

17th Annual Meeting

STS *forum* 2020



Summary of STS *forum* 2020

Summary

October 3, 4, 5 and 6, 2020

Kyoto, Japan

Science and Technology in Society *forum*

STS forum 2020 - 17th Annual Meeting

“The Role of Science and Technology in the Post COVID-19 Era”

October 2-6, 2020

Program

(Hours in Japan Standard Time UTC+9)

Friday, October 2			
		21:00-25:00 Regional Action on Climate Change (RACC12)	
Saturday, October 3			
		14:00-16:40 Kyoto Symposium	
	19:00-21:00 9 th Global Summit of Research Institute Leaders	20:00-21:30 S&T Ministers' Roundtable	
22:00-23:00	[100]	Opening Session: Science and Technology for the Future of Humankind	
23:15-24:15	[101]	Sustainable Society	
24:30-25:30	[102]	Science and Technology in COVID-19 Pandemic	
Sunday, October 4			
13:00-14:00	[200]	Science and Technology Education for Society	
– Intermission –			
21:00-22:00	[201]	Science and Technology in Business	
22:15-23:15	[202]	Global Health: Lessons from New Coronavirus Crisis	
23:30-24:30	[203]	Improving Preparedness for Pandemic Diseases: The Role of S&T	
Monday, October 5			
13:00-14:10	[300]	Cooperation and Collaboration in Science and Technology	
– Intermission –			
		18:30-20:00 Academy of Science Presidents' Meeting	
21:00-22:00	[301]	Global Governance of Information	
22:15-23:15	[302]	Basic Science, Innovation and Policy	
23:30-24:30	[303]	Shaping the Post COVID-19 Society	
Tuesday, October 6			
13:00-14:10	[400]	Energy and Environment	
– Intermission –			
21:00-22:00	[401]	Promoting Inclusive Participation in Science and Technology	
22:15-23:15	[402]	AI and Society	
23:30-24:30	[403]	Closing Session	

Kyoto	Delhi	Riyadh	CEST	Greenwich	US East	US West
UTC+9	UTC+5.5	UTC+3	UTC+2	UTC+1	UTC-4	UTC-7
Friday, October 2						
Saturday, October 3						
22:00	18:30	16:00	15:00	14:00	9:00	6:00
23:15	19:45	17:15	16:15	15:15	10:15	7:15
24:30	21:00	18:30	17:30	16:30	11:30	8:30
Sunday, October 4						
13:00	9:30	7:00	6:00	5:00	0:00	21:00 (Oct. 3)
Monday, October 5						
21:00	17:30	15:00	14:00	13:00	8:00	5:00
22:15	18:45	16:15	15:15	14:15	9:15	6:15
23:30	20:00	17:30	16:30	15:30	10:30	7:30
Tuesday, October 6						
13:00	9:30	7:00	6:00	5:00	0:00	21:00 (Oct. 4)
Wednesday, October 7						
21:00	17:30	15:00	14:00	13:00	8:00	5:00
22:15	18:45	16:15	15:15	14:15	9:15	6:15
23:30	20:00	17:30	16:30	15:30	10:30	7:30
Thursday, October 8						
13:00	9:30	7:00	6:00	5:00	0:00	21:00 (Oct. 5)
Friday, October 9						
21:00	17:30	15:00	14:00	13:00	8:00	5:00
22:15	18:45	16:15	15:15	14:15	9:15	6:15
23:30	20:00	17:30	16:30	15:30	10:30	7:30

