Science and Technology in Society (STS) *forum*

Non-Profit Organization

SUMMARY OF PROCEEDINGS

Eighth Annual Meeting

October 2-4, 2011

Kyoto, Japan

Science and Technology in Society (STS) forum (NPO)
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Sunday, October 2, 2011

Monday, October 3, 2011

Tuesday, October 4, 2011

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 2, 2011

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
- **Hasegawa, Yasuchika**, President and Chief Executive Officer, Takeda Pharmaceutical Company Limited, Chairman of Keizai Doyukai, JP
- **Kumar, Ashwani**, Minister of State for Science, Technology, Earth Sciences, Planning and Parliamentary Affairs, IN
- **Nakagawa, Masaharu**, Minister of Education, Culture, Sports, Science, and Technology, JP
- **Rubbia, Carlo**, Scientific Director, Institute for Advanced Sustainability Studies, Nobel Laureate for Phys. 84, IT
- **Schavan, Annette**, Minister, Federal Ministry of Education and Research, DE

Koji Omi welcomed the participants and declared the 8th meeting of the STS *forum* open. He thanked the international community for the support provided to Japan since the Tohoku earthquake. Though no fatalities have been attributed to radiation from the damaged Fukushima nuclear plant, it is imperative to bring the reactor to a cold shutdown and rehabilitate the surrounding area. Given that 14% of the world's electricity comes from nuclear sources, we must 'thoroughly examine' safety within the nuclear industry, and therefore, this year a plenary session is dedicated to the subject of nuclear power. Other important themes include food, sustainability, and behavioral change. World leaders have not focused enough on long term issues, and discussions on these subjects will help bring about a change in the status quo. With over 800 participants from 100 countries, businesses, and international organizations, the STS *forum* network is broader and stronger than ever.

Annette Schavan thanked the organizers and stressed that it is extremely important to have the opportunity of dialogue on the future of humankind. It is particularly important this year given the series of high profile disasters that have afflicted the globe over the past twelve months. She stated that ethical values, judgments, and government policies must keep pace with innovation. Germany places a high value on the humanities as a way of upholding ethics. People need to be able to recognize themselves as responsible for what they do. Germany's new technology policy is geared towards ensuring that ethical considerations are a constituent part of innovation and government policy from the start. The German delegation looks forward to both contributing its knowledge and garnering more information from the STS *forum*.

Masaharu Nakagawa welcomed the delegates as a minister of the host country, and thanked the international community for the support given to Japan after the Tohoku earthquake. Japan was 'filled with horror at nature's rage' in March following a disaster of 'unprecedented proportions' – a catastrophe that was not predicted despite Japan's advanced technology. The more civilization develops, the more devastating disasters become. Being prepared is no longer just a catch phrase, but a 'visionary maxim'. Japan's new five year science strategy has shifted the emphasis from straight innovation work to green innovation and life innovation. Though countries can try to resolve their own issues individually, many problems facing the world today can only be solved globally.

Carlo Rubbia started by defining 'sustainable growth' as growth which fulfills the needs of contemporary society without compromising the ability of future societies to do so. This requires a redefinition of 'cost', which until now has been based on the use of plentiful and cheap fossil fuels. Both full-scale decarbonization of the ecosphere and the development of alternate energy sources that are economically and practically viable will take time. Innovation is key to progress on these issues – as is the concentration of political will. Political institutions must be encouraged to refocus their attention, because although change is difficult, the 'price of indecision is much higher.'

Ashwani Kumar said it was a great privilege to address delegates from over 100 countries, and conveyed the deepest sympathies of the people of India to the people of Japan for the tragedy of the Tohoku earthquake. He elaborated on the theme of global problems requiring global solutions, emphasizing that technology is a means to an end – a world of equity, peace, and harmony. Science and technology must first demonstrate their positive impact on the lives of people. Likewise, the products of innovation should be diverse and affordable for all. India has also launched its own five year scientific strategy. One of the major priorities of this is to ensure that India's burgeoning nuclear industry is one of the safest in the world.

Yasuchika Hasegawa started by charting the growth of the world's population – from 4.5 billion in 1980, to nearly 7 billion today, and over 9 billion in the near future. Although this growth drives the global economy, it stretches the capacities of governments, scientific innovations, and infrastructure. In Japan, energy scarcity drove the development of a nuclear industry, decreasing Japan's reliance on difficult-to-source fuels. Yet now it is vital to make the transition to renewable sources of energy and secure supplies for growing economies. The issue of governance is perhaps the most significant at the moment. Technology and behavioral change must go hand in hand – science, after all, is at its most powerful when it frees us from limitations, and not vice versa.

11:00-12:10 PLENARY SESSION

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

Chair
- **Aho, Esko**, Executive Vice President, Corporate Relations and Responsibility and Member, Group Executive Board, Nokia Corporation, FI

Speakers

Political Leaders
- **Mbarawa, Makame**, Minister of Communications, Science and Technology, TZ

- **Suraswadi, Plodprasop**, Minister of Science and Technology (MOST), TH

Scientists
- **Agre, Peter,** Director, Johns Hopkins Malaria Research Institute (JHMRI), Johns Hopkins Bloomberg School of Public Health, Nobel Laureate for Biochem. 2003, US
- **Feng, Changgen**, Vice President and Executive Secretary, China Association for Science and Technology (CAST), CN
- **Noyori, Ryoji**, President, RIKEN; Nobel Laureate in Chemistry 2001, JP

Industrialist
- **Yamamoto, Masami**, President and Representative Director, Fujitsu Limited, JP

Esko Aho opened the session with the three questions: 'Why is dialogue so important?', 'why should academia collaborate with industry?' and 'why does this kind of collaboration not yet exist sufficiently?'. Aho stressed that dialogue and the innovation that arises from it are paramount for economic growth. However, demographic, environmental, security, and energy problems also require that we come up with new systems. Government, industry and academia have their own unique advantages and disadvantages. Industry and government work primarily on short-term, low risk goals, while academia is well equipped to deal with the long term. Without direct support from government and industry, academia is often prevented from working effectively.

Peter Agre stressed the importance of bringing young talents into science. Agre also emphasized that they must work together with more experienced members of scientific community. He stated that most of the great scientific achievements in recent decades are the product of research started at a young age – e.g., Gertrude B. Elion, 1988 Nobel Prize winner for her research that lead to the development of the AIDS drug AZT. Elion joined the Burroughs-Wellcome pharmaceutical company without graduating from university and was only later recognized in academic circles.

Plodprasop Suraswadi believes the new Thai parliament must trust in the potential of science and technology. Although Thailand has traditionally been a conservative country, it is moving towards a more progressive position. While Thai people put their trust in both fortune telling and the military, he said now is the time to believe in science and technology, and build a knowledge-based society. He added that investment in science and technology will increase from 0.2% of GDP to 2% over a four year period and US$1,000m have already been invested into expanding infrastructure. Thailand is currently particularly interested in understanding the effects of global warming and is investing heavily into oceanic research. Suraswadi also hopes that through further science and technological progress, Thailand will free itself of heavy reliance on Western states. He stressed that Thailand must still look West, and the West must look East.

Ryoji Noyori sees technology as the basis of civilization and innovation and as the cornerstone for the survival of humanity. He cited a list of the 20 greatest technological changes of the 20th Century, which included such inventions as the internet. All these great innovations have invariably been the product of collaboration. Without skillful management, science and technology cannot lead to innovation, which in turn creates new social and economic value. There is still a lack of policy to take full advantage of Japan's scientific achievements. The great East Japan earthquake made it clear that we must take responsibility for social structures, and find new and better ways to prevent our assets from being lost to natural disasters.

Makame Mbarawa emphasized Tanzania's commitment to supporting science and technology. There are already 62 Research and Development Institutions in the country, with a further 4 research-intensive universities. Tanzania is making good use of foreign investment and has successfully adapted foreign technology to local needs. At present, investment is still low with the private sector detached from the innovation process, especially in manufacturing. He stressed the government's commitment to developing a dynamic industrial sector. Some US$20m have been invested by the government in research and there are plans to raise investment in the coming years to 1% of GDP.

Changgen Feng stated that "the scientists' livelihood" is a new work concept developed after years of practice by the China Association for Science and Technology (CAST). It refers to the most immediate practical problems that are closely related to scientists' career development, including issues related to livelihood, research development and scientific heritage. As a national non-governmental organization of scientific and technological workers in China, CAST is concerned about "the scientists' livelihood" and has sought to address these issues by improving the pertinence of service for scientists. It is also playing an active role in creating a conducive academic environment and promoting academic innovation and a combination of production, education and research.

Masami Yamamoto stated that science and technology play a key role in the future of mankind. He spoke of the "K computer" - the world's fastest supercomputer. He hopes to work with academics from around the world to utilize it to its full potential. He believes it can be used for high precision test simulations of natural disasters that could lead to better early warning systems.

13:30-14:45 PLENARY SESSION

102A: Energy and Environment

Chair
- **Moniz, Ernest**, Cecil and Ida Green Distinguished Professor of Physics and Engineering Systems, Massachusetts Institute of Technology (MIT), US

Speakers
- **Beddington, John**, UK Government Chief Scientific Adviser, UK
- **Kitagami, Keiro**, Vice Minister of Economy, Trade and Industry of Japan, JP
- **Kleiner, Matthias**, President, German Research Foundation (DFG), DE
- **Koonin, Steven**, Under Secretary for Science, U.S. Department of Energy (DOE), US
- **Nishida, Atsutoshi**, Chairman of the Board of Directors, Toshiba Corporation; Vice Chairman, Keidanren (Japan Business Federation), JP

Ernest Moniz opened the plenary with a statement on the importance of mitigating the risks of global warming and climate change. However, he noted, we are further away now than we were at the time of the signing of the Kyoto Protocol. This is likely due to our failure to consider several crucial factors. Back then cost issues were not seriously considered because energy was not viewed as a commodity. Additionally, it is important to discuss how a high level of reliability can be maintained when new infrastructure is added to existing systems. Also important is the relationship between technology and policy.

Keiro Kitagami stressed that technology will be key to solving energy and environment problems. Given that Japan is a leader in technology, it should meet environmental challenges with innovation from the technological sector. Progresses in wind, solar, carbon, capture and storage (CCS), coal burning and other technologies will help reduce carbon emissions globally. A recent development in coal burning technology would reduce global carbon emission by 5% if adopted in the US, China and India. Full deployment of CCS would allow Japan to have zero carbon emissions. Over the past three years, research funding for solar power has doubled and has tripled for wind power. A solution which reduces both carbon emissions and dependence on nuclear power will have to be a mix of fossil and renewable sources. It will be necessary to balance concerns of stability, security, cost, and environmental impact in developing these solutions.

Steven Koonin discussed the three energy challenges - energy security, competitiveness, and environmental concerns, and how to integrate technological, political, business, and social science solutions. A recent United States Department of Energy (DOE) report, the Quadrennial Technology Review, outlines the energy landscape and challenges, as well as the DOE's role in fostering energy innovations. This report is deliberately pragmatic and establishes a framework non-experts can use to understand energy systems, the role individuals can play to create the desired changes, and the priorities for evaluating different technologies given finite resources. The government needs to enhance its capability to analyze techno-economic policy and incorporate social sciences in understanding energy systems.

Matthias Kleiner discussed Germany's decision to phase out nuclear energy. The Ethics Commission, which serves as an advisory body to the German government, critically reviewed Germany´s nuclear power program taking into account risk and safety regulations, security of supply, cost effectiveness, financing for research, and ways to avoid dependence on nuclear power imports. The report by the commission found that phasing out nuclear was a viable solution for Germany. The decision requires both political will and social commitment to make the necessary changes. The phase out measures are purported to help Germany become a leading provider of renewable energy solutions. Architectural and electrical upgrades can offer tremendous energy savings in both domestic and industrial facilities.

Atsutoshi Nishida stated that we have reaped the benefits of 20th Century advances and now, environmental concerns have become pressing for mankind in the 21st Century. In the past, we were able to focus on growth alone, but this must now be balanced with environmental preservation and the protection of resources. In facing this "trilemma," harmony must nevertheless be reached even in the midst of unexpected variables such as natural disasters. There have been no further formal international agreements since the Kyoto Treaty, set to expire in 2012. Emerging countries are projected to account for a majority of CO2 emissions within the next 20 years. Thermal requisition technology offers promise because much energy is dissipated as heat. He called for a "smart frugal society" in which energy needs would be managed through a totally integrated system.

John Beddington stated that we are not likely to get legally binding environmental rulings from the international community, and without economic incentives, it will be difficult to realize changes in energy generation. He stressed that 1.4 billion people are without electricity, 1 billion go hungry, and 1 billion are without access to clean water. And yet, the world's population continues to grow. By the year 2030 the populations of Africa and Asia are expected to grow by 1 billion each, with most of the growth expected to take place in small-medium sized cities. It is important to carefully design these cities to minimize people's transportation needs. These urban centers will also likely gravitate toward inexpensive 'dirty' technological solutions which is also a problem that needs to be addressed. In the UK greenhouse gas regulations have put the country on a path to reduce emissions by 20% in 2030, and 80% in 2050. But the proper mix of renewable and non-renewable energy sources and the government incentives needed to accomplish this have yet to be determined.

14:45-16:00 PLENARY SESSION

102B: Nuclear Safety and Future Development

Chair

- **Moniz, Ernest**, Cecil & Ida Green Distinguished Professor of Physics & Engineering Systems, MIT, US

Speakers

- **Amano, Yukiya**, Director General, International Atomic Agency (IAEA), JP
- **Beddington, John**, UK Government Chief Scientific Adviser, UK
- **Kitagami, Keiro**, Vice Minister of Economy, Trade and Industry of Japan, JP
- **Koonin, Steven**, Under Secretary for Science, US Department of Energy (DOE), US
- **Lei, Zengguang**, Vice President, Chinese Nuclear Society, CN
- **Stricker, Laurent**, Chairman, World Association of Nuclear Operators (WANO), FR

Ernest Moniz said that the debate on nuclear safety that took place in the previous session is of particular importance at this time, given the Fukushima crisis. He pointed out that electricity development remains central to global energy needs. There has been a loss in momentum in nuclear power development in some countries, attributable to the reduced demand brought about by the global economic downturn, and perhaps, the events at Fukushima. On the other hand, some countries such as China, India, Russia and South Korea are moving ahead with the construction of new nuclear plants. There is therefore a need to have more meaningful discussions on the benefits and risks associated with nuclear energy development.

Yukiya Amano said nuclear safety was a high priority issue for the IAEA. The nature of nuclear power is such that all countries have a legitimate interest in safety problems faced by other countries. Speaking of the Fukushima crisis, he said it was essential to bring the reactors under control and learn from this experience. He said that in the initial stages of the nuclear crisis the flow of information from the Japanese government was not always smooth. Thus, one of the lessons that can be learned from this crisis is the need to ensure that there is a high level of transparency in communicating information to partners and the public. He reiterated the IAEA's support for decontamination efforts in Japan so that people can return to their homes. Addressing a question on how the IAEA can help countries develop safe nuclear power, he said it was up to each country to decide on the most appropriate energy mix for itself, but the Agency would help countries interested in introducing nuclear power to do so safely. He pledged the IAEA's support in facilitating the development of robust safety mechanisms.

Laurent Stricker said that WANO is committed to maximizing the safety and reliability of the nuclear operations of its members. This can be achieved by ensuring operators and regulators work collaboratively, with either side respecting and complementing the other's role. He reaffirmed WANO's mandate to strive for excellence in nuclear safety, and to support WANO's members in their desire to become more efficient. To this end, collaboration with the IAEA is of paramount importance. More effective oversight, accident management and enhanced cooperation will help advance the nuclear safety agenda.

Zengguang Lei said that although China is the second largest economy in terms of economic output, it still lags behind countries like Japan in terms of per capita GDP. He said that the Chinese government is investing in the production of clean energy. In the aftermath of the Fukushima crisis, China has halted new nuclear projects and ordered a review of the safety regulations at those already under construction. Further action is needed to improve communication and safety standards. He expressed the intention of the Chinese government to take advantage of new developments, balancing benefits with costs.

John Beddington provided an update on the nuclear situation in the UK. The UK government has ordered a review of its nuclear facilities in light of the Fukushima crisis. While the UK does not face a high risk of tsunamis or earthquakes, leading to a provisional decision not to change plans on nuclear power development, there was still need for back-up and control systems. As such, the UK government is examining all power stations and reviewing safety regulations. This process of safety assessment will be used to guide further actions.

