STS *forum* – Science and Technology in Society *forum*

Sunday October 6, 2013

100 OPENING PLENARY SESSION: "Science and Technology for the Future of Humankind" (10.00h-11.00h)

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

Speakers:

- **Abe**, Shinzo, Prime Minister, Government of Japan, JP
- **Dvorkovich**, Arkady, Deputy Prime Minister, Government of the Russian Federation, RU
- **Nishida**, Atsutoshi, Chairman of the Board of Directors, Toshiba Corporation; Representative Director, Council on Competitiveness-Nippon, JP
- **Hanekom**, Derek, Minister of Science and Technology, ZA
- **McKinnell**, Henry, Chairman and co-Founder, Accordia Global Health Foundation; Chairman of the Board, Moody's Corporation, US

Chairman Koji Omi welcomed participants to the 10th STS *forum* and declared it open. The special program for the 10th anniversary covers major topics that affect all of humanity. Since it began in 2004 with about 400 participants, the STS *forum* has gained recognition, and this year, more than 1000 leaders have come together from over 100 countries. Peer meetings reinforce the conference's role as an important venue for today's leaders to discuss the future of humankind, while looking ahead not just to the next 20 years but towards the next 100. Participants should discuss these issues not simply as representatives of their organizations, but as human beings concerned about future generations.

Shinzo Abe offered congratulations on STS *forum*'s 10th anniversary. The Fukushima nuclear disaster and its aftermath have taught Japan a "bitter lesson." Japan welcomes the most advanced knowledge, expertise and assistance from around the world. Such help can work reciprocally. Japan's leadership in emissions reduction technologies can be shared to achieve dramatic reductions in greenhouse gas emissions. The Japanese government is coordinating US$110bn in investment over the next five years to spread innovations among developing nations. It is also reducing red tape to ensure that new innovations can be implemented quickly. The Okinawa Institute of Science and Technology, Chairman Omi's brainchild, is now attracting scholars and students from around the world. Japan will also play its part through diplomacy, he said, and on that note, Mr. Abe left the conference to fly to Indonesia, where he pledged to discuss this subject further with his APEC colleagues.

Arkady Dvorkovich discussed how energy efficiency has become the guiding principle behind reforms in the Russian economy. The original aim of improving efficiency by 40% by 2020 has been driven off track by the global economic crisis, but efforts continue to make efficiency gains in industrial plants, the power grid and energy consumption. Massive public-private investments are being made in areas like medical services and a major effort to create innovation centers around the country (including the Skolkovo center outside Moscow and the Far Eastern Federal University campus on Russky Island near Vladivostok). Russia is backing up its view that efficiency – in energy and other areas – is the only responsible and competitive way to proceed in the 21st century.

Atsutoshi Nishida recalled how the 20th century economy had benefitted from its singular focus on progress while in the 21st Century, the world faces the "trilemma" of maintaining economic growth, protecting the environment and securing resources. STS *forum* plays a key role in helping foster a harmonious society in which nations, corporations and individuals can all play their part, using collective wisdom to avoid the abuse of natural resources as was the case on Easter Island. Advances in neuroscience, 3D printing and scanning, as well as the use of computers, lasers and robotics can bring huge advances to society. They enable more effective persuasion techniques and can become areas of cooperation among nations.

Derek Hanekom highlighted the interdependence of the modern world and the global scale of the challenges that we face. Nearly 850 million people do not have enough food and demand will double by 2050. Some 1.4 billion people have no access to electricity, but scaling up food and electricity production based on current methods would be unsustainable even if possible. Care must be taken to base decisions on scientific knowledge, avoiding the South African government's past experience of ignoring scientific advice on the HIV/AIDS pandemic and instead looking to how it has since worked with scientists and healthcare professionals to build the largest treatment program in the world today. The multinational collaborative Square Kilometer Array project is a superb example of global scientific cooperation that builds infrastructure and human capital while advancing scientific knowledge.

Henry McKinnell reflected on the past 10 years of the conference. Chairman Omi long ago perceived the essential contradiction of science and technology in the modern world: that the benefits are as large as the problems, that it casts both light and shadows. Over 10 years, STS *forum* has seen 309 sessions and 82 plenary sessions, with participants from more than 100 countries. An estimated 220,000 hours have been spent in plenary and breakout sessions. Participants have discussed, debated and learned from each other – but the list of issues facing the world remains the same. The STS *forum* provides the chance to "learn at the feet of giants" and helps build a world with "less politics in science and more science in politics".

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101 PLENARY SESSION: "Energy and Environment" (11.00h-12.10h)

Chair:
Castell, William, Chairman, Wellcome Trust, UK

Speakers:
- **Al-Falih**, Khalid A., President and Chief Executive Officer Saudi Aramco, SA
- **Uchiyamada**, Takeshi, Chairman of the Board, Toyota Motor Corporation; Vice Chairman of Keidanren **(Japan** Business Federation), JP
- **Chuchottaworn**, Pailin, President, PTT Public Company Limited, TH
- **Matsushima**, Midori, State Minister of Economy, Trade and Industry (METI), JP

William Castell welcomed a panel drawn from a mix of the private and public energy sector. One of the key challenges currently facing the international community is to develop sustainable sources of low-cost energy that are stable and publicly acceptable. The task is expected to become even more exacting as the population grows. Global energy demand is forecast to double by 2050, but increased supply will need to be matched by innovative technologies to ensure that energy production and use is more environment-friendly. A series of geopolitical events over the past four years has disrupted energy supplies. These included the Arab Spring in Libya, the oil well disaster in the Gulf of Mexico and the damage caused to the Fukushima nuclear plant after the Tohoku earthquake in Japan. All of these obstacles should be seen against a backdrop of the need for a dramatic reduction in the global carbon footprint. The latest report from the Intergovernmental Panel on Climate Change (IPCC) has produced compelling scientific evidence that the perils of climate change are accelerating.

Khalid A. Al-Falih described the goal of developing a secure and sustainable supply of energy as one of the world's greatest challenges. But it also opened up 'promising opportunities', he said. Meeting the challenge will require all the ingenuity of the world's scientists and engineers. With the global population expected to increase to 9 billion by 2050, and the economy to expand three or even fourfold, energy requirements will increase substantially in the coming years. The three As – Adequacy, Affordability and Acceptability must lie at the heart of future energy policies. Key to these will be 'game-changing' technologies, many of which are already being developed. No single country can find the solutions on its own, so collaborative research will be crucial within the industry. "The full capacity of the scientific community must be unleashed," said Mr. Al-Falih.

Takeshi Uchiyamada said that the future for more sustainable transportation systems lay in developing the next generation of eco cars. While energy conservation is important, diversification away from oil-powered vehicles is essential, he said. The next generation of vehicles will combine technologies using gaseous and synthetic fuels, biofuels, electricity and hydrogen. However, eco cars can only contribute to the environment if they are widely used. That goal is slowly becoming more attainable. Cumulative sales of Hybrid Vehicles topped 5.6 million in August 2013. The knowledge obtained through the development of Hybrid Vehicles can now be applied to other eco vehicles, said Mr. Uchiyamada. Progress is being made in developing Fuel Cell Vehicles (FCV), which have the potential to become the 'ultimate clean car'. An FCV-R concept car shown at the 2011 Tokyo Motor Show is due to be launched around 2015, with an FC bus planned for market launch in 2016. FCV development will rely on improved infrastructure development, and several hundred hydrogen stations are expected to be opened worldwide by 2050.

Pailin Chuchottaworn observed that access to energy is essential both to economies and to the well-being of people worldwide. The business environment has changed dramatically in recent years, with social media changing the way we live, work and interact. As a result, social acceptance is increasingly important in commerce. However, the general public is losing faith in the energy sector, and especially in large corporations involved in the industry. Describing various social contract initiatives aimed at bolstering public confidence in the energy industry, Mr. Chuchottaworn said more focus is needed on promoting energy literacy. His company has invested in increasing awareness on energy issues through the creation of various learning institutions. Tackling energy illiteracy will be key to forging sustainable energy solutions for the future.

Midori Matsushima said Japan was actively pursuing wide-ranging energy policies in response to the challenge posed by a massive increase in consumer demand. The government is seeking to diversify energy sources, promote energy conservation and develop smart control for energy supply and demand. The use of information technologies is an important tool for smart energy control, she said. Developing renewable energy technologies is a core approach, including solar, geothermal and wind power. As well as research and development, the country is also addressing the issue of pricing in an effort to make energy more widely accessible. Climate change presents one of the most significant global challenges. The target of reducing global greenhouse gas emissions by 50% by 2050 can only be met by developing innovative and practical technologies. International collaboration will play a major role in achieving that goal.

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102 PLENARY SESSION: STS *forum*'s next 10 years, in view of the past 10 years (13:30h-16:10h)

Speaker:

- **Friedman,** Jerome I., Institute Professor and Professor of Physics Emeritus, Massachusetts Institute of Technology (MIT), Nobel Laureate in Physics 1990, US

Jerome Friedman introduced the special session celebrating the 10th anniversary of the STS *forum*, which looked back on key themes of the forum such as innovation and sustainability in terms of both the past and looking at the coming 10 years. Science and technology have generated great things, but they are also responsible for growing and potentially catastrophic threats, such as climate change. The discussions that take place at STS *forum* are needed now more than ever, and will likely become even more important in the future as such threats and challenges continue to intensify.

"Innovation" (13:30h-16:10h)

Chair:
Chubais, Anatoly, Chairman and Chief Executive Officer, OJSC "RUSNANO", RU

Speakers:

- **Fioraso**, Geneviève, Minister of Higher Education and Research, FR
- **Shimomura**, Hakubun, Minister of Education, Culture, Sports, Science and Technology (MEXT), JP
- **Mlynek**, Jürgen, President, Helmholtz Association of German Research Centres, DE
- **Hasegawa,** Yasuchika, President and Chief Executive Officer, Takeda Pharmaceutical Company Limited, Chairman of Keizai Doyukai (Japan Association of Corporate Executives), JP
- **Walport**, Mark, Chief Scientific Adviser to HM Government, Government Office for Science, UK

Anatoly Chubais began the special session on innovation by expressing his admiration for the vision of Chairman Omi in the creation of the STS *forum*. A simple way in which innovation can be defined is to compare it to scientific research: the latter is the conversion of money into knowledge, while the reverse relationship is typically true of innovation. Arguably one of the most important revolutions over the last 10 years has been the explosion of the internet and communication networks, with more people globally connected by telecoms than ever before. Similarly, important strides have been made across almost all areas of science.

Geneviève Fioraso emphasized the strategic importance of innovation for all countries, especially in addressing key economic and social challenges. The latest policy for France in this area is encapsulated in "France Europe 2020: A Strategic Agenda for Research, Technology Transfer and Innovation." It rests on five priorities: identifying key challenges; preserving basic research; stimulating technology research and start-ups; creating cross-links between academia, industry and civil society; and improving education for young people in science and technology. All countries share the same uncertain future without policies to guide innovation, so international collaboration in this area is extremely important.

Hakubun Shimomura emphasized the importance of science and technology for economic growth and societal reform. Japan's successful bid for the 2020 Olympic and Paralympic Games presents an opportunity for sharing new technologies and innovation with the rest of the world, as was the case with bullet train technology following Japan's hosting of the 1964 games. However, Japan also provides an example of the potential dangers of technology to society, as was demonstrated by the accident at the Fukushima nuclear power plant in 2011. He suggested that all stakeholders, including citizens, politicians and scientists, should closely examine science and technology and think about how to deal with its associated risks in order for innovation to continue to drive economic and social development.

Jürgen Mlynek examined some key ingredients for the achievement of innovation. One is creativity, which is central because innovation triggers change. Creativity can be fostered through education, training and early talent management. Another key component is having a “can-do” attitude in which failure is viewed as part of the learning process. Balance between centralized and decentralized structures is also important, with each having sufficient autonomy and clearly defined responsibilities. Such structures should also be flexible and open, promoting multidisciplinary and multidimensional approaches to problem solving. Finally, strong infrastructure for domestic and international research, together with secure financial resources must be prioritized.

Yasuchika Hasegawa began by considering the notion that innovation is not only about scientific breakthroughs, but is also about gradual improvement. In this respect, a key feature is improving the way people come together to work on joint efforts, or organizational innovation. New drug and treatment avenues are crucial for tackling the enormous burden of disease globally. These can be achieved not only through research and investment, but also by getting people in the field to work together more efficiently and using more flexible, novel and global patterns of thinking. Bringing together diverse groups of people with various backgrounds and expertise, together with overcoming the boundaries between various sectors of society are crucial to bringing about innovation.

Mark Walport noted that innovation is the result of both push and pull dynamics, with the push being produced by scientific research generating new ideas, and the pull resulting from unmet market opportunities or social needs. Increasingly in the future, we will be unable to rely on natural resources and we will turn increasingly to science and innovation to provide the foundations for prosperity. Innovation is difficult to achieve through discovery and development alone. Other skills relating to business, manufacturing and branding must also come into play. Initiatives such as public-private partnerships are extremely important, with innovation being as much about cooperation as it is about competition.

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102 PLENARY SESSION: "Sustainability" (13.30h-16.10h)

Chair:
Rinnooy Kan, Alexander, Professor, University of Amsterdam, NL

Speakers:
- **Phalusuk**, Phiraphan, Minister of Science and Technology, TH
- **Kawamura**, Takashi, Chairman, Hitachi, Ltd.; Vice Chairman of Keidanren (Japan Business Federation), JP
- **Cabrero Mendoza**, Enrique, Director General, National Council for Science and Technology (CONACYT), MX

Alexander Rinnooy Kan highlighted the fact that sustainability is one of the main themes for the conference. That is only fitting, he said, since the topic is intimately linked to the issues of energy, the environment, innovation, population, and resources being discussed at the gathering. It is also linked to the theme of several parallel sessions seeking sustainable solutions for the planet. Sustainability is not a new topic for the STS *forum*. But it is one that frequently generates frustration due to the fact that progress continues to be extremely slow. Despite overwhelming scientific evidence that confirms human activities are largely to blame for global warming, a great many climate skeptics continue to exist. One of the most depressing statistics to emerge recently, he said is that the proportion of people who do not believe that climate change is caused by human activities has quadrupled since 1995, increasing from 4 to 19%. The official target for industrialized countries is to reduce greenhouse gas emissions from 1990 levels by 25 to 40% by the year 2020. However, being realistic, it is 'almost certain' that this target will not be met, he said. Science and technology play a highly important role in finding sustainable solutions. Renewable energy is a prime example of a sector where science and technology can feed into private sector innovation.

Phiraphan Phalusuk spoke about the important role played by Science Technology and Innovation (STI) in addressing global challenges, including the rural economy, food production, poverty and climate change, all of which will have a potential impact on future world peace and security. Calling for international cooperation for sustainable development, Mr. Phalusuk said it would be important to pursue a multi-disciplinary approach, combining science and technology, social sciences and the humanities to usher in innovation. In Thailand, where the government is conscious that investment levels in research and development have been too low in the past, targets have been set so as to increase spending on this sector. Mr. Phalusuk outlined plans to develop science and technology education, reform intellectual property management and improve infrastructure for science and technology. One practical example was the creation of science parks in strategic regions of the country, so as to bring science to the community, he said. Thailand recognizes the crucial role that STI will play in fostering sustainable development, he told the meeting.

Takashi Kawamura said that with the global population set to reach 9 billion by the year 2050, it will become imperative to find the 'right symbiotic relationship' with Nature, so that the human race can continue to live on the planet. At a time of increasing natural disasters, it is crucial to understand the contribution that science and technology can make to preventing and managing catastrophes. While the world as a whole is experiencing a massive population explosion, Japan has become the first developed nation to start experiencing a decline in its population and labor force. Here too, science and technology will be key to finding solutions, said Mr. Kawamura. Observing that poverty is likely to increase with global population growth, he stressed that this was an issue linked not only to the availability of food and clean water, but which also had potential repercussions for safety and security. His own company was closely involved in using STI to address poverty issues, he said. Initiatives included research in farm factories -- now producing concrete results for improved food production and harvesting -- work on seawater desalinization and involvement in international pilot tests to monitor crop growth using satellite imagery. Information technology was central to all these initiatives, he said, since it can cross borders and help promote new technological innovation, contributing to solutions for some of the world's most pressing problems.

Enrique Cabrero Mendoza pointed to international experience which underscored the relationship between investing in science and technology and improved sustainable development. In Mexico, the government has shown its commitment to following this path through various instruments. Even though some progress has been made, for example in protecting the ozone layer, many observers claim that issues such as climate change and biodiversity decline are not receiving sufficient attention. The generation and exchange of knowledge is the only way to preserve a fragile planet, said Mr. Cabrero Mendoza. STI can contribute to sustainable solutions. Amongst other things, it can make an important contribution to disaster management, through early warning systems, prevention and recovery. Mexico is involved in developing this approach, through grants, programs and research initiatives and fora, including several related to climate change and biodiversity.