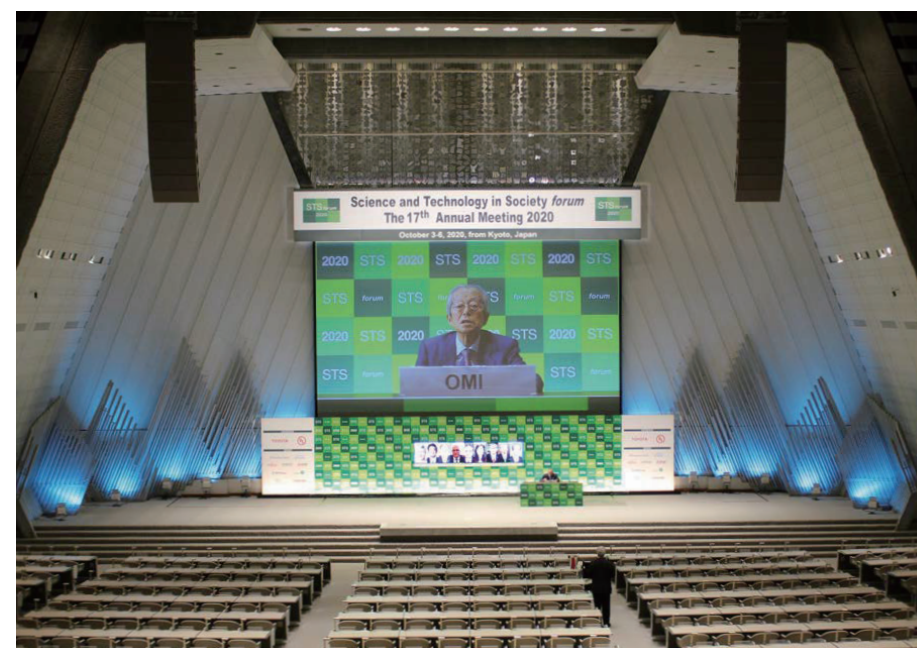
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Sessions



Opening Session: Science and Technology for the Future of Humankind

[Chair]

McKinnell, Henry A., Chairman, Moody's Corporation; Chairman Emeritus, Pfizer Inc., U.S.A.

[Speakers]

Abe, Shinzo, former Prime Minister, Government of Japan; Honorary Chairman, Science and Technology in Society *forum* (STS *forum*), Japan

Suga, Yoshihide -- "Special Message," delivered in lieu of PM Suga by Omi, Asako, Member, House of Representatives, Prime Minister, Government of Japan, Japan

Chernyshenko, Dmitry, Deputy Prime Minister, Russian Federation, Russia

Ebrard Casaubon, Marcelo Luis, Secretary of Foreign Affairs, Government of Mexico, Mexico

Gabriel, Mariya, Commissioner for Innovation, Research, Culture, Education and Youth, European Commission, EU

Droegemeier, Kelvin K., Director of the Office of Science and Technology Policy, Executive Office of the President of the United States, U.S.A.

Uchiyamada, Takeshi, Chairman of the Board, Toyota Motor Corporation; Chairman, Council on Competitiveness - Nippon (COCN), Japan

Omi, Koji, Founder and Chairman, Science and Technology in Society *forum* (STS *forum*); former Minister of Finance, Japan

Remarks

Mr. Shinzo Abe, former Prime Minister, Government of Japan; Honorary Chairman, Science and Technology in Society *forum* (STS *forum*), declared the opening of the 17th annual meeting of STS *forum*, which is being held virtually this year, as a result of the COVID-19 pandemic. He expressed his sincere appreciation for all participants connecting to the meeting from around the world, as well as his gratitude to the individuals and organizations contributing to STS *forum*.



Abe, Shinzo

The world faces an unprecedented global crisis posed by the COVID-19 pandemic, which has curtailed the movement of people and international collaboration, including in science and technology. The role of science and technology will undoubtedly grow ever more crucial in the COVID-19 and

post-COVID-19 eras. Furthermore, the importance of an organization such as STS *forum* will surely expand under such circumstances.

It is hoped that over the next few days, participants will interact with one another and discuss various subjects based on the fundamental concept of STS *forum*, namely strengthening the lights and controlling the shadows of science and technology, and that these discussions will produce valuable breakthroughs in science and technology to pave the way for a brighter future for humankind.

Dr. Henry A. McKinnell, Chairman, Moody's Corporation; Chairman Emeritus, Pfizer Inc., chaired the session and introduced each of the speakers.

Ms. Asako Omi, Member, House of Representatives, delivered a special message on behalf of Mr. Yoshihide Suga, Prime Minister, Government of Japan. STS *forum* has grown into a unique and highly regarded platform for global networking in science and technology. This year's forum will surely feature wide-ranging discussions on measures to tackle COVID-19, as well as the broader role of science and technology in the post-COVID-19 "new normal."