Steven Koonin said that in the light of the present situation, the US government's priority is to ensure the safety of existing plants, which are currently undergoing life extension reviews. There is growing interest in Small Modular Reactors. These reactors can be built in factories and easily shipped, and are thus less expensive to deploy. He said there is need for an open and frank debate about costs and benefits.

Keiro Kitagami outlined the Japanese government's plan to address lingering issues at Fukushima such as water and soil decontamination, how to get fuel out of the plants and what to do with it. Efforts to enhance safety will include introducing various cooling systems and diversifying power sources. Despite the negative effects of Fukushima, he emphasized the need to understand that nuclear power technology is still relatively new and open to innovation. As such he cautioned for a rational assessment of nuclear technology at this point.

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

103-A1: Energy for Mobility

Chair
- **Campbell, Donald**, Senior Strategy Advisor, Davis LLP, CA

Speakers
- **Fujii, Kiyotaka**, President, Better Place Japan, JP
- **Homchean, Kasemsri**, Governor, Thailand Institute of Scientific and Technological Research, TH
- **Kern, Mauro**, Executive Vice President, Engineering and Technology, Embraer, BR
- **McDougall, John R.**, President, National Research Council (NRC), CA
- **Ogumi, Zempachi**, Professor, Department of Energy and Hydrocarbon Chemistry, Kyoto University, JP

Modern transportation technologies typically utilize fossil fuels. While the internal combustion engine (ICE) has been proven to effectively convert stored chemical energy to rotational [wheel] energy, it is still inefficient and responsible for about 30% of the world's carbon emissions. Political and economic forces are driving up the price of oil which provides incentives for the development of transportation alternatives. In this session, several leaders from industry and academia discussed viable options for the future based on collaboration between academia, industry, policy makers, and society.

Electric vehicles are a clean, emission free alternative that can potentially end our oil 'addiction'. However limiting factors in battery technology threaten the practicality of this solution. Even today's cutting edge batteries are large, costly, and only permit approximately 100km of driving which creates what is known as "range anxiety."

EVs are not currently taken seriously by large auto manufacturers. The situation was very similar in 1980 with regard to personal computers. Yet China could be in a unique position to force manufacturers to produce EVs because of the size of its market. If this were to happen, EVs could see wide adoption in the next 10 to 20 years.

It was noted that there have been great advances in battery technology which have already helped improve the efficiency of EVs. Lithium-ion batteries are high energy density, meaning they can be lightweight and have increased power storage capacity compared to other batteries. These are widely used in hybrid electric vehicles (HEV), plug-in electric vehicles (PHEV) and standard EVs. The issues still to be solved concern further increasing energy density, charge and discharge rates, as well as reductions in cost.

One solution to the range problem, presented by an up-and-coming business venture, proposes that the electric vehicle (EV) market adopt a model similar to that of the gas station. Instead of recharging at home, drivers would

use battery swap centers. In about a minute, these centers could remove a drained battery from an EV and replace it with a fresh one. Drivers would pay on a subscription basis. This system makes EVs more practical in several ways. The initial cost of the vehicle is reduced, and drivers no longer suffer from anxiety. Battery swap stations could help smooth over power demands from the grid, and could easily make use of renewable energy. Even rapid EV chargers take 30 minutes and place high peak loads on the power grid. For taxis this system could be even more cost effective because the hardware can be standardized, and idle time would be less expensive in terms of fuel used and carbon emitted.

On the subject of batteries, the safety of a "scaled cell phone batteries" powering a vehicle was called into question. Experts from industry and academia argued that while safety was a consideration, especially where substantial temperature variations are involved, there have not been any issues.

Biofuels were also presented as another alternative. These can be produced from living organisms such as algae, or as is the case in Brazil, sugarcane. Sugarcane biofuel production utilizes Brazil's existing industry, and requires a land footprint which is insignificant compared to that of food production. Brazil is considered to have the first sustainable biofuel economy. While biofuel is still consumed in an ICE vehicle, and thus produces CO2 during combustion, it is said to be carbon neutral because the carbon released into the atmosphere is reclaimed as the next crop of plants is grown. Biofuels also have the advantage of being easily scalable, supporting the agricultural industry, and being compatible with existing technology. Studies in algae biofuel show that it can be produced in an even smaller area of land, has useful co-processes and co-products, and a shorter turnaround time.

103-B1: Frontiers of Personalized Medicine

Chair

- **Nagai, Ryozo**, Professor and Chairman, Department of Cardiovascular Medicine, Graduate School of Medicine, The University of Tokyo, JP

Speakers

- **Dolphin, David**, Chair, Center for Drug Research and Development (CDRD), CA
- **Goryanin, Igor**, Executive Director of Biomedicine Cluster, Skolkovo Foundation, RU
- **Hayashizaki, Yoshihide**, Director, Omics Sciences Center, RIKEN, JP
- **Stein, Christian**, Chief Executive Officer, Ascenion GmbH, DE

The discussion touched on a wide range of areas within the sphere of personalized medicine. This went from the developments that are needed in genomic and molecular bioscience techniques through to the economic and technological issues of putting into practice such knowledge in clinical terms. This is a rapidly evolving area which will require investment in the education of people who may be future pioneers in the field. Much of the discussion revolved around the nature of this medical field, and how it needs to evolve.

Although the eventual contribution of personalized medical technology to the overall field of medicine remains unclear, the participants were in consensus about its importance. Currently many drugs are ineffective for a large proportion of patients to whom they are prescribed, and the additional problem of adverse drug reactions demonstrates a clear need for better predictions of clinical outcomes and disease prevention.

However, despite recent developments in the identification of key biomarkers for disease, bridging the gap between theory and clinical benefit remains an issue that requires a multi-disciplinary approach. Key questions outside the theoretical molecular arena concern information technologies and bioinformatics databases. It was noted that these are critical requirements for the effective implementation of personalized medicine. Such databases and related data management will be of crucial importance for the extraction, stratification and integration of the thousands of factors that must be considered in personalized medicine, including not only the numerous molecular biomarkers but also other clinically relevant information such as personal and family histories and lifestyle factors. The methods for effectively recording such detailed information were also highlighted as an issue. This is because of the frequent omission of critical details in clinical trials and challenges surrounding individuals collecting their own data. It was noted that the insufficiency of database performance may well become a problem in the future, and therefore that this remains a key issue for the field.

The economics underlying the implementation of personalized medicine was identified as being a contentious issue. Although genomic sequencing costs have drastically decreased and are now potentially affordable for all, the overall financial viability of personalized medicine as a standard preventative and therapeutic option remains unclear. Healthcare costs may be driven down through the increased effectiveness of targeting drugs to the patients that will benefit. Alternatively, targeted drugs could lead to a greater financial drain on health care systems due to the increase in costs owing to expensive drug development processes that target a smaller pool of patients. Participants considered the need for clinical trials and for the licensing of drugs to become more efficient. Also mentioned was the need to educate the public with regard to the cost-benefit analysis that must be made with regards to drug safety. Education was also considered to be important in order to garner public support for such technologies, and it was suggested that the field remained too complex to be easily understandable by those outside the specialty. Trials to demonstrate to decision makers the benefit of personal medications was also considered to be an important strategy.

Patenting and legislation issues for research development were also highlighted as being important areas, since future research may be hampered by the patenting of disease biomarkers as they are uncovered. The U.S. courts have pronounced mixed judgments on the patentability of such discoveries. There is a need for policy makers to set freer boundaries in order to enable researchers to have open access and prevent inhibition resulting from too much competition.

Another future issue for the field related to the question of whether society is ready to embrace such technologies, and the ethical problems that might arise. Obvious concerns exist over the need for detailed genetic information and the privacy

and safety of such information, and how universal the eventual accessibility will be of personal medicines. Questions were also raised regarding reliability and liability of such technology, as mistakes in crucial information could become a problem with the development of huge informational databases with multiple contributors.

The session was concluded with participants reflecting on the critical importance of collaboration between patients, physicians, drug manufacturers, regulators and educators. Also under consideration were a number of issues ranging from improving the actual theoretical science and accuracy of sequence data, to the need for developments in patenting, education and funding. It was considered that careful planning in such areas was required to move the field of personalized medicine from being a largely theoretical discipline to becoming a realizable preventative, diagnostic and therapeutic reality.

103-C1: Nano-Electronics

Chair

- **Arakawa, Yasuhiko**, Director, Institute for Nano Quantum Information Electronics; Director of Nanoelectronics Collaborative Research Center, The University of Tokyo, JP

Speakers

- **Ishikawa, Tetsuya**, Director of Harima Institute, RIKEN, JP
- **Kaiserswerth, Matthias**, Director, IBM Zurich Research Laboratory, CH
- **Kwon, Oh-Kyong**, Academic Vice President, Hanyang University, KR
- **Sallin, Aymeric**, Founder and Managing Director, NanoDimension, CH
- **Yeh, Nai-Chang**, Professor of Physics, California Institute of Technology (CALTECH), US

"There's plenty of room at the bottom" said Richard Feynman as he famously challenged the scientific community at his seminal talk given on 29th December 1959. So what is Nanotechnology (NT) and how far has it progressed since then? The diverse panel gave a range of interesting perspectives based on their unique backgrounds, along with some perceptive questions from the audience.

NT has been called the enabling technology of the century, as we reach the physical design limits of silicon based transistor technology that have ridden Moore's Law of decreasing cost/increasing performance for the last 50 years. NT deals "directly with device components ranging in size between 1/10,000,000 (one ten millionth of a millimeter) and 1/100,000th of millimeter," and its greatness lies in the fact it has applications across many fields that affect our daily lives. Nano electronics (NE), an important part of NT, is present in information and communication technologies, health and consumer products, energy, sensor networks and ambient environments. It is also a fully interdisciplinary science that requires a combination of basic and market driven research to realize its full potential.

One of the most common themes that emerged in the discussion was energy efficiency, from the micro to the macro. The Achilles heel of the mobile device revolution is energy consumption, and NE can prolong the scaling of Moore's law through power efficient memory chips, batteries, switches, and other components. Another energy saving device is dynamic glass that can select the light wave length and auto adjust the tint in order to regulate temperature, resulting in substantial savings in energy consumption. Also mentioned were energy grids that could potentially transfer energy more efficiently with smart temperature sensing coatings on the wires, giving the load balancing system a real time bandwidth calculation capability. Other NE coating applications are de-icing and heat control.

Participants also heard that energy harvesting from temperature differentials or vibration has a lot of potential to power embedded sensors, with applications in a range of industries and contexts. NT is also found in solar applications, allowing the development of more highly efficient photovoltaic cells, now a big research area. NE is also crucial in space exploration and research.

Another area under discussion was the health applications of NT and NE, and in particular in cancer treatments currently accelerating to Phase 2 trials owing to promisingly low levels of side effects. Also exciting are ultra-sensitive diagnostic devices and complex tools often dubbed "labs on a chip."

But the further development of NE depends on the capacity to make it, or the 'fabrication of nanotechnology.' Plants, known as Nano FABS, are expensive to build, so owing to the importance initial investment, it is likely that the current big players (eg. IBM, Intel, Samsung) will retain an advantage over smaller new entrants. There are two main types of FAB technology - top down which is costly but precise, and bottom up which is cheaper but less precise.

NT will also still need to interface with traditional silicon or Complementary Metal Oxide Semiconductor (CMOS) technology as it will be very difficult to completely replace silicon devices. Compatibility therefore remains an issue to be watched.

One of the challenges in NE is that working at nanoscale is error prone, so reproducibility is an issue when it comes to production. Therefore, research is also being done into a new NE computational paradigm with robust error tolerance to overcome this. The efficient integration of large numbers of nanodevices is also another driver for this new NanoComp paradigm.

One audience member raised the important issue of risk in relation to the toxicology of nanoparticles, and asked how much progress had been made on this issue. There are potentially serious safety issues with nano materials that can affect both health and the environment. It seems this is recognized as a concern in every country, but it is also very expensive to investigate so funding is an issue. In the US, for example, the University of California has a Center for Environmental Implications of Nanotechnology to study these issues, in addition to the FDA's protocols.

There are also innovative collaborative projects between academia and industry (Tokyo University, IBM Zurich) which aim to optimize research and the commercialization of this key technology. The last 12 months have also seen US$500m raised and over 500 jobs created, ranging from researchers through to operations technicians. Finally, NT was described

as “wonderful science” and, as one participant suggested, perhaps we could stimulate some creative discoveries just by having fun with it.

103-D1:Collaboration among Academia, Industries and Government

Chair
- **Rinnooy Kan, Alexander**, President, Social-Economic Council (SER), NL

Speakers
- **Chakrabarty, Ananda**, Distinguished Univ. Professor, Microbiology & Immunology, Univ. of Illinois, US
- **Fortier, Suzanne**, President, Natural Science and Engineering Research Council of Canada (NSERC), CA
- **Lammers, Rene**, SVP & COO PepsiCo’s Corp. R&D, PepsiCo, Inc., US
- **Nishimura, Yasutoshi**, Member, House of Representatives, JP
- **Oliva, Glaucius**, President, The National Council for Scientific and Technological Development (CNPq), BR
- **Taufik, Tatang**, Deputy Chairman, Technology Policy Assessment , Agency for the Assessment and Application of Technology (BPPT), ID

The combined forces of academia, industry and government must be recognized as driving economic growth. In order to facilitate innovation in the area of integrated resources, universities should be deregulated and allowed to pursue new avenues to collaborate with the private sector.

An expert opined that universities can function optimally if they focus their research efforts in certain specific fields. He said this is particularly important in an environment where government funding has been reduced due to the economic downturn. Such reductions in university funding should provide an impetus for the pursuit of new and innovative goals in order to ensure continued viability and success.

While many industries are willing to partner with universities and governments, it is crucial to remove unnecessary hurdles. Collaborators are urged to be agile and flexible while maintaining high professional standards. In an extremely competitive global economy, it is understandable that companies want to be certain that they will derive benefits from a partnership before they agree to invest in it. Thus, initial interaction to assess challenges and decide what is feasible in a given time frame is essential before embarking on a collaborative agenda. A participant argued that it is the role of governments to create opportunities to facilitate this collaboration process.

The issue of intellectual property rights dominated the discussion. Participants were divided in their opinions of what universities should be willing to contribute in attempting to establish collaborative endeavors. Some participants expressed the view that universities must be proactive in protecting their rights and should not be too hasty in transferring their intellectual property rights to companies without assessing potential losses. Conversely, other participants argued that the over-protection of intellectual properties can potentially be detrimental to the collaboration process. The general consensus on the issue of transfer of property rights was that there is a need for open and frank discussion on legitimate expectations from the early stage of negotiations. It was further pointed out that collaboration does not always involve a transfer of intellectual property rights, but can also include sharing of knowledge and expertise.

A participant mentioned that the Japanese tend to view the flow of technology out of their country negatively. At the same time, some foreign countries have withdrawn from Japan partly because it does not have an established framework for facilitating high-level international collaboration. This will therefore need to be a priority for the Japanese government in the coming years.

A corporate representative highlighted efforts by his company to improve partnerships with universities. He said that food and beverage is one area in which his and other companies can partner with universities for the benefit of consumers.

The issue of whether, or to what degree, developing countries will be able to cope with the challenge of innovation was also addressed. It was agreed that governments need to support this process while developing national strategies based on scientific and technological innovations.

A number of participants raised the question of whether more attention should be paid to basic research or, alternatively, to applied research which has clearer short term benefits. This is a potential problem because companies may not want to invest in fundamental research that delivers no short term results. On the other hand, it is essential to maintain long-term research objectives that are likely to be beneficial in the future. The panel agreed that a compromise must be reached to support these two objectives. Governments in particular should support fundamental research.

One participant stressed that there is an inherent bias in collaborations in that less elite institutions are likely to be marginalized. Governments must therefore be prepared to act as moderators and provide all necessary support to include as many partners as possible.

Universities were encouraged to keep in touch with their alumni who can become ambassadors and facilitate collaboration efforts. Industries also need to work closely together, although this will be easier in some countries than others. It is important that small companies are given an opportunity to collaborate as this can further drive innovations. Finally, there is a lot of work to be done in building strong collaborations, but there is also great potential for success.

103-E1: Water

Chair
- **Toh, Michael**, Director Industry Development, Public Utilities Board (PUB) Singapore, SG

Speakers
- **Abe, Koichi**, Senior Vice President, Toray Industries, JP
- **Al-Hinai, Hilal**, Secretary General, Research Council of Oman, OM
- **Park, Eun-Kyung**, President, Korea Water Forum; Ambassador for Water Resources, Ministry of Foreign Affairs and Trade, KR

- **Percy, David**, Borden Ladner Gervais Chair of Energy Law and Former Dean, Faculty of Law, University of Alberta, CA
- **Upadhyay, Vibhav**, Chairman, India Center Foundation, IN

Biodiversity is intimately connected to issues such as food. The theme of this year's STS session on water was sustainable water use in urban environments.