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103- S1 Shale Gas/Oil Revolution (16:40-18:40)

Chair:
Toyoda, Masakazu, Chairman and Chief Executive Officer, The Institute of Energy Economics, JP

Speakers:
- **Pinti**, Daniele, Professor, Universite du Quebec a Montreal (UQAM), CA
- **Tanguy**, Philippe, Vice President, International Scientific Development, Total S.A., FR
- **Yuen**, Anthony, Global Energy Strategist, Citi Research and leads the Gas and Power Team, US

The shale oil/gas revolution is a complex issue of interconnected economic, geopolitical, and environmental concerns. The discussion dwelt largely on the predicted availability and nature of shale gas resources, the environmental impact and the effect on global pricing and the worldwide balance of power.

There are diverging opinions about how much and where shale gas/oil reserves can be found and the economic, technical and political feasibility of exploiting them. Most of the currently known reserves are in traditional reserve areas like the U.S.A, Russia and Argentina. Some participants expressed the opinion that the bulk of the exploitable shale gas/oil reserves will also continue to be found in these areas. However, some were of the opinion that we can expect to find previously untapped resevoirs all over the world. For example, exploration has shown shale gas deposits in China, the EU and Canada.

Even though reserves around the globe exist, it is still too early to say whether extraction will be economically or politically feasible. Decisions about feasibility are further complicated by the difficulty of accurately predicting the lifecycle and future flow rate of a shale gas field.

The potential shale gas fields found in China and Australia are far from sources of water, essential to the hydraulic fracturing process. However, as new fracturing techniques are developed, this may cease to be an issue. Additionally, in regions which up till now had no history of hydrocarbon exploitation there is none of the necessary infrastructure in place, which may prove to make the extraction and transportation infeasible. It is also often difficult to gain the license for fracturing due to public environmental concerns.

Some worry that in this initial “gold rush” period, regulatory frameworks won’t be developed fast enough to protect the environment. Countries with a history of natural resource exploitation need new laws that take into account the new environmental problems posed by hydraulic fracturing: primarily groundwater pollution, fugitive emissions and used water decontamination and disposal. Countries new to production need instruction about how to proceed in an environmentally responsible manner. For the most part the panel shared the view that while the concerns about the environmental impact are justified, the question of how and if to proceed needs to be posed in the context of comparison to currently available energy sources. Shale development requires large amounts of fresh water, but not as much as other fossil fuels, because natural gas does not require intensive processing. While there have been issues with leakage and groundwater pollution in the past, these were because producers did not follow currently accepted best practices. For example, in the past the USA didn’t require well casings for drillings, but since they became mandatory, fugitive emissions have been greatly reduced. The effort to create effective environmental regulatory regimes is complicated by a lack of research focusing on unexploited areas so that acceptable baselines for methane levels can be created. The industry largely agrees with studies that have shown cases of flammable water to be naturally occurring, and not caused by fracturing activity.

It was generally agreed that natural gas can be seen as a low-carbon-footprint transitional energy, as part of a mix of resources focused on reducing CO2 emissions.

The expansion of hydraulic fracturing activities in the USA and around the world is expected to lead to shifts in the geopolitical power balance as well as changes in the pricing of fossil fuels. As production increases, the price of natural gas should decrease and availability should rise. If countries like the USA are able to begin exporting large amounts of natural gas, as the current focus on building infrastructure for exporting indicates, it should increase competition, lowering the prices of not just natural gas, but other energy sources. This would affect global trade flows, creating new importing options for countries. It would lessen the negotiating power of exporters and give importers more leverage, leading to a shift of political power around the world. It is also hoped by many participants that such a shift of global power would serve to alleviate the current “Asian premium”, or the additional costs imposed on Asian nations for energy imports. Currently, Asian nations on average pay around two to three times the price for energy enjoyed in the USA and Europe.

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103-S2: Energy Efficiency (16:40h-18.40h)

Chair:
Bamberger, Yves, Scientific advisor of the Chairman and Chief Executive Officer, Electricité de France (EDF), FR

Speakers:
- **Yamanishi,** Kenichiro, President & CEO, Mitsubishi Electric Corporation, JP
- **Çakıroğlu**, Levent, CEO, Arçelik A.Ş, TR
- **Kasagi**, Nobuhide, Professor Emeritus, University of Tokyo; Principal Fellow, Japan Science and Technology Agency (JST), JP
- **McDougall**, John, President, National Research Council (NRC) Canada, CN

As the world population continues to grow, energy consumption is increasing at a significant rate. Consumption levels exceed population growth and the global demand for energy is predicted to increase dramatically due to economic and population growth, particularly in developing countries. There are still millions of people without access to electricity, so the issue of how to reduce society's carbon footprint is one of major significance. There is a high level of awareness of the urgent need to reduce society's reliance on fossil fuels, but in order to tackle the issue of growing energy demand, the ultimate goal needs to be defined. One participant asked: "do we want to reduce CO2 emissions, primary energy or the total cost?" Each would have different consequences, so it is important to be precise when defining energy efficiency.

Energy efficiency impacts three main areas: energy bills at the consumer level, national energy bills and finally, carbon emissions and the environment. The importance of pursuing energy efficiency is clear: high levels of energy losses mean that there is substantial potential for savings, especially in the sectors of housing, other buildings and transport. According to the International Energy Agency (IEA), the largest contribution to the reduction of CO2 emissions comes from energy efficiency. Urban areas have great potential due to technologies such as solar power, insulation and energy management systems. Transport also has potential, with the rise in electric vehicles and the use of carbon fibers in transportation systems. Integrating efficient building and transportation systems would be an effective solution to energy losses. However, existing infrastructure in such areas can be expensive to replace.

Consumers are the greatest users of energy. A recurrent theme in the discussion was homes, and particularly appliances, which are significant sources of energy use. Participants discussed how small changes at the individual level can reduce overall energy consumption. Advances in technology can lead to more energy-efficient products. However, a sustainable society does not only need energy-saving technologies, based on efficiency and consumer needs. It is also important to popularize them. If attitudes change, small efforts can lead to large improvements. Examples provided included switching refrigerators to energy-efficient models and the use of cold water washing machines. One participant noted that Japan is an energy-efficient society and could serve as a model for other countries. Even so, overall efficiency in the country is less than 40%. Another speaker noted that Japan is energy-efficient in public transportation, especially in urban areas, but less so in housing.

With simple innovations such as the use of solar curtains, immediate solutions are available for households. One participant commented that in Europe, there are many buildings that were constructed during the 1970s and 1980s, with little attention paid to insulation. Changing or replacing such buildings is expensive. It was suggested that priorities should include mobilizing and guiding scientists in creating practical solutions and finding ways to encourage capital investment.

Canada has shown some of the greatest improvements in energy efficiency, as rated by the IEA, and this has been partly achieved through a regulatory approach. The Energy Star program has encouraged manufacturers to attribute energy ratings to their appliances, producing effective results. During the period from 1990 to 2005, the number of appliances in use increased by 40%, but total energy consumption declined by 17%. Building codes have been introduced to encourage efficiency and heat recovery and a national energy code has been set up, with the aim of making buildings energy neutral or even energy producers. Fuel efficiency standards have also been introduced, so that by 2025 all new cars in Canada will have considerably improved fuel efficiency, resulting in savings for consumers and a reduction in greenhouse gas emissions. Public policy and regulation may be effective mechanisms for achieving such goals.

In addition to measures for encouraging regulation, other suggestions included redesigning the integrated

economy in order to reduce transportation costs. The challenge is to use less energy and save more energy. Participants noted that many solutions for energy efficiency resulted in more resources being consumed elsewhere. It was also suggested that companies transfer energy efficient technology to developing countries that have growing populations and increasing energy demands. There was an emphasis on consumers benefiting from energy efficiency and on providing incentives for the use of such technologies, for both individuals and companies. If non-renewable energy use were to be taxed at a higher level, carbon emissions might decline. Unfortunately, putting a value on energy is no easy task.

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103-S3: New Developments of iPS cell (16:40h-18:40h)

Chair:
Yamanaka, Shinya, Director, Center for iPS Cell Research and Application (CiRA); Kyoto University, Nobel Laureate in Physiology or Medicine 2012, JP

Speakers:

- **Okano**, Hideyuki, Professor, Department of Physiology, Keio University School of Medicine, JP
- **Stacey**, Glyn, Director, Division of Cell Biology and Imaging, The UK Stem Cell Bank, UK
- **Fellner**, Thomas, Director, Cell and Viral Therapies, Lonza Walkersville, Inc., US
- **Sourdive**, David, Executive Vice President, Cellectis, FR
- **Miyamoto**, Norimasa, Senior Principal Scientist, Biopharmaceutical Assessment Core Function Unit, Eisai Co., Ltd.; Associate Professor, University of Tsukuba, JP
- **Norris**, John, CEO, Health Discovery Corporation (HDC), US
- **Takahashi**, Jun, Professor, Department of Clinical Application, Center for iPS Cell Research and Application (CiRA), Kyoto University, JP

Participants engaged in a lively discussion about potential applications for induced pluripotent stem (iPS) cell research, recent breakthroughs, stem cell banking and the regulatory, technical and economic challenges that currently limit use of this technology.

The iPS cell technology holds exciting promise for generating new approaches to treat diseases and research into the therapeutic potential of iPS cells has made exciting strides over the past seven years. The first applications of iPS cells for macular regeneration of the retina have now been demonstrated. Ongoing research is also being conducted into potential treatments for neurological conditions such as Parkinson's disease and spinal injuries, using non-human primates to create conceptual models. It is anticipated that trials for spinal injury treatment in humans could start in about four years.

Human stem cell derived tissues may also be used as a tool for streamlining regulatory processes such as drug testing, by providing a more accurate and sensitive alternative for testing than animal models. This in turn has the potential to vastly reduce the costs and time needed for drug development, by enabling pharmaceutical companies to discover whether or not a potential new drug might have clinical potential much earlier in the testing process. Currently, 90% of tested drugs ultimately fail to pass all stages of the testing process, with many failing following large investments of time and money.

Applications of iPS cells could lead to major breakthroughs in preemptive and personalized medicine. By deriving iPS cells from the patient in question, existing drugs can be tested on the cells in order to optimize treatment regimes. Furthermore, by aging iPS cells, it may be possible to prognose age-related diseases by identifying cell system degradation.

Stem cells may be utilized autogenically (i.e. derived from a patient for application to that patient), or they may be utilized allogenically (i.e. cultured from donors for less specific application to a wider population). Stem cell banking was discussed by participants as a way in which large numbers of standardized stem cell preparations can be stored and provided for research or, potentially, clinical use. In Europe, a selection of 80-100 donor lines based on certain genetic conditions could be compatible with 75-80% of the population. However, the development of international banks for supplying large numbers of stem cells requires international coordination and careful planning.

Participants also discussed the many challenges that still face iPS cell technology. Certain technical issues need to be addressed in order to reduce barriers to widespread use of iPS cells. Powerful analytical techniques exist for monitoring cells *in vitro* for genetic mutations, or for the presence of contaminants such as viruses. However, many false positives may be generated by such techniques and a certain level of genetic drift is to be expected, since this occurs naturally in an organism's cells. For this reason, sensitivity levels and acceptable detection rates need to be standardized. Generated iPS cells also need to reach a standardized level of safety if their clinical potential is to be realized. This will require better defined terminology, as "good manufacturing practices" may have different meanings in different areas, and do not necessarily equate to safety, but rather imply consistency or reliability.

Regulatory barriers remain a major challenge. Scientific consensus and international coordination will be necessary in order to produce guidance for best practice, but current methods for approving new technologies remain slow and prohibitively expensive. Some participants suggested that regulatory agencies need to be less influenced by dogma in order for new technologies to be given a chance. Otherwise, the bar may be set so high that it can never be reached. Furthermore, although stem cell models for toxicology testing are more sensitive than animal models, regulatory agencies such as the US Food and Drug Administration still do not accept data obtained by these means.

There are significant economic barriers to some potential iPS cell applications. Autogenic use of iPS cells brings advantages such as enabling personalized medicine and a reduced risk of contaminants. However, culturing cells in this way is both time consuming and extremely expensive, as all manufacturing and testing costs are borne by a single individual. Such costs need to be reduced if autogenic uses are to become a clinical reality. Although allogenically derived cells are cheaper, improvements could be made in terms of time and cost effectiveness by using clearly defined quality criteria and cooperation on developing common protocols when producing assays for processes such as drug testing.

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Sunday 6th October 2013 16:40h-18:40h

103 - S4 Recycling Systems and Approaches

Chair:

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

Speakers:

- **Duncan**, Dwight, Special Advisor, Ontario Municipal Employees Retirement System (OMERS), CA
- **Okada**, Masanori, Chairman, JX Nippon Mining & Metals, JP
- **Freyssinet**, Philippe, Deputy Director General, France's National Research Agency (ANR), FR
- **Kleiber**, Michał, President, Polish Academy of Sciences (PAN), PL
- **Dolphin**, David, Chair, Center for Drug Research and Development (CDRD), CA

Recycling was discussed for the first time at this year's STS *forum*. An important but complex issue which continues to present a range of technological and social challenges, recycling requires extensive long-term planning if it is to have an impact on the economy and the environment. A number of OECD countries have made a commitment to recycling at consumer, commercial and industrial levels, with varying degrees of success, the session heard.

In Japan, the so-called 3R approach – Reduce, Reuse and Recycle – is gaining ground, with the introduction of two recent laws on recycling end-of-life vehicles and specific kinds of home appliances, such as televisions, refrigerators, washing machines and air conditioners. The legislation, which requires manufacturers to take back waste products and consumers to bear part of the cost, has proved successful, leading to a recovery rate of more than 80%. A new law, introduced in April 2013, covers smaller appliances such as mobile phones, computers and cameras. However, question marks remain over the effectiveness of the latest legislation due to high costs, the limited quantity of value-bearing materials being recovered, logistical difficulties in sorting and problems of transportation.

In Canada, where household recycling was introduced in the early 1980s, an enduring challenge remains that of finding markets for recycled products. In some cases, the recycling of items such as newsprint may conflict with local industries, such as the pulp and paper sector. Cost – and who pays it – is a major issue, since recycling is generally more expensive than traditional waste disposal. Apportioning responsibility can also prove difficult, especially within government, where several layers of administration may be involved.

Figures show that many European post-industrial societies have made what was described at the meeting as an 'eco-efficient turn' since the mid-1970s, achieving progress in economic growth without consuming raw materials on the same scale. That trend is to be welcomed, said participants, but the urgency of finding innovative ways of improving recycling systems has become even more acute over the past decade. This is due to increases in the price of raw materials, imbalances in material flows caused by globalization and the growing complexity of products being manufactured. However, although it will be crucial to improve the rate of recycling raw materials, a range of important barriers remain. Among these are legal hurdles, which can be significant at national and international level, often due to outdated attitudes based on the notion that waste is worthless.

Waste management and recycling is a social challenge. In countries with abundant natural resources such as Canada, it may require a greater cultural shift to convince consumers to accept recycling and the higher costs and commitment it entails. But the social dimension may also present an opportunity. Several speakers highlighted the scope for increasing awareness of the importance of recycling through education campaigns, especially those targeting young people. Initiatives aimed at teaching schoolchildren to recycle in the home and select recycled and recyclable products when making purchases have created a ripple effect, as young household members apply pressure on their parents to change their waste management practices. One effective French model cited during the discussion was the so-called Michelin Fleet Solution, which enables transportation companies in France to hire truck tires instead of buying them. This has revolutionized the way tires are designed, manufactured and recycled. Another example aimed at promoting recycling is the *Autolib* scheme running in Paris, based on electric cars available for rental from a network of more than 1000 stations. The system enables the control of the entire lifecycle of products, from conception to recycling.

Given the challenges posed by recycling – and the urgent need to develop processes and uptake – investment in research and development is far too low, participants agreed. More research is needed to improve the recycling rates of materials, including improved technologies for sorting and recycling. Programs need to be developed to promote business models, including incentives for industry to engage in forward planning when designing products, so that they can be easily and effectively recycled. The meeting agreed that the 3Rs generally referred to in connection with recycling should in future become the 5Rs. The first addition would be Research, to address the many outstanding technical issues needed if the impact of recycling is to be effective at both economic and environmental levels. The second one is Rethink – helping to foster a social commitment on the part of both industry and consumers to recycle instead of discarding waste, and to plan ahead for the future.

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Sunday October 6, 2013

103 S5 WATER (16.40h-18.40h)

Chair:

- **Kennel**, Charles, Distinguished Professor Emeritus Scripps Institution of Oceanography, US

Speakers

- **Al-Hinai**, Hilal, Secretary General, the Research Council of Oman, OM
- **Eggen**, Rik, Deputy Director, Swiss Federal Institute of Aquatic Science and Technology (Eawag), CH
- **Hüttl**, Reinhard, President, acatech (National Academy of Science and Engineering), DE
- **Kurihara**, Masaru, Fellow, Toray Industries, Inc., JP
- **Oki**, Taikan, Professor, Institute of Industrial Science Tokyo University, JP

This session took a multi-faceted approach to tackle what is a complex issue. Water is the hallmark of organized civilization everywhere around the world. Since the agricultural revolution, it has given rise to sophisticated management systems. But since climate change became an issue, the question of water, its cost, accessibility and purity has become a major problem. Participants heard that in many parts of the world, salt water intrusion is causing major challenges while in others, changing patterns or extreme weather phenomena are disrupting the natural water renewal cycle.

