases have been shown to change behavior and growth patterns in warmer conditions. This raises the risk of infection and illness but also impacts on the time it takes for an infection to turn into illness. Particularly striking is the increase in zoonosis (SARS, foot and mouth, etc.) which has been attributed to these changes. Also of concern are future risks of other animal-carried pathogens invading human spaces as flooding pushes certain animals, such as rats, into cities.

The session’s overall focus on water levels was challenged by another participant who emphasized that it is actually dry lands that face the gravest problems generated by global warming. He estimated that already 2bn people are already affected, with the number inevitably rising over the next decades. As it is, today 14 countries in northern Africa currently face chronic water shortages. These are areas where inhabitants used to live on 1,000 m³ of water per year. They now have to make to make do with less than 500m³. It is predicted that by 2050, at least 200 million people will be displaced as a consequence of climate change.

Participants unanimously agreed on the need to support scientific endeavors to find new ways to produce food. The Netherlands was cited as an example because of its tremendous food output despite its small land size. Other topics included investing in desalination research to make up for the absence of water in dry areas. Participants also agreed that first world countries must take responsibility for the effects of climate change in the developing world, as they will be most affected. It was strongly felt that time was running out and that action is needed now. However, there was uncertainty as to what could be achieved and what would be most appropriate: a top down structure or a more grass roots movement. In either case, the need for strong Knowledge Action Networks

that facilitate collaboration between institutions and local governing bodies are likely to provide at least the beginnings of an answer.

201-G2: Modifying Human Behavior for a Sustainable World

Chair:

- **Friedman, Jerome**, Institute Professor and Professor of Physics Emeritus, Physics Department, Massachusetts Institute of Technology (MIT), US

Speakers:

- **Carty, Arthur**, Research Professor and Executive Director, University of Waterloo Institute for Nanotechnology, CA
- **Colombani, Pascal**, Chairman of the Board, Valeo S.A., FR
- **Gutscher, Heinz**, President, Swiss Academies of Arts and Sciences (AWS), CH
- **Matsumoto, Yoshihisa**, Executive Vice President, Representative Director, Idemitsu Kosan Co., Ltd., JP
- **Steen, Tomoko**, Senior Research Specialist, Science, Technology and Business Division, Library of Congress; Adjunct Professor, Department of Immunology and Microbiology, Georgetown University, Medical School, US

Scientific knowledge is not sufficient in itself to solve the problems facing humankind. Science can identify and help us understand the issues, but the changes in human behavior that must follow often do not happen. This is one of the most important issues in developing a strategy to deal with the problems facing humankind. This lively discussion considered the questions of how scientists should best communicate and who they should be talking to.

One perspective was that developing the political will to make the right choices requires the public to be engaged. Policymakers often cannot take the lead with sensible policies (such as a carbon tax in the United States) in the absence of public support. This argues for greater engagement with the public to achieve persuasion.

The problem is that people do not always make rational choices. Examples were mentioned of recipients of development assistance using their new toilets as storerooms or failing to use water filters. Global warming, collapsing fish stocks and the growing social acceptance of obesity were all cited as examples of how people fail to act to prevent harmful outcomes. The goal must be to produce evidence-based behavioral change. Successes in persuading the public to change their light bulbs and buy organic food show that such engagement is possible, but also that it is very difficult to achieve, even to effect small changes. Dramatic catastrophes can have a big impact on public opinion, but even disasters like the BP oil spill in the Gulf of Mexico or the Fukushima Dai-Ichi nuclear disaster do not always permanently change public perceptions. In any case, relying on catastrophes to convince the public is probably an unwise strategy.

A number of models of persuasion (including the RANAS model that combines Risk, Attitude, Norm, Ability and Self-regulation as factors that lead to behavior change) were introduced and discussed as being important ways to understand behavior and influence it. Providing people with a sense of purpose, achievable goals and positive reasons to change were all identified as important.

Persuasion is made even harder by the opposition of constituencies which contribute to or benefit from negative environmental outcomes, such as energy companies producing oil or resource companies looking to operate in a newly ice-free Arctic. It was pointed out that significant fossil fuel consumption is guaranteed to continue for many decades from now owing to the installed capacity and current investment paths of governments and corporations. Persuasion efforts must acknowledge the reality of the situation and target the appropriate stakeholders. This includes acknowledging that people are locked into systems of behavior that they cannot easily change, and since human beings have a very natural inclination to fit in with their peers, their behavior consequently does not change. Often it is the larger system of expectations for behavior that need to be targeted.

The technique of 'nudging' people into the desired behaviors aroused considerable interest. Examples in the environmental arena could include making low flow the default choice on hotel showers so as to conserve water. Nudges do not remove choice, but are a clever way to generate personal contributions.

On the other hand, regulation is often the best way to achieve behavioral changes, and it requires convincing political leaders and other opinion formers. The latter are often very small in number so are easier to convince. Government action can sometimes be extremely effective, as with the setting of high emissions standards in California which have helped to drive global production and adoption of hybrid car technologies. Governments can also change education systems, which have a formative impact on beliefs and worldviews.

Psychologists, marketers, social scientists and business people often have expertise in persuading people to change their behaviors, so finding ways to involve them and their expertise is crucial. Social scientists in particular often have complementary expertise, and better collaboration is necessary. People with arts and humanities backgrounds can also be hugely effective here. Upton Sinclair's The Jungle and Rachel Carson's "Silent Spring" were both cited as examples of vivid narratives which dramatically changed public perceptions and led to societal change. It was mentioned that the media in the English-speaking world is perhaps not best regarded as a platform for discussing ideas or disseminating truth. Rather than scientists trying to make their case in the media, it might be more productive to have experienced professionals representing scientific viewpoints, in much the same way as private sector firms hire experts to represent them publicly.

A final point mentioned was that discussions such as this one concern everyone around the world, and that voices from regions like Sub-Saharan Africa should be better represented in such forums.

The multitude of ideas presented showed the ongoing difficulty of progress in this area, but was also encouraging in that a large number of plausible avenues for improvement clearly do exist. Greater interdisciplinary collaboration will be a key short-term step.

13:00-14:10 PLENARY SESSION

202: Population & Resources

Chair:

- **Sulston, John**, Chair, Institute for Science, Ethics and Innovation (isei); Nobel Laureate for Medicine 2002, UK

Speakers:

- **Bhumiratana, Sakarindr**, President, King Mongkut's University of Technology, Thonburi (KMUTT), TH
- **Kamar, Margaret**, Minister of Higher Education, Science and Technology, KE
- **Lee, Yuan Tseh**, President Emeritus; Distinguished Research Fellow, Institute of Atomic and Molecular Sciences, Academia Sinica; President of International Council for Science (ICSU); Nobel Laureate for Chemistry 1986, CHINESE TAIPEI
- **Nagayama, Osamu**, Chairman & CEO, Chugai Pharmaceutical Co., Ltd., JP
- **Shiraishi, Takashi**, Executive Member, Council for Science and Technology Policy (CSTP), JP

John Sulston started by thanking the organizers of the STS *forum*. He emphasized that the population was likely to reach 9bn by 2050, and this would have a tremendous impact on the world's resources. A recent report by the Royal Society entitled "The People and the Planet" examines the impact of this phenomenon on the relationship between humans and the world's resources. The report recommends that those at the bottom end of the development ladder should be lifted out of poverty as soon as possible, and that serious efforts be made to stabilize the world population at 10bn this century. This latter goal is entirely achievable, providing poverty is tackled urgently. Bold leadership is required to initiate the profound changes to our socioeconomic systems needed to ensure this occurs.