The world is becoming progressively more urbanized. Currently, 50% of the earth's population lives in cities. By 2050, this number will rise to 70%. Up to 3,000 new cities are projected to emerge in Africa and Asia in the coming decades. Without good water management, the ecological footprint of cities will be far greater. As one participant suggested, 'think of the impact of having a houseguest for a month on the household's water usage. Now consider doubling an entire city's permanent population.' How can we secure a sustainable water supply for our urban future?

One key part of any solution is addressing how to obtain more water for cities. Singapore's recent achievement of complete water self-sufficiency provides several examples of innovation, including programs to harvest as much as possible of the 2400mm of rainfall it receives each year. Another was a shift from "keep away" rules by which people were not allowed near water reservoirs to a policy embracing interaction, positive use, and understanding, thus building public awareness of water issues. Other innovations include advanced desalination techniques, such as those using reverse osmosis (RO) membranes.

Another key part is investigating how to make cities more water efficient. This too can be an area for technological innovation – such as reusing household water for other purposes. Toilets do not need to use potable water to flush; and surely there could be ways to recycle liquid human waste.

Alongside innovative technological solutions must come innovative social solutions. Said a participant: "If water were priced at $80 a barrel like oil, maybe cities wouldn't be losing half of it into the ground through leaky pipes." One Middle Eastern country was cited as an example of how successful management of scarce water resources has been in place for hundreds of years thanks to a system involving market forces. Markets may not be the ultimate solution for fair and efficient water allocation, but some of the principles found therein are unquestionably valuable. What is per capita water use in our city compared to cities of similar profile elsewhere? Is our city's pricing structure for water appropriate? These are important bases to start from when pursuing greater efficiency.

Of course water is not an issue that concerns cities alone. Many solutions to urban water needs will likely involve reallocating water between urban and rural areas, since not every city will have all the resources nearby that it needs. Agriculture is another area of potentially sizeable water efficiency improvements, such as transitions to drip irrigation or less soil tilling.

Water security goes far beyond urban-rural tensions to cross national boundaries and threaten global-scale conflict. For example, ageing water treaties that have not been adapted to reflect new demographic or climate realities could potentially result in serious destabilization in Central Asia. That in turn could lead to conflict next century. Decisions about the future of the Himalayan watershed will affect at least 3 billion people. Eleven different nations share the waters of the Nile. Failure to find solutions to water sharing issues that are satisfactory to all parties could lead to open warfare.

Despite the innovations mentioned above, in some ways it could be said that water has not been the subject of enough innovation – and certainly not a share of innovation proportionate to water's importance to all known civilization and life. If we attempt to compare the number of innovations, both technological and social, that have been introduced to tackle energy issues in the past decades, with the number of initiatives in favor of water conservation, the list for the latter is considerably shorter. Participants in this session called for the same sort of fervor to tackle water issues that has been dedicated to sustainable energy development.

Along with innovations, capacity building and developing talent in the water industry is needed. Even when governments want to invest large sums of money in renovating their water systems, the reality can curtail such efforts. Even with a worldwide increase in water awareness, there are still too few scientists and too few graduate programs specializing in water.

It is vital for us to keep debating the issue of water and discover solutions and opportunities at conferences like the STS *forum*, World Water Forum, Stockholm World Water Week, Singapore International Water Week, etc. We cannot let such an important issue drop off the agenda.

103-F1: Developing Human Habitat: Smart Cities

Chair
- **Rubinstein, Ellis**, President and CEO, (NYAS), US

Speakers
- **Bellingham, Richard**, Senior Research Fellow, Energy Policy Fraser of Allander Institute, University of Strathclyde, Business School, UK
- **Dutkiewicz, Rafał**, Mayor, City of Wrocław, PL
- **Foley, Donough**, Head, Government & Regulatory Affairs Philips Electronics Asia Pacific, IE
- **Harrison, Colin**, Director, IBM Enterprises Initiatives, IBM Corporation, UK
- **Noda, Yoshihiko**, Head of PPP, Infrastructure & Gov. Asia Pacific PWC, JP
- **Okuyama, Emiko**, Mayor, City of Sendai, JP
- **Schmitt, Gerhard**, Senior V.P. International Institutional Affairs, Swiss Federal Institute of Technology (ETH) Zurich, DE
- **Yasuda, Yutaka**, Chairman, KDDI R&D Laboratories, JP

The session focused on the future of cities with particular emphasis on how technology and science can protect them from major challenges. In the wake of the Tohoku earthquake, the session initially drew on the difficulties faced by Sendai. While a major earthquake in 1978 proved that the city's infrastructure was advanced enough to withstand considerable seismic activity relatively easily, it was not sufficiently equipped to resist the major tsunami that followed. New technologies, such as innovative barriers and early warning systems, are being implemented to restrict future damage.

It was also stressed that such large redevelopment schemes should utilize the private sector to ensure cost and quality optimization. However the public sector must approach the private sector from the start and work closely with it from then on. Communication and consensus building is key in order to ensure each side achieves its envisioned goal.

This view was echoed by numerous examples of successful collaborative efforts between industry and government. For example Rio de Janeiro is using advanced IT capabilities to improve the management of future disasters, emergencies as well as planned events of national importance. This came about after the city was hit by devastating torrential rainstorms in 2010, which caused the death of more than 200 people.

Similarly, the city of Glasgow is working closely with industry and academia to develop systems to improve sustainability. The city hopes that this will help in regenerating urban areas as well as cutting carbon dioxide emissions by 30%. However, it was stressed that a major problem cities face is the education of its citizens, as people tend to be more focused on short-term issues, such as the current price of electricity, instead of sustainability to be achieved in the future. It is therefore imperative for city governance to be transparent and work with its citizens.

A particularly common fear is that a well connected city is also a city that is more intrusive into the privacy of the individual. This concern needs to be addressed. Technology is merely an 'enabler' and citizens need to be educated that a smart city increases the possibility to engage with other people but does not force this upon them. However, the capability of smart cities to bring people together should be harnessed where possible to allow for example, for more effective traffic flow, or better citizen governance. A better understanding of the circulation of stocks of foodstuffs and other goods would also contribute to a more effective integration of rural and urban areas. With cities growing at a rate unprecedented in human history, support systems need to be put in place. Instead of a city-centric approach, a regional view of cities would be more effective for the future development of sustainable cities.

The development of environmentally friendly cities on the basis of technological innovation also received much attention during this session. Were cities to remain unchanged, they, as one speaker phrased it "should come with a health warning." City dwellers are more likely to suffer from serious illnesses like cancer or obesity. Thus the task of making cities greener is as much about the environment as it is about improving the quality of life of its citizens. Particularly, the development of clean energy combined with a reduction in energy consumption is one of the key areas that need to be addressed. Already some vital technologies are seeing large-scale implementation such as solar power, or the use of energy efficient bulbs. Participants heard about a nationwide program currently underway to install 23 million LED light bulbs.

However fears were voiced that making a city more sustainable or more efficient can potentially have damning side effects. For example, by redrawing the streets of some urban areas in the USA, neighborhoods have been destroyed and they have become less habitable. Likewise, city renewal needs to be implemented while taking the culture and heritage of the area into account. As one speaker stated, 'a city without an identity is nothing more than earth.'

Another concern stressed was that there is no single solution to building a working effective smart city. Every city runs along different parameters that are determined by a host of factors, such as demographics, geographical location, and/or cultural context. Furthermore, the question was raised that the meaning of 'smart city' has not been sufficiently explored and that the meaning varies considerably. Whilst for some it refers primarily to sustainability, for others it is about media convergence and for yet others it is about data collection.

103-G1: Role of Media in Science & Technology

Chair
- **Blanco Mendoza, Herminio Alonso**, Founder and CEO, Soluciones Estratégicas, MX

Speakers
- **Gergils, Håkan**, CEO, Ecofin Invest AB, SE
- **Kolman, Michiel**, Senior Vice President of Global Academic Relations, Elsevier B.V., NL
- **O'Reilly, David**, Head of Group Research & Development, British American Tobacco Plc., UK
- **Rangaswami, J.P.**, Chief Scientist, Salesforce.com inc., IN
- **Steen, Tomoko**, Senior Research Specialist, Science, Technology and Business Division of the Library of Congress; Adjunct Professor, Department of History, Johns Hopkins University, US
- **Turner, Sebastian**, Chairman of the Board of Trustees, Falling Walls Conference, DE

The panel agreed that there is a 'DNA system in innovation [and] journalism is the fourth strand to the double helix.' The promotion of transparency was identified as a vital function of media involvement in science and as one of its benefits. The pioneering use of eGovernment by the Obama administration was cited as an example, in contrast with the lack of clarity surrounding the Fukushima reactor incident.

However, the media should describe innovation in its context. It should be clear how innovations are used as this influences politicians and laypeople alike. The media must describe how the process of innovation functions, emphasizing the counter-flow of ideas between innovators and their customers. Studies should be conducted on the impact of innovation coverage by journalists as there is a lack of academic work in this area.

Some of the most contentious issues in science are discussed through the media resulting in 'full and frank debate'. On occasion this fails – for example, the media has not conveyed information about cigarette alternatives in the shape of nicotine-delivery systems that are up to 99% less dangerous than smoking cigarettes.

Electronic media is also of vital importance. Content needs to be vetted for accuracy, and rather than being 'comprehensive and complex', our contemporary sound-bite culture often sees a 'life's work reduced to a tweet' online. However, engagement with the public is no longer just 'nice to have', and transparency and participation are vital. A good example of the power of participation was Project Tohoku, in which the restoration of the photos damaged during the Tohoku earthquake was crowd-sourced. Another example is the rise

of highly proficient amateurs who can articulate innovations to the average person through blogs. Electronic information, often lost once communicated, should be stored. The Library of Congress, for example archives all tweets through an agreement with Twitter.

Conventional media nevertheless continues to be important – much online content is derived from printed material. There are however several trends of concern. With more articles being published, it is increasingly difficult to identify articles of note. Research is also more technical, making its mass dissemination more difficult; academic misconduct is increasing and the number of working scientific media professionals around the world is dwindling. Clear communication is also necessary to avoid scares, such as the post-Fukushima nuclear contamination issue, which was and still is characterized by a lack of knowledge and some examples of sensationalism. Practitioners and journalists should develop a 'lingua franca' based on common terminology to prevent obscuration in the sciences.

The inability of scientists to fully engage with the media was also discussed. While scientists have high credibility because they are not 'active in the media game,' one of the main issues is 'the unwillingness of academics to simplify'. The impact of this is clear in the field of genetics in Germany for example, where research has been curtailed because practitioners are unable to explain their work transparently. Nanotechnology, in contrast, has done much better. As one participant put it, when it comes to communicating with the public, 'the bait has to fit the fish, not the fisherman'. It is also important for scientists to keep in mind the social importance of their work, which would not only allow them to keep their ethical priorities clear, but would also enable them to explain their work simply and not simplistically.

The question of peer review was discussed extensively. One issue was the disproportionate number of Western reviewers. Another issue was that peer reviews are often carried out by colleagues. Peer reviewers on occasion also believed that the work they carried out was very technical and impossible to convey to a wider public. However, some participants pointed out that the system has its redeeming qualities. Peer review is not 'truth control', but rather an attempt by the scientific community to establish a system of quality control. Peer reviewers are often identified by editors, not writers, and their experience must be appropriate to the article's subject matter.

However, anyone can be a 'watchdog', if trained. For this, social media has great potential. A good example is Wikipedia, in which some 100,000 active members drive the site's development. In any given online forum, usually only 5% of people participate in a discussion – not because they all agree on the topic, but because they are interested in it and willing to enter into the kind of debate that many scientists are reluctant to engage in. These figures also make clear that mass participation does not necessarily mean the participation of everyone, but usually of a group of people who are engaged with the issue and are more qualified than the average. The passionate amateur must be allowed in. This safeguards quality.

19:30-21:00 PLENARY SESSION

104: Official Dinner

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

Speaker
- **Earle, Sylvia**, Explorer-in-Residence, National Geographic Society, US

Paul Rübig welcomed the guest speaker, encouraged everyone to enjoy the evening and take pleasure in the opportunity to sit back and hear about the Earth from someone who has spent a lifetime traversing and studying it.

Sylvia Earle made a presentation replete with imagery and stories of the deep oceans and the Arctic, and reminded participants of the profound responsibility we bear in the immediate present with respect to the future of the planet.

She pointed out that in many ways, we know more about space than we do about the deep oceans. We have invested in 'reaching for the stars,' in aviation and aerospace, and have ventured out into the solar system. Travel beyond our planet is an adventure we can and must pursue – and it has paid off. We understand a lot more about the Earth thanks to our journeys away from it.

But meanwhile, the oceans have been neglected, and this has undoubtedly led to untold damage. The oceans make up three quarters of the Earth's surface and 97% of the Earth's biosphere – and yet we know relatively little about them.

On the positive side, this means the oceans remain a tremendous frontier of adventure and discovery. The deepest place in the ocean is 11 kilometers down (many participants flew 11,000 kilometers to get to Kyoto for this conference), and only two people have ever been that deep. More people have walked on the surface of the Moon, and Mars is becoming better mapped. Yet 95% of the ocean lies unexplored.

From the huge to the microscopic, the ocean is teeming with life. Every spoonful of water is like "a living minestrone," she quipped. Japanese scientists only recently managed to capture a picture of a giant squid in its natural habitat. The species was known but had so far remained elusive. Completely new and fantastic marine species are being discovered all the time.

The oceans can provide adventures for generations to come. Earle encouraged adults who are blasé or unmoved by the natural world to take a child along to be and be inspired by their wonder and excitement.

Rapid technological advancements have given rise to new tools to help on this journey of discovery. One easily accessible tool for exploration is Google Earth. Until two years ago did not show ocean topography, but it can now be used to learn about ocean species and ecosystems all around the globe.

A lot more could be done. Submarines exist, and Earle wondered why more are not built. Why isn't there a Hertz Rent-a-Sub that any family can book as part of their vacation? she wondered. Technologies exist that allow humans to live

underwater, at least for a time, and what better way to get to know the oceans than waking up to it and being surrounded by it for days? To Earle it is the “best trip in the world.” She urged participants not to wait until they were 81 to go scuba diving for the first time, nor let being 81 stop them from doing so.

Beyond simple enjoyment and wonder, there are practical reasons for investing in exploration of the oceans. Some 90% of the stocks of the fish we love to eat are gone. Oceans are not infinite and mankind has already eliminated whole species…by the thousands. Half the coral reefs in the world are gone or are in decline. Just as scientists are realizing they can learn something from tuna, it may be actually too late and the chance may be lost for figuring out how this fish achieves 90% efficiency of movement. The Arctic ice is disappearing at a terrifying rate, threatening the loss of a whole wondrous, vibrant ecosystem.

Yet there is hope. Knowledge and understanding of oceans are growing by the day. More is known about the connections between the more than 250,000 varieties of life in the sea and how they are affected by factors such as temperature, acidity, and currents. It is possible to track the movements of ocean-crossing species. Modern technologies like the internet mean discoveries can be shared with unprecedented breadth and ease. Amateur fish-watching is beginning to become a popular activity. It is providing the same impetus for conservation in the oceans as amateur bird-watching has done for earth conservation for decades.

Earle saw the present moment in history as being unprecedented in terms of the power of human beings as a species that can understand and guide the development of life around it. Mankind is beginning to have both sufficient knowledge and technology to master the world and the nature of its presence in it. The decisions that are made now will have an unprecedented impact in the years to come. The next ten years are likely to be the most important in the next ten thousand years.

Monday, October 3, 2011

08:30-09:50 PLENARY SESSION

200: New Challenges in Global Health

Chair
- **Alberts, Bruce M.**, Editor in Chief, Science; Professor, Department of Biochemistry and Biophysics, University of California, San Francisco (UCSF), US

Speakers
- **Barner, Andreas**, Chairman, Boehringer Ingelheim GmbH, DE
- **Drake, Michael**, Chancellor, University of California, Irvine (UCI), US
- **Goel, Anita**, Chairman and CEO, Nanobiosym Diagnostics, Inc., US
- **Nagayama, Osamu**, Chairman of the Board, Representative Director and President, Chugai Pharmaceutical Co., Ltd., JP
- **Warren, John Robin**, Emeritus Professor of Medicine, University of Western Australia (UWA), Nobel Laureate for Physiology or Medicine 2005, AU
- **Yamanaka, Shinya**, Director, Center for IPS Cell Research and Application (CIRA), Kyoto University, JP

Bruce Alberts started the session by introducing two central themes: what developments can be expected in the next decade that might affect the lives of people in the industrialized world, and can we sustain this as our levels of healthcare? Also, what new developments can we anticipate in the next decade that will improve the health of people who live in poverty, how much will it cost, and who will pay?