Technology has produced both positive and negative effects on how water is used, produced and managed. In some cases, age-old methods that valued scarce water as a precious resource and managed it in an ingenious sustainable manner have disappeared in favor of mechanisms that have drained it from deep in the underground. This has caused not only loss of agricultural land but also the genetic depletion of species of drought resistant crops.

On the positive side, new technology such as mega-ton water production and desalination systems that rely, for example, on membrane technology, are capable of producing ever cheaper and larger amounts of both drinking quality and agriculture grade water. But these high tech developments do not address more evident issues such as the lack of drinking water in case of disasters such as major floods. “Science has neglected water for a very long time,” one participant pointed out saying that in such situations a bottle of water costs more than the same amount of refined petroleum.

Another area in which technology is being applied to improving water quality is in analyzing chemical and bacterial contamination. These are increasing even in areas as pristine as Switzerland. Some studies suggest millions of people will die or become ill from the increasing number of chemical compounds in the water they drink. Pollutants have been allowed to seep into water over extended periods of time, and this long-term exposure combined with the impact of climate change can have untold consequences on health.

Also under discussion was the fact that large-scale water projects very often impact on more than one country, and can affect a whole region. Participants felt that an integrated approach is needed and that codes, rules and regulations must be put into place to achieve a fair distribution and sharing of the resource. Sustainability rests on three pillars: technological solutions, incentives, and regulations. All three must be addressed for a project to succeed.

Also under discussion was the fact that water projects are often very large scale. This is not appropriate some many societies. One participant pointed out that in some parts of Africa, solutions need to be simple, local, sustainable and culturally sensitive. For example, most often it is women who are responsible for water collection and management. Bringing in a man to provide solutions or suggest changes is not likely to succeed.

Participants agreed that while the "food, water energy nexus is well known" the "water, society and technology nexus" deserves greater attention. Water was described as an 'emotional' not and 'intellectual' issue, and this calls for a far a more multi- and trans-disciplinary approach. Attempting to solve water-related issues with science alone cannot work. Social scientists should be involved from the early days of developing a project rather than be consulted as an afterthought and be treated like "PR people" to sell an idea to the public. An example was cited of a very successful project that had involved social scientists, lawyers, philosophers, economists and community leaders from its inception. It was felt that water raised questions around values and that even a small number of keen advocates could make an initiative work much better than a purely scientific approach.

What is needed is a new interface to help the many actors come together so that scientists, politicians, social scientists and other stakeholders can start working together with mutual respect. Working in a multi-disciplinary way takes more time but is more effective in the long run. A common language must be developed to figure out what is doable in society. Scientists cannot expect others including social scientists, to apply their ideas if they do not match the goals of their interlocutors in their respective disciplines.

In conclusion, the most important message emerging from this session was that the Science and Technology in Society *forum,* by virtue of its very name permits social science to be involved and integrated in scientific efforts to address water related issues.

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Sunday October 6, 2013

103-S6 SMART CITIES (16.40h-18.40h)

Chair:
Harbour, Malcolm, Second Vice-Chairman; Member, Science and Technology Options Assessment (STOA); European Parliament, UK

Speakers:
- **Piou**, Olivier, CEO, Gemalto, FR
- **Schmitt**, Gerhard, Senior Vice-President, Swiss Federal Institute of Technology (ETH) Zurich, CH
- **Ota**, Toshihiko, Mayor of Toyota City, JP
- **Püttgen**, Hans Björn, Director and Energy Systems Management Chair, Energy Center, Swiss Federal Institute of Technology, Lausanne (EPFL), CH
- **Kohno**, Michinaga, Senior Chief Engineer, Hitachi, Ltd., JP
- **Sterken**, Elmer, Rector Magnificus, University of Groningen, NL
- **Koonin**, E. Steven, Director, NYU Center for Urban Science and Progress (CUSP), US

The central theme for this session was the role of data in the creation of a smart city. Data was discussed as a cornerstone to helping city governors make the right decisions. Knowledge derived from data makes it easier for them to respond more quickly to fluctuating patterns, predict how the city might grow and plan accordingly, and also make it more resilient to unpredictable catastrophes. Although successful case studies are still few, plenty of energy is being expended around the world, with many attempts at utilizing data to create more responsive and intelligent systems that allow ground-level policy makers to make the most effective decisions possible. For example, when Hurricane Sandy hit New York in 2012, four days after the storm hit, city governors had no way of telling which parts of the town were still without electricity.

The question of how large data sets can actually be acquired, and how these can be turned into meaningful information, was seen as a major problem. Innovative ideas on data collection were raised. For example, taking swabs of fingerprints in public spaces can help researchers understand the health status of people in a certain neighborhood. But the data is heterogeneous, making it difficult to piece together in a meaningful way. The situation is made more difficult by government reluctance to share extensive data with other parties. As one participant pointed out: “governments fear that the data they have collected could actually be used against the government.”

Lastly, the most pressing issue concerning data collection is the strong concern on the part of the general public that data collection is an infringement of privacy and can potentially be hacked and misused. Although multiple bodies are working on ways to ensure that privacy remains sacrosanct, it was agreed that it is crucial to develop official frameworks, in addition to anonymity systems, outlining what data will be collected and how it will be used. These need to be made public. In addition, educating people in the value of data collection needs to be addressed. Successful case studies should be brought to the public’s attention as part of this process.

There was an in-depth discussion on how to turn data into useful information. While good systems can ease communication between academics and policy makers, the doors have to be kept open between the two. New ways need to be found to overlay and analyze different data sets in order to extract new information. There was debate as to whether data should be open to the public. Data might be powerful and dangerous in the wrong hands, but well intentioned individuals can bring about potentially new and innovative methods of using it.

Most research on smart cities is limited to solving problems of existing cities in the northern hemisphere. But with a predicted 2.5 billion individuals moving from the countryside into cities located in tropical climates, the focus of building the next generation of cities needs to shift to the South. These cities face very different problems to the old towns of Europe and America, so even existing successful systems cannot simply be adapted, but must be rebuilt from scratch. However, as one participant pointed out, cities such as London offer insight into how a city grows organically, and these can be used as valuable reference points in predicting the expansion of urban centers.

No matter how good the data or master plan, data cannot predict everything, one participant observed. Humans are the core of a smart city. However, the way in which they interact with the systems provided can never be fully predicted. The world has seen many city master plans, such as Le Corbusier's *Ville Radieuse*, but when finally realized, these designs are often rejected and the cities become dormitories. This is the challenge that urban planners face: ensuring that a city is not only smart, but is also a place where people want to live. It all comes down to the basic premise of creating a functioning space where people can live happy lives. One idea was that rather than fully planning the city, harmonized cross-national guidelines could be put into place to help architects and engineers make the right decisions to make a building, a city block or even an entire neighborhood 'smarter.' It is at the local level that the greatest success can be seen.

The session concluded that technology is only part of the solution, and that the question of livability needs to be brought more into the focus of the debate on what a smart city should look like. While the overall definition of a smart city was highly contested, one version garnered applause from the crowd: "A smart city achieves the balance between quality of life and the efficiency of services that facilitate health, transport and other areas. This to ensure the realization of the evolution of the city is people, values and culture."

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Sunday October 6, 2013

103 S7 NEW MATERIALS (16.40h-18.40h)

Chair:
- **Nicolais**, Luigi, President, National Research Council (CNR), IT

Speakers:
- **Okumura**, Naoki, President, Japan Aerospace Exploration Agency (JAXA), JP
- **Cheetham**, Anthony K., Treasurer and Vice-President, The Royal Society; Goldsmiths' Professor of Materials Science, University of Cambridge, UK
- **Hosono**, Hideo, Professor, Frontier Research Center & Materials and Structures Laboratory, Tokyo Institute of Technology, JP
- **Richter**, Kobi, Chairman of the Board, Medinol Ltd., IL

New materials promise to help address major global issues in a wide variety of fields such and sustainability, health and science. New materials feature in many aspects of our daily lives, including in batteries, cell phones, solid state lighting, lasers and drug delivery technology. Long-established traditional technologies are also enhanced: one novel combination of calcium and aluminum appears to be able to considerably improve the efficiency of the ammonia-generating Haber-Bosch process. As Prime Minister Abe suggested in the opening plenary, making cars out of carbon fiber instead of steel could dramatically lower their weight, and therefore fuel consumption.

Participants agreed that the possibilities for new materials are endless. It seems that every time something is said to be impossible, for example, conducting polymers, amorphous metals, or even faster superconductors, it is only a matter of time before someone proves it wrong. Some 30 years ago, no one imagined that we would soon discover three new forms of carbon such as buckyballs, carbon nanotubes, and graphene. One participant suggested there may be as many as 10^{150} possible viable combinations of known elements – greater than the number of atoms in the universe.

New materials face many challenges, however. One is that simply developing and testing them is a time consuming and costly process. Participants agreed that more funding for basic research is needed. Another challenge is finding materials with useful properties more efficiently. Participants suggested that making a reliable database of parent materials could be useful and since there may be growing potential in computational analysis to predict promising combinations. Shifting the current focus on rare materials in research to more commonplace abundant elements as parent materials could also be more productive.

The other half of the equation is not so much the discovery of materials but how to turn them into products and get them onto the market. However promising it initially seems, it often takes 25-35 years for a new material to arrive on the market in product form. Experience suggests that what form a successful product will take is hard to predict and it is often completely different from original assumptions. How this process can be speeded up through special incubators or subsidies is the subject of great and continuing interest.

More partnerships between business and academia were strongly encouraged. Industry representatives suggested two impeding factors. One is that IP-sharing with academia is often less like partnership (shared risk, shared rewards) and more like membership in a library where many of the books are irrelevant or turn out to be useless. It was also compared to having little or no influence on the library's acquisitions department - blanket licensing fees that reward not just success but everything. Other obstacles to the profitability of new materials include the time and financial cost of having to go through a separate regulatory approval process for each individual country.

It was proposed that the process should be reversed, with end users suggesting what new materials are needed and researchers supplying them. One speaker called for more in-depth multidisciplinary training. For example, people who know enough about medical biology to understand what materials are needed and have enough knowledge of chemistry and physics to pursue them.

Two industries that were mentioned as particularly ripe for new materials are health and space, and both have benefitted greatly from new materials in the past and present.

The space industry has been the impetus for many new materials, from heat shielding to rocket engines. Using silicon-carbite for mirrors in space telescopes promises to reduce weight by up to 80% (the Hubble's primary mirror weighs 828kg). Further research into rocket materials is needed to address new challenges such as how to shield human beings and equipment from radiation during the two years it would take for a potential Mars mission.

Medicine has many uses for new materials, for example the matrices used to grow new tissue for grafting. Cutting edge technologies include minimally invasive health interventions, such as long-term sensor implants and catheters used to deliver pieces for in-situ valve replacements, reducing the need for open-heart surgery. Materials for these require two challenging properties: biocompatibility (the material mustn't be rejected by the body) and in-body durability (the material mustn't break down too quickly in the body).

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Sunday October 6, 2013 16:40h-18:40h

103-S8 Nanotechnology

Chair:
Arakawa, Yasuhiko, Director of Institute for Nano Quantum Information Electronics; Director of Nanoelectronics Collabor, The University of Tokyo, JP

Speakers:

- **Collard**, Dominique, Research Director at Laboratory for Integrated Micro Mechatronic Systems LIMMS/CNRS-IIS (UMI 2820), FR
- **Kaiserswerth**, Matthias, Director and Vice President, IBM Zurich Research Laboratory,
- **Kono**, Junichiro, Professor, Rice University, JP
- **Sudo**, Akira Executive Vice President, Toshiba Corporation, JP

The session focused on three main themes: the definition of nanotechnology, the history and future of nanotechnology and the negative aspects of this branch of science.

Discussions started with speakers providing varied definitions of nanotechnology. One participant cited a definition from a bank: nanotechnology is a science affecting all areas of daily life, from medicine to Information and Communication Technologies (ITC) and space exploration: nothing significant changes in our daily life, but everything is just a little more intelligent. An audience member stated his belief that nanotechnology was essentially a field of converging and integrative science, such as quantum physics and material sciences. Another speaker commented that the meaning of nanotechnology was becoming less and less clear, to the point that it was meaningless to talk about this technology on its own. To address the issue, it was suggested that the meeting accept a definition from the International Organization for Standardization (ISO). Speakers agreed that nanotechnology was multi-disciplinary, with physicists, chemists, computer scientists and material scientists all involved in the field.

The past achievements of nanotechnology centered on computing and the fusion of nano particles with existing materials. Several speakers noted the advances made in the computer sector: the processing capability of computers has increased by a factor of about 1000 over the past 10 years; processors are so prevalent that there are now “more processors in this room than people”. Other advances include batteries and the development of cellphones, which are now devices providing real economic benefits. Participants outlined other uses of nanotechnology in daily life: Teflon and other modern coatings, such as self-cleaning windows and ship paint that block the growth of organisms on vessel surfaces. Also mentioned was the use of nanotechnology in anti-bacterial materials and in textiles to reduce odors.

Participants agreed that nanotechnology – and its associated disciplines – held out substantial scope for the future. Nanotechnology is expected to help in the development of semi-conductors, which some people believe have already reached their limit in terms of scaling and miniaturization. This technology could also create semi-conductors with higher performance properties and higher densities and lower levels of power consumption. The benefits of quantum devices, developed through Spintronics (the manipulation of the spin of electrons), could lead to devices with greatly improved circuits, boosted energy efficiency and very fast and dense memory capacities. A speaker described the goal of producing high-level calculations without electronics/electricity and advanced Artificial Intelligence (AI) systems. One example was IBM’s *Watson*, the computer that competed on the game show Jeopardy. Nanotechnology could also contribute to the development of next generation lithium-ion batteries. One speaker noted that a consortium of car and battery manufacturers was currently aiming to use lithium-air batteries to power a car for a distance of 500 miles.

Nanotechnology is increasingly important in the field of health sciences. It is helping to sequence DNA at a significantly cheaper and faster rate, as well as aiding drug delivery and improving water filtration. Finally, there was a discussion on the future of carbon nanotubes and graphene. An audience member observed that commercial applications and everyday use of these technologies were not commonplace. However, speakers said there were still great hopes for the technology – carbon nanotubes are very light, strong and are good conductors, while grapheme has excellent high frequency properties. Developmental and manufacturing challenges, such as potential toxicity and difficulties in the scaling up process, are hampering large-scale use.

Negative aspects of nanotechnology include its significant economic costs and the real, or imagined, dangers to human health and the environment. One speaker noted that nanotechnology-related devices are very costly for companies to develop: projects have lower maturity rates and a lack of potential for mass production. Shifting public perceptions of the word 'nano', and of the science itself, are also problematic. In the early stages, 'nano' had positive connotations, with many products such as sunscreen and lipstick using the term. However, 'nano' has since been widely removed, largely because of alleged health concerns. Speakers agreed more effort is needed to educate the public to resolve any misconceptions.

Some participants commented on industry and scientific responses to health concerns. Several laboratories are now implementing methodological safeguards to limit any potential risk from carbon fibers. Scientists are required to make very careful calculations with a focus on the sources rather than measuring the effects on the body. A speaker added that scientists want to make new particles, but do not want to study the effects of the particles on the human body. For this reason, more studies of the health and social implications of nanotechnology would be beneficial for everyone.

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Sunday October 6, 2013

103-S9 Robotics for the Future (16.40h-18.40h)

Chair:
Kleiner, Matthias, Head of Institute of Forming Technology and Lightweight Construction, TU Dortmund University, DE

Speakers:

- **Asama**, Hajime, Professor, Department of Precision Engineering, University of Tokyo, JP
- **Dario**, Paolo, Professor of Biomedical Robotics; Director of the BioRobotics Institute of the Scuola Superiore Sant'Anna, IT
- **Hackwood**, Susan, Executive Director, Professor of Electrical Engineering,California Council on S&T; University of California, Riverside, US
- **Kheddar**, Abderrahmane, Director, CNRS-AIST Joint Robotics Laboratory; French National Center for Scientific Research, FR

This session took stock of the current state of robotics technology and assessed the direction it will be taking in the decades to come. The questions posed to participants included: which overall definition of robotics can experts from different fields agree upon in 2013? What are the main financial, material and technical challenges to making the benefits of robotics available to a growing global population? How does robot technology contribute to human resilience, including disaster response? What robotic innovations are desirable?

One participant pointed out that robotics is a discipline of robotics technology (RT) that allows artificial systems to interact with the physical environment. RT involves system design and integration to achieve a given mission in a given environment. Autonomy, or artificial intelligence, which is the most challenging area of research in robotics, is seen as the means to realize adaptive functionality in robots.

Another participant said robots are machines that resemble humans in their structure and tasks. Robots are designed to perform tasks that are too difficult or too dangerous for humans. But this concept was developed when manufacturing was the main driver of progress. Today, services are the main impetus of economic activity around the world. As human activities are becoming more brain and sensor-centered, robots are being designed to be less mechanically comparable to humans and more intellectually similar. Cyber-physical and embedded systems are emerging as the dominant helpers for human activities.