Dealing with the COVID-19 pandemic is the foremost priority of the Suga administration, which is committed to protecting people's lives and health. It is highly encouraging that active and fruitful discussions on this subject, as well as other key issues, will take place at this year's annual meeting.

The number of global agenda items calling for common solutions across humankind is rapidly



Chair: McKinnell, Henry A.



Suga, Yoshihide
"Special Message" was received and delivered in lieu of Prime Minister Suga by Omi, Asako, Member, House of Representatives.

Source of Photo: Official Website of the Prime Minister of Japan and His Cabinet (<https://www.kantei.go.jp/>)



Asako Omi, Member, House of Representatives, Japan, delivered the "Special Message" from Mr. Suga



increasing. Besides the response to COVID-19, another example is digitalization. Astounding technological progress is driving huge changes around the world. All countries must work to ensure connectivity among all people and things and integrate the cyber and physical spheres.

Japan is, in one sense, ahead of other countries in tackling future problems, for it is already dealing with an aging population and a declining birthrate. The Japanese government is promoting the Society 5.0 initiative to solve these issues. Central to that is the digitalization of society, and the Suga administration will make earnest efforts to realize this. STS *forum* plays a key role in bringing together global efforts to tackle the shared issues of humankind and the Japanese government is committed to supporting those efforts.

Mr. Dmitry Chernyshenko, Deputy Prime Minister, Russian Federation, stated that the global community is facing an unprecedented digital transformation. Massive flows of cross-border data are being generated not only by people but also devices. States must participate in this global digitalization process to develop successfully.

Against this backdrop, Russia is striving to improve the quality of people's lives and modernizing infrastructure and public administration through the use and management of data. Digital transformation is one of the Russian government's five national development goals.

Russia is implementing a plan to digitalize public administration, social activities, and data infrastructure. The new, digital Russia will have a unified digital environment and a citizen-centric services ecosystem. This system will provide the digital tools for Russia to interact with states and businesses. In addition, Russia is developing and implementing digital products, platforms and solutions based on end-to-end solutions, such as AI and the Internet of Things. Russia is also developing high-tech fields such as quantum computing and 5G mobile networks. Furthermore, Russia is sponsoring efforts to develop the digital specialists that will be essential to digital transformation, including educational reform and retraining opportunities.



Chernyshenko, Dmitry

Russia is also promoting efforts to advance science and technology and is pursuing research and technological development to anticipate and respond to global challenges. One example is the development of tests for detecting coronavirus antibodies, as well as vaccines. Russia has also developed a rapid test system in collaboration with Japan. Russia is ready to share its experiences with the international community, including its Sputnik V vaccine, and believes that global challenges such as the COVID-19 pandemic can only be overcome with the joint efforts of scientific communities around the world.

Mr. Marcelo Luis Ebrard Casaubon, Secretary of Foreign Affairs, Government of Mexico, shared the perspectives of the countries of Latin America and the Caribbean, explaining that Mexico is currently the President Pro-Tempore of the Community of Latin American and Caribbean States (CELAC). CELAC has made innovation its priority for the year, because, for many years, science and technology has not been a top priority in the political agenda among Latin American and Caribbean countries.



Ebrard Casaubon, Marcelo Luis

CELAC has been working with STS *forum* in this regard for 11 years now and is organizing a dialogue with STS *forum* to take place next year. The dialogue will bring together scientists, entrepreneurs and policymakers. The aim of this dialogue is firstly to discuss ways to accelerate science and technology innovation. The COVID-19 pandemic has created a clear imperative for countries to work together and share knowledge about treatments, testing, and vaccines. In addition, the dialogue is aimed at building new and more equal societies once the pandemic is overcome, including promoting greater gender equality, and harnessing science and technology to that end.

STS *forum* is one of the most important cooperative organizations in the world. It is unique for bringing together policymakers, businesses, technology entrepreneurs, and the scientific community. CELAC looks forward to working together with STS *forum* and wishes for the success of the 17th annual meeting.