Shinya Yamanaka said that stem cell research will hopefully lead to breakthroughs in developing new drugs and treating patients in the near future. However, it will take time to establish methods to generate clinical-grade cells for transplantation and to find chemical compounds for drug discovery. We will also need to obtain patents on those technologies. Cures are good, but prevention is better, and hence we 'have to pay more attention to preventative medicine.' A focus on a good lifestyle is 'simple but very important'. It is also important not to use unnecessary treatments on patients for the sake of the treatment itself. These factors are important in both developing and developed countries.

John Robin Warren stated that in the past, higher levels of mass infection caused by living in cities were mitigated through better urban design. Antibiotics were first being used in the 1940s. Since then, pharmaceutical companies have developed penicillin-based compounds that are far more potent. However, doctors now prescribe antibiotics 'far too often to far too many people', and as a result, they are more resistant to bacteria. This has been aggravated by the use of antibiotics in agriculture. Unfortunately, there is no obvious remedy to this situation, except perhaps simply decreasing the use of antibiotics.

Andreas Barner observed that life expectancy has increased by around 3 months per year for the past few decades in industrialized countries, with a concurrent increase in quality of life. Vaccination, better drugs and greater wealth, among other factors, have contributed to this. New antibiotics, new vaccines, better diagnostic tools, targeted treatments, analysis of the human genome, and a greater focus on prevention will ensure this trend continues. Average healthcare costs have gone down in terms of percentage of personal income - but will almost certainly rise in terms of GNP. Education and healthcare accessibility must be improved as 'it is the duty of every country in the world to fight healthcare inequality everywhere'.

Osamu Nagayama started by saying economic recession and aging are leading to spiraling costs in healthcare. Furthermore, the number of new drugs being discovered is decreasing. In 1996, 56 new compounds were approved by authorities; in 2010, only 21 were. The costs have also soared. In the future, drugs will be better targeted, and design by supercomputer simulation is an exciting and increasingly likely possibility. Personalized healthcare, based on biomarkers, is also gathering pace. Such opportunities allow pharmaceutical companies to continue to 'play an important role in society', and it is important to ensure effective cooperation between government, academia, and industry.

Anita Goel believes global health problems require thinking that cuts across disciplines and borders. Issues need to be tackled holistically. Nanotechnology, for example, provided a bridge between the physics and biology. In industrial countries, patients are gaining more power over their own healthcare. Another shift is an emphasis on 'wellness'. Increasing access to healthcare in developing nations, and making it more mobile means it may not be necessary to build expensive infrastructure. It might be possible to leapfrog to more modern techniques.

Michael Drake said the direct treatment of diseases is only one aspect of the issue of quality of life. Access to healthcare constitutes an area in need of significant reform and the Human Development Index 'relies strongly on educational attainment to determine the relative level of development in a country.' The poorest countries earn about '2% of the income of the richest, and [have] roughly 50 times more early childhood mortality.' In addition, they now face 'the emerging burden of chronic non-communicable diseases'. Innovative solutions are needed. 'The health of people and populations worldwide is a subject of great concern to us all [and] require remedies outside the traditional bounds of the health care system'.

In the discussion, it was made clear that nutrition is important to both general health and wellness and advances are being made in genomics that allow people to design diets most appropriate for them. The side-effects of nanotechnology were also discussed, with an emphasis on the fact that that much more work is needed in investigating these. It was also stressed that nanotechnology is a long way away from widespread implementation. Finally, it was emphasized that it is impossible to disaggregate the health of the human species from the health of the planet as a whole: to work on one and not on the other is simply to 'chase our tails'.

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

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

Chair

- **Püttgen, Hans Björn**, Director and Energy Systems Management; Chair, Energy Center Swiss Federal Institute of Technology, Lausanne (EPFL), CH

Speakers

- **Behrendt, Frank**, Head of Chair for Energy Process Engineering & Conversion Technologies for Renewable Energies, Berlin Institute of Technology, DE
- **Godorr, Sven**, Manager of Research and Dev., Sasol Technology, ZA
- **Khanna, Madhu**, Professor, Dept. of Agricultural and Consumer Economics/Energy Biosciences Institute University of Illinois at Urbana-Champaign, IN
- **Minster, Jean-François**, Senior Vice President Scientific Development, Total S.A., FR
- **Phalakornkul, Kanokro**s, VP, General Manager of Innovation PTT Public Co. Ltd., TH
- **Tadeu da Costa Fraga, Carlos**, Executive Manager Research and Development Center, Petrobras (CENPES), BR
- **Williams, Ellen**, Chief Scientist, Research & Technology BP p.l.c., US

This discussion began with several questions being asked regarding the forces that drive energy consumption and climate change. There are many new and upcoming renewable energy technologies being proposed today. How do we choose which to pursue?

A number of participants expressed the view that there is no single 'silver bullet' and argued that the proper blend of energy sources will vary from one country to another, and that this balance will in fact change as technology progresses.

Several additional points of consideration were suggested. What resources are needed to implement different energy options (eg. lithium batteries for electric vehicles, or water for various power plants)? In the discussion that followed, one answer was clear: global research and development on multiple technologies should continue. In addition, it was pointed out that for energy solutions to take root, energy storage solutions, such as chemical bonds, Coulomb, and gravitational interaction, also need additional R&D.

The question was asked as to how the developed world should sober up and transform its energy consumption patterns. It was pointed out that in the current state of political affairs, there is a lack of technical rigor in public discussion about alternative energies.

The once-held view that mankind would soon exhaust portions of its fossil fuel reserves is now antiquated. The scientific consensus has shifted toward projections that there is oil to last 30 years, more for gas, and well over a century for coal. Despite the fact that the resources are not as limited as previously thought, renewable alternatives are still vital in order to combat climate change. Differing opinions were offered on the topic on coal consumption. A participant from industry promoted the idea that coal could and would be used to depletion – it was merely a question of how long this would take. It was suggested that it is important to use this coal intelligently, cleanly, and efficiently, especially in the developing world. Academics and others said prolonged usage of coal at or above current rates was neither probable nor conceivable. They argued that the continued use of coal would result in a global temperature rise of 5-7degrees Celsius.

Another point was made, stressing the importance of considering the safety of an energy source through its entire usage cycle. Although recent discoveries in shale gas are promising to some, the hazards of extraction must be taken into consideration. In this respect, France's decision to institute a ban on fracking was brought to light. However, it was mentioned that this sort of decision would be politically difficult in the U.S. where natural resources are not nationalized.

Participants hopeful of witnessing a 'nuclear renaissance' were at odds with Germany's decision to close all nuclear plants despite the inevitable increase in CO2 output. When changing from one energy system to another, care must be taken to ensure a proper disposal of dangerous materials.

Energy conservation efforts and behavior modification can offer dramatic savings in the very short term. Japan's adaptation of a lower power lifestyle following the March 11 disaster was cited as an example. Other measures such as proper insulation were proposed as a way of increasing energy efficiency.

In exploring what other elements might help the development of renewable energies, it was pointed out that banks are currently only set up to finance large systems. A new model is needed to help fund smaller renewable energy projects.

Another point of discussion centered on how it might be possible to allow developing economies to maintain aspirations for 'first world' lifestyles without becoming heavy polluters? The global community has been failing to help China develop its economy in this way. China uses four times as much energy per product unit than Switzerland.

Thailand renamed its National Gas and Oil company and called it National Energy to make clear its commitment to blending fossil fuels with renewable sources. It is investing heavily in biofuels: E10 has 30% market share, and B5 20%. Several manufacturing operations generate their own power and sell the remaining energy back to the government. Thailand also has a large capacity for geothermal generation, however the technology is still under development. In many circles, growth in demand is considered natural law, though efforts should be made to mitigate this.

The inconsistency of what was described as "Stop and Go" energy policies can threaten long term goals. Participants explored ways in which the tenacity needed to achieve these goals could be developed. As global conditions and technologies rapidly change, it will be necessary to design policies that don't fall behind. More effort could be made to get the general public involved. Programs which educate and engage the general public can be helpful in sustaining government policy as well as helping to achieve other environmental goals.

201-B2: The Science of Aging

Chair
- **Seike, Atsushi**, President, Keio University, JP

Speakers
- **Chapman, Paul**, General Manager, Pharmaceutical Research Division, Takeda Pharmaceutical Company Limited, US
- **Furuichi, Yasuhiro**, Chairman and Director, GeneCare Research Institute Co., Ltd., JP
- **Imura, Hiroo**, President, Foundation for Biomedical Research and Innovation (FBRI); Professor Emeritus, Kyoto University, JP
- **Schnitzer-Ungefug, Jutta**, General Secretary, German Academy of Sciences, Leopoldina, DE
- **Serizawa, Hiroaki**, President and Chief Executive Officer, Coyote Pharmaceuticals, Inc., JP
- **Ugrumov, Mikhail**, Advisor of 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 session aimed to deepen discussions on how to cope with the problems caused by aging populations, and the speakers approached this theme not only from a scientific perspective but also taking into account economic and social considerations. A common idea linking these areas was that of "aging itself not being the problem", but rather that it often brings with it severe and debilitating diseases that place a high burden not only on individuals, but also families, health care systems and ultimately societies.

From a socio-economic perspective, the development of so-called "life-long active societies" was identified as being critical to counteract the average per capita burden of aging societies. In "active" societies, older people would keep on working beyond the current average retirement age, which relieves financial systems and drives economic growth. Such a system would be dependent on the extent to which older people are healthy, and therefore tackling age-related diseases is critical to alleviate the increasing financial burden of aging populations. The system is also dependent on the motivation of older people to work for longer and this is something that may be encouraged by revising public pension systems and mandatory retirement practices where they exist. Given the number of years individuals can now expect to live beyond retirement age, it is crucial that older generations continue to contribute to society and do not become a burden. Issues relating to long life expectancy should be considered not only by the elderly but also by the young, to ensure everyone is prepared for this reality.

From a scientific perspective, there was strong emphasis on the importance of preventative and pre-emptive medicine with regards to age related-disease. Many such illnesses have a very long pre-clinical phase where the patient is asymptomatic. This may be a critical intervention period during which identified biomarkers can be targeted to prevent progression to full-blown disease. This is considered to be particularly important in the field of mental and neurodegenerative diseases. These are predicted to increase in incidence to overtake other non-communicable diseases as the main medical burden within 15 years. By 2040, the incidence rates of Parkinson's and Alzheimer's disease alone are expected to double and triple respectively. Tackling this issue is a pressing and difficult problem for science, due to the complexity of the disorders. Scientists must elucidate the pre-disposing factors which result in some individuals developing these disorders in the later years of life. They must also explore the link between these factors and the physiological outcome which need to be better understood. Biomarkers may enable efficient and cost-effective screening for the early stages of the diseases, which is when treatment might be more effective. In addition, identifying high-risk individuals is important in order to constitute target groups for prevention trials. The genetics of aging and related disorders are becoming clearer, with single gene mutations that contribute to certain age-related diseases now better understood. The accumulation of mutations in DNA is known to play a key role in aging, and this is likely to be another target for drug development. Some medicines have shown promise in promoting nerve growth, and small molecular compounds have also been developed which may be a future therapeutic option for treating Alzheimer's disease.

In terms of solutions for the aging problem, the importance of education for preventing ill-health later in life was another common theme discussed by participants. Educational status has been shown to be a key predictor of health status, with students who do better in school having been shown to maintain good health for longer periods. The participants considered that persuading individuals to take responsibility for their own health and the factors that affect it such as diet and exercise was critical to avert high levels of morbidity due to age-related diseases. Other thought-provoking views included questioning the seriousness with which governments were treating the aging problem, and whether or not funding drug research to prolong the latter years of a person's life should be considered a valuable pursuit by the numerous stakeholders involved in the process.

Finally, while the age-related diseases remain a complicated and challenging area, many participants were optimistic that current and future developments in science and society would be able to unlock the secrets that may lead to prevention and cure in the near future.

201-C2: Nanotechnology for Health

Chair
- **Rietschel, Ernst**, Former President; Professor Emeritus, Leibniz Association (WGL), DE

Speakers
- **Fouke, Janie**, Dean of College of Engineering, Nanyang Technological University, US
- **Hashida, Mitsuru**, Professor, Department of Drug Delivery Research Graduate School of Pharmaceutical Sciences, Kyoto University, JP
- **Kraegeloh, Annette**, Head of Department, Nano Cell Interactions, INM-Leibniz Institute of New Materials, DE
- **Songsivilai, Sririrug**, Executive Director, National Nanotechnology Center (NANOTEC), TH

The discussion on the implications of nanotechnology for health centered around three main points: the status quo, the impact of nanotechnology, and its future.

Nanotechnology provides tremendous opportunities for companies and has a wide range of medical and other applications for society in general. Concomitant with the development of this technology is the need to develop clearly thought out ideas on how best to assess and evaluate risks associated with it.

Panelists took turns highlighting some of the applications of nanotechnology. One participant described his own research involving the use of nanotechnology to improve health care in his home country. This includes using nanotechnology to make mosquito nets in an effort to control the spread of malaria.

Other applications of the technology include the use of nanotech particles in ambulances and operating theaters to control the spread of diseases. It is also used in water purification systems to provide clean water to communities in developing countries.

A participant stated that nanotechnology is making inroads into healthcare in areas such as imaging, sensing and targeted delivery. A point made earlier by another panelist was reiterated, emphasizing the fact that the global market for nanotechnology applications has increased significantly over the past few years from US$1.7 billion in 2007 to US$1.9 billion at the end of 2008 to a projected US$3.8 billion by 2013.

The panel devoted considerable time on the issue of safety and discussed the need for transparent mechanisms to monitor the effects of nanotechnology at every stage of its use. Some of the speakers argued that while there are clear benefits in the use of the technology, it is imperative that applications pass rigorous safety checks before they are commercialized. Developing countries are seen as particularly vulnerable in that they may not have sufficient safety structures in place to monitor the use of the technology.

One participant mentioned that the use of nanotech in diagnostics and other areas can lead to clear benefits, but he cautioned against rushing to use the technology in drugs. He saw this as a potentially risky application that is most likely to lead to problems if there are any short-cuts in the safety procedures.

Devices will have to be developed to enable proper risk assessment and measurement. Further, there needs to be a clear definition of what nanoparticles really are in the first place. The effects of nanotech materials on biological systems will also have to be assessed. To this end, collaboration is essential between scientists and legal practitioners in order to build a strong and effective legal and ethical research framework.

The issue of cost was also raised: what can be done to make the technology accessible to people in poorer countries? High technology may only be available to the wealthy, so efforts must be deployed to make safe nanotechnology available and accessible to people in developing countries. An area that has borne fruit is the use of nanotech in miniaturizing medical devices, thus cutting expenses both in infrastructure and actual cost. Thanks to nano-technology, individuals will soon be able to assess their own health condition and as such, they will be empowered to make more informed decisions.

This of course must take into account problems that can arise from giving individuals this power. The aim is not to do away with the need for consultation with practitioners. Is society prepared for both the benefits and risks?

It was mentioned that countries such as Japan and Germany are generally more receptive to the use of nanotech. But even there, it depends on the particular application and inevitably, questions are raised if the technology is applied to the food and beverage industry, for example. Rules will have to be introduced in cases and this raises the further question of whether regulatory bodies like the FDA are prepared to develop effective control mechanisms.

The panel agreed that the future of nanotechnology is very promising. Integrating different disciplines in addition to engineering and medicine, such as pharmaceuticals holds promise. There is also scope for further applications in diagnostic drug delivery systems. Nanodiagnostics can revolutionize our scientific and social behavior but this must not be at the expense of safety.

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

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

Speakers
- **Bartels, Dennis**, Executive Director, ExplOratorium, US
- **Carneiro, Sandoval**, General Manager for Partnerships and Research Funding, Vale S.A., BR
- **Farley, Sara**, COO, Global Knowledge Initiative, US
- **Honeth, Peter**, State Secretary, Ministry of Education and Research, SE
- **Natera, Angélica**, Senior Program and Development Officer, Harvard University - LASPAU, VE
- **Ponomarev, Alexey**, Deputy Minister of Education and Science, RU
- **Wanniarachchi, Pavithra**, Minister of Technology and Research, LK

This session focused on issues related to STEM (science, technology, engineering and mathematics) education in the 21st Century. The world currently faces many challenges, and science and engineering will play a key role in addressing them. But how do we combine the technological knowledge needed to address them with the creativity and innovation which is the heart of research in order to stimulate the younger generation?