Margaret Kamar also thanked Mr. Omi and the organizers of the STS *forum*. She too drew attention to the detrimental impact of population growth on resources and climate change. The solution to these destructive cycles is 'green growth', where economic growth, through environmentally-friendly policies and technological innovation has a limited impact on the environment and reduces dependency on raw materials. Technology and policy experiences should be shared so that green-growth can be grounded in country-specific approaches. Strategies to deal with land, water, and energy consumption should be developed as these are basic needs. The sustainable development of infrastructure is also a necessity. In providing assistance, developed countries should keep in mind the particularities of the nations which are being helped.

Osamu Nagayama offered a perspective from the healthcare sector, and emphasized that 'keeping the 9 billion people on earth as healthy and socially active as possible should be a major objective'. He described the experience of post-war Japan, where life expectancy rose from 51 years to 83 years today. People over the age of 60 consume four to five times more medical resources than the rest of the population. Their rehabilitation and care should take place primarily outside professional medical establishments, which should be free to concentrate on intervention. Large-scale data collection can aid professionals in the prevention of disease and illness. Such an approach will be vital in the future, especially in a country like Japan where a recent survey indicated that some 85% of people want to continue working beyond the age of 65.

Sakarindr Bhumiratana discussed the issue of population from the point of view of a developing country, using his own, Thailand, as an example. The largest proportion of the Thai population consists of the under privileged - mainly rural farmers. The research objectives within the country are geared towards improving the conditions of these people. At the same time, however, there is an acknowledgment that research does not occur in a vacuum: policy makers, innovators, and wider social agents must also be engaged in the process of change in rural areas and elsewhere. Localities can also be the sources of knowledge concerning sustainability and productivity, and so it is important to ensure a counter-flow of information from these areas into the realm of scientific research. The promotion of scientific education in rural communities and improving the quality of science teaching should be encouraged to help citizens grasp basic scientific concepts and techniques. Education, rather than legislation, is the key to sustainable and enduring change.

Takashi Shiraishi observed that it is only in the last few centuries that the human population has exploded. In the short and medium term this will remain a critical issue. Even if they sustain economic growth levels of around 7%, in the foreseeable future, countries like Indonesia and China, for example, will still be unable to fully catch up with the economies of the West in terms of individual income. Internally, stark wealth gaps are likely to persist. Add to this the overall rapid aging of the population that inevitably comes with longer individual lifespans, and it is easy to see why this issue is so pressing. The way forward centers on general education, and technological innovation. The private sector, governments, and regional bodies should therefore start investing in the gifted and talented at a much higher level, immediately.

Yuan Tseh Lee suggested that the demographic-resource crisis is in fact far more severe than is generally acknowledged. The oft-quoted population figure of 9bn by 2050 is not guaranteed. The demographic future is in our hands. Controlling it is imperative, and techniques for doing so are well tested around the world. These include better education, empowering women to control their own fertility, and improving the life conditions of aging parents so that it is not necessary for them to have large numbers of children for security in old age. To ensure this happens, a multidisciplinary strategy, incorporating all interested parties, and a results-orientated approach are vital.

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

203-A3: Energy and Environment: Nuclear Technology Prospects

Chair:

- **Stricker, Laurent**, Chairman, World Association of Nuclear Operators (WANO), FR

Speakers:

- **Allen, Jack**, President, Asia, Westinghouse Electric Company LLC, US
- **Bolshov, Leonid**, Director, Nuclear Safety Institute (IBRAE RAN), Russian Academy of Sciences (RAS), RU
- **Morichi, Massimo**, Senior Vice President R&D, Areva Group, FR
- **Parmentola, John**, Senior Vice President, General Atomics, US

The major theme of this spirited discussion was safety in the nuclear industry in the aftermath of the events at Fukushima Daiichi reactor following the Great Tohoku Earthquake. This event proved that 'a nuclear accident anywhere is a nuclear accident everywhere'. Concerns about safety have been extensively discussed in Russia, where research into ensuring the integrity of nuclear operations is under the remit of the New Technological Program for Nuclear Power 2010-2020. Designs should be developed that rely on natural processes, such as gravity and evaporation, as an integral part of their safety measures, and it should be ensured that these can be relied upon for at least 72 hours. Similarly, it is vital to improve safety drills and to monitor human behavioral trends to ensure that operators are rigorously prepared for dealing with unexpected events. Inter-agency communications and command and control structures which are activated in emergencies should be reviewed and at maximum functionality. Nuclear operators in Europe have been cooperating closely with the IAEA to ensure safety, but one participant pointed out that it is difficult within the industry to upgrade the safety of existing equipment, much of which is 40-50 years old. Nonetheless, one participant observed that there has been very little technological innovation in the industry in response to the Fukushima crisis.

Public perception is a serious concern, and there does appear to be a certain amount of anti-nuclear media bias. Governments and organizations alike are struggling with nuclear policy as a result. While it is certainly the case that many of the safety standards in reactors in Europe, for example, are peer reviewed, it is vital to communicate a preoccupation with safety to the wider public. One participant observed that in Japan, the restarting of reactors recently occurred under the same regulatory regime as the one that existed prior to March 2011, which will not instill much public confidence. Safe design, regulation, operation, effective emergency response, and severe accident mitigation are vital in re-earning public trust. Demonstrating proper attention to these areas, and better communication about concerns surrounding public health on the part of the industry is imperative. It will be impossible to recapture the public imagination without addressing widespread anxieties about the proliferation of nuclear technologies, and without public support, further expansion of nuclear power will be well-nigh impossible. Some participants did point out, however, that safety within the nuclear industry has improved dramatically since the 1970s, but unfortunately it still remains at a 'socially unacceptable' level.

The future prospects of nuclear power in countries such as Russia, South Korea, and India (which intend to expand their usage of nuclear power) and Japan (which does not) was discussed. There are over 63 reactors currently under construction worldwide, and many of these will be in Asia. There are as yet no feasible renewable alternatives to nuclear power. Currently, there are around 440 nuclear power stations around the world, generating around 13% of the world's electricity, leaving much room for expansion. However, with efficiencies of around 60%, relatively low carbon output, low upfront capital costs, and relatively short construction times for power plants, natural gas will continue to be a major competitor to nuclear power. Other fossil fuels also continue to provide better value for money. In the USA, for example, the only two nuclear power stations under construction are not mercantile but subsidized, so there is a profound need to reduce the price of atomically generated energy.

Innovation within the realm of atomic power is progressing, with sodium, lead, and lead-bismuth cooled reactors due to be constructed in Russia by 2020. France is also involved in these developments, and indeed bilateral cooperation in this field is growing. Current light water reactors only utilize some 0.5% of the energy contained in uranium, and their level of functionality was compared to 'running a lumber mill where you sell the sawdust and throw away the wood'. The total amount of energy in all known nuclear fuel sources amounts to around 90 trillion barrels of oil. Worldwide reserves of actual oil are estimated at 1.5 trillion barrels. Efficiencies of 50% can be achieved, one participant emphasized, through new model compact fast gas reactors, which hold out the possibility of achieving these levels of output while reducing waste output by 97%. Developing these reactors to the point where they can be easily used, however, poses not only technological challenges, but requires massive upfront capital outlays as well. Here again, new supercomputers functioning in the exascale are being utilized to run simulations, e.g., of the capabilities of various configurations of assemblies. One participant pointed out that the pervasive technology within the nuclear industry is yet to undergo a meaningful paradigm shift, and this will surely come soon.