The two main uses of robotic systems are in industrial and service applications. There was broad consensus that robots will serve an increasingly important role in healthcare fields, such as surgery and physical therapy. "The notion of robots going into medicine is a huge game changer," said one participant. One of the most important areas for robotics applications will be as quality-of-life assistants for the elderly and the disabled. As populations age, the demand will grow for robots that are designed to assist old people. A new generation of robot companions will one day help us in our home, at work and in hospitals.

There has been a revolution in robotics in the past few years, with autonomous robots no longer the primary goal. Instead, robots will be integrated through the web in the future. Fully autonomous robots will not be acceptable to users, because humans "need to be in the loop." Given this, robotics research should emphasis interactive systems. One participant observed that communications are essential to the improvement of robotics, but there is still considerable room for improvement in speech recognition technology.

Robotic innovations that are highly desirable include: simple, safe and non-invasive surgery; human sensory augmentation; neuro-control of robotic devices for human rehabilitation; unmanned locomotion; rescue operations in various disaster scenarios; police and military operations; and robotically-managed homes. One participant sees potential breakthroughs in soft, stretchable electronic circuitry; understanding of human behavior for proactive robotic assistance; intrinsically safe actuators; and cognitive capabilities allowing self-learning from observation or demonstration.

Predictions were made that robots will be designed to combat desertification by reforesting denuded areas, and that others will maintain solar-powered facilities in inhospitable desert regions. Other robots will be made of new materials that will create soft-bodied machines—ideal for the care of the elderly.

In the case of nuclear accidents, such as the one in Fukushima, Japan following the March 2011 earthquake, robots can be designed to do tasks deemed too dangerous for humans, including damage assessment, debris clearing, setting up of instruments, sample taking and decontamination and construction work.

Participants agreed that the robotics community needs to come up with answers to the ethical, legal and social issues posed by the technology as it advances. For example, who will be held responsible when robots cause damage to property or injuries to people? If robotic surgery goes wrong, who will be held liable -- the doctor or the manufacturer? Safety and privacy concerns will grow, along with the increasing connectivity of robots. There are serious questions arising on the ethical, legal, and societal implications of integrating autonomous or self-directing machines into society, but very little has filtered into public policy. A robot law project has been started in the European Union, which is preparing a white paper on regulating robots.

A key challenge in robotics development is lowering the cost in order to make the technology and its benefits more widely available around the world. Collaboration of robotics scientists, neurophysiologists, neuroscientists, cognitive scientists and biologists is crucial to understanding the mechanisms of human adaptive behavior, which will provide insight into how to design adaptive artificial systems.

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STS *forum* – Science and Technology in Society *forum*

Sunday October 6, 2013

103-S10: "Social Innovation for Sustainability" 16:40h-18:40h

Chair:
Mayer, Karl, President, Leibniz Association (WGL), DE

Speakers:

- **Taquet**, Philippe, President, Academy of Sciences of France, FR
- **Boyle**, Paul, Chief Executive, Economic and Social Research Council, UK
- **Crawley**, Edward, President, Skolkovo Institute of Science and Technology, US
- **Diderichsen**, Børge, Vice President, R&D Outreach, Novo Nordisk A/S, DK
- **Wong**, Peter, Chairman, Culture Resources Development Co. Ltd., HK
- **Patel**, Ketan, Chief Executive Officer, Greater Pacific Capital, UK
- **Tamaki**, Rintaro, Deputy Secretary-General, OECD, JP

The concepts and definitions of both "social innovation" and "sustainability" were subjected to interrogation from a diverse range of perspectives during this wide-ranging discussion.

Possible definitions of social innovation include ideas, organizations and strategies to improve the lives of individuals, ensure the cohesion of societies and foster civil society. Understood in these ways, it is through social innovation that scientific knowledge translates into concrete action in specific societal contexts.

In the corporate world, the "Triple Bottom Line" is one such successful social innovation: companies use this concept to measure their performance against financial, social and environmental metrics. This is deployed most successfully when engaging customer, employee and community stakeholders, and involves a critical examination not just of the core business but also the supply chain. Corporations can often find ways to improve access to their products and services among less privileged groups. Examples can be found of companies which have sustained impressive levels of growth while simultaneously boosting their social engagement and reducing the resource intensity of their operations.

Government also has a role to play in social innovation. Policies meant to influence behavior without compulsion (such as warning labels on cigarette packets) may not work effectively. But banning smoking in UK pubs for example also reduced smoking in homes. Where water or waste charges depend on volume, usage of such services has been shown to go down (reflecting the importance of prices in setting incentives for behavior). These examples and others show how regulation can generate changes in individual behavior and in social norms. Often it is in local areas – where policymakers are close to community groups and are empowered to work across departmental silos – where meaningful policy innovation takes place. Good examples of this from Japan include Kitakyushu's "Ecotown Plan" initiative to reduce waste and boost recycling. Also successful is Toyama's "Compact City" initiative to provide convenient services for an aging population in a specific area. Such innovations can later be scaled up to the national level.

The concept of sustainability was considered critically. The Brundtland Commission defined it in 1987 as being a state of affairs or development "that meets the needs of the present without compromising the ability of future generations to meet their own needs." But what level of needs is being met? The needs of today's 7.5 billion people, or the needs of 2050's projected 9 billion? The needs of today's level of urbanization, or the 70% of the population projected to be living in urban areas in 2050? The living standards of the average inhabitant of New York, or those of a person in the slums of Mumbai? It is difficult to create coherent strategies in the absence of such definitions. And how can sustainability be conceptualized in the context of nuclear waste, which will persist on a timescale that far exceeds the length of human civilization to date?

The discussion often revolved around the need for a change in mindset as more important than specific social innovations. Consumers cannot be expected to act ethically or rationally in the economic sense, so influencing their behavior is important, a participant suggested. Happiness in modern culture is often defined in terms of consumption. If the answer to "what makes me happy?" is linked to greater consumption, then consumption will continue to increase indefinitely. Getting people to change the answer to this question would require them to conceptualize themselves and their societies in fundamentally different ways. It would also require changes to the measures by which society defines its success. If metrics such as GDP growth (which is linked to consumption) retain their current status, participants warned that society will continue to strive to maximize the 'wrong' things.

The role of schools and universities in shaping attitudes was central to the discussion. While the question of whether it is possible to teach students to be creative is an open one, it is certainly possible to teach students *not* to be creative, and many universities do. Much analysis of the value of universities at present focuses on the "microeconomic" aspects of their work: the research that is completed, how it can be applied, and the value of the resulting practical applications. Research into Stanford and MIT found that their impact in this area can be measured in the tens of billions of US dollars. But their "macroeconomic" impact (the revenues earned by companies founded by their alumni) was valued at over one trillion US dollars for each institution. It is the extent to which attitudes can be reshaped, more than the specific social innovation initiatives that are implemented as a result, which will ultimately determine humanity's ability to become more sustainable.

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Sunday October 6, 2013

104 Tenth Anniversary Dinner (18:45-21:30)

Chair:
Ishige, Hiroyuki, Chairman and Chief Executive Director, Japan External Trade Organization (JETRO), JP

Speaker:
- **Yamanaka**, Shinya, Director, Center for iPS Cell Research and Application (CiRA), Kyoto University, Nobel Laureate in Physiology or Medicine 2012, JP

Presenter:
Shimomura, Hakubun, Minister of Education, Culture, Sports, Science and Technology (MEXT), JP

Hiroyuki Shige welcomed participants and expressed pleasure at being chairman of the opening dinner and pride in JETRO's continuing support of the STS forum over the past 10 years. He spoke of how Mr. Yamanaka's work has changed the world not only through his research achievements, but also through his management style, breaking down walls and creating pathways for communication across government ministries and laboratories, helping researchers to communicate smoothly with each other.

Shinya Yamanaka started by saying he wasn't going to talk about his Nobel Prize tonight. Instead he wanted to talk about his personal motto: 'VW'. This stands for 'vision' and 'work'. He went on to highlight the important events in his career, demonstrating the role that this mantra has played in his life.

Dr. Yamanaka started his career as a surgeon. During his residency, he saw many patients that medical science could not help. Frustrated by this and feeling that he was a "terrible" surgeon, he decided to become a scientist, dedicating his life to helping those suffering from intractable medical problems. He left for San Francisco to study towards his PhD.

While studying there at the Gladstone Institute, his professor, Robert Mahley, introduced him to the VW philosophy. At that time he was working very hard, but when he asked himself what his vision as a researcher was, he could not find an answer. He resolved to reconnect with his original goal to find cures through science. It was during that period that he was introduced to Embryonic Stem Cells.

After returning to Japan he continued his work on stem cells, but he was not happy. In America he had been surrounded by top-class scientists, supported by excellent staff and working in a sophisticated scientific environment. He no longer had those things and felt that again, he wasn't progressing towards his vision. At the time he was studying mouse ES cells and his colleagues always asked him: "What are you doing? Do you want to be a mouse doctor?" He was on the verge of returning to his career as a surgeon when two important events took plqce. First, Dr. James Thompson derived human ES cells. With these it would be possible to make many different kinds of cells and cure many different types of disease. However, because of the ethical controversy surrounding the issue, he could not use human ES cells in Japan. Second, he was promoted to the Nara Institute of Science and Technology. He now had his own well equipped lab with support staff and the talented, hard-working graduate students he needed. He resolved to make ES-like stem cells directly from human blood and skin cells.

He and his team worked hard and within six years, in 2006, they had created induced pluripotent stem cells, or iPS cells, from mice. In 2007, Dr. Yamanaka and his team duplicated their success with human cells. Self-effacing, the Nobel Laureate attributed much of the credit for the breakthrough to his students and staff who had worked so hard.

The two main applications of iPS cells are in transplants and drug screening and discovery. In the future, patients with heart failure could be treated using a sheet of tissue derived from iPS heart cells instead of having to undergo a complete transplant.

Dr. Yamanaka emphasized that the work is not over, and that as yet, no patients have been helped by stem cell technology. He has established the Center of iPS Cell Research and Application (CiRA) at Kyoto University and another small group of researchers at the Gladstone Institute to continue the work. He remains optimistic that with sustained effort, he will see this technology brought to patients within his lifetime. He spoke of clinical trials for macular degeneration, and procedures like cardiac toxicity testing as applications that will soon be realized, noting that many pharmaceutical companies are already using the technology in testing.

Following Shinya Yamanaka's presentation, there was a brief award ceremony recognizing the loyalty of participants who have attended the forum nine times or more.

Hakubun Shimomura introduced a performance of the Sambaso Marionette Kabuki Dance, noting kabuki's historic role in Japanese culture. He also expressed his eager anticipation of the 2020 Olympic games which as Minister of Education, Culture, Sports, Science and Technology (MEXT), he will oversee.

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STS *forum* – Science and Technology in Society *forum*

Monday October 7, 2013

200 PLENARY SESSION: Information & Communication Technology (08.30h-09.50h)

Chair:
Ito, Joichi, Director Media Laboratory, Massachusetts Institute of Technology (MIT), JP

Speakers:

- **Rake**, Michael, Chairman, British Telecommunications Plc. (BT), UK
- **Marafih,** Nasser, CEO, Ooredoo Group, QA
- **Guo**, Ping, Deputy Chairman of the Board, Huawei Technologies Co., Ltd., CN
- **González Rodríguez**, Francisco, Chairman & CEO, BBVA-Banco Bilbao Vizcaya Argentaria, S.A., ES
- **Shoji**, Tetsuya, Senior Executive Vice President, NTT Communications Corporation, JP
- **Koanantakool**, Thaweesak, President, National Science and Technology Development Agency (NSTDA), TH

Joichi Ito introduced the panel and observed that Information and Communication Technology (ICT) is all encompassing and ubiquitous: to have a plenary about ICT was like having a plenary about electricity. The field has grown from something that was relatively straightforward and closed to an open system that is connected everywhere and is also very complex. As the level of complexity grows, the system becomes harder to control. Security mechanisms are therefore also changing. Security in ICT will operate less like today's firewalls and become more like a robust immune system when dealing with threats. This holistic approach requires collaboration from all operators in the ICT ecosystem.

Michael Rake said ICT was now a basic utility and a major tool in the development of a nation and international trade. In Britain, the provision of efficient high speed broadband is seen as the same as the supply of electricity and gas. Broadband also facilitated a wide range of innovation and efficiency gains. As a country's competitiveness and economic status increasingly relies on innovation from the ICT field, so does the need to protect the systems that aid this growth. Cyber security is therefore a critical issue. National trade agreements of best practice and global norms in cyber security need to be established at both bilateral and multilateral level.

Nasser Marafih spoke of the importance and challenges of mobile technology penetration in the developing world. He said World Bank studies have shown a 10% increase in mobile penetration producing a one to one-and-a-half percent increase in Gross Domestic Product (GDP). However, barriers to mobile technology still exist. More than 2 billion people live below the poverty line, making affordability the biggest issue. Another barrier is access itself. Governments tend to over-regulate and overcharge telecom operators. He said more transparent laws would benefit everyone.

Ping Guo said society was at a new starting point of digitalization, and that further integration of the digital and physical worlds is predictable. The key is to "base the physical world on data and then make it smart". ICT will also shift from resolving simple problems to rebuilding traditional industries. The car industry, for example, is now moving in two key directions: electric and self-driving cars. Both leverage ICT technologies so that they no longer constitute mere support systems, but become a core business system, that will play an important role in allowing businesses to build competencies and market share.

Francisco González Rodríguez spoke about the importance of a synthesis of ICT, in particular in the banking sector. The key to using ICT is to turn knowledge and data on customers into products. Banks must provide simple and transparent services which are available anytime, anywhere and any place, while being fully integrated into existing platforms. This poses a significant challenge, since most ICT-based banking platforms started in the '60s are what he called "spaghetti platforms": aging, inefficient, complex and not integrated. The solution is world class platforms that can connect everything in a seamless way, a shift from place to space that was a "matter of survival".

Tetsuya Shoji spoke about the benefits of ICT and its future in cloud computing. ICT has progressed very far in the past 10 years: a decade ago fixed line transmission data services could only transmit 1.5mb/s, compared to contemporary wireless transmission speeds of 100 mb/s. Cloud computing as a standard is also very significant because of its potential to simultaneously meet global and local demands: the management of everything from email to financial networks from any device in any part of the world is hugely significant. Cloud computing is also driving other benefits, such as decreasing ICT costs through greater scalability and expanding customer choices. However, as the cloud expands it will also become less transparent and concerns about the integrity of the system will increase.

Thaweesak Koanantakool spoke about the increasing importance of ICT and social media in Thailand. The Thai government sees ICT as a key driver, as reflected in its Smart Thailand policy of using ICT to create smart networks, smart government and smart business. Thai people love social media, with Bangkok having the highest number of Facebook users in a single city in the world. Although this technology brings many benefits, great concerns remain. How do the government, industry and society deal with all the stored media? Data remains vulnerable to hackers and the problem is greater for developing countries, where vulnerabilities outpace their capability to protect users. The best approach is international cooperation on internet and cyber security.

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Monday October 7, 2013

201-A1: Challenges and Solutions for Renewable and Transitional Energies (10:20h-12:20h)

Chair:
Pierce, John, Chief Bioscientist, BP plc, USA

Speakers:

- **Kubota**, Takashi, Executive Chairman, Chiyoda Corporation, JP
- **Konagai**, Makoto, Professor, Graduate School of Science and Engineering, Tokyo Institute of Technology, JP
- **Light**, Peter, Director, Global Product Management, Bloom Energy Corporation, US
- **Schmidt**, Thomas, Head of Electrochemistry Laboratory, Paul Scherrer Institute (PSI), CH
- **Zaghib**, Karim, Director, Energy Storage and Conversion, Hydro-Québec Research Institute (IREQ), CA
- **McDonald**, Jim, Principal and Vice-Chancellor, University of Strathclyde in Glasgow, UK
- **Durongkaveroj**, Pichet, Secretary General, National Science Technology Innovation and Policy Office, TH

One panelist began with a key question: What do we want our energy system to look like after current infrastructure reaches the end of its life, e.g. around 2050? Released from restrictions, what could we do? We should start from that goal and work backwards.

The present paradigm was a reasonable response to the circumstances of the mid-20th century. Generators (small, distributed) were less reliable and affordable than people needed; demand had to be aggregated and centralized to provide reliability and cost reduction. Fossil fuels were abundant and cheap; pollution was not a great concern. Nuclear energy was assumed to be an inevitable progression that would provide power "too cheap to measure". A massive grid with centralized power plants made sense.

However, the 21st century faces new challenges with new requirements. Firstly, new energy solutions must be affordable without market manipulation. Secondly, they must be resilient, able to absorb disruptions such as Fukushima and Hurricane Sandy and keep operating. Resilience can be achieved through diversification. Thirdly, they must be personalized. The idea of "average demand" actually describes noone, and obscures a great deal of specific needs at specific times. Responding to power consumers, from data centers to families with electrical cars, to isolated townships in the far north of Canada, in a personalized, appropriate and optimized-to-needs fashion, promises considerable efficiency gains.