Declining interest by students in STEM careers was a recurring theme echoed by many participants throughout the session. Understanding the student perspective is critical to developing solutions, and it seems there are a number of factors which mean students shy away from STEM studies. One reason was that many see science not as the solution but as the cause of the world's problems. Along with this, historically, science does not have a good track record with respect to communicating its role in everything that underpins the modern lifestyle. Because of this, it loses out to "exciting" fields that are far less important but much more adept at communicating emotional excitement and short term rewards.

In short, science isn't "sexy."

Other participants raised the issue of the quality of teaching, or more precisely the outdated nature of rote memory, cookie cutter solved-problem teaching. This is the opposite of what is needed since the current environment demands creative and critical thinking skills, the courage to question, and multi-disciplinary skill sets in order to fuel innovation across a number of key new problem areas. Einstein's maxim by which "anyone who has never made a mistake has never tried anything new" could well be a good principle for such a learning environment.

One solution is to redefine what science is. It is not just a body of knowledge to be taught. It is a process with a number of dimensions which needs to be actively explored by the learner in order to generate the motivation that will excite members of the next generation into committing to a creative and productive STEM career. That, in turn, can develop into an ecosystem of innovation.

Some good examples and emerging best practices were given. The US National Academy of Sciences released a seminal report in 2006 entitled "Taking Science to School." The objective was to boost K-8 Science achievement, which introduced four strands as the basis for new science standards, assessments, and curricula.

Consider that only 18% of a child's life up to the age of 18 is spent in school, and only 5% of life for most adults is spent in a formal school environment. Lifelong learning is the reality, and STEM education needs to be promoted. Access to it be facilitated available via robust and engaging platforms to ensure that a science literate society is developed that can make informed decisions about key issues.

This can range from hands-on interactive science playgrounds like Exploratorium in the US through to game-based STEM learning environments. Other examples include low-cost, high touch initiatives such as a World Bank project which identifies great scientists to go and teach in schools. This is especially important given that number one predictor of women becoming a scientist is having a role model.

Sweden has emerged as a leader for STEM education in Europe, and the experience there indicates that STEM education should be introduced as early as possible - even as early as primary school - and the barrier between research based learning and learning based research should be dissolved. Placing PhD students in schools is one way of doing this, as is the creation of research facilities for teachers.

Some industry examples (aerospace, mining) from Latin America also highlighted the emerging shift from closed R&D models to more socially aware, sustainable, open innovation processes which harness the full power, knowledge, and creativity of the total workforce. Feedback also indicated that students want to make a difference; they want to "change the world" and do something significant. There a good examples from the developing world too, with projects undertaken through the Global Knowledge Initiative that use resource matching and optimization techniques such as Challenge Mapping and S&T Innovation Context Analysis. The aim is to effectively harness the best industry, government, and educational resources in order to solve pressing problems. The development of 'collaboration innovation process skills' are a key part of this.

Einstein also said: "We can't solve problems by using the same kind of thinking we used when we created them." Perhaps it is also time to say "We can't solve problems by using the same kind of teaching we used when we created them."

201-E2: Sustaining Forests

Chair
- **Innes, John**, Faculty of Forestry, The University of British Columbia, CA

Speakers
- **Raitio, Hannu**, Director General, Metla, The Finnish Forest Research Institute, FI
- **Sophonpanich, Kalaya**, Secretary General, Rajapruek Institute Foundation, TH
- **Suzuki, Kazuo**, President, Forestry and Forest Products Research Institute (FFPRI), JP

We are "all guests of the plant kingdom," participants heard. Forests cover 30% of the world's surface. Wood is the 'only generally available low-energy, renewable, and carbon-neutral biomaterial'. Two billion people rely on wood as their source of energy. Using wood as a building material circumvents the carbon output of concrete production, and provides an enduring carbon sink. A Science Council of Japan report also identified other benefits derived from forests including the mitigation of natural disasters, the protection of water resources and the creation of agreeable surroundings. In addition, forests bring health benefits such as limiting allergies and providing spaces for healthy recreation.

Human activity causes the loss of around 5.2 million ha of forest a year, causing specific issues in different areas. Deforestation causes 'multiple synchronous collapse' (such as floods in China), disrupts rain cycles and may contribute to triggering earthquakes. It is estimated that deforestation has led to the creation of some 100 million 'environmental refugees'. In many tropical countries, forests succumb to disease. In Australia, Canada, and New Zealand, forests are susceptible to diseases and pests such as the possum and pine beetle.

The value of the world's forests is estimated at US$4.7 trillion. One participant suggested that ideally, forestry should be bolstered by 'significantly increasing investments in the environment as a means of promoting sustainable economic growth, job creation, and poverty reduction. At the same time, this would help reduce greenhouse gas emissions, extracting and using fewer natural resources and creating less waste'. Yet, only 4% of forests worldwide have been planted by humans. Planted forests cannot fully replace destroyed natural ones. New Zealand, for example, has replaced native forests that were logged with plantations, but its young geology means that once forest cover is lost, it is difficult to grow it back. Huge expanses of planted protected forest in Australia are monocultures lacking in natural biodiversity.

The notion of forest management has origins in the 18th century. Although there have been considerable advances since, a participant pointed out that 'we know what we have

to do, [but] we are failing to do it'. How can we improve the way forests are sustained?

One approach is through institutions such as the Intergovernmental Forum on Forests, Forest Europe, and the United Nations Forum on Forests. The objective could be 'a worldwide legally binding agreement on forests'. Making sure this is effective and enforceable is challenging – Canada, for example, recently rescinded its agreements on the Kyoto agreement and suffered no consequences. In order to ensure the integrity of binding agreements, the preservation of forests could be included in the 'responsibilities of sovereignty'. Projects such the Heart of Borneo preservation project involving Brunei, Malaysia, and Indonesia, and the 'debt for forests' plan in Costa Rica and Indonesia, already cross international borders. International organizations could include environmental requirements as a clause in, for example, loans provided by the World Bank or other institutions.

Another approach emphasizes social considerations, seeing sustainability as 'very much local'. In Thailand, forest cover continued to decline despite logging bans. In 1992, the government launched a forest sustainability program. Tax incentives and a reduction in the amount of red tape ensured private sector involvement. Local inhabitants were encouraged to participate in tree planting. This resulted not only in the return of the forest habitats and animals, but also brought concurrent economic benefits. Thailand's forest coverage went from 22% to 30%. Such projects also fulfill the need for new forests, which are the primary carbon sinks in the world. An important lesson was that sustainability must involve those who are directly affected. It is also essential to learn from pre-existing local forms of forest management, such as the Aboriginal management of eucalyptus trees in Australia.

Galvanizing political and public opinion is vital. One suggestion is that, much like the moon exploration projects of the 1960s, governments need to 'focus on this issue like a laser'. The main obstacle however is the overwhelming concern with short term economic priorities. One way forward may be to replicate the R20 system which brought together US cities unwilling to wait for the federal government to move on environmental issues. In terms of raising public awareness, the internet can be used as a tool to disseminate information. It is also important to promote catchphrases such as 'lungs of the earth' which provide effective 'marketing' of conservation ideas. Above all, conveying a sense of urgency could raise public and state interest. Brunei has spearheaded such a 'change in mindset' effort by incorporating teaching about forests and the environment in universities and schools. Growing awareness of deforestation is needed and its direct relationship to disasters such as the Katrina hurricane – four of which could wipe out the US Treasury. Given the importance of this issue, participants suggested that next year, the STS *forum* should dedicate a plenary session to deforestation.

201-F2: Capacity Building in Developing Countries

Chair

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

Speakers

- **Amirinia, Hamidreza**, Advisor to the Presidency Center for Innovation and Technology Cooperation of I.R. Iran; Member of Commission, Supreme Council of Science, Research and Technology (ATF), IR
- **Dzinotyiweyi, Heneri**, Minister of S&T Development, ZW
- **Gunaratna, Locana**, President, National Academy of Sciences of Sri Lanka (NASSL), LK
- **Hara, George**, Group Chairman and CEO, DEFTA Partners; Chairman of the Board, Alliance Forum Foundation / UN, JP
- **Hassan, Mohamed**, Treasurer, The Academy of Sciences for the Developing World (TWAS), SD
- **Jamal Al-Lail, Haifa**, President, Effat University, SA
- **Koanantakool, Thaweesak**, President, National Science and Technology Development Agency (NSTDA), TH
- **Simons, Thad**, President and CEO, Novus International, Inc., US

Developing countries face the difficult task of finding new models in order to achieve prosperity with scare resources. With foreign aid drying up as result of the economic downturn, developing countries are harder pushed to find ways to achieve self-sufficiency. The objective of capacity building is to ensure citizens to 'enjoy a free and healthy life in a safe environment'.

The session participants were unanimous in stressing that capacity building efforts will have to focus on improvements in education. In particular, since the majority of developing countries tend to be relatively poor in natural resources, developing the educational bases necessary to move local industries into the tertiary sector is crucial. Many questions were raised concerning the implementation of such a shift. A participant from one developing country stated that its expenditure in education was as high as 22% of GDP, and yet it faces declines in education quality, with between a 34.6% and 47.7% of educational facilities below national standards. Understanding the parameters of such conditions is crucial. The education sector is not seen as favorable employer, and very often, those who seek a fulfilling career in education leave the country.

Numerous initiatives are being implemented across the developing world to improve the reach and quality of education. E-learning platforms are perhaps attracting most of the attention. With the growth of ICT infrastructures, and cheaper computers, it is hoped that new technological solutions will help maximize existing resources and bring quality education into even the remotest areas.

Human capital flight, or "brain drain" as it is known, was cited as the most pressing issue facing developing countries today. Those who are able to educate and instruct leave their home countries in disproportionate numbers for higher salaries and better working conditions abroad. This raises the question of how to retain these talents and perhaps even attract skilled workers from abroad. In order to maximize what are scarce resources, suggestions were made to bring regions together and develop joint collaborative projects. Above all, resources must to be channeled into building a capable scientific community. It is hoped that by doing so, many problems can be tackled through the effective use of technological innovation. Technology from abroad must be adapted or even indigenized to local needs and skilled workers need to be educated in how

to utilize them. In the long term, local innovations should be generated.

Developing countries need to build education systems that encourage a child's enthusiasm for science from a young age, through expanding the implementation of ICT and hands-on science in schools. This way, it is hoped, a greater number of scientists will be trained, so that, even if some emigrate, enough remain to support the development of the country. Moreover, a more scientifically literate society will demand more education, over time raising the education level of a country, creating a virtuous circle.

Science and technology are also seen as the answer to many of the fundamental problems of the developing world. Scientific research can lead to more resistant crops, or more reliable electricity sources. Moreover, it can help in the development of stronger independent economies. New sources of feed for poultry have, for example, not only helped in cutting the cost of animal protein, they have also helped in increasing the number of small-scale farmers. Regrettably, these kinds of innovations are too often detached from commercialization and product marketing. Educational institutions must work closely with the private sector to develop ways of commercializing products.
A number of participants stressed the fact that low levels of education are not the only problem that prevents the developing world from building self-sustainable economies. A modernization of the economic management system is essential. Many countries across the developing world still have only rudimentary banking services and cannot deliver loans and/or mortgages. Even such basic purchases as a new car have to be made in cash. Moreover, developing countries are, at present, still too reliant on foreign aid and are thus over-dependent on developed nations. As long as they are not able to generate sufficient national income, they are at risk of collapsing whenever the developed nations have to tighten their belts. Such risks hinder capacity building efforts.

201-G2: Modifying Human Behavior for a Sustainable World

Chair
- **Campbell, Philip**, Editor-in-Chief, Nature, UK

Speakers
- **Bamberger, Yves**, Scientific Advisor of the Chairman and CEO, Electricité de France (EDF), FR
- **Kleiber, Michał**, President, Polish Academy of Sciences, PL
- **Kurokawa, Kiyoshi**, Professor, National Graduate Institute for Policy Studies (GRIPS); Chairman, Health Policy Institute, JP
- **Noser, Ruedi**, National Councilor, Swiss National Parliament, CH
- **Patel, Ketan**, Chief Executive Officer, Greater Pacific Capital, U.K.
- **Staudinger, Ursula**, Vice President and Dean, Jacobs Center on Lifelong Learning and Institutional Development Jacobs University Bremen, DE, DE

In any discussion on long-term sustainability, the need for widespread behavioral change is invariably said to come hand-in-hand with the need for technological innovation.

Some estimates suggest that if a number of simple energy efficiency measures were implemented in every household in the US, total global carbon emissions might drop by as much as 3%. In Japan, following the earthquake and the Fukushima power plant disaster, citizens managed to voluntarily reduce electricity demands by 20%, averting forecasted summer blackouts. Participants examined how behavioral changes can be encouraged in society without the impetus of a catastrophe or a crisis.

Education and raising awareness are obviously important should start with children as young possible. It is important to ensure that the way we educate our children encourages lifelong learning and adaptability to our planet and our rapidly growing understanding of it.

Unfortunately however, at some point, it is important to face the reality must that knowledge and moral stances alone are relatively weak motivators. Looking to behavioral science for advice, we find instead that one known strong characteristic in humans is the tendency towards choosing path of least effort.

Many issues in sustainability are fairly complex, and without clear, evidence-based standards by which to judge different alternatives, only the most dedicated will make the effort to try and figure out what choices are likely to be best. Establishing good, agreed-upon standards that make choices easier is therefore a vitally important task for the scientific community.

In a similar vein, real-time data provision has recently also become popular as a method of encouraging behavior self-modification. For example, instant fuel consumption readings in cars may lead to efficiency gains of as much as 5 or 10%. This works because we are a self-reflective species that cares about its own image and actions. However, one of the dangers of such data provision strategies is that they might have strong initial effects that later decline as the novelty wears off. People who do not gain deep satisfaction in constantly monitoring and micromanaging their gas mileage will sooner or later discover that such monitoring requires real effort and return to their previous driving habits.

It may be more effective to focus on surrounding ourselves with intelligent, suggestive machines that "nudge" us in the direction of more sustainable choices. An example of this might be a washing machine that asks the user when a new load of clothes is inserted whether they need them washed immediately, or whether doing them by the following morning would be acceptable - and then does its own calculations about when and how would be most efficient to run that load (taking into account, for example, peak electricity demand hours). Such a machine could even "get used to" individual user preferences so that eventually even the opening question could be skipped. Additionally, default settings could lead us to the most sustainable option.

A question that inevitably arises, however, is whether we should even be giving people choices at all. Restriction of choice may be useful, but we know from behavioral science that it must be done in such a way that people do not notice that their choices are being restricted lest they balk. Quietly removing the worst options from multiple-choice menus is neither unusual nor inherently evil – suggestive technologies do this all the time – but it does involve surrendering individual agency to the will and ideals of the designers, which for most

people, can be an uneasy concept.

Another unsurprising but nonetheless useful lesson from behavioral science is that we humans also have a tendency to seek paths that are the most hedonistic. Rewards are important. Some creative thought might be well spent, especially by CEOs and leaders, in determining how to make good behavior a naturally pleasant part of our lives.

A crucial wildcard and important factor in behavior change with both positive and negative potential is social media technology. On one hand, the way it connects us and illuminates inequalities, especially between people in developed and developing countries, can engender dissatisfaction and accelerate drives to greater consumerism. On the other hand, it can be a tremendous way of sharing information, stimulating friendly competition between neighbors, and providing a venue for mutual reinforcement of positive behaviors. Social media has even been used to crowd-source innovation, for example in brainstorming ideas to reduce household energy consumption in the months following Fukushima.

One thing is clear – we know some things about behavior of individuals thanks to the social sciences, but we do not yet know enough about how to translate this to groups of individuals. Encouraging (and funding) serious investigation of these issues by the social sciences is something that should be considered alongside investment in physical technologies.

In all of this we must recognize that social norms and situations differ across regions, cultures, and societies. Something that is a clever solution for France, for example, might not work as well in Germany.