203-B3: Infectious Diseases

Chair:

- **Nagai, Yoshiyuki**, Director of Center of Research Network for Infectious Diseases (CRNID), RIKEN, JP

Speakers:

- **Dobner, Thomas**, Scientific Director, Molecular Virology, Heinrich-Pette-Institute, DE
- **Hayashizaki, Yoshihide**, Director, Omics Science Center, RIKEN, JP
- **Kiyono, Hiroshi**, Dean, Institute of Medical Science, The University of Tokyo, JP
- **Matar, Maryam**, Founder and Chairman, UAE Genetic Diseases Association, AE
- **Sawanpanyalert**, **Pathom,** Deputy Director General, Department of Medical Sciences (DMSc), Ministry of Public Health (MOPH), TH

Infectious diseases continue to be one of the biggest contributors to morbidity and mortality worldwide, being responsible for more than 40% of deaths globally and 58% of deaths in children under the age of 5. Examples of key infectious diseases include Hepatitis B, with around 2bn people worldwide affected; malaria, which causes an estimated 655,000 deaths per year, and tuberculosis and HIV which together are the most deadly illness globally. Many of these diseases are strongly associated with poverty, but drug resistance and emerging infectious diseases with pandemic

potential remain a serious threat worldwide. Further challenges include co-infection, such as in the case of HIV and hepatitis/TB, and hospital acquired infections and the potential for complicated infections resulting from immunosuppressant treatment regimes.

To tackle these complex and challenging issues, a multi-faceted approach is required. Basic scientific research must be analyzed from an epidemiological perspective and clinical studies implemented at international level. Monitoring and detection of existent and emerging infections is of critical importance, together with tools for preparedness, prevention and treatment. In this respect, monitoring organizations play an important role, and there is a need for collaboration between them. The Japan Initiative for Global Research Network on Infectious Diseases, or J-GRID, was given as an example of a platform for international collaboration. It has established 13 overseas collaboration centers in 8 countries across Asia and Africa. These kinds of partnerships are essential for sharing knowledge and facilitating rapid reporting and response to disease outbreaks.

Another area for discussion concerned the role of technologies for the speedy identification of infectious agents. Such technologies enable life-saving rapid treatment of patients and also the fast identification of infectious agents in cases of major disease outbreak. Point-of-Care Testing (POCT) technologies utilize immuno-chromatography and single-nucleotide polymorphisms to rapidly identify known pathogens. They are also capable of identifying strains with resistance to certain drugs. DNA sequencing for the identification of unknown pathogens is also essential, particularly in the case of identifying drug resistant infectious agents.

Vaccine development is another important area in which further innovation is greatly needed. Promising new approaches include those that specifically target the mucosal immune system, through novel administration in the form of patches, sprays or oral solutions. This may help in the development of vaccines for diseases that have historically been difficult to tackle, such as those causing gastrointestinal illness.

These types of vaccines may also help to overcome major problems surrounding vaccine administration in developing countries, such as the requirement of a cold chain.

A somewhat divisive topic among participants was whether or not an emphasis on eradication of disease was an appropriate strategy. One participant suggested that a paradigm shift was required to move away from “search and destroy” strategies, as the tools required for this effort such as new vaccines and drugs, cannot be produced at a rate that keeps up with the mutation of pathogens. Furthermore, it was argued that the healthcare infrastructure required for the delivery of many of the interventions for disease control is extremely ambitious and still unrealistic in many parts of the world. On the other hand, it was argued that strong responses to outbreaks are required because to let them go unchecked is dangerous. It was also suggested that with the help of vaccines, it remains possible that polio might one day be eradicated in the same way as smallpox.

All the participants were however in agreement about the need to use tools for fighting disease more carefully. Multi-drug resistance poses a serious threat to the control of many diseases, and cases of multi-drug resistant TB have been documented in almost every country that has been surveyed. There needs to a more uniform international approach to the regulation of antibiotics, as in some countries their liberal use in humans and animals is reducing the efficacy of these drugs.

203-C3: New Materials

Chair:

- **Ushioda, Sukekatsu**, President, National Institute for Materials Science (NIMS), JP

Speakers:

- **Cheetham, Anthony K.**, Goldsmiths’ Professor of Materials Science, University of Cambridge; Treasurer and Vice-President, The Royal Society, UK
- **Iskandar, Marzan Aziz**, Chairman, Agency for the Assessment and Application of Technology (BPPT), ID
- **Kirschbaum, Robert**, Vice President Open Innovation, CTO Office, Royal DSM N.V., NL
- **Mazur, Eric**, Dean of Applied Physics; Balkanski Professor, School of Engineering and Applied Sciences, Harvard University; Founder and Scientific Advisor, SiOnyx Inc., US
- **Neltner, Louis**, Head of Corporate R&D/Innovation, Solvay S.A., FR
- **Shankland, Ian**, Vice President and Chief Technology Officer, Honeywell Inc., US

New materials promise to help humanity solve some of the sustainability challenges of the 21st Century. Innovations in materials laid the groundwork for current photovoltaic technology and are likely to bring further enhancements in solar energy harvesting via concentrators, wavelength shifters, etc. They play roles in advanced biofuel production. Organic LEDs are revolutionizing lighting and displays. Sails made of new super-strong fibers can reduce fuel usage on container ships by up to 30%. Catalysts, membranes and other types of filters help in cleaning up pollutants. Biodegradable polymers produce petrochemical plastics that leave no traces at the end of their useful lives. At the same time, durable polymers made from renewable sources offer similar benefit to many current plastics without reliance on petrochemicals.

New materials are also crucial in medical innovations that keep people healthy and productive for longer periods of their lives – particularly those involving surgical implants. These have evolved from “bio-passive” materials (materials the body won’t reject for applications like joint replacements and shunts) to “bio-active” materials (e.g. slow release drugs). The not-too-distant future will see “bio-interactive” materials with targeted therapeutic and regenerative effects such as cartilage repair.

A cutting edge area of research in materials science is hybrid organic-inorganic materials – sometimes called “multi-materials”. These come in two main forms: porous framework materials and non-porous denser materials. The former have interesting potential for absorption, chemical separation and drug delivery. For example, one material shows promise in capturing iodine, such as the radioactive iodine that was dispersed in the Fukushima accident. The latter may be useful in pressure transducers as well as sensors. Advantages include some of the stability of the inorganic materials with

the lightness of the organic materials.

How new materials are discovered, developed, and ultimately brought to market was the subject of much discussion. Typically, the whole process takes at least a decade, more often two or three. Many products result from "serendipity" – unintended discoveries of interesting properties that researchers have had the freedom to pursue. Participants had many suggestions as to how to increase the likelihood of serendipitous discoveries and speed up the process of getting the discovery to market.

Overcoming a culture of resistance to change and fear of failure is important for encouraging the pursuit of the unknown. Joint business developments, open innovation paradigms, and other forms of collaboration can increase exposure and potential for insight. Licensing and venture capital can play valuable roles in funding development and accelerating paths to market.

Participants noted a serious concern about how to make sure developing countries are not left behind when seeking to develop their infrastructure into a sustainable future. Research, development, and deployment should not, panelists warned, be driven entirely by financial rewards but by concern for human wellbeing and the future of the planet as well. Open innovation partnerships and technology transfers offer promise here as well.

Finally, participants heard a real story of mixed caution and hope. It concerns the history of refrigerants, which went from the original toxic and dangerous materials to the at-the-time wondrous-seeming development of chlorofluorocarbons (CFCs) to the realization that CFCs were creating a hole in the ozone layer, the Montreal Protocol agreement that brought international banning of their use, and the years since. Several lessons can be drawn from this experience: 1) when a material is proven useful and commercially viable once, it will generally expand well beyond initial forecasts; 2) irresponsible use is inevitable to at least some degree; 3) international responses CAN solve global problems, and the Montreal Protocol is a great model for how to implement this. Such instruments incidentally could include gradual measures of technology transfer to help developing countries through transitions; 4) strong environmental persistence of any material should be a warning flag indicating the need for robust life cycle analysis; and 5) no material is perfect (CFC replacements are still high impact greenhouse gases though newer replacements developed since have much lower GHG impact and much shorter life cycles). The final lesson is: there is always room and opportunity for improvement.