Gone is the discussion of whether renewable energies such as solar and wind power are affordable. The new question is what kind of energy system will be built to counter their quirks (e.g. intermittency), make best use of their strengths (e.g. distributed, smaller-scale generation), and meet the energy requirements of the 21st century.

Humanity is unlikely to resist using remaining fossil fuel reserves. Natural gas exploitation will continue to grow, so long as it is economically lucrative. The question to ask is how to make sure we use those fossil fuels most efficiently? Technologies such as solid oxide fuel cells hold great potential, promising efficiencies of 60-70%, reliability at small scale as well as large scale, and deployability in the location where energy is consumed. This technology could work well with a flexible, renewable-based smart grid.

Participants noted that a contrast is often drawn between "bigger is better" and "small is beautiful", but this may be misleading. A physically small technology used by millions can hardly be called unscalable. Perhaps what is needed is small, beautiful and scalable - or an optimized mix of small and big, supported by a flexible, robust grid.

Updating grids that are relics of a different energy past needs to be a priority, not an afterthought. Smarter grids that can address protection and control issues, advanced autonomous systems, energy storage and more are critical. An EU smart grid taskforce formed in 2009 determined that in the next 15-20 years,

Europe will need to spend 550 billion euros to upgrade its grid. Rapid prioritization and clear and coherent policy are required to find investment and begin this task as soon as possible.

Transportation is also a massive problem, and its overhaul will require a coherent vision and concerted effort across a large number of stakeholders. Vehicles, fuels and delivery infrastructure must evolve together. Liquid fuels, such as biofuels, have the home field advantage, able to use existing delivery systems and combustion engines with little or no modification. However, innovations in hydrogen delivery that transport fuel in the form of liquid methylcyclohexane (converted to gas on site at refueling stations) may allow a system of hydrogen fuel cell vehicles to use existing fuel delivery infrastructure as well.

Electrical vehicles should not be discounted. Battery technology has improved considerably over the past 10 years. Advances in lithium-based battery technology, such as lithium-sulphur and lithium-air systems could produce 10 times greater energy density in the future. So rapid is the change in the situation regarding electrical vehicles (for example, vast deployments in the US over the past 12 months, 4000 charging stations built in New York) that one discussion member suggested any report on energy older than 2 years is already obsolete.

Developing countries face the twin challenges of developing energy sources as engines of economic growth and keeping emissions down as members of the global community. Hydropower sources are quickly being exhausted, nuclear energy is taboo and imported energy can often end up accounting for 10% of GDP. Renewable energies could take their place, but they need to be affordable without heavy subsidies.

Finally, the world's poorest billion people still have no access to electricity at all. Renewable energies -- for example, small solar systems with portable batteries that could be charged while students are at school and taken back to remote homesteads -- could demonstrate remarkable adaptability and value in responding to this challenge.

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Monday October 7, 2013

201-B1: Preemptive Medicine 10:20h-12:20h

Chair:
Imura, Hiroo, President, Foundation for Biomedical Research and Innovation (FBRI), JP

Speakers:

- **Iwatsubo**, Takeshi, Professor, University of Tokyo, JP
- **Puente**, Jorge, President, Asia Pacific and Canada Oncology Business Unit, Pfizer Inc, US
- **Es Sabar**, Karimah、President and Chief Executive Officer, The Centre for Drug Research and Development (CDRD), CA
- **Syrota**, Andre, Chairman & CEO, Inserm (National Institute of Health and Medical Research), FR
- **Fidock**, Mark, VP & Head Personalised Healthcare and Biomarker Laboratories, AstraZeneca UK Ltd, UK
- **Hamid**, Eisa Bushra Mohamed, Minister of Science and Communications, SD
- **Ward**, Brian J., Professor, Medicine/Microbiology, Infectious Diseases/Microbiology, McGill University; Medical Officer, Medicago Inc, CA

Participants brought a range of different perspectives to the session, resulting in a fruitful discussion about the potential of preemptive medicine for tackling non-communicable diseases (NCDs), revolutionizing our approaches to medicine and the societal, regulatory and technical challenges facing the field.

Preemptive medicine is concerned with the prediction and treatment of diseases before their clinical presentation. This field has great potential for managing NCDs that typically emerge at middle age and as a result of interactions between genetics and the environment. The “developmental origin of health and disease” hypothesis posits that even the pre-natal and post-natal environment may have a critical influence on early cells, affecting the development of certain NCDs later in life.

It has been suggested that the future of medicine may be represented by the “four Ps” – personalized, predictive, preventive and participatory. Preemptive medicine has the potential to be a paradigm shift for moving healthcare delivery toward being more proactive than reactive. Examples of preemptive medicine already exist. One of the most successful drugs ever developed, for example, is a statin prescribed to patients with high LDL cholesterol, and has resulted in a 50% reduction in incidence of cardiovascular disease in the USA. Dementia, a disorder affecting 36 million people worldwide and responsible for medical and social costs of over $600 billion per year, may be an excellent candidate for interventions implemented during the long pre-clinical stage. PET scans can be used to detect the amyloid deposits that build up during the long period before clinical presentation of Alzheimer’s disease, identifying patients who may benefit from early pharmacological intervention. However, the field of preemptive medicine does not only incorporate higher technology approaches utilizing genomics and drug targets, but also incorporates basic health promotion such as immunization, maternal and child health and improving lifestyle factors such as diet, smoking and exercise. As such, including social science into medical school training may be important, and doctors should be incentivized to provide patients with guidance for making behavioral changes.

Participants also identified challenges and issues that may affect this area moving forward. From a societal perspective, certain ethical issues must be considered. Advances in science are providing patients with ever increasing amounts of information, but patients will need counseling to help them to interpret and respond to this information. This is especially the case when interventions are drastic or potentially harmful, such as mastectomy for patients who may have a genetically higher risk of breast cancer. There is also the question of how much power patients should have in making their own decisions. Another point raised was that of parity. The pursuit of expensive high tech innovations may widen the disparities between the wealthy and the poor. However, basic health promotion should not be overlooked as it is an important component of preemptive medicine. A related point concerning whether or not healthcare systems will pay for screening and interventions was also raised, and it may be necessary to generate faster, less expensive and better coordinated platforms.

From the regulatory perspective, it was suggested that certain changes are required for preemptive medicine to progress more easily. The value of small clinical trials needs to be recognized, and diagnostic tests must be validated. Drug development processes in general may need to change in order to look beyond classical approaches to drug discovery.

A point of disagreement among participants was around the question of whether the current drug development system is appropriate for preventive medicine. Some participants believed the current system was only suited to creating treatments for disease, other participants pointed to statins and vaccination as an example of preventative drug development. Existing regulatory structures may nevertheless pose problems for the development of technological interventions that target currently healthy people.

Finally, technical challenges still remain. Many NCDs have been poorly defined at the molecular level, and progress in this area has been slow. Furthermore, genetic factors of different diseases may vary according to ethnicity, or even according to subtypes of the same disease. Public-private partnerships and collaboration may be very important for tackling this issue. Consideration of other perspectives may also be important for generating new targets for intervention, as, despite the name “non-communicable”, infectious agents often play at least some role in NCDs. Recent research has also demonstrated that the gut microbiome may have important implications for both undernutrition and obesity by affecting rates of calorie extraction, raising the intriguing possibility of novel approaches to this issue that target symbiotic microorganisms.

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Monday October 7, 2013

201-C1: "S&T Diplomacy and International Collaboration" (10:20h-12:20h)

Chair:
Arnon, Ruth, President, Israel Academy of Sciences and Humanities, IL

Speakers:

- **Malone**, David, Rector, United Nations University; Under-Secretary-General, United Nations, CA
- **Harayama**, Yuko, Executive Member, Council for Science and Technology Policy (CSTP), Cabinet Office, JP
- **Grimes**, Robin W., Chief Scientific Adviser, Foreign and Commonwealth Office, UK
- **Wince-Smith**, Deborah, President & CEO, Council on Competitiveness, US
- **Kobayashi**, Makoto, Professor Emeritus, High Energy Accelerator Research Organization (KEK), Nobel Laureate in Physics 2008, JP
- **van den Berg**, Dirk Jan, President, Executive Board, Delft University of Technology, NL

The international nature of modern science is necessarily underpinned by collaboration between states. There are three types of diplomacy related to science and technology: 'Science and Diplomacy', in which scientific advice supports national and foreign policy objectives, 'Diplomacy for Science', in which diplomatic activity facilitates international scientific cooperation, and 'Science for Diplomacy', in which scientific cooperation improves diplomatic relations.

'Science and Diplomacy' will sometimes involve competition and naturally, countries reflect their national interest in their international science policy. This sometimes gives scientists an important bridging role in which they can mediate relations between nations. The problem of 'brain drain' can arise in this context: at the peer meeting for science ministers at this year's STS *forum*, the ministers discussed how to turn this into a win-win 'brain circulation', showing how scientific engagement can reframe a problem into an opportunity.

'Diplomacy for Science' - which often relates to 'Big Science' (large-scale, highly expensive projects such as particle accelerators) - is only possible because of international collaboration. CERN in Geneva, where the Higgs Boson was recently found, can only exist because of diplomatic efforts. The Nobel prizes awarded to researchers at ESRF in Grenoble illustrate another example of science diplomacy enabling state-of-the-art research. Such large projects don't just rely on collaboration, they enable it: the number of large particle accelerators in the world is very small and the teams needed to achieve results are very large, leading to a well-established practice of making facilities available to researchers from around the world. Outside 'Big Science', bilateral initiatives begun between the United States and Eastern European countries in the 1970s or the United States and India in the 1980s seeded research projects and regulatory reforms, the results of which can still be seen today. Multilateral initiatives such as the Intelligent Manufacturing Systems program and other initiatives under the aegis of APEC and NAFTA play similar roles. Diplomatic initiatives in these areas created very fruitful and long-lasting areas of international collaboration and underpinned economic growth and prosperity on a large scale.

'Science for Diplomacy' has a long history. The first British mission to Japan in 1613 presented a telescope (invented just five years earlier) to the *shogun*, who sent two suits of armor back to Britain, the metallurgical composition of which was so advanced, according to the speaker, that the British could not understand how they were made for another 350 years. Scientists often talk to each other when politicians will not: today, the Synchotron-Light for Experimental Science and Applications in the Middle East (SESAME) in Jordan brings Israeli and Iranian researchers together collaboratively. Science can thus open channels of cooperation and communication that may not exist elsewhere.

But there are many challenges, of which money is one. Much international science collaboration is funded by international aid budgets, which have been plummeting. At the same time, many countries tie their budgets to domestic research (and domestic researchers often lobby to keep it that way), inhibiting international funding flows. Happily, some governments (such as the UK and Canada) and foundations such as the Gates Foundation and the Wellcome Trust allocate funding without such restrictions. Another challenge is the language barrier. Communication is crucial but researchers do not always speak English.

Other issues include intellectual property theft, the misuse of dual-use technologies, and cybercrime. These are major problems in the modern world and have major impacts on society and on the scientists working on them. Addressing these problems will require international collaboration on many levels. Often this will require addressing larger tensions between equally admirable goals, such as the protection of intellectual property (which often underpins innovation) considered against the value of lives that may be saved through

sharing it openly (as in the case of antiretroviral drugs used to combat the HIV/AIDS pandemic). Scientists have a role to play in providing warnings about impending issues which will impact policy (such as pandemic disease or climate change). Despite some examples of good collaboration, speakers pointed out that scientists and diplomats need to learn to appreciate how they can be helpful to each other and work better together.

The scientific community has many advantages in diplomatic contexts. Scientific knowledge is non-subjective, fact-based and open to peer review and interdisciplinary approaches. It reaches across community boundaries, both across nations and within them. And it reaches across generations, being tightly bound up in teaching and the transmission of knowledge and values to the young. All this gives scientists a strong foundation for extending and developing international collaboration in the future.

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Monday October 7, 2013

201 D1 OCEANS 10.20h-12.20h

Chair:
Lubchenco, Jane, Distinguished Professor of Zoology and the Wayne and Gladys Valley Professor of Marine Biology, Oregon State University, US

Speakers:

- **Shirayama**, Yoshisha, Executive Director of Research, Japan Agency for Marine-Earth Science and Technology, JP
- **Choi**, Hang Soon, Vice President of Policy, The Korean Academy of Science and Technology, KR
- **Sathyendranath**, Shubha, Head of Remote Sensing and Marine Optics, Plymouth Marine Laboratory, UK
- **Mohri**, Mamoru, Executive Director for the Miraikan (National Museum of Emerging Science and Innovation, JP

This session explored how science and technology can best guide governments, industries, and communities to better manage oceans. As life in oceans is changing in response to the increasing demands on them, emphasis was given to solutions to the challenges to their sustainable use.

Oceans cover 70% of the planet and represent 90% of the Earth's biosphere. Some three billion people depend on the oceans for their primary source of protein. Humanity is dependent on ocean ecosystems for economic and social well-being through activities including recreation, transportation, food, and energy. The oceans provide oxygen, nutrient recycling, carbon storage, and climate regulation. But these benefits are at risk due to global environmental alterations such as acidification, over-fishing, and climate change. An "angry ocean" can wreak havoc that knows no limits as seen with the tsunami that struck Japan.

Global warming threatens the oceans. Despite worldwide efforts to reduce the use of hydrocarbons and develop renewable energy, it is expected that the world will depend on hydrocarbons as the main source of energy until 2030. Some 40% of world oil production comes from offshore oil fields in ultra-deep waters of 1,500 meters or more. As the depth of ocean drilling increases, so do the risks. An example of this is the Deepwater Horizon accident in the Gulf of Mexico in April 2010, which resulted in the world's worst oil spill. The key lesson from this event is the need for greater wisdom in the use of technology to prevent such accidents from happening. In light of this, engineering students must be taught human sciences, particularly ethics, so that they will be aware of the potential impact of engineering designs that are not sufficiently safe. To that end, engineering curricula at university level must follow the ABET Code of Ethics of Engineers.

One participant remarked that more is known about the dark side of the moon than the bottom of the Earth's oceans. So knowledge is crucial if humankind is to be a better guardian of the oceans. Improving ways for scientists to share their knowledge with the public is vital to raise awareness of the importance of the oceans.

An integrated approach to ocean studies is needed. Data from satellites is only two dimensional, but studying the depths is necessary in order to gain an overall understanding of the oceans. An integration of scientific measurements taken from space, the ground, and the oceans themselves will provide a holistic approach to ocean studies. Satellite observations show that the oceans are a single, integrated system. They also show that oceans are oblivious to manmade boundaries. The interconnectivity of the entire earth system becomes more obvious as we study the oceans.

Acidification caused by the burning of fossil fuels is another major threat to that must be put squarely on the table. The ocean's PH levels are decreasing year by year, and this will have a serious impact on coral systems and other sea life. Acidification will be very serious in 50 years time and the outlook for mitigating this is very pessimistic if humanity continues its business-as-usual use of fossil fuels. A cut in CO2 emissions is the only solution.

Oceans are also under threat by over fishing. But good progress is being made in some parts of the world to curb over fishing and rebuild fish stocks with to strong legislation that comes with teeth and timetables. This year the EU has made very difficult and courageous decisions to put in place requirements to end over fishing by member countries. In addition to improved sustainable fishing within national waters there is also the issue of the high seas, which pose a very difficult management problem due to the illegal fishing that occurs on the open ocean. The grand challenge is to transition all the world's fisheries to an industry that is sustainable.

Enhanced capacity for ocean observation is crucial to meet the increasing policy demands and requirements for ocean management. But meeting those requirements is a struggle. Stewardship of the oceans necessitates integrated, multi-disciplinary observation to foster handle sustainable management and to provide improved disaster warning systems. Information is "our weapon" to deal with these problems. "Let's work together to take care of the oceans," concluded a participant.

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Monday October 7, 2013

201-E1 Collaboration among Academia, Industries and Government:

10.20H-12.20H

Chair:

- **McCullough**, Richard, Vice Provost, Harvard University, US

Speakers:

- **Cantor**, Brian, Vice-Chancellor, University of Bradford, UK
- **Courvoisier**, Thierry, President, Swiss Academy of Sciences, CH
- **Hashimoto**, Kazuhito, Professor, University of Tokyo, JP
- **Ponomarev**, Alexey, Vice President, Industrial Cooperation and Public Programs, Skolkovo Institute of Science and Technology, RU
- **Khokhlov**, Alexei , Vice-Rector, Lomonosov Moscow State University, RU
- **Reddy**, Daya, President, South African Science Academy, ZA
- **Akimoto**, Hiroshi, CEO & COO, Intellectual Property Strategy Network, Inc., JP

The session focused on emerging models for funding research in the public and private sectors, the challenges of academia and industry collaboration and the role of government in the regulation and facilitation of research and development. New models of funding have emerged since the 2008 global downturn, which saw a decrease in funds and a greater emphasis on research that produces immediate economic gains. This has resulted in improvements and fractures in the relationship between the three institutions. Finally, there was a discussion on the importance of government in stimulating growth, while restricting regulation.