Gabriel, Mariya

Ms. Mariya Gabriel, Commissioner for Innovation, Research, Culture, Education and Youth, European Commission, conveyed that STS *forum* has become a worldwide reference for science and technology. This is thanks to the dedicated efforts of its founder and the scientific community. Japan should also be commended for putting science and technology at the center of actions for the future of humankind.

The annual meeting of STS *forum* is therefore as critical as ever. Science and technology is, by its nature, international and fosters global cooperation. It will also help society tackle ongoing global challenges and trends. The current crisis has reinforced

the need to invest in research and innovation, and promote international cooperation. The STS annual meeting is proof of that and a perfect venue for holding open discussions and finding common solutions.

STS *forum* was founded based on the concept that science and technology have brought lights and shadows to society. While science and technology has enriched the lives of much of humankind, its benefits have not reached all members of the global population. Furthermore, advances in science and technology can also raise ethical, safety and ecological issues.

History shows that crises can make societies stronger. The COVID-19 pandemic is no exception and has brought both lights and shadows. It has highlighted the interdependence of countries' economic, social, natural and technological spheres. In the face of this crisis, the European Union is firstly investing more in research and innovation. Second, it is promoting stronger international cooperation. Third, the EU is exploring new ways of promoting research and innovation, pursuing impact-oriented interdisciplinary research aimed at societal challenges. Fourth, the EU is focusing on people and will foster the next generation of scientists, including efforts to promote gender equality and ensure no one is left behind.

Dr. Kelvin K. Droegemeier, Director of the Office of Science and Technology Policy, Executive Office of the President of the United States, stated that collaboration in science and technology is essential for overcoming the COVID-19 pandemic. The United States and Japan have long engaged in such collaboration, including over 160 projects in many critical fields, including infectious diseases, particle physics, neuroscience, space, cancer biology, and disaster resilience.



Droegemeier, Kelvin K.

Advances in science and technology are essential for socio-economic progress. Furthermore, science and technology is a global enterprise and the United States values international cooperation in this field, particularly with Japan. The United States and Japan are engaged in dialogue at various levels with the aim of further deepening collaborative relations in science and technology.

One emerging field of great promise is quantum information science and technology, a shared priority for the two countries. In 2019, the United States and Japan signed the Tokyo Statement on Quantum Cooperation. Following the signing of that statement, Japan has been promoting various moonshot research projects, including in quantum fields, and such projects are to be commended.

STS *forum* also plays an essential role in bringing together researchers, policymakers and business leaders from around the world as part of the global enterprise that is science and technology. Holding this annual meeting, despite the obstacles of COVID-19 pandemic, is

truly admirable and important, and it is hoped that the meeting will yield fruitful discussions and outcomes.



Uchiyamada, Takeshi

Mr. Takeshi Uchiyamada, Chairman of the Board, Toyota Motor Corporation; Chairman, Council on Competitiveness - Nippon (COCN), spoke about the role of science and technology in the post-COVID-19 world. The COVID-19 pandemic has brought to light many challenges confronting the world, in fields such as life, health, and socio-economic structures. The world must work together in solidarity to tackle this pandemic. This is an enormous challenge, but human history shows that science and technology will play a major role in conquering COVID-19. The pandemic has brought economic and societal changes and changes in people's ways of living. Now is the time for us to

renew our awareness of a new society for which we should aim. This is also a great turning point for accelerating a shift to the society.

Japan has raised Society 5.0 as its banner for a new type of society. Applying information and communications technologies, artificial intelligence, digital technologies, and others, Society 5.0 aims to achieve a human-centered, sustainable society. However, the COVID-19 pandemic has made obvious Japan's delays in implementing digital technologies into socioeconomic systems. Such technologies are supposed to form the foundation of Japan's aimed-for society. The pandemic has placed limits on freedom of mobility and contact. That is a freedom that humankind should have. Because of this, interest has suddenly grown in the societal application of digital technology. Now, people are about to experience firsthand the shift to a safe and secure society.

In addition to preventing the spread of COVID-19, the world must also remember the energy challenges that form the foundation of this kind of sustainable society. We must become acutely aware once again that initiatives for the realization of a decarbonized society and the realization of a society based on sustainable energy are important issues related to the survival of humankind.