203-D3: Capacity Building in Developing Countries

Chair:

- **Kurokawa, Kiyoshi**, Professor, National Graduate Institute for Policy Studies (GRIPS), JP

Speakers:

- **Abdulrazak, Shaukat A.**, Secretary / Chief Executive, National Council for Science and Technology, KE
- **Hara, George**, Group Chairman and CEO, Defta Partners; Ambassador, UN; Chairman of the Board, Alliance Forum Foundation, JP
- **Quevedo, Fernando**, Director, The Abdus Salam International Centre for Theoretical Physics, GT
- **Yusof, Fadillah**, Deputy Minister, Ministry of Science, Technology and Innovation (MOSTI), MY

Education and capacity building are major issues in a world of 7 billion inhabitants. An important question is how can we make education more accessible. A participant stated that a paradigm shift is needed to address the problems of the future. An example of a global problem is the question of how are we going to feed a world population that is expected to reach 9bn in 2050. Developing countries will need to build capacities so that they are able to meet the needs of their people. Socio-economic factors must be examined in order to equip developing societies and enable them to function better in a global environment. Education and training of people are essential, but developing countries face the problem of 'brain drain' and often struggle to retain their educated individuals. We need to build networks that encourage these students to return to their countries at the end of their studies in developed countries, by helping them find jobs that are attractive and relevant to their training.

A participant suggested that an alternative to sending students from the developing world to study in developed countries is to get 'touring professors' from the developed world to travel to developing countries to help train local scientists and researchers in their home countries.

Intra and international collaboration is an essential element in capacity building in the developing world. Access to available knowledge is also key, and as such, there is a need to make intellectual property rights inclusive, rather than exclusive. It was suggested that the developing world must establish centers of excellence or colleges that are committed to training the present generation of young scientists to assume the responsibilities of the future. They must also have access to appropriate mentorship geared towards helping them strengthen their capacity to tackle the challenges facing their societies.

Knowledge exchange, rather than money exchange, should be encouraged as a basis for cooperation between developed and developing countries. A participant suggested that the establishment of more fellowship programs and other funding opportunities that allow students from the developing world to study in developed countries is essential to providing useful access to important facilities available in developed countries. The International Center for Theoretical Physics (ICTP) was cited as a UN-backed organization that promotes science in the developing world by providing access to scientific training for students. These scientists should be encouraged to return to their home countries to play a meaningful role in their development.

In addition to working with developed countries, developing countries can benefit from partnering with each other to find local and regional solutions to some of the problems they face. For instance, it was suggested they could share their education facilities with neighboring nations. One participant mentioned a collaborative program between the University of Cape Town and universities in seven other countries in the region, which involves exchanges of both research students and faculty. However, the lack of funding for such programs remains a serious problem.

Technological input can provide creative and innovative ways to finding solutions to some of the problems that developing countries face. One speaker stated that a good example of this model is the technological transfer from Japan that has helped Malaysia become an industrialized nation.

People empowerment is key to closing the gap between wealthy and poor countries. Developing nations require differing levels of expertise to help them build innovative and entrepreneurial structures that are both profitable and address the needs of their local populations. Africa is resource-rich and programs must be designed to help countries there utilize their resources for the benefit of their own people. One participant reiterated that strengthening existing structures in Africa and turning them into centers of excellence could be a good approach. These could be twinned with centers in developed countries to further strengthen their capacity. He added that the UN could play a role in this process.

One speaker disagreed with the suggestion to build centers of excellence and instead proposed the use of technology to transmit educational programs via satellite. He argued that there is a need for better communication networks and structures that prioritize the use of technology in education. This is seen as more appropriate for a country such as India.

Developing countries, like those in Africa, face a bright future. More and more countries are enhancing their capacity to respond to the challenges of tomorrow by investing in education and training for their people. The partnership between the developed and developing world must continue as both sides can learn from each other and better position themselves to deal with present and future global challenges.

203-E3: Measures Against Disasters

Chair:

- **McBean, Gordon**, Professor and Research Chair of Institute for Catastrophic Loss Reduction, Departments of Geography & Political Science, University of Western Ontario, CA

Speakers:

- **Amirinia, Hamidreza**, Advisor to the Presidency and Head, Center for Innovation and Technology Cooperation of I.R. of Iran Presidency; Member of Commission, Supreme Council of Science, Research and Technology (ATF), IR
- **Koshimura, Shunichi**, Professor, International Research Institute of Disaster Science, Tohoku University, JP
- **Loyzaga, Antonia Yulo**, Executive Director, Manila Observatory, PH
- **Rovins, Jane**, Executive Director, Integrated Research on Disaster Risk (IRDR), US
- **Takeuchi, Kuniyoshi**, Director, International Center for Water Hazard and Risk Management (ICHARM), Public Works Research Institute (PWRI), JP
- **Yasuda, Yutaka**, Chairman, KDDI R&D Laboratories, JP

The impact of natural hazards is increasing, driven both by a rise in the frequency of natural catastrophes and in the number of people affected. Research is ongoing into how best to prepare for disasters and mitigate the damage they cause, and the discussion during this session covered some of the latest thinking in this area. Updates from international institutions and initiatives in the field were also shared.

One initiative under discussion was the Hyogo Framework for Action (HFA), agreed in 2005 in Kobe by 168 governments. The HFA endorses priority areas for disaster risk reduction (focusing on institutions, warning systems and preparedness). The term of the HFA was 10 years, so a renewal agreement must be reached by 2015, preferably with better implementation and monitoring of goal achievement. Also expiring in 2015 are the UN's Millennium Development Goals (MDGs), which are to be replaced with Sustainable Development Goals (SDGs). There are no MDGs relating to disasters but it is hoped that some measurable suggestions for SDGs will be adopted. This could include halving by 2030 the population without protection against natural hazards with a recurrence interval of less than 10 years, and by the same date, to halve the population without basic early warning systems for extreme natural hazards.

Another initiative which was discussed was Integrated Research on Disaster Risk (IRDR), which seeks to bring together quality, interdisciplinary research from around the world and facilitate its coordination and communication to reduce the compartmentalization of useful knowledge. IRDR is genuinely global and seeks to apply research in both national and multinational contexts. It works with academia, governments and practitioners to put research into practice. It also seeks to create standards to make data comparable across countries. It is eager to collaborate with any and all interested parties.

Developments in the role of technology in dealing with disasters were also discussed. Mobile phones in particular play a strong role in providing information and communication services (including earthquake and tsunami alerts and disaster message boards). Japan saw a number of these uses after the earthquake in March 2011, and new advances such as GPS navigation and scalable vector graphic maps (both of which will be available even if phone networks fail) can help direct people to safe areas or secure routes home. International discussions facilitated by the International Telecommunication Union (ITU-T) are enabling knowledge transfer and standard setting across countries. Future technologies such as sensor networks, machine-to-machine communication and real-time big-data analysis point the way to future improvements.

Vulnerability was identified as a very important issue. With particular reference to exposed Pacific countries, it was emphasized that vulnerability is contextual to the specific conditions of any given state. More interdisciplinary cooperation is urgently needed as disasters disrupt many complex systems across society and affect behavioral patterns. Vulnerability can thus be reduced through public education so that people better understand how to respond to disasters. Vulnerable states are often exposed to hazards occurring beyond their jurisdictions, and monitoring the "commons" requires infrastructure often beyond the capacity of individual at-risk countries.