The first topic of discussion focused on which models could achieve high quality research, balance financial imperatives and promote collaboration between industry and academia. Examples included a recent Singaporean government initiative to tie university research funding to industry endorsement or co-funding: 75% of funds would be provided; however, if there was no industry involvement, the remaining 25% would not be given. Another new model is a master agreement contract, towards which many US universities are starting to move. A master agreement is created for a project and if anyone wants to join the initiative, they have to agree to the terms of the contract – no extra negotiation takes place. One participant spoke of the Life Science Global Business Platform, which is situated close to the Tokyo Station area. The platform provides infrastructure to host industry, government and academia bodies to facilitate a higher level of collaboration in the life sciences and aid the business side of research. Research and development costs for Japanese companies are huge: it takes more than 15 years to launch a new drug and the success rate is only one in 30,000 projects. Another participant suggested a new index for evaluating a researcher's performance in academia. There was too much emphasis on the number of papers published; other measures, such as technology-based innovation, should be explored.

Finally, examples were given of the Russian experience. Russia experienced 15 years of research stagnation, but strong government intervention appears to be stimulating academia and industry through a host of new measures: new management models, consortiums and organizations, fresh capacity programs between universities and companies and targeted financial tools, such as special credits and mega-grants. The initiatives have had a real 'synergy effect' and the systematic approach appears to be accelerating significant collaboration. So government regulation can be positive, so long as it is done in a creative manner.

Despite such economic and legal solutions, many participants agreed that problems stem from different academic and industrial viewpoints. Speakers noted that industrial and private research focused on projects that could yield commercial benefits, while academic institutions focused on broader issues and solutions funded by public investment. Private research meant that any technology and benefits were privately held (through patents) and the knowledge was not made available to the public. Meanwhile, public institutions were left with reduced budgets and pressure to monetize its research through a focus on projects that could be mass produced and/or technologically transferred. Participants noted that important technologies, such as the Internet, magnetic resonance imaging (MRI) and GPS were all results of government and university-funded research that did not start with a profit-making motive. Basic research was laudable and not to be undervalued. Another approach was to encourage academic professors to bring their tools to solve major problems and then involve industry-specific knowledge and expertise to ensure the technology

can be used. It was also noted that these tensions could be eased through collaboration with the state.

Finally, the role of the state was widely discussed. Participants agreed that countries need to find models that work for their situation. For example, many countries issue government finance for basic, peer-reviewed research. This works well for certain countries, but not for others. Other governments are also willing to invest in “patient capital”, while others are not. It is important for governments to respond to individual needs and contexts. Many governments have failed in attempts to recreate knowledge and innovation hubs, such as the Silicon Valley, which itself was established with minimal government interference over a period of 30 years. This highlighted the issue of balancing state control. While the state was the only entity that could ensure the general well-being of the population, it could also stifle innovation. One participant noted that in the United Kingdom, universities need autonomy and money, but tend to be unsuccessful once they are controlled. They (academics) “couldn’t be civil servants”. It would also be better for states to offer incentives instead of enacting control mechanisms. Participants acknowledged the contrasting nature of these statements and noted more dialogue was needed to overcome the difficulties.

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Monday October 7, 2013

201-F1 INDUSTRIAL INNOVATION (10.20h-12.20h)

Chair:
Blanco Mendoza, Herminio, Founder and Chief Executive Officer, Soluciones Estratégicas, MX

Speakers:
- **Pekarun**, Mehmet, President, Industry SBU, Sabanci Holding A.Ş., TR
- **Parker**, Richard, Director of Research & Technology, Research and Technology, Rolls-Royce plc, UK
- **Colombani**, Pascal, Chairman of the Board, Valeo S.A., FR
- **Kasuga**, Fumiko, Vice-President for International Affairs, Science Council of Japan, JP
- **Mallory**, Greg, Partner & Managing Director, The Boston Consulting Group, US
- **Revellin-Falcoz**, Bruno, Honorary President and Delegate for Foreign Affairs, National Academy of Technologies of France (NATF), FR

The session understood innovation as fundamentally important for both governments and private enterprises if they are to be successful in today's world. As one participant commented: "You can grow fast by copying, but you can't become number one without innovation." However, the main question is how innovation can be effectively supported and turned into applications.

The cost of innovation has grown exponentially over recent decades, so much so that investment in innovation is increasingly outstripping potential returns. This cost is partly due to increased capital investment required for the actual research, and partly to the often neglected cost of integrating innovation into existing systems. An example given during the session was the introduction of 'directed energy weapons' to a naval fleet. Here, the expense of developing the weapon is only a small fraction of the final cost, as the ship would need to be substantially rebuilt from the ground up – with bigger propulsion systems to generate the power for the weapon. This in turn would require more space, meaning the entire naval vessel would have to be redesigned for one single addition. One potential way of reducing such problems is to concentrate more on incremental innovation, since this allows the ripple effect to be predicted and controlled more accurately.

The spiraling cost of research was a dominant topic throughout the discussion and much support was voiced for public-private partnerships. With innovation increasingly of central national importance, many governments around the world are trying to find ways to encourage innovation. For example, the Science Council of Japan (SCJ) is working to increase communication channels between academics, business and the public sector, emphasizing topics that they deem to be of national importance.

Such partnerships can take many different forms. The most common model is collaboration between businesses and educational institutions. An increasing number of companies are spending a substantial proportion of annual turnover on funding research at universities (by directly funding PhDs or professorial chairs) or establishing specialized research institutions. This was seen as an effective way of supporting innovation that is already under way and of harnessing the energy of young researchers and seasoned scientists. Often, these researchers will join the company after completing their education, or stay in academia but remain closely linked to the company. Such a system of collaboration was referred to as 'closed external' collaboration by one participant, where a company is working with only a few selected outsiders, compared with purely open collaboration where research is public.

However, even with the right frameworks in place, the challenge remains of how to encourage individuals to come forward to spearhead innovation. Even in countries such as Turkey, which has a large population of young educated individuals, very few have turned to creating new ideas. Ten years of political stability and high economic growth have helped, but the young population still tends to choose the safe option. The European Union has tried to address similar problems with a new initiative dubbed the European Institute

of Innovation & Technology (EIT). It aims to bring together all sides of the 'knowledge triangle' – higher education, research and business – and cluster them together in Knowledge and Innovation Communities (KICs). Here, an entrepreneurial spirit is encouraged, and individuals are supported in their journey from turning fresh ideas and new research into viable business ventures. Although initial funding has been low, the budget has been increased to EUR 2.7 billion for the period 2014-2020, with the aim of ensuring Europe's competitive advantage in the future.

While innovation was seen as positive in general terms, a number of participants stressed the need for it to be appropriate. Innovation should be based on local culture, but should also provide new frameworks on which to build. "Successful innovation respects culture, but from a scientific base," said one participant. Similarly, real successes in innovation are those that build on the existing strengths of a culture. Once these have been defined, it is important for governments to focus on such natural strengths and capitalize on them, even if that means declaring certain ventures to be 'losers.'

Participants agreed that promoting innovation and entrepreneurship largely depends on convincing governments of their value at all levels. Government support is essential for realizing projects that cost more than the sums private enterprises can afford.

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Monday October 7, 2013

201-G1 Adaptation to Climate Change (RACC5) (10.20h-12.20h)

Chair:
Zehnder, Alexander, President and Founder, Triple Z Ltd., CH

Speakers:
- **El-Beltagy**, Adel, Chair, International Dryland Development Commission (IDDC), EG
- **Hassan**, Mohamed, Co-Chair, iap, SD
- **Swartz**, Derrick, Vice Chancellor, Nelson Mandela Metropolitan University, ZA
- **Yasunari**, Tetsuzo, Director-General, Research Institute for Humanity and Nature (RIHN), JP
- **Sumi**, Akimasa, President, National Institute for Environmental Studies (NIES), JP

A session on climate change adaptation explored the risks posed by global warming and natural hazards to the world's coastal cities. The meeting followed a workshop, held two days earlier, as part of the Regional Action on Climate Change (RACC). This grouping was launched in 2009 to hold annual adjunct sessions to the STS *forum*, with the aim of discussing the challenges that climate change is posing at local and regional level, and the potential for developing adaptation strategies. One of RACC's achievements has been to launch Knowledge Action Networks (KAN) around the world, to link generators of local knowledge with decision-makers and promote activities to reduce the negative impacts of climate change. Plans are in hand to set up a platform to connect the various KAN networks and help them interact.

Focusing on coastal cities, the session heard some of the effects of global warming on these communities and infrastructures. In many coastal areas, increasingly frequent extreme weather events, coupled with rises in sea level, are resulting in flooding of harbors and residential areas, loss of arable land and damage to cultural heritage. Property loss, destruction of the economic base, water shortages and food crises trigger migration, with far-reaching consequences. The impacts on a city whose economy relies on exports can be severe. Recent flooding in Bangkok almost brought the global electronics industry to a halt, as well as causing a massive decline in vehicle production and food exports. Often, it is the poorest urban inhabitants who suffer the most. They need support in their efforts to adapt. However, cities are also places where innovative adaptation measures and better mitigation initiatives can potentially be put in place. With well embedded KANs, cities can become the drivers of efforts to overcome the threats of climate change, the session heard.

Discussing the threat posed by global warming to coastal cities, the meeting heard that in Africa, at least one-quarter of the population lives 100 km or closer to coastal areas and 320 cities with more than 100,000 inhabitants are located near the coast. By the year 2020, between 70 and 250 million people globally will be affected by increased water stress, reported one participant. By the year 2050, that figure will increase to between 350 to 600 million people. Recent statistics show that 50% of rainfed agriculture in Africa will be damaged by climate change, which will also have severe impacts on health, infrastructure and cause salt intrusion in lowlands. A World Bank study on the world's deltas has pinpointed the Nile Delta as one of the most vulnerable. A 0.5 meter rise in sea level will mean resettling 3 million people in Egypt, as well as major degradation of agriculture and serious damage to industry and the economy. In Asia, air pollution is a serious problem, due to high population density, especially in urban areas. So too is deforestation, which in turn is affecting the region's climate.

Against this background, KANs could make a difference, said participants. Possible interventions range from geo-engineering plans for dams and locks to genomic initiatives aimed at making crops more tolerant to heat and water stress as well as agro-management techniques that address irrigation and other systems. One speaker observed that at local level, a vast pool of innovative knowledge exists for adapting to climate change. Though often not recognized by policy makers, this local knowledge can provide valuable lessons on sustainable ways of protecting livelihoods and communities from global warming.

More research and technologies are needed to increase forecasting techniques and help people adapt to climate change, in coastal cities and beyond, participants agreed. Communications will play a key role in relaying that information to people who need it at local level. Other urgent interventions called for at the meeting included the implementation of national action plans and more capacity building for local scientific communities to help them assess climate change impacts and determine how best to adapt to them. It is essential to train a new generation of young scientists to tackle climate change, said participants. Funding will be crucial, especially for the world's Least Developed Countries (LDC), 40 of which are in Africa. Although the LDCs have made the least contribution to global warming, they are suffering the most severe consequences and will need special help in buffering its impact. Meanwhile, the world's wealthiest nations produce 75% of carbon dioxide emissions, the meeting heard. In the words of one speaker, the G20 countries have a 'moral obligation' to contribute at least 75% of the funding needed by LDCs.

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Monday October 7, 2013

201 - H1 ICT for Education (10:20-12:20)

Chair:
Eriksson, Per, President, Office of the Vice Chancellor, Lund University, SE

Speakers:
- **Leebron**, David, President, Rice University, US
- **Kurokawa**, Kiyoshi, Academic Fellow, National Graduate Institute for Policy Studies (GRIPS), JP
- **Saracco**, Roberto, Director, EIT ICT LABS ITALY, Telecom Italia SpA; Italian Node Director, EIT ICT LABS, IT
- **Yasuda**, Yutaka, Chairman, KDDI R&D Laboratories, JP

There is a consensus that information and communication technology (ICT) and massive open online courses (MOOCs) can be an important force for improving the quality of education for all age groups, in both developed and developing countries and for many different purposes. The participants discussed how to effectively use ICT in education and ICT's effects on the business models of four-year university courses and continuing education.

Most of the discussion focused on the 'blended' classroom – one that uses both the traditional classroom and ICT – which was described as superior to either individually. For a blended classroom to be effective, it must be interactive. One concept that participants suggested is the 'flipped classroom', in which the students learn content outside of class using ICT, which frees class time for in-depth discussion and question-answer sessions. This is similar to the education style that was prevalent in Japan during the Edo era, the *Tera-Koya*, or 'Temple elementary school'. One of the main features of this system was the small class size in which a high level of deep communication was possible.

Almost all participants agreed that interaction with fellow students and teachers is a crucial part of the education process and one of the ways traditional education continues to retain value over ICT-only instructional methods. Activities like mingling with professors and meeting students from other disciplines are also important for building social skills. Working with team members and supervisors on projects which require practical skills is also an important part of the education process. Universities should be more focused on delivering these kinds of real world, educational experiences, as opposed to the traditional lecture style. However, there are examples of how MOOCs can be successful even without any such interactions. A Mongolian boy taking an online class offered by MIT was one of a small percentage of students who was able to get a perfect score on the test. Some participants expressed hope that a focus on real world problem solving could contribute to a virtuous circle benefiting society in general.

ICT also introduces a wide variety of ways in which classrooms can become more adaptive. ICT systems can gather a massive wealth of information about the learning process of the individual student and of students in general. It becomes possible for students to study at their own pace and for materials to be tailored specifically to their needs and interests. Also, access to comprehensive data about the learning process presents new ways for educators to study their effectiveness. ICT provides an enormous wealth of data about how students are progressing, so that it is possible to see which techniques work well and which do not. Although teachers are constantly experimenting in the classroom, before now, there have not been sufficient metrics to represent the results clearly. However, as teachers and students are monitored more closely, there are also concerns about privacy.

Education is one of the only major social institutions that has not yet undergone major creative destruction during the ICT revolution. There is a very low tolerance for experimentation in schools and attempts to incorporate ICT into the classroom are often met with resistance from teachers and the bureaucratic system. Some of the resistance to change comes from security concerns and giving children access to the internet and inappropriate material. Schools using ICT have attempted to limit access, but keeping children within the designated computer network remains an ongoing problem.

The effect of ICT on the higher education business model was an area of concern to many participants. Will the campus university system suffer the same fate as other services that have been replaced by communication technology? There is no doubt that higher education's current content, delivery and assessment and certification bundle will need to be repackaged. Nevertheless, there was optimism that a blended classroom can provide the best of both worlds.

The digital tools necessary for ICT are constantly becoming more affordable, creating hope that new ICT could lower the cost of and increase access to education in poorer parts of the world and in low-income communities.

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Monday October 7, 2013

202A PLENARY SESSION: Population and Resources (13.00h-14.10h)

Chair:
Lee, Yuan Tseh, President Emeritus; Distinguished Research Fellow, Institute of Atomic and Molecular Sciences, Academia Sinica; President of International Council for Science (ICSU), TW

Speakers:
- **Wambugu**, Florence, CEO, Africa Harvest Biotech Foundation International (AHBFI), KE
- **Alberts**, Bruce, Professor Emeritus, Department of Biochemistry and Biophysics, University of California, San Francisco (UCSF), US
- **Serageldin**, Ismail, Director, Library of Alexandria, EG

Yuan Tseh Lee said that soaring population and consumption levels are the two biggest drivers of unsustainable development in the world today. The problem, together with many of the issues it raises, have been known about for some time. Solutions, such as family planning policies and facilities to slow birth rates, have been available for years, but with little effect. "Why have we done so little?" he asked. The issues are complex, acknowledged Mr. Lee. But at the heart of the matter is some "pretty simple Math". A constantly growing population and rising levels of consumption on a planet with limited resources simply do not add up, he said.

Florence Wambugu chose to focus on the opportunities for her native Africa, rather than the negative implications of a growing population, which is expected to double by 2050. Although the continent faces challenges posed by rural migration, high food prices and the brain drain, amongst others, it also has great potential. Rich in minerals, water, agricultural land and resources, Africa has one of the world's youngest populations, with 70% of people aged 30 or under. A great deal of planning and technical innovation will be required to ensure a sustainable future for African youth, she said. But science technology and innovation offer 'major opportunities to turn Africa around.' According to the World Bank, more than 650 million Africans now have mobile phones, and in Kenya alone, a total of US$17.33 billion was transacted through mobile devices in 2012. By 2015, 800 million people in Africa will have access to the Internet. Information and Communication Technologies (ICT) will have major repercussions for improved agriculture, linking farmers to markets and to information on crops and livestock, as well as to education through e-learning and improved health through e-medicine. Partnerships will be essential for capitalizing on ICT developments, providing benefits for both North and South.

Bruce Alberts spoke about the very close link between women's education and population growth. Various studies have shown that women with higher levels of education have fewer children. Better education for women also leads to better health and higher levels of economic growth for the societies in which they live, said Mr. Alberts. Projections of education for women showed that, given current levels, population growth would reach 7 billion to 8.9 billion by 2050 and then tail off. With lower levels of women's education, the population would rise to 10 billion by 2050 and continue to grow. "Education is therefore key to our future in many ways," he said. Mr. Alberts pointed to ICTs as opening promising opportunities for improving education prospects in developing countries, especially for marginalized groups such as women. In India a low-cost tablet device costing US$50 has been produced to provide education for all. Five million of the tablets will be distributed to schools. The question that remains is exactly how they will be used. Good research is needed to understand the most effective way of harnessing such tools, he said.