The COVID-19 pandemic has made it clear to us that all countries share in their destinies. Border-transcending cooperation and solidarity for resolving societal issues based on strong coordination and trust among academia, government decision-makers, and industry have become more important as we head toward a post-COVID-19 era.

Mr. Koji Omi, Founder and Chairman, STS *forum*; former Minister of Finance, welcomed the participants from all around the world. He expressed his pleasure and pride at the holding of the 17th annual meeting of STS *forum* and thanked all stakeholders for their ongoing support. Lastly, he expressed his hope that STS *forum* would continue to grow in importance and contribute to addressing the lights and shadows of science and technology for a better future for humankind.



Omi, Koji

Sustainable Society

[Chair]

Kleiner, Matthias, President, Leibniz Association, Germany

[Speakers]

Benson, Sally M., Professor, Department of Energy Resources Engineering, School of Earth Sciences, Stanford University; Co-Director, Precourt Institute for Energy, Stanford University, U.S.A.

Brady, Terry, President and CEO, Underwriters Laboratories Inc., U.S.A.

Molina, Mario J., President, Mario Molina Center for Strategic Studies on Energy and the Environment, Mexico; Professor, Department of Chemistry and Biochemistry, University of California, San Diego (UCSD), U.S.A. [Nobel Laureate 1995 (Chemistry)]

Reddy, Daya, President, International Science Council (ISC), France; Professor, Department of Mathematics & Applied Mathematics, University of Cape Town, South Africa

Rockström, Johan, Director, Potsdam Institute for Climate Impact Research (PIK), Germany

[Commentator]

Lee, Yuan Tseh, President Emeritus, Academia Sinica, Taiwan [Nobel Laureate 1986 (Chemistry)]

Remarks

ONLINE October 3-6, 2020, from Kyoto, Japan



Kleiner, Matthias

Dr. Matthias Kleiner began by stating that the COVID-19 pandemic has demonstrated the vulnerability of humanity as rarely before seen in recent human history. In addition to the still increasing number of deaths worldwide, it has also caused tremendous social and economic impact. There is a historic chance for universal transformation of all sectors in order to achieve the sustainable development goals (SDGs) and the Paris Agreement, and, according to the 2019 Global Sustainable Development Report, there are four levels for bringing the necessary transformation to achieve the SDGs: governance, economy and finance, individual and collective action, and science and technology.

Dr. Sally M. Benson expressed the belief that, at this moment in time, humankind has more reasons than ever to be optimistic about the future of humanity and the planet thanks to extraordinary advances in science and technology. On the other hand, this can also seem like the worst of times, with a global pandemic, a global economic crisis, and a rapidly changing climate. In the face of such circumstances, it is firstly important to provide high-quality education for everyone, everywhere. Second, it is vital to rely on evidence-based decision-making. Third, societies must factor equity and inclusiveness into their decisions. Fourth, it is necessary to improve skills related to systems-thinking. Fifth, humankind needs to realize that it is at the physical limits of what the planet can provide. Lastly, people need a change of heart to shift away from an economy that is based on consumption to one based on conservation and restoration.



Benson, Sally M.

Mr. Terry Brady stated that the global pandemic has revealed that global economies, as well as the infrastructures and systems of trade, commerce and health, remain deeply vulnerable. Leaders must have a long-term vision and an unwavering commitment to drive positive outcomes for global populations. Researchers, policymakers and industry leaders must work together to accelerate scientific and technological development to solve complex problems and build a more resilient society. To that end, Underwriters Laboratories has conducted rigorous independent research and developed safety standards that guide the safe, secure and sustainable use of new and emerging technologies and validate the performance, environmental health, and sustainability of innovative products. It also works in collaboration with government agencies, international organizations, and non-governmental organizations. It is the organization's belief that, if society is to address sustainability through a lens of science, then it should merge safety into that vision.



Brady, Terry



Molina, Mario J.