The experiences of Japan, Iran and Thailand received particular attention as countries with frequent and recent disasters. Iran has set up a National Disaster Management Organization and is investing heavily in training and public education, early warning systems and earthquake-proofing of older buildings. Japanese researchers – including those in

the newly-founded International Research Institute of Disaster Science at Tohoku University – have recently been focusing on remote sensing and photographic analysis for modeling the extent of tsunami damage. They are also working on producing actionable information that can be disseminated to the public through early warning systems. Some of the information sent out by the Japan Meteorological Agency about the expected height of the tsunami on March 11, 2011 was incorrect, which may have increased the loss of life. It is important not to overestimate the amount of information that can be produced in a short period of time, and it should be remembered that safeguards are never perfect and should be designed so that if they fail, they do so in well-understood ways. The importance of sharing experiences was also widely discussed.

Another discussion centered on slow-moving disasters like desertification and rising sea levels. Policy changes can help to deal with these, and information sharing is essential. But in the meantime, efforts to combat the disasters (such as the sea gates defending Venice from surging seawater) will merely buy time.

The heavy toll from disasters continues to be dispiriting, but the potential for scientific and organizational changes to mitigate them further is encouraging. Academia, governments and private companies are all playing important roles in driving this agenda forward.

203-F3: Intellectual Properties Rights

Chair:

- **Dickinson, Todd**, Executive Director, The American Intellectual Property Law Association (AIPLA), US

Speakers:

- **Iwai, Yoshiyuki**, Special Advisor / Former Commissioner, Japan Patent Office (JPO), JP
- **Jørgensen, Anne**, Director, Policy and Legal Affairs, Danish Patent and Trademark Office, DK
- **Kaiserswerth, Matthias**, Director and Vice President, IBM Zurich Research Laboratory, IBM Research GmbH, CH
- **Kitano, Hiroaki**, President & CEO, Sony Computer Science Laboratories, Inc., JP
- **Stoll, Robert L.**, Partner-Former Commissioner for Patents, USPTO Drinker Biddle & Reath LLP, US
- **Thampuran, Raj**, Managing Director A*STAR (Agency for Science, Technology & Research), SG

Technology, globalization and emerging economies all increase the advantages of a unified patent policy across governments, or “harmonization”. However, there are myriad complications standing in the way. Participating governments must agree on what can be patented, what constitutes a good patent, and how developed and developing economies can reach mutually beneficial agreements. Another issue of debate is the best way for universities and industry to coordinate their efforts.

Any company interested in exporting technology in the current global marketplace is forced to register patents in many different countries. This process is expensive and companies would much rather spend the money on research and innovation. Governments also desire increased legal certainty of patent legislation, and a shared cross-cultural understanding of what a patent is among the people of their country. Ideally, there would be one patent system governing all nations. Harmonizing policies between smaller groups of countries may be a more practical option. Still, the topics surrounding any patent reform efforts are so diverse and intricately linked that it’s difficult to resolve each one individually. The way forward is to work on groups of issues through rigorous negotiations that are likely to last some years.

Countries have different ideas about what is patentable. Some participants credited the US’s boom in biotechnology to the 1980 US Supreme Court decision establishing that oil-eating bacteria and other living organisms could be patented, whereas in Europe they cannot. Some argue that because developing drugs is time intensive and costly, pharmaceutical companies need patent protection. On the other hand, some attendees argued that software companies don’t have difficulty making money without patents, and software patents stifle innovation in ways that pharmaceutical patents don’t. Additionally, as more and more software runs on the cloud, the need for patents in this field becomes a non-issue. Countries also differ on such things as to whether manufacturing techniques are patentable.

Due to the internet, technological developments go global immediately and this creates patent problems. The US has recently passed legislation that enables an inventor to submit evidence of prior art during a “grace period”. The debate over the grace period is one of the main obstacles to harmonization.

Many participants also agreed that there are a lot of “bad quality patents”, but governments disagree about what that means. Often companies intentionally obfuscate the information in their patent applications to make them overly broad. The rules governing patents for nascent technologies are often quite vague. Patents with bad translations and patents for devices that simply don’t work create further problems. Patent offices don’t have the resources to deal with these difficulties, and the public often misunderstands the role of a patent office. Many US citizens, for example, believe that the patent office first tests the functionality of the accepted patents, which it does not.

There are concerns from developed countries that developing countries ignore patent laws. At the same time, do developing countries have anything to gain from recognizing patents? Why should developing countries buy in to the current laws of the developed world? A representative from a developing economy argued that the problem is not a lack of buy-in on the part of developing nations, but rather, the fact that they have other priorities. When a country becomes able to benefit from attracting international business, it will gladly start working to protect patents. China was cited as an example of a country that had no patent law 30 years ago, but now does.

Increasingly, innovation is done in collaboration, not within a single company or institution. This leads to the cross-licensing of patents which has driven much of the push for patent reform. Of particular interest is the relationship between universities, research institutions and companies. One problem faced by academic institutions is that pursuing litigation against violations is expensive. Also, research takes time and patenting takes time. One advantage academic institutions have in the patent process is that they are often

freer to work on technologies with less obvious current practical uses. Often long-term funding is an issue. In addition, selling an individual patent to create a long-term licensing stream of revenue is often not very lucrative. One suggestion was for institutions to do research on narrower fields of study—finding niche undeveloped markets—and grow a portfolio of patents to market to companies. The participants generally agreed that making publicly funded organizations release their research to the public free of charge was undesirable because it discouraged commercial development.

203-G3: Public Outreach of Science and Technology

Chair:

- **Rubinstein, Ellis**, President and Chief Executive Officer, New York Academy of Sciences (NYAS), US

Speakers:

- **Appenzeller, Tim**, Chief Magazine Editor, Nature, US
- **Cohen, Jay**, Principal, Chertoff Group, US
- **Mainzer, Klaus**, Professor, Chair for Philosophy of Science, Director of the Munich Center for Technology in Society, Technical University of Munich (TUM), DE
- **Patel, Ketan**, Chief Executive Officer, Greater Pacific Capital, UK
- **Strohmeier, Rudolf**, Deputy Director General, Directorate General for Research and Innovation, European Commission, BE
- **Tachikawa, Keiji**, President, Japan Aerospace Exploration Agency (JAXA), JP

The session focused on the difficulty faced by the scientific community in dealing with a disengaged public and aimed to find new scalable action plans to get all segments of society excited about science. One participant expressed concern about a general 'knowledge deficit' of many people in relation to science – people are scared of what they do not know. But even if ways are found to fill knowledge gaps, the scientific community needs to understand that individuals engage with science through specific cultural, historical, and emotional lenses. As such, Europe's general distrust of genetically modified food is not down to a lack of knowledge but rather down to traumatizing memories like the Thalidomide scandal, which the USA never experienced. 'People are loyal to their roots, perhaps even more than to facts' and so it is paramount for the scientific community to listen closely to the concerns of the public and engage with people as equals. The UK in particular was mentioned as a good example of public consultation: scientific questions are openly debated, allowing for more targeted communication to challenge the negative press about science. This is further supported by the Science Media Centre, which acts as a central communication organ to actively represent the whole community. Concerns were however raised as to whether science should ever resort to the use of what might be called a 'PR engine.'

One speaker stressed the benefit of seeing the public-science communication flow as more of a business exchange, where scientists pitch their ideas like goods to a consuming public. Scientists should learn to tailor their explanations to target the personal added value to the individual. There is a substantial role for governments to play. Up until relatively recently, governments and institutions were in a sort of parent-child relationship with the public, whereby decisions could be made without its approval. However, with the spread of information, the power index has changed. Governments are now required to engage with their people as equals. As one participant expressed: 'The public is ready but we the scientists and institutions are not, we are still too bogged down with our own egos.'