13:00 – 14:00 PLENARY SESSION

202: Food and Population

Chair
- **Fahey, John**, Chairman and Chief Executive Officer, National Geographic Society, US

Speakers
- **Beachy, Roger**, Professor, President Emeritus, Washington University in St. Louis; former Director of National Institute of Food and Agriculture (NIFA), US
- **Huang, Sanwen**, Professor, Institute of Vegetables and Flowers, Chinese Academy of Agricultural Sciences, CN
- **Kamar, Margaret**, Minister of Higher Education, Science and Technology, KE
- **Klausener, Alexander**, Member of the Executive Committee and Head of Research, Bayer CropScience A.G., DE
- **Serageldin, Ismail**, Director, Library of Alexandria, EG

John Fahey set the stage by suggesting that food may be the "lynchpin common denominator" that brings together many critical issues today: population, water, habitats, biodiversity, greenhouse gases, pollution, geopolitical power, stability, and health. Of the 7 billion people on the planet, one billion go hungry, while another billion develop lifestyle diseases from eating too much. The population is projected to rise to 9 billion by 2050. To adequately feed this number, food production may need to rise by as much as 70% during the same period - possibly within the constraints of little more area than is currently being used for agricultural production. Only 60% of grain crops are consumed by humans, 35% go to feeding livestock, and 5% are used to make biofuels. Up to 30% of food in western countries goes to waste. Meanwhile, increasing standards of living in the developing world are leading to ever greater demand for meat and other sources of protein. Yield per acre will have to increase, waste and excess must be eliminated, and balance found between desires for diversity and richness of diet with concerns for sustainability of production.

Ismail Serageldin echoed the challenges of population growth and food production and added concerns about the increasing proportion of people buying food instead of growing their own, as well as the role of food insecurity in conflict areas. He listed seven key messages in addressing hunger and food production. The abolition of hunger in the world must be a top priority. Decision makers must be convinced that scientists do have the answers. It is desirable to encourage the proliferation of best practices and empower the poor with knowledge. Markets as a distribution mechanism must be improved by reducing volatility, readdressing subsidies, promoting fair trade, and reducing waste. Evidence-based regulation must be adopted and risk recognized as a reasonable part of adopting new paradigms. Improvements in health are needed with particular attention to mother and child health. R&D throughout the food chains must be promoted including in the aquatic food chains. Also paramount are good governance with transparency and accountability, not just in government but also in NGOs, farmers' associations, and businesses.

Roger Beachy emphasized the global importance of agriculture. He remarked that historically, agricultural knowledge was passed down through families, while new approaches are required to disseminate newer technologies. He praised the successes of genetic engineering in improving crops, stabilizing soils, and reducing dependence on agricultural chemicals. He mentioned other budding technologies such as precision agriculture that are likely to bring further improvements. He also pointed out the importance of agriculture in a country's economic portfolio. The US, for example, anticipates agricultural exports of some US$140 billion in 2011. He pointed out that his country could not have arrived at this point without major past investments in agricultural R & D. He closed by pointing out that advances in knowledge do not lead to innovation unless policy makers put food and agriculture high on policy agendas. He asked why these are not a priority for more governments.

Sanwen Huang suggested that plant breeding should be redefined with genomics. He pointed out that through plant breeding, humans have actually been practicing gene selection for around ten thousand years. The art of modifying the genetics of plants for human benefit has always existed. Genomics, the study of the complete genetic makeup of organisms, is simply a tool to help us do this at a new level. Sequencing genes has come down in cost to the point that it is now possible to sequence the whole genomes of every known variety of a plant (e.g. cucumbers) and by doing so, understand the genetic background of that plant and see exactly what genes humans have selected for over thousands of years (in the case of cucumbers, this turns to be about 700

individual genes). It also gives us unprecedented power to make new, optimized configurations of these genes – a whole new set of crops that will be needed to feed 9 billion people.

Margaret Kamar talked about how science and technological innovation in agriculture are providing solutions for drought in East Africa. This year alone, 12 million people have been left hungry due to drought, and hundreds of thousands have been forced to relocate. The Horn of Africa faces many challenges related to food production, which in turn contribute to conflict, strife, and widespread suffering, but many believe that focused scientific and technological advances in agriculture could make the Horn a greener and more peaceful place. She indicated seven areas where further development is needed: the promotion of dryland crops like sorghum and millet; reform in seed aid and seed policy; assessing and managing climate risks; fertilizer microproduction; conservation agriculture; development of fast, simple, and reliable tests for toxins, especially aflatoxin and micro-irrigation. She called on international partners working in these areas to focus on this kind of science-based aid.

Alexander Klausener reminded the audience of the importance of public investment in R&D in agriculture. He noted that global public investment in agriculture has fallen over the last several decades. At the same time, private sector investments have risen to about one-third of all agricultural R&D. He mentioned that there is much that can be done, but also stressed the importance of investments in the developing world where crop yields sometimes reach only 20% of those in the developed world. GDP growth from agriculture reduces poverty much more than GDP growth in other areas. Yet, there is even more that can be done, including investing in the education of women, food chain partnerships, and microcredit and food aid services. He closed with a call for more R&D investment from both the public and private sectors, and encouraged public-private partnerships to foster the efficient use of resources and sharing of skills.

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

203-A3: Nuclear Technology Prospects

Chair
- **Dowdeswell, Elizabeth**, President and CEO, Council of Canadian Academies, CA

Speakers
- **Cashmore, Roger**, Chairman, United Kingdom Atomic Energy Authority (UKAEA), UK
- **Motojima, Osamu**, Director General, ITER (International Fusion Energy Organization), JP
- **Shahkarami , Amir**, CEO, Exelon Nuclear Partners; Senior Vice President, Exelon Generation, Exelon Corporation, US
- **Yeh, Gong Ping**, Senior Physicist, Fermi National Accelerator Laboratory, US
- **Yokomizo, Hideaki**, Executive Director, Japan Atomic Energy Agency (JAEA), JP

The group, consisting of operators, regulators, and scientists in the field of nuclear power agreed first of all that the disposal of nuclear waste is a concern. Though nuclear waste constitutes only 1% of all fuel waste, disposal problems could potentially hamper the expansion of nuclear power. The oldest nuclear reactors are coming to the end of their livespan, causing rising levels of nuclear waste production. Geological disposal facilities (GDFs) are, for many countries, either not worth the expense or are simply unfeasible. Construction of disposal facilities should begin now, in order to avoid issues in the future.

Currently, with around 400 reactors in the world, there has only been a 3% reduction in greenhouse gases. Various new technologies are being pursued which will improve both the efficiency and capacity of nuclear stations. Experimental processes are being explored in Japan at sites including Tokai. Thorium and smaller reactors are being explored in the United States, but some of these may not be functional for another twenty years or more.

Thorium reactors are an interesting prospect. The half-life of thorium waste is only 100 years and is much smaller than that of conventional reactors. Thorium is abundant in many countries including China, India, Australia, and South Africa, far more so than uranium. One ton of thorium is as powerful as 200 tons of uranium. China will have a thorium reactor in five to ten years. Thus far, the major problem with developing thorium has been a lack of initiative and big-business investment.

Britain's main priority is successful fusion and a report on the subject is expected soon. In Japan, it is hoped the first test fusion reactor will 'demonstrate the scientific and technological feasibility of producing 500 mw of energy' from the process. As it stands, the energy produced this way is still somewhat expensive, but it is hoped that the next stage will result in the production of electricity for the grid. Issues include ensuring the safety of fusion reactors, which can be achieved by using various kinds of steel to prevent irradiation and smaller amounts of fuel.

Other potential advances were also discussed. Small modular reactors look promising, and in fact, have already been used in US naval ships. New cooling technology that bypasses the need for actively pumped coolants is also going to become more popular.

But there are limits to the growth of the nuclear industry. The Fukushima incident will have a direct impact on Japanese funding for nuclear research and development, perhaps reducing the money available for this and refocusing on safety. In the US, the costs of building reactors are extremely high, especially when compared to places like China, and falling demand will possibly affect the rate of construction of power stations there. Efforts also be needed to retrofit power stations in the US to withstand unexpected incidents like the recent Virginia earthquake.

Non-proliferation is also an issue. Uranium poses more of a danger as it is easier to weaponize and transport. Plutonium produced from reactors can also be weaponized. One method to prevent this is by effective storage, either through the traditional process of dry or wet storage, or via reprocessing (there is already an international market in reprocessing catering to German and French needs). Another is the development of fast reactors, such as the experimental Japanese installation in Fukui, which will burn more fuel

more effectively. Proliferation containment needs to involve as many countries as possible, to promote transparency and ensure widespread coverage. Any international safety regime will need to be mediated through national oversight bodies, as international institutions leave much to be desired in terms of access and authority.

The social compatibility of nuclear power was also discussed. In the UK, there has been a shift towards viewing coal as negative and nuclear as a viable alternative. Similarly, local populations have been consulted in the construction of GDFs in Sweden. In France, the members of the public are encouraged to visit power plants. In Germany, however, there is a belief that there are alternatives to nuclear power which are more compatible with local social attitudes.

On the whole, for some, nuclear accidents are no different to normal industrial accidents, whereas others believe that such incidents call for the eradication of all nuclear power. It is important for nuclear power suppliers not to misrepresent the power they supply and compete with other energy sources on an equal footing.

203-B3: Infectious Diseases

Chair

- **Tyrrell, Lorne**, Professor, Dept. of Medical Microbiology and Immunology, Li Ka Shing Institute of Virology, CA

Speakers

- **Herrling, Paul**, Head of Novartis Institutes for Developing World Medical Research, Novartis Pharma AG, CH
- **Nagai, Yoshiyuki**, Director, Center of Research Network for Infectious Diseases (CRNID), RIKEN, JP
- **Ruxrungtham, Kiat**, Associate Dean for Research, Faculty of Medicine, Chulalongkorn University, TH
- **Shahabudin, Sharifah Hapsah**, Vice Chancellor, National University of Malaysia (UKM), MY
- **Were, Miriam**, Co-Founder and Health Specialist, Uzima Foundation, KE
- **Winter, Alan**, President and Chief Executive Officer, Genome British Columbia, CA

The session began with an overview of the challenges in the area of communicable disease. Changes in diseases patterns can be expected as a result of global warming, increasing globalization, over-crowding, emerging zoonotic diseases and also the re-emergence of diseases previously under control. Malaria and tuberculosis (TB) were previously well controlled but are now re-emerging due to drug resistance and the influence of HIV on co-infection. Many of these diseases also create the heaviest burden in countries and social groups of lower economic status. The threat of pandemic diseases remains a serious for people across all countries and socio-economic groups.

Discussions also centered more specifically on issues particular to communicable disease. With regard to HIV, current treatments have now made it possible for individuals to have near-normal life expectancy. Such treatments have also been shown to result in a 96% reduction in HIV infection when used as prophylaxis. However, the cost of anti-retrovirals and laboratory testing for HIV remain high, and there is a lack of knowledge on the part of both patients and doctors for the successful implementation of universal coverage programs. It was, however, noted by a participant that many effective preventative measures are extremely cheap to implement, such as circumcision, anti-microbials and condom use. However, for many developing countries the cost of therapy remains high and therefore access is limited for many.

There is also hope in the area of TB and malarial drug resistance thanks to the development of promising new compounds which could lead to fresh avenues for tackling the diseases. Vaccines have also been developed to cure some of the most deadly diarrheal diseases, such as salmonella, and these have now reached phase 2 trials. Treatments for dengue fever have been difficult to develop due to the absence of older drug classes upon which to build research knowledge. However, it is hoped that new drugs which are effective for treating hepatitis C might provide important leads for the discovery of new agents effective in treating dengue. Despite these promising developments, funding of drug development from conception through to market debut remains a barrier.

Participants also discussed the threat of pandemic disease, and the importance for having plans in place to deal with such situations. In particular, dense sub-populations such as universities should have measures in place to prevent the spread of illnesses such as pandemic influenza. It was also suggested that individuals should increase their personal preparedness for pandemics by having home supplies for measures such as quarantine. A promising area for tackling infectious and pandemic diseases has been the advancement of microbial genomics. Through a range of techniques, it is possible to trace pathogen transmission and origin of outbreak, discover and detect new pathogens, identify targets for drugs, and develop vaccines. Participants emphasized the importance of global links in this area for standardizing genomic analysis and the rapid reporting of disease outbreaks to the WHO.

Collaboration among stakeholders and health care systems for disease control was also discussed as a key issue. Collaboration between NGOs, pharmaceutical companies, governments, and academia is extremely important. Patient advocacy is crucial in order to that policy makers remain committed to their policy decisions. In the case of HIV, many patients are only eligible for cheaper drugs if their CD4 counts fall below a certain level, resulting in worse prognosis than is the case with early intervention. The cost of drugs therefore needs to be lowered, and this is something which might be achieved through preferential pricing according to the GDP of the country. Altered dosing according the actual required dose of individuals based on pharmacogenetic studies is another avenue for reducing treatment costs. Whilst infectious diseases may frequently transverse borders, sharing information and research between countries can be difficult. The establishment of international programs which facilitate exchange through collaborative research centers is important, a good example being Japan's J-GRID program which has 13 collaboration centers across 8 Asian and African countries.

In terms of health care systems, community health approaches based on committees and health workers have made great progress in Africa. Such an approach has had a significant impact on reducing big killers of children such as diarrheal diseases. It has also helped with making progress towards

the achievement of the Millennium Development Goals 4 and 5 which relate to child and maternal health through improved health care access for mothers and children.

203-C3: New Materials

Chair
- **Carty, Arthur**, Research Professor and Executive Director, University of Waterloo Institute for Nanotechnology, CA

Speakers
- **Byrne, Jennifer**, Vice President, Corporate Engineering and Technology, Lockheed Martin Corporation, US
- **Cantor, Brian**, Vice-Chancellor, University of York, UK
- **Chetanachan, Wilaiporn**, Director, CTO Office, The Siam Cement PLC, TH
- **Joris, Pierre**, Chief Scientific & Innovation Officer, Solvay S.A., BE
- **Kramvis, Andreas**, President and Chief Executive Officer, Honeywell Specialty Materials, US
- **Mesot, Joël**, Director, Paul Scherrer Institut (PSI), CH
- **Ushioda, Sukekatsu**, President, National Institute for Materials Science (NIMS), JP

Materials lie at the core of everything, and historically new developments have had a dramatic impact on society. Examples of this are bronze, iron, steel, plastics, and silicon. A question posed to the panel was: are we on the cusp of a new materials revolution? There was some debate as to whether we should see this in terms of an inflection point, or if we should see it more as incremental materials innovation.

New materials and manufacturing processes are under constant development. In the current period of great challenges on a global level, radical innovation is needed in a wide variety of areas. Energy is one area there is a pressing need for new technologies for harvesting, storage and distribution. Nanotechnology is set to play a key role in this area, as well as with other discoveries graphene, composites, and carbon nanotubes. Other notable areas in which call for new materials are construction and transportation.

Discussions followed on how to meet the challenges posed by the need for sustainable health and energy solutions. A sobering fact is that the mathematics of exponential growth and finite resources does not work, and it is important to disconnect consumption from growth. This point led to a discussion on the need to consider multiple strategies in order to solve the exponential growth/resource dilemma. The scarcity of raw materials, such as rare earth elements and the need to find cheaper replacements are factors which are likely to stimulate new areas of research and development. Reduce, Reuse, Recycle! The 3 Rs are needed, but must be implemented along with other initiatives such as design for recycling, more efficient production processes, less raw material input, longer life products, and new economic models that sell or rent functionality instead of the product per se.

The airline engine technology is a sector of industry in which this new economic model may be applied. The automobile sector has also implemented modalities for disassembly, and ISO has set standards for recycling in situ. Implementing changes such as these on a large scale will imply considerable social engineering challenges and require a great deal of planning. Japan is a good example of a country that is implementing the 3Rs on a massive scale and it already put into place stringent regulations on household recycling and the sorting of garbage.

In addition, the commercialization of new materials was discussed, as well as the difficulty in picking “winners”. However, one member of the panel demonstrated that small gains in the right place can lead to huge efficiency gains downstream. For example, the use of a new method of catalysis in crude oil resulted in a 4% increase in useable fuel output, which on a large industrial scale is a very significant production gain. Other examples of new high impact products currently in the pipeline towards commercialization are non-ozone depleting aerosols mew bio-fuels. A key issue raised was that sometimes, the economic viability of new materials is affected by the fact that they compete in the market against alternatives whose costs, such as carbon dioxide emissions, are not all reflected in the market price.

An industry participant brought up commitment to sustainability as a core principle underpinning innovations in improving existing products or process and also in new product development. A central objective should be to use fewer raw materials to produce a better quality product that produces less waste.

The subject of risks to health and the environment from new nanomaterials was discussed extensively. While there are some risk management protocols in place, there is apparently, no holistic regulatory regime in place anywhere. Research with precautionary principles in mind is the current best practice for nanotechnology risk management. However a number of participants suggested that light needs to be shed on the potential nanotech “shadows” well before the commercialization stage.