Dr. Mario J. Molina declared that the sustainability of the planet is an issue of fundamental importance. Civilization has been changing many aspects of the functioning of the planet that will make it very difficult for future generations to have the same quality of life as the current generation. The largest problem is, of course, climate change. Society has been worrying about climate change for decades and yet it has not taken sufficient action to address it. In fact, the scientific community believes that the climate is changing faster than previously anticipated. Already, it has exacerbated natural disasters such as hurricanes and droughts. Other changes include the melting of snow in the Arctic and increased forest fires. All of

these issues are coupled and if they continue, they could cause a climate catastrophe. All stakeholders must work together to take action and avoid such a catastrophe.



Reddy, Daya

Dr. Daya Reddy pointed out that even before the COVID-19 pandemic, there was a consensus emerging from the scientific community that there is an urgent need for thorough socio-ecological transformations towards resilient and sustainable societies. Existing inequalities have been exacerbated by the pandemic, and progress towards achieving the SDGs has been stalled. The approach to the current crisis has provided an impetus for humankind to reconsider its approach to climate change. The world has a collective responsibility to refine design pathways that will lead to a more sustainable world. In addition, the prevailing focus on growth, profit and efficiency in economic systems

must be counterbalanced by due regard for sustainability principles, equity and resilience. There is also a need for a sustainability science that effortlessly integrates natural, social and human sciences. The scientific community should promote interdisciplinary and trans-disciplinary research, strengthen research cooperation and capacity, and take an open, non-competitive and collaborative approach to research.

Dr. Johan Rockström stated that the planet is at the limits of its biophysical capacity with extreme natural events taking place worldwide. Several of the major systems that regulate the state of the planet are coming close to potential irreversible changes. Humankind must recognize that these impacts are interconnected. Climate impacts interact with ecosystem changes, and today, are interacting with the Corona Crisis. The unsustainable exploitation of habitats leads to a higher risk of zoonotic viral spill-overs such as COVID-19. There are many studies on how to transition back into a safe operating space within planetary boundaries. Humanity must translate those recommendations into actions, such as a carbon law, with the aim to cut emissions by half every decade and to reach a net zero world economy in 30 years' time. Policies, investments, and momentum need to be put in place, sector by sector, to achieve the necessary transformation towards a sustainable and healthy planet. Going forward, there needs to be a new narrative, a new vision for the World 2.0, where sustainability is treated as the entry point for success, equity, prosperity, economic development, human health and dignity.



Rockström, Johan

Discussion

Dr. Kleiner opened the discussions and pointed out that while the COVID-19 pandemic has left the world on tenterhooks, it also provides global society with an opportunity to make a renewed effort to achieve a sustainable future and pursue the SDGs. Research organizations such as the Leibniz Association generate new knowledge and research that can be transferred to society and can provide policy advice on issues of science and technology. Of particular importance is to achieve the 2030 targets for tackling climate change. He underlined that even if the COVID-19 pandemic is currently overshadowing everything, we should not forget that a sustainable future is a responsibility to be built for and with coming generations. In particular, without the Fridays for Future movement, which takes ownership of science in regard to climate change, we would not be where we are today.

Dr. Kleiner then reminded the participants of the key points of discussion for the session: How can we make our economies and societies more resilient to environmental and health crises such as the corona pandemic? What are the key actions to move fast to realize a true

sustainable society? What role does sustainability science, i.e. the integration of the social sciences and humanities, play to achieve the SDGs? What do we think about the theoretical approach to the assessment of human well-being, such as “The Recoupling Dashboard”? Which future technologies are most promising to a sustainable society?

Dr. Benson answered the first question, particularly in relation to resilience against climate change. In the long-term, humankind needs a change of heart and to transition away from societies that focus on consumption, to societies that value restoration.

Mr. Brady addressed the question about the key actions needed to move fast in realizing a true sustainable society. He believes that all members of society need to work together more closely, so we can move forward more effectively and efficiently. When researchers, policymakers, and industry leaders come together, global communities can accelerate much needed scientific and technological development. Scientific findings also need to be shared with current and future policymakers, including through stronger education and outreach in science, technology, engineering, and mathematics fields. Underwriters Laboratories conducts primary research with an eye towards sustainability and develops safety and performance standards, thus playing a key role in helping to bring innovative and sustainable solutions to market safely.

Dr. Molina tackled the same question. He pointed out that scientists must work together with decision-makers and political leaders. Climate change is a huge challenge and continued investment in science and technology is needed to overcome it. There are many potential solutions available and nuclear energy is one that is very effective but often overlooked.