It was generally felt that scientists lack the skills to communicate effectively with the public. Far too often, scientists are unable to talk to people in an engaging way and there is no clear leadership on the subject within the scientific community. The communication surrounding the Fukushima incident was cited as an example of differing information coming from different parties which only added to the uncertainty. Numerous solutions were suggested, from encouraging more women to take on a mediating role, or targeting key opposition individuals and/or groups and convincing them to change their standing. An example was US Senator John McCain's about turn and his coming out as a proponent of the fight against global warming.

However some steps are being taken across the globe to bring the public closer to scientific endeavors. JAXA, Japan's aerospace program, has invested heavily to foster science literacy amongst school children – this has included most notably schemes to train teachers in how to inspire children and capture their interest at an early age. The project has grown tremendously over the last 5 years to include 82 schools reaching over 7,000 children across Japan. The importance of reaching children early was a commonly held view amongst participants. Children need to be inspired with clear messages and images of scientific achievements, and be provided with suitable role models such as Jacques Cousteau or even other children. Moreover, science needs to be made more fun and accessible. First attempts have been made through such events as the Robot Olympiad for high school students in the U.S.A., or the German Museum at Munich offering an 'Open Lab,' which lets children see how science is actually conducted. Similarly, the New York Academy sends many young academics into schools across the city to offer afternoon activities around the sciences. Not only has this proven to be very successful with the students, but it helps the young academics become better teachers, to the point that many in fact decide to become teachers after finishing their education.

Schools were also found to be responsible for the lack of engagement in the subject of science. One participant stressed the need for a national curriculum that brings together different strands of education by giving children problems to solve that require multiple disciplines be combined.

16:50-18:00 PLENARY SESSIONS IN PARALLEL

204A: The Role of Universities for the 21st Century

Chair:

- **Matsumoto, Hiroshi**, President, Kyoto University, JP

Speakers:

- **Braun, Helge**, Parliamentary State Secretary, Federal Ministry of Education and Research, DE

- **Chalupa, Leo M.**, Vice President for Research, George Washington University, US
- **Dorfan, Jonathan M.**, President and CEO, Okinawa Institute of Science and Technology Graduate University, US
- **Naylor, David**, President, University of Toronto, CA
- **Rajatanavin, Rajata**, President, Mahidol University, TH

Hiroshi Matsumoto welcomed attendants to the plenary and introduced the five members of the panel. He discussed how technology is changing society. Communication has become extremely fast and abbreviated, and often does not convey deep thoughts or feelings. He cited social networking as an example of this change, and cautioned us to be careful of the impact this can have on our thought processes. The role of a university in the 21st Century is to maintain a long-term perspective, particularly in three areas. First is education: ICT provides us with access to educational resources online. However, there needs to be a cross fertilization of ideas. Knowledge must be shared, disputed, refuted, reconstructed and adopted through face to face interaction. We must strive for a holistic view of how human endeavors fit into a body of knowledge. Second, research universities should not adopt a short-sighted approach to research but must be mindful of future challenges. Finally, social contribution: universities have to strike a balance between training students to pursue basic research and to meet the immediate needs of society.

Helge Braun mentioned five main challenges for the future. There is need for more students to be able to access university education. More academic experts are needed to drive economic growth. There is also the question of what to offer young people who do not wish to have an academic career in a globalized world. Vocational training is a solution and can provide high levels of qualification at reduced costs. International cooperation is also important and universities should be enabled to pursue research in a collaborative environment. There is a challenge in building collaboration and establishing a worldwide scientific and education system. Furthermore, support must be provided to university researchers for collaborating with industries to bring their findings to the market. Germany has established a freedom of science law and provides funding to foster this development.

Leo Chalupa stated that there is a wide cross-section of people who are interested in what the 21st Century university will be like. Globalization, technology and innovation are themes that have been important over the past 10 years. Globalization will increase and there will be a shift from the US to other countries; instructional programs will increase, accompanied by a shift from the transmission of knowledge to the creation of knowledge with emphasis on lifelong learning. There was a furor in the US 20 years ago when a university required that every student have a laptop. Today every student has instant access to technology with mobile phones, iPads or laptops. Online course options can play an important role in the education process. Innovation is important to the future of education, and so a key question is how universities can teach and encourage innovation.

Rajata Rajatanavin said that universities are centers of civilization and must respond to the needs of society. Universities must also serve as a platform for social reform and social development, and can contribute to economic development. There are a lot of regional links in free trade in the ASEAN countries, which will see an increase in the movement of people across national boundaries. Universities must therefore train students to be regional and global citizens. Emphasis should be on critical thinking, long-term learning and language education.

Jonathan Dorfan stated that universities have two fundamental roles: knowledge creation and knowledge dissemination. However, changes in demographics affect the role of universities. There are challenges to the sustainability of our planet, and global efforts will be required to tackle them. Universities have a role to play in this process. They must continue to pursue basic research, but must also focus on short-term outcomes. Research universities must encourage and support their faculties to collaborate with industries to make their innovations available for the benefit of humankind. The Japanese government has played an important role in the creation of the Okinawa Institute of Science and Technology (OIST), which has a global mission of attracting talented faculty and students from around the world.

David Naylor made three observations about the role of universities. One is the importance of leadership – we need creativity, ingenuity, and communication ability in order to develop individuals with both breadth and depth of knowledge. We must embrace globalization and collaboration between government, society and industries. We also need to prioritize "quality, availability and affordability" in education. There is a need for a balance between basic and applied research. University rankings that favor research universities undermine the important role that other tertiary institutions such as polytechnic universities play. We should aim to strike a healthy balance between fundamental and applied research.

204B: Research Organizations Update

Chair:
- **Fuchs, Alain, President**, French National Center for Scientific Research (CNRS), FR

Speakers:
- **Koanantakool, Thaweesak**, President, National Science and Technology Development Agency (NSTDA), TH
- **Mason, Thom**, Laboratory Director, Oak Ridge National Laboratory (ORNL), US
- **Nicolais, Luigi**, President, National Research Council (CNR), IT
- **Nomakuchi, Tamotsu**, President, National Institute of Advanced Industrial Science and Technology (AIST), JP

Alain Fuchs began by outlining a series of common problems facing research institutions around the world. These encompassed not only conflicting economic and educational demands, but also the balancing of administrative and political considerations with agendas that are focused primarily on furthering research in their chosen subjects. In particular, he pointed out that most states are constantly trying to make their funding of research efficient, but some may disagree on whether particular strategies are efficient or not. Long-term objectives require secure long-term funding. Countries should be careful that international collaboration does not result in long-term 'brain drains.' However, in the case of Europe, the positive exchange involved in joint intellectual projects to some may alleviate the facilitate meaningful joint action within the context of the EU.

Tamotsu Nomakuchi outlined the activities of the AIST, and described how the attendance of seven Asian educational institutions at a recent a recent conference in Kyoto was representative of the growing power of this part of the world on the global educational scene. This proceeds from the spectacular economic growth of Asia in general, and East Asia in particular, over the past 20 or 30 years. The conference concluded that exchanging technology, management techniques, and 'brain circulation' will facilitate a general improvement in the work of universities and institutes, which should not be considered passive but rather active agents of general change. These exchanges will also enable individual areas to develop localized solutions based on global knowledge. This year's conference resulted in a joint declaration, and there will be another conference in 2013. It may be wise, in the meanwhile, for institutions to create their own long-term research strategies, on the basis of which they might then approach numerous sources of funding, including the government.