Finally, the challenges facing those who are teaching on the subject of new materials in science and engineering were discussed extensively. This area poses major issues for universities and colleges as a mix of interdisciplinary skills and knowledge is needed as well as more practical experience via industrial internships. In addition, important social and cultural issues must be navigated for the successful introduction of new materials into the public domain. One university’s slogan sum up the situation well: “We are teaching students to equip them for jobs that do not yet exist, to solve problems that have not been thought of, using technology that has not yet been invented”.

203-D3: New University Models for the 21st Century

Chair
- **Chan, Tony F.**, President, The Hong Kong University of Science and Technology, HK

Speakers
- **Dorfan, Jonathan**, President-elect, Okinawa Institute of Science and Technology, US
- **Inoue, Akihisa**, President, Tohoku University, JP
- **Johnsrud, Linda**, Executive VP, Academic Planning Affairs/Provost, University of Hawaii, US

- **Khakhar, Devang**, Director, Indian Institute of Technology Bombay (IITB), IN
- **Şahin, Muhammed**, Rector, Istanbul Technical University (ITU), TR
- **Schiesser, Fritz**, President, ETH Board - Swiss Federal Institute of Technology (ETH), CH
- **Wintermantel, Margret**, President, German Rector's Conference, DE

The session started with a presentation of university models in Japan and the efforts of the Japanese government to collaborate with international partners to build an exemplary global university.

There was a presentation of the work done by a university in Japan during the reconstruction efforts after the Tohoku earthquake. As a center of knowledge, the university aims to contribute to reconstruction and regeneration efforts in the region and to create a center of excellence for disaster reconstruction. This highlights the important role that universities can play in problem-solving through cross-disciplinary collaboration.

A speaker pointed out that universities can also play an important role in economic development. The EU has implemented new policies to foster greater research in universities. The US has also implemented policies to enhance the academic competiveness of American universities. Rankings have become important to governments and universities, and competition among universities is fierce. However, the speaker warned that rankings can fail to take into account many strengths universities have and some of the transformational work that they are doing. For example, many universities partner with communities to address important challenges and this may not be reflected in rankings.

In countries where resources are limited, universities need to be ready to provide insights on how to move innovation forward. The growth of the service and manufacturing sectors creates a huge demand for college education. It was mentioned that fees alone cannot possibly cover the operating costs of a high quality university. Institutions should therefore seek opportunities for involvement in technology and innovation.

Knowledge and information sharing are very important to the 21st century university model. Universities must be able to keep up with technological and scientific advances while having the freedom and opportunity to develop their own missions. Technical universities must find solutions to address local, national and international problems. This can only be done through innovation and entrepreneurship.

Another speaker stated that excellence depends not only on competition and comparison between universities but on the exchange of ideas and the development of mutually-beneficial partnerships. He also encouraged strategic alliances between companies and research institutes. He identified the establishment of a sustainable campus network as an initiative worth pursuing.

Another speaker emphasized that whereas it is essential for undergraduates to receive a broad education, it is just as important that their talents be identified early in order to provide them with the specialized training and support they need to develop to their fullest potential in the future.

The session addressed the question: can teaching and research be pursued in a balanced way? A participant spoke of current European initiatives to foster partnerships among universities. University graduates must not only be competent in their own subject areas, but must also possess proper job skills and be ready for 'global citizenship'. Lifelong learning and autonomy must also be encouraged. The European University Association (EUA) has been actively monitoring the effects of the economic crisis on university operations, and their findings show that European universities face immense hardships in coping with funding cuts. The recent fee increase in the UK was cited as an example.

A speaker made the point that the session focused excessively on research-oriented universities while neglecting the fact that many universities are either education-oriented, or have diversified systems with specialized missions that distinguish them from major research institutions. He urged participants to reflect on the role of such universities in the development of a future university model.

It was further suggested that new models will need to look further at the changing dynamics of the student population and try to increase access by offering courses through the internet, distance learning or other innovative methods. To do this, it will be incumbent upon universities to sort out their priorities and decide whether their focus will be on the professors or the students. A representative of a university in the developing world expanded on this point by indicating that if universities do not aim to cater to the needs of students and provide them with mentorship, the quality of education will suffer. He argued that the role of universities is not merely to transfer knowledge, but also to build character and foster student-centered leaning environments.

203-E3: Sustaining Oceans

Chair
- **Nepstad, Tore**, Managing Director, Institute of Marine Research (IMR), NO

Speakers
- **Earle, Sylvia**, Explorer-in-Residence, National Geographic Society, US
- **Eggen, Rik**, Deputy Director, Swiss Federal Institute of Aquatic Science and Technology (Eawag), CH
- **Shirayama, Yoshihisa**, Executive Director of Research, Japan Agency for Marine-Earth Science and Technology (JAMSTEC), JP
- **Taylor, Martin**, President and CEO, Ocean Networks Canada (ONC), CA

The concept of sustainability was the focus of the first part of the session. Sustainability is an approach that aims to meet the needs of the present generation without prejudice to ability of future generation to cover their own needs. In this respect, the issue of governance to achieve sustainability was emphasized, and governance must be built on a scientific base.

The world's population will soon reach 9 billion. The human need for marine proteins can only be met by an increase in aquaculture production, and this leads to a need for sustainable fisheries and aquaculture. In this context, is it important to

recognize the different approaches to the sustainable use of the world's oceans. The FAO/SOFIA conference in 2010 stated that 15% of the world's fishery resources are underexploited, 53% are fully exploited and 32% are overexploited or depleted. From a management point of view, this shows that 68% of the world's fishery resources are sustainably harvested. But from an environmentalist point of view, this shows that 85% are overexploited or depleted.

The only way to achieve a balanced approach in this discussion is through science and a focus on the concept of sustainability. The focus must be on conservation for use instead of conservation for protection, leaving little or no room for the harvesting of marine resources. The need for technological development and the use of technology to increase our knowledge of the oceans was highlighted. Submersibles are needed to conduct research and surveys in the deep areas of the oceans. It is important to understand what is down there, and the effect the deep-living organisms have on the marine ecosystem. It is also important to fully understand the effects of geology on marine ecosystems.

The role of rivers as possible pollutants for the oceans was discussed. The erosion, waste and spill water from cities, industry and agriculture obviously have an effect on the oceans. How these various agents affect marine life and the marine habitat is of great importance and we may know too little of the long term effects. Special focus should be put on surveillance of the effects of chemicals. There is a limit to what the oceans can take. Today the same kinds of problems are appearing in the oceans as have appeared in smaller, definitely-not-infinite freshwater systems in the past: pollution saturation, dead zones from algae blooms caused by overflow of nutrients from human habitation, etc. One additional reason for caution is that there are likely to be many ways the oceans can support life on the planet. Chief among these might be oxygen production by phytoplankton. These microscopic organisms are photosynthesizers of the oceans and are responsible for fully half the oxygen present in the Earth's atmosphere. For reasons yet unknown, phytoplankton populations have dropped by half in the last few decades. This may be as worrying as it sounds.

Data-collection and real time monitoring are increasingly important. Establishing permanent stations for the monitoring of temperature, salinity, nutrition factors and ph will be needed. Is important to secure and increase oceanographic data collection by establishing networks and using drifting buoys. Such networks should be established as international networks sharing data and information. The model used in Canada may be worth developing further. Fixed cable networks together with moored and drifting buoys may be a model for the future.

It is a complex task to understand the various physical and chemical cycles of the oceans - to say nothing of how those cycles affect the individual living creatures in them. A complete understanding of these dynamics will involve solving a complex systems problem so enormous that even if we had a comprehensive model, we might not have a computer powerful enough to run it.

To begin addressing this lack of knowledge, one key is developing technologies for studying the oceans. For example, in some areas, fixed ocean cable monitoring systems allow for the continuous measurement of sizeable sections of ocean using a suite of instruments over long periods of time. Complementing this are web 2.0 platforms and freely available data streams enabling international collaborative science. Establishing more such fixed and mobile monitoring systems is imperative.

The oceans cover 71% of the Earth's surface and house 97% of its biosphere. Yet there are estimates that only 10% of its species are known. Some 95% of the ocean lies unexplored. Moreover, with regard to the species that are known, very often little or nothing is known of their historical numbers. This is true even for the largest and most easily tracked species. How many whales were there 50 years ago? 500 years ago? 5000 years ago? What about herring? It is hard to judge whether present situations are good or bad when we do not know what the baselines are, or where tipping points might be.

During the discussion, the participants agreed that it is only through science, and an increased effort from all nations, that we can secure sustainable oceans for future generations. Throughout the world there are several organizations that bring together scientists, for example, the International Council for the Exploration of the Seas (ICES). This is a scientific organization, working in the Atlantic, with affiliate member states from South-America and Oceania. It is a politically independent organization. ICES may work as a model for other similar politically and economically independent organizations for science and scientists. The session concluded that there is a need for such organizations and governments should be asked to establish them.

The session also agreed that there is a need for more effort and resources in marine science throughout the world, and the UN should be asked to play a role. The need was emphasized to investigate the depths of the oceans and conduct survey-programs for ocean floor mapping.

Finally the session expressed the hope that the issue of oceans and most of all, sustaining oceans should be placed higher on the international agenda, since the world is totally dependent on healthy sustainable oceans.

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

Chair

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

Speakers

- **Arteaga, Rosalïa**, President, Fundacion FIDAL, EC
- **Burkhardt-Holm, Patricia**, Head of Man-Society-Environment Program, University of Basel, CH
- **Watanabe, Tsugihiro**, Deputy Director-General, Professor, Research Depart. Research Inst. for Humanity and Nature (RIHN), JP
- **Zehnder, Alexande**r, Scientific Director, Alberta Water Research Institute; Alberta Innovates – Energy and Environment Solutions (EES), CH

Climate change is one of the major challenges we face today. Although the extent of it in the future remains uncertain, small changes in temperature have already caused substantial damage. As recently as 2007, the scientific community spoke of mitigating climate change, but it soon became apparent that any kind of countermeasure would take decades to deploy – and many more decades for any impact to become noticeable. Consequently, the emphasis has shifted to adapting to environmental change, rather than trying to stop it from happening.

The session primarily concentrated on sharing of real life case studies of successful adaption. The session opened with the story of Venice's battle with ocean. The city has seen occasional floods for over 400 years, but the great flood of 1966 caused real concern about its future. Venice is now investing €4.7 billion in anti-flood protection. A newly installed barrier was lauded as a first great step forward in adaptive systems in dealing with climate change. Its effectiveness has, however, come into question with new findings concerning the potential rise in sea level. Should the findings of recent research be accurate, the barrier will be too low. Nevertheless, Venice is an excellent case of collaborative local work. Environmental protection groups voiced worries that a barrier could damage the ecology of the lagoon. Local government agreed to carry out an impact assessment every 5 years. Similarly, when local fishermen expressed concerns about being unable to exit the lagoon, the platoon barrier was fitted with a lock.

Another speaker from another country reported large decreases of up to 60% in fish catches in the last 20 years. By bringing together organizations, both public and private, in a knowledge action network, research into the cause of the rapid decline was funded and 70 research projects over a span of 8 years were carried out. River water temperature has increased between 0.7 and 1.1°C over the last 40 years. The native stock of salmon has suffered considerably. During a hot summer, growth ceases, but with the seasons changing, fry have trouble developing. The knowledge action network stepped in and has worked to restore rivers across many communities in Switzerland. Riverbeds were planted with more vegetation to offer shade in hot summers. Attempts are being made to reeducate local citizens, turning them into 'river watchers' – who report back to local government or even initiate restoration projects themselves. The year the project came to a close, a new water protection law was passed as a consequence of the project. It was so successful that it has spawned similar projects in Belgium and the UK.

In another example of local action in adapting to climate change, the city of Alberta, located in the great plains of Canada, is tackling issues of fresh water. Alberta is semi arid, similar to Israel. The water from rivers coming down from the Rocky Mountains is the only source of fresh water for an area with a population of around one million. This water only flows when the snow on the mountains melts. The agricultural produce of the area is very important – for example, most of the hard wheat used for pasta in Canada comes from Alberta. The climate is now very varied, with draught periods lasting as long as several years. With climate change, these draughts have become even more unpredictable and require drought management plans.

One speaker stressed the challenges of changing habits that contribute to climate change. In the case of the countries surrounding the Amazonian rainforest, limiting environmental damage is a difficult task. The economies of these countries rely heavily on the natural resources of the Amazon. Any kind of reduction in extraction of these resources will have substantial impact on the short-term wellbeing of the people of the region. The speaker emphasized that problems need to be understood in their local context and to solve them, we must talk of them in a 'global' context – a balance between the global and the local.

In conclusion, while mitigating environmental damage is crucial, adaption to climate change requires locally appropriate solutions. As it is still unclear to what extent the climate will change, local areas need to be ready to constantly readapt to changing parameters. It was hoped that future STS *forum*s will explore these problems further.

203-G3: Science and Technology Diplomacy and International Collaboration

Chair
- **Lim, Chuan Poh**, Chairman, A*STAR, SG

Speakers
- **Bates, William C.**, Chief of Staff, Council on Competitiveness; Executive Director, Global Federation of Competitiveness Councils, US
- **Mazur, Eric**, Dean of Applied Physics, Harvard University, US
- **Thinaphong, Somchet**, Chairman, Executive Board, Geo-informatics and Space Technology Development Agency (Public Organization) (GISTDA), TH
- **Watanabe, Kazuo**, Ambassador for Science and Technology Cooperation (MOFA), JP

Participants decided to start by offering formal definitions of diplomacy and collaboration. Diplomacy: the practice of conducting negotiations and other relations between nations. Collaboration: working together to achieve a common goal. They continued by defining how science and technology play a key role in international diplomacy, emphasizing their benefits, and proposed mechanisms to foster better relationships.

Questions were raised on the wording of the title of this session since diplomatic objectives often appear to be at odds with those of scientists. Nevertheless, both parties can gain considerably from the other.

The Global Federation of Competitiveness Councils (GFCC), a diplomatic organization formed by industry leaders from around the world, maintains that global economic growth is not a zero- sum proposition. The organization promoted the idea that the pursuit of self interest by nations is beneficial to the global economy as a whole. The GFCC recently compiled a list of guiding principles, which it hopes, will aid policymakers in strengthening national competitiveness, fostering innovation, and stimulating economic growth both globally and within their own countries. Working through international bodies such as the GFCC is a form of diplomacy which effectively strengthens international and industrial ties.

Challenges like global warming require the global community to take joint action. A common understanding of the science involved is fundamental to the development of the global

framework needed to tackle the challenge. An exchange between scientists and engineers will help countries develop energy plans that will ensure a cleaner and more sustainable future.

Participants remarked on the importance of educating scientists - providing them with international cross-cultural experiences, and language skills. The Fullbright scholarship program, for example, promotes 'peace and understandings through international exchange' – and has an impressive record of Pulitzer and Nobel prize winners, a testimony to the success of this approach. There are many other similar programs and it is important to ensure that these continue to receive funding.

Participants expressed a desire to see more scientists doing diplomatic work and/or educating diplomats about the sciences. Scientific and technology diplomacy was considered easier than diplomacy per se as fewer political considerations are involved. One diplomat expressed the view that "a scientist can do the work of a diplomat, but a diplomat cannot do the work of a scientist". Another commented "we all like the idea of scientists as politicians, but nobody has any great ideas on how to make that happen." The UK has established a program by which scientists and members of parliament shadow one another for a week.

Even when diplomacy cannot prevail and international conflict breaks out, scientific collaboration has sometimes been able to transcend the tension. Scientific cooperation arises spontaneously from the common ground inherent in the scientific pursuit. For example in the 1960s, political strain prevailed between Egypt and Germany and yet "scientific discussions actually continued".

Iranian diplomats and other top officials were cited as a present day example of how science diplomacy can continue despite a tense political environment. Meetings are routinely held in which clear intentions are expressed of creating multinational, jointly funded projects, often involving the public and private sectors.

The creation of the Egypt Japan University of Science and Technology (EJUST), proved highly beneficial to the diplomatic ties between the two nations. This fostered scientific collaboration between Egypt and Japan and helped provide training to Egypt on how to improve higher education for its citizens.

There are many motivating factors for international science and technology collaboration. This can be bottom-up, starting with scientists, or top-down starting with policymakers. Diplomats must ensure that they are taking the right steps to foster international scientific collaboration. Closing remarks on best practices placed importance on student mobility, public/private partnerships, proper funding, a scientifically educated general public, interaction between politicians and scientists, and a scientific presence at embassy locations.

16:50-18:00 PLENARY SESSIONS

204: What Future Information Communication Technologies will Transform Economic Activities and Other Aspects of Society?