Ismail Serageldin said that although issues of growing populations and levels of consumption had been discussed for generations, no-one could have imagined that the number of people would one day exceed 9 billion. Nor could anyone have envisaged the scale of consumption and waste or the extent to which technology could damage the planet's ecology. An increase in population leads to a damaged natural resource base. But so too does a rise in incomes, with people consuming more animal protein and demanding an unlimited supply of services and manufactured goods. Explaining the so-called demographic transition, which affects birth and mortality rates at various points in a country's development, Mr. Serageldin said different societies currently face different problems, with aging populations in industrialized countries and very young populations in many developing nations. Helping youth to make the transition to adulthood and employment will be essential for societies with a large number of young people, he said. Mapping out a five-point plan for young people, Mr. Serageldin said it was essential that they be encouraged to learn, make a smooth transition into the labor market, develop healthy lifestyles, start a family and exercise citizenship. Education would play a key role in the process, using new tools offered by the Internet and presenting important opportunities, especially for women. "Women play a central role in the population equation," said Mr. Serageldin. "Empowering them is the fastest route to bringing down birth rates and moving us on the path towards sustainable development."

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Monday October 7, 2013

202B PLENARY SESSION: "The Future Role of CTOs" (13.00h-14.10h)

Chair:
Johnson, Ray O., Senior Vice President and Chief Technology Officer, Lockheed Martin Corporation, US

Speakers:

- **Azuhata**, Shigeru, Executive Vice President and Executive Officer, Hitachi, Ltd., JP
- **Berger**, Geneviève, Chief Science Officer, Unilever NV, FR
- **Roberts**, Richard J., Chief Scientific Officer, New England Biolabs Incorporated, Nobel Laureate in Physiology or Medicine 1993, UK
- **Khan**, Mehmood, EVP and Chief Scientific Officer Global R&D, PepsiCo Inc., US
- **Bonvin**, Bertrand, Senior Vice President Research & Development, Philip Morris International, CH

Ray O. Johnson said that the context in which a Chief Technology Officer (CTO) operates is replete with challenges that are increasing in both number and complexity while resources available to combat them are decreasing. The CTO must act as the bridge between the latest science and technology developments and the business needs of the organization that they work for. This entails certain contradictions - or even "schizophrenia": science and technology often operate over long timeframes, while public companies report their progress on a quarterly basis. The job also requires tremendous collaboration between business, academia and government, in a context of intense business competition. The CTO thus plays an essential role in any organization.

Shigeru Azuhata spoke about three basic leadership requirements of a CTO: generating new products and technology, proposing a technology strategy in alignment with management policy, and reflecting technology development back into the management strategy. These responsibilities touch on many management areas. It is therefore essential for all C-level executives to understand them - decisions about which R&D to support and which to abandon will have a major strategic impact on their company. As companies are part of society and their technology often has a big impact on society, the CTO's responsibilities are not limited to their employer and what they do can affect many other stakeholders.

Geneviève Berger shared her conviction that worldwide, the community of CTOs is, and has to be, an engine for change – for future society, for people and for the environment. In positive circumstances, their actions can lead to improvements in global quality of life. This is increasingly the responsibility of companies, far beyond traditional definitions of corporate social responsibility. Unilever, while not abandoning its growth agenda, encourages sustainable living through its products and relationships with its customers. It affects the nutrition, health, hygiene and environment of its customers. The CTO is responsible for innovation in a company's core business, and also for bringing breakthrough thinking to support its future directions. She argued that the CTO's role is to help the company address the right questions with regard to technology, take calculated risks, support cutting edge science - often in a multidisciplinary way. Also important is to take into account the rapid evolution of the world to build an externally focused organization that can develop the new relationships and ideas that lay the foundation for the company's future success.

Richard J. Roberts spoke about his experiences working for a much smaller organization. As one of the first employees of New England Biolabs, he introduced technology that kick-started the growth of his entire industry. His role today is in some ways unchanged: setting the agenda for future research and identifying areas which may be profitable. In a socially conscious organization committed to sustainability, he has also been able to channel research efforts into partnerships and research projects that benefit the developing world and are personally satisfying. He is still able to devote 50-70% of his own time to research. He hopes that this example of how the role can function in a small organization can be an inspiration to others.

Mehmood Khan focused on the range and scope of the CTO's role in a large organization. Some 1.2bn people consume a product made by his company, PepsiCo, every day. The CTO's role is to translate invention into innovation, and to influence R&D not just inside the company, but in the ecosystem in which it operates. For example, PepsiCo buys more plastic film than any other company in the world. The decisions it takes about whether to focus on bio-degradable or bio-dispersible films will have an impact on a supplier ecosystem removed from its own business. In such a context, the role of the CTO is turn complexity in unfamiliar areas into clarity to enable executive decision making.

Bertrand Bonvin described how Philip Morris International (PMI)'s future depends on technological innovation. He recognized that smoking is a leading cause of morbidity and mortality. PMI's goal is to develop alternatives to cigarettes and reduce the harm caused by smoking. The CTO needs to push the limits of technology to produce new, more reliable risk assessment methods in support of this. This requires highly advanced technologies in a number of fields to understand the relationship between smoking and disease. Collaboration with the academic community and with regulators is essential. Multidisciplinary methods must be validated and gain acceptance from all stakeholders. The CTO therefore needs not only to understand the research methods being used, but to build bridges with all relevant stakeholders. The future of the company will depend on his or her efforts.

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Monday October 7, 2013

203-C2: Capacity Building in Developing Countries (14:20h-16:20h)

Chair:
Nutbeam, Don, Vice-Chancellor, University of Southampton, UK

Speakers:

- **Daoudi**, Lahcen, Minister of Higher Education, Scientific Research and Staff Training, MA
- **Natera**, Angélica, Deputy Director, LASPAU (Latin America Scholarship Program with American Universities), Harvard University, VE
- **Abdulrazak**, Shaukat Ali, Secretary / Chief Executive, National Commission for Science, Technology and innovation, KE
- **Iskandar**, Marzan Aziz, Chairman, Agency for the Assessment and Application of Technology (BPPT), ID
- **Ahmad**, Kamal, Founder, Asian University for Women, BD
- **Murenzi**, Romain, Executive Director, TWAS, The World Academy of Sciences, RW
- **Hara**, George, Deputy Chairman of the Expert Committee, Council on Economic and Fiscal Policy, Special adviser to the Cabinet Office of the Prime Minister of Japan; Chairman of the Board, The Alliance Forum Foundation, JP

At the end of the colonial era in the 1950s and 1960s, many newly independent countries established universities as a point of national pride. As time went by, however, the focus on tertiary education faded. This was partly due to local political factors (one participant observed that student protests were particularly unwelcome for politicians), and partly to a shifting focus in development towards primary and secondary education. Tertiary education has been seen as delivering lower social returns relative to other investments.

This is now changing. The discussion in the session focused on the reasons why, and considered some examples of institutions and government policies that are bringing about such change.

The role of the university in a developing country is becoming clearer. Primary and secondary school teachers are taught in universities, which means these are crucial for building an indigenous capacity for teacher training. Other sophisticated professions vital to the smooth functioning of society are taught in universities, preparing the next generation of doctors, health workers, lawyers and civil servants. Developing countries need strong universities to train such professionals locally.

Universities also maintain a pool of expertise in a variety of knowledge areas, enabling the inter-generational storage and transmission of knowledge. Local repositories of expertise are necessary for addressing local problems. The training of graduate and doctoral students is therefore vital. Unfortunately, the "siloed" organization of universities sometimes inhibits effective engagement with local stakeholders. An example was given of a farmer in Africa receiving separate, contradictory advice from experts in different areas - oil, crops, livestock, marketing - from the same university. This fragmentation inhibits the effective sharing of available knowledge. Furthermore, the number of graduates is insufficient. As one participant pointed out, if Africa wishes to have one PhD per 250 people, it needs to train 40,000 PhDs over the next decade – a number that is vastly out of its current reach.

Other regions are investing heavily in capacity building. Brazil is sending 100,000 students to study overseas, using foreign institutions to develop its human capital to enable long-term capacity building at home. Chile is updating its university curricula and faculty development programs and has succeeded in making its university system one of the best in the region. Ecuador is also raising standards and establishing new universities, including some in more remote and deprived regions.

Indonesia is seeking to create 'two-way' transfer systems to create situations for 'learning together.' An example is the Science and Technology Research Partnership for Sustainable Development (SATRAPS) which brings together Japanese and Indonesian organizations (including government agencies and universities) to develop capacity in the field of meteorology radar and buoy technology so as to study extreme weather related to climate change. The Asian University for Women in Bangladesh has been established to provide tertiary education for young women, selecting its intake on the basis of leadership potential. The World Academy of Sciences (TWAS) in Rwanda is seeking to redress the lack of research opportunities in Africa and soon plans to offer nearly 700 PhD and post-doctoral research fellowships per year to major universities and research centers in the 'Global South'.

One participant suggested that it is not always necessary to seek to improve the average quality of a system, since a single institution that provides a world-class example of excellence can often galvanize change in the wider context and provide powerful multiplier effects in its local community. Connected to this is the perspective that universities require academic freedom and institutional autonomy to set their own standards and goals, free of political interference. There is no consensus on these points, however. Some participants argued that capacity should be built at national level and that governments should play a powerful role in setting knowledge transfer priorities for their countries.

As one participant observed, by 2050 the world population may be close to 10 billion, with the aggregate population of Europe, North America and Japan accounting for less than 15% of the total. Growth in the first half of the 21st century will come from Asia, and in the second half will come from Africa. A strong tertiary education sector with embedded indigenous knowledge will be crucial to help these emerging economies to build their own capacity to thrive.

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STS *forum* – Science and Technology in Society *forum*

Tuesday October 8, 2013

203-H2 Science and Engineering Education for the 21st Century (14:20-16:20)

Chair:
Grimson, Eric, Chancellor, Massachusetts Institute of Technology (MIT), US

Speakers:
- **Mishima**, Yoshinao, President, Tokyo Institute of Technology, JP
- **Zgurovsky**, Mykhail, Rector, National Technical University of Ukraine "KPI" (Kyiv Polytechnic Institute), UA
- **Dorfan**, Jonathan, President & CEO, Okinawa Institute of Science and Technology Graduate University, US
- **Negishi**, Ei-ichi, Herbert C. Brown Distinguished Professor of Organic Chemistry, Department of Chemistry, Purdue University; Nobel Laureate for Chemistry 2010, JP
- **Andersson**, Bertil, President, Nanyang Technological University (NTU), SE
- **Smith**, Steve, Vice-Chancellor and Chief Executive, Streatham Campus, Northcote House, University of Exeter, UK
- **Al-Misnad**, Sheikha, President, Qatar University, QA

The current generation of science and engineering students is different from previous ones. They are more motivated to solve real world problems, and face an increasing need for cross-disciplinary communication with other scientists and engineers. This is because they will be more involved in global research, more likely to work in multicultural workplaces, and face a greater need to communicate with the non-technical public.

In the past, students were more likely to choose a field of study because they were interested in the discipline itself. The present generation of students, however, chooses a discipline because they are interested in solving real world problems. 'Action driven learning' is an attempt to attract and train these students to solve those problems through an active, hands-on, stimulating learning environment. Students learn in context through solving real problems, rather than learning through traditional instruction like lectures. However, attempts to transition to action driven learning curricula often meet with resistance from professors, parents, students and accreditation agencies. Professors are often resistant to change. They have their own areas of expertise around which they like to base their courses. Parents often have difficulty seeing the monetary value of action driven learning. It often pushes students to be active participants in the learning process, which makes some of them uncomfortable. Accreditation agencies often want more traditional courses and have difficulty evaluating action driven learning curricula.

All participants stressed the importance of a multidisciplinary education. This involves the student having a core competency, but being balanced by exposure to other disciplines. This is often done by requiring science and engineering students to take humanities courses, and sometimes by having students from one science or engineering discipline gain experience in another through coursework or collaboration. Some institutes require students from one science or engineering discipline who are comfortable in that discipline's lab environment, to do research in an unfamiliar environment, pushing them outside of their comfort zones. This produces graduates who are ultimately more comfortable in a multidisciplinary environment. One participant suggested having joint supervisors or multiple supervisors, especially from different fields.

'Metacurricular' skills – such as leadership, communication and collaboration – are also receiving more focus. While participants agreed that having a balance between a core discipline and metacurricula was important, it was noted that finding that balance is often difficult, and that no one formula would work in all situations.

Most participants brought up the importance of diversity in student and faculty bodies. Some noted that even within the same discipline, two people from different cultural backgrounds will have different approaches. Science and engineering education is different across cultures and around the world in terms of emphasis, range of instruction and subject matter.

The reality of today's globalized world is that scientists are likely to be engaged in multicultural collaboration. Research around the world is becoming increasingly international. Over the past 20 years, the number of research papers with international co-authors has been growing rapidly and studies have shown that those papers receive more attention from the science and engineering communities. Multinational companies also bring engineers together from diverse backgrounds to collaborate on common projects. Their success or failure depends on their ability to communicate and their willingness to accept different approaches to problem-solving. These attributes are just as important as technical knowledge.

While the job market for science and engineering is relatively good, it is changing rapidly and it is difficult to ensure students have the necessary skills for the future. There was a general consensus that science and engineering jobs will be instrumental in solving many of the world's most pressing challenges, such as addressing world's energy needs. Participants noted that society is realizing that research is a key to being able to compete internationally in an increasingly competitive global economy.

Science and engineering education faces an image problem and often has difficulty attracting top students who will be able to compete in a global research environment. Many students find science and engineering intimidating, and some feel it is too theoretical or abstract. This impression can be changed partly by reforming the education process and making classrooms more student-centric as well as improving the recruitment process. One participant recommended implementing outreach programs to high schools involving science and engineering competitions. Several participants noted that the gender gap in science and engineering education remains a crucial problem.

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Monday October 7, 2013

204B PLENARY SESSION: Research and Innovation (16:50h-18:00h)

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

Speakers:

- **Yamamoto**, Ichita, Minister of State for Science and Technology Policy, JP
- **Strohschneider**, Peter, President, German Research Foundation (DFG), DE
- **Sakakibara**, Sadayuki, Chairman of the Board, Toray Industries, Inc., JP
- **Al-Saud**, Turki Saud Mohammed, Vice President for Research Institutes, King Abdulaziz City for Science and Technology (KACST), SA
- **Chubachi**, Ryoji, President, National Institute of Advanced Industrial Science and Technology (AIST), JP

Alain Fuchs welcomed the audience, introduced the speakers and opened the session.

Ichita Yamamoto explained the current policy of the Abe administration with regards to Science, Technology and Innovation (STI). STI is crucial for addressing Japan's biggest challenges, including the problem of contaminated water from the Fukushima Dai-Ichi nuclear power station. It is also central to the government's defining policy of 'Abenomics'. Prime Minister Abe has convened the Council for Science and Technology Policy (CSTP) more frequently than ever before, and has set an ambitious target: for Japan to be the most innovation-friendly country in the world. Numerous initiatives seek to increase Japan's engagement with STI globally. These include setting up innovation hubs with world-class research environments, supporting organizations such as the Okinawa Institute of Science and Technology (OIST), increasing the number of foreign students in Japan from 140,000 to 300,000 and doubling the number of Japanese studying abroad from 60,000 to 120,000 by 2020. Another goal is for 10 Japanese universities to be among the global top 100 within 10 years. Finally, the government will seek to establish a strong 'headquarters' function at policy level to coordinate and guide various sectors, eliminate silos between ministries, industry and academia and promote R&D which directly focuses on high-risk, high-impact research.

Peter Strohschneider described the organizing principles of Germany's funding for research. He noted a global trend for demanding that research demonstrate its impact in order to win funding. Germany's system takes the opposite approach. Some 30% of German R&D spending is funded by federal or state governments, and impact-related criteria play no role. The structure of R&D in Germany ensures that impact occurs regardless (with 70% of total R&D spending coming from private industry, and a network of research institutes focusing on applied research). The impact is observed afterwards, rather than relying on foresight; this allows for serendipity.

Sadayuki Sakakibara pointed out that R&D not only seeks to drive economic and business growth – it also solves issues related to the environment, food security, energy security and water shortages. In the 1960s, Toray began R&D into carbon fiber and reverse osmosis membranes. It persisted with developing these technologies, despite decades of losses. Today, carbon fiber is in many ways superior to steel and is dramatically reducing weight (and thus fuel consumption and CO2 emissions) for a variety of applications, including aircraft, automobiles and wind turbines. Reverse osmosis membranes are now being used in seawater desalination and wastewater recycling and process 27 million tons of water each day for use in the daily lives of 100 million people worldwide, while reducing energy consumption by more than 80% compared with conventional processes. CEOs and top management must have confidence, passion and patience for such research to succeed.