Thom Mason considered how it might be possible to recognise the need for near-term economic development and yet take into account longer term societal issues. Issues such as water supply and health care require 'fundamental breakthroughs of the highest order' which would be scientific in nature. The point, however, is that publicly funded institutions make the implicit promise that public money will be repaid with research of public value. This is easily achieved by using facilities for projects of obvious public benefit – the supercomputers at Oak Ridge, for example, can model climate change as easily as it can exploding stars. Another example is a reduction in the cost of producing carbon fiber, which involves research into lignin growth and resin production in plants – research conducted in universities – that will eventually allow the material to be used in many other industries. It continues to be vital for institutions to 'push the envelope' in this manner. In doing so, there must be engagement on all levels, all the way from individual citizens to – though it may be difficult – international cooperation.

Thaweesak Koanantakool thanked Chairman Omi for organizing the STS *forum* and went on to describe issues of higher education from the perspective of a developing country, in this case Thailand. He pointed out that research and development has only enjoyed substantial support in the last 20 years. Initially, research was only funded in areas of practical application, such as resource exploitation and infrastructure. Funding levels remain low even today. Nonetheless, Thai universities have risen to the challenge of providing value to society, for example during the 2011 floods. One way to secure the required level of funding is to join with the private sector, which is encouraged in Thailand through tax breaks on research spending and the encouragement of research parks. Another method is by reaching out to overseas institutions. Cooperation will help reduce the effect of high research costs and sparse specialists. Industrial partners are also vital.

Luigi Nicolais began by describing the size and function of the National Research Council of Italy, which has over 10,000 members and encompases areas as disparate as the social sciences and bioengineering. The current economic crisis, however, has had a detrimental effect on all research and development in Europe. For Italy to remain competitive in terms of global innovation, it is necessary measure the output by its quality rather than its cost and to 'produce science which is very high level, in order to transfer this knowledge to industry'. This interface between industry and research (many small companies, for example, are now involved in technological development) is vital in overcoming the status quo in which money is readily transformed into research, but research is not so readily turned into money. Beyond this, international cooperation is also essential. Mere cross-fertilization of ideas is no longer sufficient, but must be backed up with genuine cooperation. He ended by thanking the STS *forum* for the opportunity to initiate this process.

Tuesday, October 9, 2012

08:30-09:25 PLENARY SESSION

300: Key Messages from Concurrent Sessions

Chair:

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

Speakers:

- **[A] Bamberger, Yves**, Scientific Advisor of the Chairman and CEO, Electricité de France (EDF), FR
- **[B] Goel, Anita**, Chairman and Chief Executive Officer, Nanobiosym Diagnostics, Inc. US
- **[C] Migus, Arnold**, Senior Counsellor, French Court of Audit, FR
- **[D] Bazergui, André**, Special Advisor to the President & Chief Executive Officer, Consortium for Research and Innovation in Aerospace in Quebec (CRIAQ), CA
- **[E] Hassan, Mohamed Hag Ali**, Co-Chair, iap, SD
- **[F] Yamauchi, Susumu**, President, Hitotsubashi University, JP
- **[G] Blanco, Herminio**, Founder and Chief Executive Officer, Soluciones Estratégicas, MX

Matthias Kleiner opened the session by suggesting that this was not only the time to reflect on the past, but also an opportunity to look forward.

Yves Bamberger said he would speak about the per capita consumption of energy in developed countries at the 2013 edition of the STS *forum*. In terms of energy consumption, there will still be an 80% reliance on fossil fuels in 2030. Shortages in water supply will be inevitable. There is also a pervasive reluctance on the part of the public to tolerate risks, in particularly in relation to nuclear power generation. On a more positive note, however, fossil fuels are still relatively plentiful; efficiencies of power plants high and increasing (gas plants at 60%, coal at 40%) and new energy sources are being developed. Breakthrough innovation is ongoing in the use of hydrogen as a fuel. There is growing integration across the world in terms of dealing with these issues.

Anita Goel discussed three pillars of modern health 'on the threshold of a paradigm shift:' personalized medicine, the technology of dealing with aging and infectious disease treatment. The use of information is essential to all three. The ultimate goal is to understand the parameters of these problems through a holistic view that takes into account disparate processes. The relationship between individual organisms and their environment is of crucial importance, and it is perhaps more reasonable to aim for co-existence with other creatures than for eradication and dominance.

Arnold Migus reported on three proposed definitions: ideas turning into success, ideas generating money, and creating a better life. In all three of these areas, it is important to balance opportunity with risk. Innovation includes the process of bringing a product to market – and that process may take as long as 20 years. New fabrication techniques such as additive manufacturing will accelerate time required for a product to reach the market. Governments have a responsibility to encourage and support innovation by providing tax breaks, for example. Fear of failure is a dangerous mentality. Lastly, serendipity remains a factor innovation, and it will always remain a one.

André Bazergui reported that participants from many countries had emphasized that strong collaboration is vital to achieve global educational progress. The perception in academia is that money develops ideas, while in industry, that ideas generate money. In fact, they should be seen as complimentary. Within educational systems, the humanities should not be neglected, and the different definitions given to terms such as 'design' should be kept in mind when interaction between different disciplines occurs. Better pedagogic training and greater incorporation of ICT are needed. International relations based on knowledge exchange, and not only money exchange can serve to improve equality and generate benefits for both developed and developing countries.

Mohamed Hag Ali Hassan identified three critical issues: ocean, water and disaster management. Some 90% of disasters are caused by water-related events, such as floods and sea level rise. Oceans receive insufficient attention from governments. The academic world should do more to provide advice and ensure issues related to oceans become a priority. Some 40% of the population in developing countries has no access to clean water. Finally, disaster management should be comprehensive at national level and fully integrated internationally. There should also be joint research at global level.

Susumu Yamauchi dealt with the issues related to habitat. Human beings live in a state of dependency with each other and with their environment. The issue of habitat therefore concerns not only people but the environment in which they live. Hence, habitat should be considered not only from a biophysical standpoint, but also from a scientific perspective. Lastly, patent laws often reflect the complexity in the relationship between corporations and citizens. Knowledge should be used for the benefit of both.

Herminio Blanco said some of the topics he was reporting on ranged from the important to the crucial. It is unfair to leave the results of these discussions as simply records. Instead, the STS *forum*, perhaps in conjunction with the OECD, could circulate its recommendations to all, and thus add value to the debate. In diplomacy, an OECD document provides guidelines to best practice within the sphere of international collaboration. There is a sense of extreme urgency when it comes to the need for modifying human behavior. Finally, JAXA's outreach activities for children were cited as a great example of successful engagement with the public.

Future leaders expressed their thanks for the opportunity to participate in the STS *forum*. Science, they said, has a crucial role to play in improving human life in nearly every sphere. Other stakeholders, including members of civil society organizations, should perhaps participate in future forums. Scientists generate knowledge, policymakers implement policies. In order to ensure this happens in an effective manner, a long-term view is important, even if the benefits are not immediate.

10:45-11:40 PLENARY SESSION

302: ICT and Security

Chair:

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

Speakers:

- **Okuda, Motoi**, Executive Architect, Technical Computing Solutions Unit, Fujitsu Limited, JP
- **Piou, Olivier,** Chief Executive Officer, Gemalto, FR
- **Rangaswami, JP**, Chief Scientist, Salesforce.com, Inc., IN
- **Suffolk, John**, SVP, Global Cyber Security Officer, Huawei Technologies Co, Ltd., UK

Hiroyuki Yoshikawa started by discussing the 'light' or positive side of ICT, observing that its benefits are apparent in the everyday use of emails, online shopping and entertainment. More profoundly, digital and automated systems are now pervasive in industry and manufacturing, which has hugely increased efficiency and flexibility. Design has also benefited from the enhancements brought to the human brain by computers, and worker safety has also been boosted. On the 'dark' or negative side, the development of an 'information society' has been detrimental to privacy. There is little awareness among younger users in particular of the dangers of putting too much information online. Indeed, the very methods used to ensure security online can be seen as constituting a loss of privacy – e.g., biometrics. Cybercrime and national security are also major areas of concern. With concerted action, however, there is no reason to believe these issues are insurmountable.