Chair
- **Onwurah, Chinyelu**, Her Majesty's Loyal Opposition Spokesperson on Innovation and Science, UK

Speakers
- **Curran, Thomas Aidan**, Chief Technology Officer, Product and Innovation, Deutsche Telecom, IE
- **Gannes, Stuart**, CEO, XVD Technology Holdings, US
- **Higashi, Tetsuro**, Chairman, Tokyo Electron Limited, JP
- **Schlichting, Richard**, Executive Director, Software Systems, AT&T Labs Research, US
- **Wei, Xin**, Chairman of Peking University Founder Group, CN

Chinyelu Onwurah started by thanking the STS *forum*. She quoted Neils Bohr who said 'prediction is very difficult, particularly about the future'. Having spent 20 years as an electrical engineer, she has seen firsthand its 'huge economic and social impact'. Two billion people regularly use the internet 'and four billion would like to'. Innovation in ICT is at the heart of combating climate change and managing population growth. It also raises issues of trust (through online shops), privacy (twitter), liberty (online political activism) among others. We must ensure that 'as far as possible our fellow citizens are prepared for the ICT changes to come'.

Tetsuro Higashi started by discussing the impact of ICT in the aftermath of the Tohoku earthquake, during which is was vital to maintaining the 'social infrastructure'. The internet and social media enabled people locate loved ones, find material assistance and emotional support, and evaluate local conditions in real time. The post-Fukushima setsuden campaign of limiting electricity consumption was popularized by real-time online updates. ICT not only connected people, but did so more effectively than television or radio. This will continue in the future, and companies must produce low cost and low power products so that ICT can be used 'by all, for the benefit of all'.

Thomas Curran spoke of the dangers posed to privacy and information by cyber-criminals and the lack of internet safety. The high level of connection between people via ICT is creating a 'gigabit society'. This encompasses even the industrial base of the economy, initiating a 'fourth industrial revolution'. It is vital to establish global standards of security, and 'while there is no easy answer to protecting networks, some obvious first steps' are clear. Security-related investments in education, network enablement, transnational agencies, and public private- partnerships will allow us to maintain 'privacy, freedom of speech, and ubiquitous access to the innovations and digital services we know and cherish.

Stuart Gannes stated that the future of communications is always the by-product of invention and circumstance. The Internet itself originated as a military project. And the World Wide Web was invented by a physicist who was focused on information sharing. Today's Internet frontiers are 'rich media' and 'mobility'. In 2011, 14.5 billion unique video streams were shown in the US. By 2012, Internet video will account for 50% of all Internet traffic in the US. Wireless access already exceeds broadband in the US. This is a tremendous change. Mobility, real-time communications, rich media, and feedback are vital influences on the future of ICT. He hoped that we can keep the spirit of inventors alive as their contributions are never fully appreciated at the time they are made.

Xin Wei began by discussing the rapidly developing ICT industries in China. In the future, every aspect of life will be affected by ICT. Radio Frequency Identification will, for example, make our lives 'more automatic', and cloud computing will also have a major impact. Furthermore, it will have a considerable effect on the world economy, increasing productivity and brining 'substantial benefit to consumers'.

During the discussion, it was noted that mobile networks took just 36 hours to recover after the Tohoku earthquake – though in future it may be necessary to construct back-up infrastructure to cope with such events. Also raised was the issue of the impact of the use of rare earth metals. It was argued that it is possible that the efficiency of components made from rare earths could improve, mirroring the development of silicon chips. Lastly, it was pointed out that music distribution and the increasingly electronic nature of communication not only meant these were more accessible, but no longer relied on physical transportation and associated carbon costs. In conclusion, Chinyeku Onwurah warned against seeing ICT as 'magic', but rather as a human creation which is defined by the manner in which it is used.

Tuesday, October 4, 2011

08:30-09:25 PLENARY SESSION

300: Key Messages from Concurrent Sessions

Chair
- **Vest, Charles**, President, National Academy of Engineering (NAE), US

Rapporteurs
- **[A] Yoshikawa, Hiroyuki**, Director-General, CRDS, Japan Sciences and Technology Agency, JP
- **[B] Andersson, Bertil**, President, Nanyang Technological University (NTU), SE
- **[C] Kim, Doh-Yeon**, Chairman, National Science and Technology Commission, KR
- **[D] Bhumiratana, Sakarindr**, President, King Mongkut's University of Technology, Thonburi, (KMUTT), TH
- **[E] Rock, Allan**, President and Vice-Chancellor, University of Ottawa, CA
- **[F] Fox, Marye Anne**, Chancellor, University of California, San Diego (UCSD), US
- **[G] Steinlin, Walter**, President, Commission for Technology and Innovation (CTI), CH

Charles Vest explained that the reports come from the 'core of STS activity', the break-out sessions, and emphasized the 'need to be inclusive' in all the endeavors of the scientific community. He concluded by stressing the importance of education.

Hiroyuki Yoshikawa said that the refining of existing technologies was discussed and that conversations often centered on innovation in science and societal changes. A conceptual shift is taking place in thinking about energy supply, described as a 'fatal limit' to growth. Politics has been the main determining factor in energy supply. This can no longer be so, and we must rely on innovation instead to deal with issues as they arise. Innovation must result from inter-disciplinary cooperation, and to this end, it was suggested that an international grouping of thinkers be established to promote cooperation in the exchange of ideas and action.

Bertil Andersson pointed out that there are persistent inequalities in access to healthcare and in quality of life. However, people are becoming increasingly empowered when it comes to managing their own healthcare, a development which requires education to ensure everyone is suitably informed. Individuals also need to benefit from 'not just personalized medicine but a personalized retirement age.' Genome therapy is progressing rapidly, making personalized medicine a possibility. Access to treatments and private sector funding for research were also discussed. In terms of infectious diseases, the status quo is a 'draw': more public funding must be targeted at less common diseases. The dangers of a pandemic remain a concern.

Doh-Yeon Kim reported that nanotechnology has been the main subject of discussion. In healthcare, cancer treatments and diagnostic tools are areas of rapid progress. Nanotechnology has also played a major part in the sphere of energy supply, with important contributions in improving the performance of photovoltaic cells. 'Materials are civilization itself', and nanotech is at the cutting edge of development. One concern, however, is the lack of raw materials. The dangers of nanotech were also highlighted, particularly from nanoparticles. Failure to pursue research on this may compromise progress in the field and leave room for misinformation.

Sakarindr Bhumiratana said that various methods of research collaboration were discussed, each with its own virtues and specific strengths. Both private companies and governments need to uphold their commitments to funding, while at the same time promoting international cooperation and developing metrics for the measurement of innovation. The issue of attracting young people to the field and realizing their potential was discussed, for example by providing teachers with basic scientific method training. ICT must be integrated into the teacher-learner experience. Universities need to maintain a diversity of research and avoid the 'ranking trap,'while also being clear as to whether the PhDs they award are for research, industry, or teaching.

Allan Rock reported that science alone cannot provide comprehensive solutions to environmental challenges: social sciences are also vital in helping find ways to influence human behavior. Reporting on sessions dealing with water, oceans and forests, he noted that insufficient research has been conducted into water: there are very few graduate programs and degrees on the subject. Among other issues, water is the only commodity not priced by volume of use. It is inefficiently used, especially in agriculture, and is also a geopolitical concern.Oceans are seldom regarded as the complex living organisms they are. A non-governmental international organization should be created to manage oceans as a 'global commons.' Forests are the lungs of the earth, and provide sustenance for vast numbers of people. Both 'top-down' and 'bottom-up' approaches to management should be used, with the former predicated on international agreements and the latter on local projects.

Marye Anne Fox said that over 50% of the world's population lives in cities. Consequently a number of issues are of vital concern such as construction, capacity, and the economic role of towns. Urban areas will need to re-examine interdependencies, and ensure that opportunities are distributed equally across the social spectrum. Energy "is the key to any other thing'. Rational, scientific planning is required. Behavioral changes are important, and if local expertise and global wisdom are combined, and local norms respected, we will all be able to 'live in peace'.

Walter Steinlin stated that media plays an essential role the innovation ecosystem. In "Controlled media" (by professional journalists) a refusal to simplify is a refusal to communicate beyond one's peers. The new "social media" offers huge opportunities in collaboration, with manageable risks, that have to be learned yet by the older 'digital immigrants' Regarding human behavior there was ambiguity between a gloomy outlook which holds the developed and developing economies as responsible for depleting all available reserves, and optimism by which humanity may be able to adapt if people are given the right information. In the multifaceted relationships between science, technology and diplomacy one thing is obvious: student exchanges are one of the central and most sustainable means of promoting understanding between cultures and states.

10.45-11.40 PLENARY SESSION

302: Sustainability for the Future of Humankind

Chair
- **Lee, Y.T.**, President Emeritus, Institute of Atomic and Molecular Sciences, Academia Sinica; Nobel Laureate in Chemistry 1986, Chinese Taipei

Speakers
- **Abe, Shinzo**, former Prime Minister of Japan; Member, House of Representatives, JP
- **Guo, Shuqing**, Chairman and Executive Director, China Construction Bank Corporation, CN
- **McElwee, Charles**, Vice President Programs, ClimateWorks Foundation, US
- **Yargop, Ulhas**, President of IT Sector; Group CTO and Member of the Group Executive Board, Mahindra & Mahindra Limited, IN

Y.T. Lee expressed his concern that things are getting worse in terms of climate change and biodiversity loss, and that if humanity does not change course, it may be too late to avoid catastrophe. There is no more time for procrastination. The two key words for the way forward are “transformation” and “action”. Developed countries must take action to reduce their footprint and examine their development models. We should also see to it that developing countries do not simply imitate the unsustainable patterns of developed countries. And we must find better ways to manage the population explosion and reduce starvation and poverty. We must also refocus science to make the world a better place, instead of simply expanding markets and consumption. Globally, US$1 trillion is spent on defense, while the real threat is human un-sustainability. If we redirected just 1% of this for research on sustainability (US$10 billion), it would go a long way.

Shinzo Abe said that since WWII, science and technology have been the driving force of Japan’s economic miracle, but the 11 March 2011 disasters of have shown that even Japan still faces many challenges. Advanced theories are of no use if they contain threats to society. The exploration of all available options must continue and everyone is concerned. For example in energy technology, further advances are required to make renewables viable, and Nuclear Power Plant (NPP) safety must be improved. Research results and technology solutions must be shared with rest of world. Due to Kyoto’s long history in science and technology, this is an ideal place to discuss these issues.

Shuqing Guo stated that science and technology have made great contributions to economic development, but have also brought uncertainties, contradictions and dilemmas. Although China is encouraged by the world to stimulate domestic consumption, Guo expressed the view that the country is already consuming enormously. For example, it already uses as much as 50% of the global steel, cement, and glass output. What is more, its human ecological footprint is twice what the ecosystem can sustain. Although Chinese foreign exchange assets have increased dramatically to around US$3.2 trillion, the cost of restoring the environment is closer to 10 times that. Chinese multiculturalism and diversity preservation issues were also highlighted as an example for the preservation of the diversity of the wider human culture. Challenges are also posed by the imbalance of development and in how to build up the younger generations. Global economic growth models must be changed. So must global political governance and socio-economic frameworks. Even finance and monetary systems must be restructured.

Ulhas Yargop stated that the focus on sustainability means any decision involves tradeoffs on two levels: self-interest versus the wider human interest and a better present versus a better future. However, people with pressing issues find it difficult to focus on the future. Sustainability requires a level of social equity and education. It can also be the growth engine for companies that adopt it as a strategy. New technologies will emerge to solve sustainability issues. Social media is also making an impact. The Japanese used social media massively to implement the “setsuden” energy conservation effort after the March 11 disaster.

Charles McElwee referred to the 1992 for the Rio earth summit, and deplored the fact that that little progress has been made since. But, he said, it is more important to focus on successes than failures. The Montreal protocol initiated in 1987 on ozone depleting substances is one of these. As a result of it, by 2010 more CO2 had been prevented from entering the atmosphere than under any other international treaty. It was successful because it fully engaged the science, business, and political communities. The key to success was that the science never became political, and there was early buy-in by business and technology communities who were motivated to find solutions. While it is easy to be despondent over lack of progress since 1992, there are successful models that can lead us to hope that when we look back in 20 years time, we will be able to say we have made a difference.

11.45-12:30 CLOSING PLENARY SESSION

303: Science and Society; How do we move forward?

Guest of Honor
H.I.H. Crown Prince of Japan

Chair
- **Holliday, Jr., Charles**, Chairman of the Board, Bank of America Corporation, US

Speakers
- **Komiyama, Hiroshi**, Chairman of the Institute, Mitsubishi Research Institute, Inc.; President, The Engineering Academy of Japan (EAJ), JP
- **Omi, Koji**, Founder and Chairman, Science and Technology in Society (STS) *forum*, JP
- **Roberts, Richard**, Chief Scientific Officer, New England Biolabs Incorporated; Noble Laureate for Physiology of Medicine 1993, UK
- **Serageldin, Ismail**, Director, Library of Alexandria, EG

Charles Holliday welcomed His Imperial Highness to the session and pledged that the world will forget neither the tragic events of the 11th of March, 2011 nor the bravery of the Japanese people in the subsequent days.

His Imperial Highness conveyed his condolences to those who were affected by the Great East Japan Earthquake and thanked the international community for its support. It is very

important that 'lively discussions' were conducted during the STS *forum* on issues such as nuclear power and sustainability – particularly as only six months have passed since the earthquake and subsequent Fukushima nuclear crisis. The breadth of the term 'sustainability' was recognized, and it was important that all aspects had received attention at the conference. His Imperial Highness concluded by saying that he hoped that in future, we would be able to pursue scientific research and progress for the benefit of all mankind.

Charles Holliday emphasized the need for action and suggested that UN goal of doubling renewable energy supplies by 2030 was an important but achievable target. The way forward is to ensure that sufficient numbers of projects are being funded. Collaboration between research institutions, the private and public sectors is also important, as is the choice of partners.

Ismail Serageldin made the comment that, whereas previously knowledge had been compartmentalized, such as in books, contemporary systems like the internet are 'one large interactive vibrant tissue…growing exponentially'. It is impossible to contribute to the common knowledge of humankind. Computational tools will become more integral to research. Scientific method encourages questioning, engagement with contrary views and hails changes in conventional wisdom as paradigm shifts. Yet many of the issues facing us today are social in nature – and consequently, the 'wisdom of the humanities' is essential. It is important to consider what kind of societies we wish to build, and remember that they must be built on ethics. Science should be free to promote civility, discourse, inquiry, and rationality.

Hiroshi Komiyama remarked that in order to resolve the various issues facing the global community, we must look to the progress of scholarship and the 'explosive' increase in knowledge. It is important to avoid the compartmentalization of academic disciplines, which would leave us 'in chaos'. Traditional academic and private sector 'roles' are outmoded and restrictive, and cooperation and the correct structuring of knowledge are crucial. In short, 'vision without action is a daydream and action without vision is a nightmare'. In order to nurture vision, the Platinum Society had been established to encourage action with vision, pursuing various projects in the area of global warming, for example.

Richard Roberts lamented the tendency of political leaders and corporations to distort scientific findings 'unless they fit their political agenda'. Stem cell research, abortion rights, and the politicization of risk are all areas 'where we are losing our reason'. Scientists must 'insist our voices are heard' and 'be clear about our message.' They must also insist that religion be kept in its 'proper' – that is, private – place. The 'worship of money' is also deeply disturbing, as is the fact that some of the same people who have brought about the current financial crisis were helped by some of the most able scientists in the world. Science is truly international and free of boundaries, and is thus an invaluable conduit of international interaction. Politicians should help this process, and not stand in the way of attempts to consume fewer resources, spread wealth more evenly, and use the power of reason to solve global issues.

Koji Omi emphasized the uniqueness of the STS *forum* as a venue for 'deepening ties of friendship' and for the unhindered expression of opinions. Energy and the environment were the central concerns of this year's forum, reflecting our realization that the earth is not infinitely bountiful. From the long-term perspective, however, sustainability will be a very serious issue for the next generation. The world's population will reach 9 billion in due course, and there will be a need for sufficient energy and food supplies. Other issues of vital importance included nanotechnology, nuclear energy, disease control, and supporting research in developing countries. Humanity is also a part of nature, but world political leaders seem uninterested in the fact that we must live in harmony with it. The STS *forum* hopes to influence a change in this in the near future.

Finally, the key point was made about the need for holistic or "systems thinking" approaches to resolve issues like the introduction on non-ozone depleting HFCs that in fact have global warming potential.

The next STS *forum* will be from 7th to 9th October, 2012.

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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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