Turki Saud Mohammed Al-Saud described Saudi Arabia's strategy for building a knowledge economy to reduce its economic reliance on fossil fuel production. The kingdom's strategy seeks to build an ecosystem for STI, considering education, R&D, infrastructure, funding, legal aspects and international collaboration. Implementation began in 2007. Infrastructure will be built in the first phase, the kingdom will seek to be a leader in the region and in Asia in the second phase, and in the third phase Saudi Arabia will seek to become a leader among developed countries with a knowledge-based economy and society. Fifteen research programs have been set up, focusing on strategic technologies relating to water security, biotechnology and nanotechnology. Research will be carried out in three segments, with universities

focusing on basic research, national institutes focusing on applied research and ministries carrying out operations-oriented research to solve immediate problems. Five research centers have been established so far, and two more will be established this year. An incubation program and a national company for technology investment (to invest in start-ups and transfer technology from overseas) are also being set up.

Ryoji Chubachi has recently returned from a global summit of research institute leaders, and reported on steps that are being taken to improve 'brain circulation' and cooperation among research institutes. The aim is that joint offices and labs, joint seminars and improved support for research abroad will lead to an increase in the number of co-published papers. Challenges relating to intellectual property protection, incompatible career structures and bureaucracy relating to taxation, pensions and visas will need to be overcome. In the meantime, AIST continues to function as an innovation hub, promoting a sustainable society by accelerating collaboration with universities and industries and opening innovation centers in Tsukuba (since 2009) and Fukushima (planned for 2014).

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Tuesday October 8, 2013

300 PLENARY SESSION: Global Health (08:30h-09:25h)

Chair:
Nurse, Paul, President, The Royal Society, Nobel Laureate in Physiology or Medicine 2001, UK

Speakers:
- **Vela Olmo**, Carmen, Secretary of State for Investigation, Development and Innovation, Spanish Ministry for Economy and Competitiveness, SP
- **Nagayama**, Osamu, Chairman & CEO, Chugai Pharmaceutical Co., Ltd., JP
- **Hacker**, Jörg, President, German Academy of Sciences Leopoldina, DE
- **Hayashizaki**, Yoshihide, Program Director, Preventive Medicine and Diagnosis Innovation Program, RIKEN, JP
- **Smith**, Stephen, Dean, Faculty of Medicine, Dentistry and Health Sciences, University of Melbourne, UK

Paul Nurse welcomed participants to the session, noting the importance of the global health issue in this forum. Considerable progress has been made in global health in recent years. For example, mortality from malaria has dropped 25% since 2000. Challenges are becoming increasingly global, however. The issue of non-communicable disease is becoming increasingly important, in both in developed and developing countries. Infectious diseases issues continue to pose a global threat and new challenges are emerging such as antimicrobial resistance and new viruses. He concluded by suggesting that new means of delivering health care effectively are necessary, with more emphasis on cross-cutting approaches.

Carmen Vela Olmo noted that no single definition for global health exist: it involves the worldwide improvement of health, reductions in health disparities, and protection against health threats. Disparities between countries are a major problem, and those with fewer resources have not only complex health care systems but often also suffer from "brain drain", due to the emigration of qualified human resources. Intervention strategies are required now, and action must be taken by all sectors of society. Governance, universal health coverage and challenges of access to knowledge must be addressed. Safe and effective interventions must also be socially acceptable and accessible. Cooperation between countries to address global health issues are extremely important. She concluded by noting the need for open discussion and the development of concrete action plans.

Osamu Nagayama focused on the importance of population health as a foundation for economic growth, particularly in low and middle income countries. Access to appropriate medical systems remains a challenge, and establishing health insurance mechanisms may be one solution. Japan established its system of universal health coverage in 1961, and it played a major role in Japan's economic growth by improving worker health. Japan's GDP captured only 3.9% of the global economy in 1960, but this grew to 18% by 1994. Life expectancy also rose in men and women from 65 and 70 to 79.6 and 86.4 years respectively. Japan has managed to contain health care costs while improving equity, and it may provide important lessons for other countries going into economic growth phases.

Jörg Hacker emphasized the changes that are occurring in the health agenda. Health issues resulting from other factors such as climate change and human mobility are becoming increasingly urgent. The threat of infectious diseases remains, and while vaccination has eradicated small pox and come close to eradicating poliomyelitis, previously well controlled diseases can reemerge as problems as the measles epidemic in Europe has demonstrated. Antibiotic resistance perhaps represents one of the greatest threats to progress in health, and this problem has been tabled at various G8 meetings including at one meeting this year. Non-communicable diseases are responsible for an increasing burden worldwide. He suggested there is a need for international cooperation in scientific research and strengthening of preventive and preemptive approaches to tackle these challenges. Gathering data, promoting public-private partnerships for innovation and the global transfer of technology and methods are all needed.

Yoshihide Hayashizaki suggested that a number of trends could be identified in the global health field. An increasing number of countries are suffering from "Japan Syndrome", with growing social security expenditure to support an increasingly older population suffering from more and more age related diseases, with a shrinking workforce to support the costs. The disease profiles between countries are also growing in similarity due to age and lifestyle related diseases. The value of other approaches, such as education, is becoming increasingly apparent. For example, educational interventions have been shown to be one of the most successful approaches to HIV control. Ways must be found to manage the costs of new and existing technologies, but few grants currently exist for this.

Stephen Smith focused on how systems must change to cope with the current demands of global health. Old models of fragmented healthcare must be replaced with integrated systems with the patient at the center. Healthcare systems must also be capable of self-learning in real time, but this remains a distant goal. The explosion in the "omics", such as genomics and metabolomics, is set to transform conceptions of health, and systems must embrace these new fields. He also suggested that the creation of more interdisciplinary academic centers may be of extreme benefit. Such centers must learn to share data transparently and further expand their international links.

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Tuesday October 8, 2013

301 PLENARY SESSION: Key Messages from Concurrent Sessions (09.55h-11.40h)

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

Speakers:

- **[S1 + A2] Yoshikawa**, Hiroyuki, Director-General, Center for Research and Development Strategy (CRDS), Japan Science and Technology Agency (JST), JP
- **[S2 + A1] Rubbia**, Carlo, Scientific Director, Institute for Advanced Sustainability Studies e.V. (IASS), Potsdam, Nobel Laureate in Physics 1984, IT
- **[S3 + B1+ B2] Rietschel**, Ernst, European Affairs Representative, acatech (National Academy of Science and Engineering), DE
- **[S4 + C1+ C2] Yeh**, Nai-Chang, Professor, Physics, California Institute of Technology (CALTECH), US
- **[S5 + D1 + D2] Campbell**, Philip, Editor-in-Chief, Nature, UK
- **[S6+E1+E2] Bhumiratana**, Sakarindr, President, King Mongkut's University of Technology Thonburi (KMUTT), TH
- **[S7+F1] Onishi**, Takashi, President, Science Council of Japan (SCJ), JP
- **[S8+F2] Gutfreund**, Hanoch, Executive Committee Chairperson, Israel Science Foundation, IL
- **[S9+G1+G2] McBean**, Gordon, Professor and Research Chair of Institute for Catastrophic Loss Reduction, University of Western Ontario, CA
- **[S10+H1+H2] Dijkgraaf**, Robbert, Director and Leon Levy Professor, Institute for Advanced Study (IAS), Princeton, NL

Megan Clark welcomed the audience, introduced the speakers and congratulated Chairman Omi and STS *forum* on its 10th anniversary. The discussions in the detailed sessions have been "deep and intimate", and one of the clearest outcomes is an awareness of their interconnectedness. Rather than individual topics, it is better to think of the concurrent session topics as a single system. She said that leaders will need clarity, foresight and an awareness of these linkages if they are to influence policy.

Hiroyuki Yoshikawa reported on shale gas and oil as well as nuclear energy. Shale gas experts expressed confidence in the potential for the technology based on its success so far. There was a feeling that "the results are in" from its global rollout, that it works reliably and can produce energy at a lower cost than its alternatives. As with any new technology, there are uncertainties around its impact, especially with regard to the environment. But regulation should address these in due course. In the global environmental context, nuclear power was described as continuing to be necessary. Also discussed was new, safer nuclear technology such as fuel containers that do not melt. A key idea was the concept of an independent global institution to administer a transparent process for licensing new nuclear plants. Based on the two sessions, a new dialogue across all groups of energy stakeholders seems necessary to come to the ideal mix of energy sources.

Carlo Rubbia discussed energy efficiency as a generic strategy for innovation with the potential for enormous benefits: even a relatively parsimonious country like Japan still wastes 60% of its energy, with clear opportunities for savings in buildings and transport. Levels of public investment in renewable energy have fallen during the economic crisis, but the need remains to rigorously pursue technologies to address their intermittent nature and improve energy storage.

Ernst Rietschel reported on the latest developments in the science of iPS cells, preemptive medicine and the brain. Some 50 years ago the leading causes of morbidity and mortality were infectious diseases. Today non-communicable diseases loom as the "epidemics of the 21st Century". These are chronic and complex, and their origins, risk factors or mechanisms are not necessarily known. These diseases may not express themselves until it is too late to treat them. This requires new techniques for early diagnosis and other methods of 'preemptive medicine.' There is great hope for new technologies such as iPS cells which despite technical and regulatory barriers, have "fantastic" potential.

Nai-Chang Yeh described four important aspects for success in recycling: developing technology for dealing with different types of materials, devising new business models to encourage recycling, changing society's value systems in support of it as well as the legal and regulatory environment to mandate it. Governments also have a role to play in international science collaboration, enabling big science projects like CERN. More projects like this will be needed in future to address challenges facing humankind such as climate change, food security and poverty. Funding for this will be necessary. This includes money for capacity building in the developing world to support graduate students, to develop university curricula, educate girls and women and build centers of excellence. Ms. Yeh argued that each country will need a strategy to match its own needs

without compromising academic independence and intellectual freedom.

Philip Campbell emphasized the importance of interdisciplinary cooperation and awareness building in confronting challenges related to water, the state of the oceans and biodiversity. Successful projects in these areas rest on three pillars: appropriate incentive design, regulation and technology. Designing incentives and regulations to be effective will require social scientists to be closely involved in such projects from the beginning. He hailed several developments, including the idea of a global license fee to be paid by ocean users such as oil firms. These funds would support ocean research and research into algae, for example. Other initiatives include the launch of the African Plant Breeding Academy in December to focus on orphan crops in Africa. Scientists can use their links to journalists, filmmakers and writers to spread awareness of the challenges to a broader public.

Sakarindr Bhumiratana reported on developments in the areas of smart cities, collaboration across academia, industry and government, and the public outreach of science and technology. The key theme regarding smart cities is data: whether these cities are long-established or brand new, tightly controlled or joyfully chaotic, the challenge will be how to gather appropriate data and translate it into information and thus knowledge. The challenge for collaboration, on the other hand, is for universities, governments and firms to gain a deeper understanding each other's cultures and requirements. For public outreach to succeed, the public must be literate in science, which requires an education system that encourages curiosity rather than destroying it, so as to make science appealing to new generations.

Takashi Onishi described the latest developments in new materials and industrial innovation. Materials can be considered from the supply side: developing new materials and then finding applications. Or they can de viewed from the demand side: researching materials for a specific purpose. Both are important. Industrial innovation is downstream from basic research, and requires collaboration across different sectors. The biggest challenge is to carefully design systems so as to ensure that companies cover research funding without removing the incentive to innovate.

Hanoch Gutfreund reported on the sessions covering nanotechnology and intellectual property rights. Nanotechnology has made great strides in the last two decades, but the striking conclusion of the discussion was: "We ain't seen nothing yet". New applications for computing, medicine and many other fields are just around the corner, and this technology is so all-encompassing that it is poised to revolutionize every domain of human life. Intellectual property is key to innovations in fields like nanotechnology, but seems more complex and less inspiring. The field concerns relations between many players, conflicting interests and different regulatory systems. As the ratio of intangible to tangible capital increases, it is hoped that intellectual property systems will become more internationally transparent, comprehensible and standardized.

Gordon McBean reported on the fields of robotics, adaptation to climate change and disaster preparedness. Robotics have applications in medicine, manufacturing, transportation and disaster recovery. Along with opportunities, there are open questions about autonomy, regulation and liability. Similar issues apply to the use of geoengineering to adapt to climate change, with ideas like damming the Straits of Gibraltar to protect the Mediterranean against sea level rises. Such concepts raise ethical concerns to match the practical considerations. On the subject of disaster preparedness, education and awareness raising were seen as very important.

Robbert Dijkgraaf summarized the discussions on social innovations supporting sustainability, the role of ICT in education, and changes in science and engineering education. The common themes are the value of innovation and the transfer of knowledge. Markets and individual consumers can, and do, fail to make sustainable choices. Regulation, pricing and taxation all play a role in addressing these failures, as do greater involvement by social scientists and reforms to education systems. ICT is currently disrupting education both at the university level, where MOOCs are forcing changes to university business models and in primary and secondary education where the Khan Academy, for example, is making learning more accessible. The greatest impact may not be on students but on teachers, who will need to adapt the most as institutions around the world experiment with new concepts of learning.

Future leaders expressed thanks for having been invited and shared their take-away points. They will take their designation as "future leaders" seriously and strive to understand how their work fits into the broader context of society.

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Tuesday October 8, 2013

302 CLOSING PLENARY SESSION: How do we move forward to maintain sustainability for the future of humankind? (11.45h-12.30h)

Chair:
Omi, Koji, Founder & Chairman, STS forum, JP

Speakers:

- **Yonath**, Ada, Director, The Helen and Milton A. Kimmelman Center for Biomolecular Structure and Assembly; Weizmann Institute of Science, Nobel Laureate in Chemistry 2009, IL
- **Yonekura**, Hiromasa, Chairman, Nippon Keidanren (Japanese Business Federation), Chairman of Sumitomo Chemical Co.,Ltd, JP
- **Alsuwaidi**, Faisal, President of Research and Development, Qatar Foundation for Education, Science and Community Development, QA

Koji Omi said that this year, as every year for the past decade, the STS *forum* has provided a platform for discussing pressing science and technology-related problems that affect people and the planet on which we live. Participants of many different nationalities have discussed their shared concerns for the long-term future of humankind. "Thanks to your participation, the forum has developed from a mere conference into a movement for the global future of humankind," he told the audience. "The forum has begun to make breakthrough achievements. I hope participants will spread the message through their own networks, so that our movement can become even more influential."
Next year, the Japanese government will be hosting a new conference, the Global Energy and Environment Innovation Forum (GEEIF), to be held in Tokyo immediately after the STS *forum*. Mr. Omi expressed his hope that participants at next year's *forum*, scheduled for October 5 to 7, 2014, will also attend the Tokyo event. "It will be the eleventh annual STS *forum* and the beginning of the next decade for us," he said. "I look forward to all of us gathering here again in order to pave the way for the future generation."

Ada Yonath said that in spite of major advances in prolonging human life expectancy, quality of life was frequently compromised by severe diseases. Among these were cancer, diabetes, HIV and age-related conditions such as Alzheimer's. Much of the focus of medical science is now on combating these diseases. However, the impact of infectious diseases in the world is also a massive problem, with often fatal effects. In most cases, infectious diseases are caused by pathogenic bacteria. The current treatment for such diseases is antibiotics, but pathogen resistance to these drugs is becoming a significant problem due to rapid pathogen mutations. Ms. Yonath said that while it may not be possible to overcome this problem, it may well be possible to control it. The challenge is an urgent one since multi drug resistance (MDR) is proving a "globally serious threat to human health," she said. The high levels of cost and risk versus uncertain benefits are dissuading the pharmaceutical industry from investing in solutions. However, the European Union, the United States of America and other countries have launched programs to address the issue. Ms. Yonath said she found the threat of spiraling MDR "terrifying". Humanity desperately needs innovative antibiotics," she said. She added that she hopes that by the next STS *forum*, there will be at least one new antibiotic under development.

Hiromasa Yonekura spoke about global warming, describing it as "one of the most crucial challenges" to the future of humankind. It is essential to seek truly effective mitigation measures while promoting sustainable economic growth. The Japanese business community is convinced that innovative technology is the key to tackling global warming, without sacrificing economic progress, said Mr. Yonekura. It has already demonstrated its commitment by introducing new technologies for renewable energies and becoming actively engaged in technology transfer. Commenting on the goal set by the international community to reduce greenhouse gas emissions by 50% by the year 2050, Mr. Yonekura said the best hope of achieving this would be by disseminating effective technologies on a global scale and accelerating innovation. Developing innovative breakthrough technologies requires time, capital investment and carries a burden of

risk that individual companies are unlikely to be able to bear alone. In the particular context of finding solutions to global warming, it will be essential for business, academia and governments to join forces, he said.

Faisal Alsuwaidi spoke of his country's determination to move from a carbon-based economy to a knowledge-based one. The goal is for Qatar to become a leading center of excellence for research and development (R&D) and, as part of its commitment, the government has pledged to invest 2.8% of national income to support the R&D agenda. Financial investment aside, there is an urgent need to expand the country's human research capital, which is low compared with other industrialized nations, he said. To address the challenge, Qatar is launching programs to attract talented graduates and skilled foreigners working in the research and development sector. It is also building state-of-the-art facilities to attract the best international scientists and create a world-class hub for research and commercialization, focusing on some of the major issues and challenges facing the future of the region and the world as a whole.

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