Olivier Piou emphasized that the social conventions of the real world do not apply in the virtual one, and people often lose their inhibitions online. Data suggest that up to 20 million Americans alone share their full birthdate online, and 5 million indicate when they are leaving home. These two examples are emblematic of the immensity of the challenges involved in ensuring a safe and 'civilized' web. The fact that the internet is a place where 'your personal data, your money, your reputation and even your identity are at stake' should be emphasized to young to people. In 2011, nearly 10 million people were victims of hackers (38% more than in 2010), causing damage estimated at $3.2bn. It is important to use protection tools such as two factor authentication techniques. We already have the requisite devices to ensure this, such as real-world portable devices (SIM cards, electronic passports, etc.), which can be used in conjunction with a password.

Motoi Okuda began by thanking Chairman Omi for organizing the STS *forum* and went on to speak about cyber security in the context of how supercomputers are being used. High-performance processors have a variety of applications, ranging from climate modeling to financial management. They are now an 'essential part of our social infrastructure'. Indeed the Japanese government's commitment to the development of technology for public application is reflected in the K Computer Project. Although it has proved tremendously important since it was completed and has won numerous awards, there are now computers in the exascale are which are 100 times more powerful than the K. The continuing development of such extreme high capacity processing capabilities will continue to contribute to the progress of ICT worldwide.

John Suffolk thanked the organizers of the STS *forum* and emphasized the fact that ICT is a driver for personal and global prosperity throughout the world. Our approach to managing the inevitable catastrophes of the natural world, such as the 2011 Tohoku earthquake, must reflect this reality. Following the events of March 11, 2011, Huawei surveyed damage to their equipment in live networks and launched their Emergency Response Plan. Some 50% of impacted stations were online within six days as a result. For most companies, it remains a challenge to keep up with the pace of technological change and in the world of ICT, they must further deal with the ability of consumers to completely circumvent security settings. We should not assume that there is nothing we can do. Research indicates that up to 80% of security breaches can be avoided by adhering to as few as four security protocols. The private and government sectors must align goals and collaborate to ensure the integrity and security of data. This unity of purpose will breed strong solutions. As a Japanese proverb says: 'a single arrow is easily broken, but not ten in a bundle'.

JP Rangaswami emphasized the fact that solutions to the problems discussed at the STS *forum* should be evidence-based. He described how our conceptualization of security is still very much linked to the three-dimensional real world, and is not qualitatively different from that of our pre-modern ancestors. This is reflected in our desire to physically possess and protect our computing power, and our assumption that doing so will promote our online security. This is both untenable and unnecessary. 'Multi-tenancy in the cloud', with online storage of information, is surely a more effective solution. Security must be an integral part of the architecture of an online presence in this virtual world. One way to ensure this is by reducing areas that are vulnerable to penetration by hostile agents. Online companies must also attract a competent talent pool to manage and maintain their security systems, and be responsive to their customer base. Identity protection and education are important issues, but more serious is the actual design of online security systems.

11:45-12:30 CLOSING PLENARY SESSION

303: How do we move forward to maintain sustainability for the future of humankind?

Chair:

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

Speakers:

- **Rubbia, Carlo**, Scientific Director, Institute for Advanced Sustainability Studies e.V. (IASS), Potsdam; Nobel Laureate for Physics 1984, IT
- **Grantham, Jeremy**, Co-founder and Chief Investment Strategist, Grantham Mayo Van Otterloo (GMO), UK
- **Correia de Campos**, António, Chairman of Science and Technology Options Assessment (STOA), European Parliament, PT
- **Omi, Koji**, Founder and Chairman, Science and Technology in Society (STS) *forum*, JP

Ismail Serageldin observed that we are living in dangerous but exhilarating times. Advances in science and technology

have enabled us not only to exploit resources more effectively and live more comfortable lives, but has also increaed our impact on nature. Rather than try to 'force ourselves into the dangerous domains' where we push the ecosystem to tipping point, we must come together to develop a sustainable lifestyle. Science alone is not enough. We need the insights of the humanities and the social sciences to create truly effective solutions. Human beings are after all social creatures whose institutions have a profound influence on their behavior. Anchored in the sciences and guided by the humanities, we can learn to coexist, not only with the many creatures of the Earth, but with each other. We must go forth and fashion 'the wise constraints that make people free'.

Carlo Rubbia commenced by thanking Chairman Omi for organising the STS *forum*. He went on to elaborate on how we are living in a time of crisis. Since the industrial revolution, 6.6bn tons of carbon dioxide have been added to the atmosphere. Stability of the climate is a requisite for human life; and yet despite this, our attempts at reducing emissions have been feeble thus far. We must refine our production nuclear power, increasing it from the mere 6% of primary energy it currently supplies, but also resolving issues of safety and sustainability. Beyond this, it is crucial to commit to developing alternative sources of energy such as solar power. For all of these, true innovation is required to maximize output. The question, however, is whether the political will exists to ensure that the worst consequences of the 'anthropogenic era' can be avoided.

Jeremy Grantham described how, up to 2002, the main index of 31 resources had been declining in value on average by 1.2% a year. In the subsequent six years to 2008, however, prices tripled. This sudden increase reflects the current squeeze on resources driven by the growth of China (which now consumes 45% of the world's iron and coal) and the depletion of materials such as potash and phosphorus. These are crucial to modern mega-agriculture. Yet there is no widespread awareness of, nor the political will to counteract the impending catastrophe of combined climate change and the inevitable societal destabilization that will accompany heightened competition for materials. An example of this is the dominance of the fossil fuel industry, which wields extraordinary political power. Yet the burning of all fossil reserves will add over 5 times the agreed acceptable limit of carbon to the atmosphere. Leadership in raising awareness about the 'crisis of our species' must come from the senior scientific figures. Otherwise, the future looks bleak.

António Correia de Campos pointed out that while technologies can help with concerns about the environment, states are approaching the division of resources and economic growth in the spirit of competition. This cannot continue. Food production is already hugely effected by the overexploitation this approach causes. Rare earth materials have bred intense competition for mines and our current energy models still rely on fossil fuels. Europe has moved to manage its resources sensibly, set goals for increasing energy efficiency and prioritized the development of alternative energy sources. It has worked to ensure 'cooperation, openness', both within and without the sciences to achieve these goals. It has also promoted commensurate education both science and in the social scientific. Despite the upfront costs of this, the benefits are numerous. In the short term, it provides opportunities for innovation, funding for research and new jobs. It also opens up entire new sectors of the economy. In the long term, it may well be essential for the survival of the human species.

Koji Omi congratulated Dr. Shinya Yamanaka on his recent Nobel Prize award, and thanked him and all attendees, for their past participation in the STS *forum.* He also thanked the various sponsors of this year's forum which has issued a statement dealing with numerous important issues. While many countries will have their own energy policies, nuclear power will remain a presence in global energy production for the foreseeable future. Progress in addressing degenerative health disorders should be accelerated, and ICT can be utilized to expedite this process and to bring education to more people around the world. Among other issues discussed this year was the tripartite collaboration between the private sector, the government, and academia. We now know that the earth is finite. Balancing growth and sustainability is therefore crucial to the very survival of the human race. Chairman Koji pledged to continue to promote the activities of the STS *forum* to the world, and expressed the hope that all participants would do the same.

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

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

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