Dr. Reddy commented on resilience and building a sustainable society. In the COVID-19 pandemic, scientists have addressed policymakers and citizens about how to tackle this issue. Science is essential to guiding the response to such issues. However, at the same time, there have been huge amounts of misinformation being spread around as well. To deal with this issue, the International Science Council has been strengthening public outreach and communication efforts to counter such misinformation and to engage and educate the public, so that science can be put to work to address challenges such as the current pandemic.

Dr. Rockström spoke about the role of sustainability science. Humankind is at risk of destabilizing the life support systems on Earth and contemporary sustainability science is therefore about global sustainability science. The COVID-19 virus has spread from animals

to humans, which is linked to the unsustainable exploitation of natural habitats. In other words, environmental change is coupled to human health and the recent economic lockdowns. It is important to stabilize the biomes that regulate the Earth's stabilizing forces. The global commons such as the atmosphere, land and forests need to be internalized in human well-being and sustainability is the only pathway to delivering the SDGs. For example, COVID-19 is a lung infection, for which lung capacity is essential. This capacity is degraded by air pollution, which is also linked to global warming, and the only way to solve that is to couple it to economic policies. The only way to address this is an interdisciplinary science such as sustainability science.

Dr. Yuan Tseh Lee began by quoting Martin Luther King: “We are now faced with the fact that tomorrow is today. We are confronted with the fierce urgency of now.” There may be no more “now,” 10 years from now. Day by day, the situation in the world is getting worse and the world is getting warmer. Humankind is fighting a losing battle, but must not give up. It must make sure that it does not lose too badly, so the next generation has the chance to win the battle.



Lee, Yuan Tseh
(photo from STS forum 2019)

It is not the smartest or strongest who survive, but those best able to adapt. Humankind needs to learn to adapt better to climate change and make society more resilient. COVID-19 has reminded people of the need for global collaboration as the safeties of all countries are interrelated. To tackle climate change, there is a need to reexamine the development of human society, particularly in relation to Mother Nature.

Dr. Kleiner asked Dr. Benson to elaborate on her point about the need for a change of heart.

Dr. Benson talked about how attitudes to, say pollution or recycling, have changed over the course of her lifetime. This change of norms represents a change of heart. Modern society needs a similar change of heart in relation to climate and eco-degradation.



Dr. Kleiner wondered if Mr. Brady's vision of a resilient society fits this concept of a change of heart.

Mr. Brady agreed. He believed that education would be key to achieving a change of heart. Furthermore, more investment in science and technology is needed to drive new discoveries. These should be shared with policymakers and efforts should be made to educate the public.

Dr. Kleiner asked Dr. Rockström to comment on the concepts of tipping points and World 2.0.

Dr. Rockström explained that natural systems such as the Greenland ice sheet or the Amazon rainforest have multiple stable states. They are resilient systems with restorative feedback mechanisms, but if they are pushed too hard, their feedback mechanisms can change direction, instead acting to push them beyond a tipping point, and thereby shifting them irreversibly to a different state. Dr. Rockström also expressed his agreement with the points made by Dr. Benson and Mr. Brady, but worried that the world is running out of time. The education and change of heart that they mentioned need to be complemented with top-down policies that mean that no society can shirk these responsibilities.

Dr. Kleiner concurred that there is no time to waste. He then invited Dr. Molina to elaborate on his point that societies should stop using fossil fuels and make greater use of nuclear energy, while noting that it can take 10-15 years to build and begin operations of nuclear power plants.

Dr. Molina pointed out that nuclear energy is just part of the solution and also that the time to get nuclear power plants up and running can be shortened. He then made the point that science does not tell society what to do, but what will happen if a particular path is taken. The issue of sustainability is in many ways a matter of ethics or social responsibility. Dr. Molina also commented that, just like the COVID-19 pandemic, climate change is also an emergency that requires similarly urgent actions.

Next, Dr. Kleiner asked Dr. Reddy to speak about the public's trust in science and technology and the understanding that science does not represent one final and stable truth but is an ongoing process of investigating and analyzing reality.

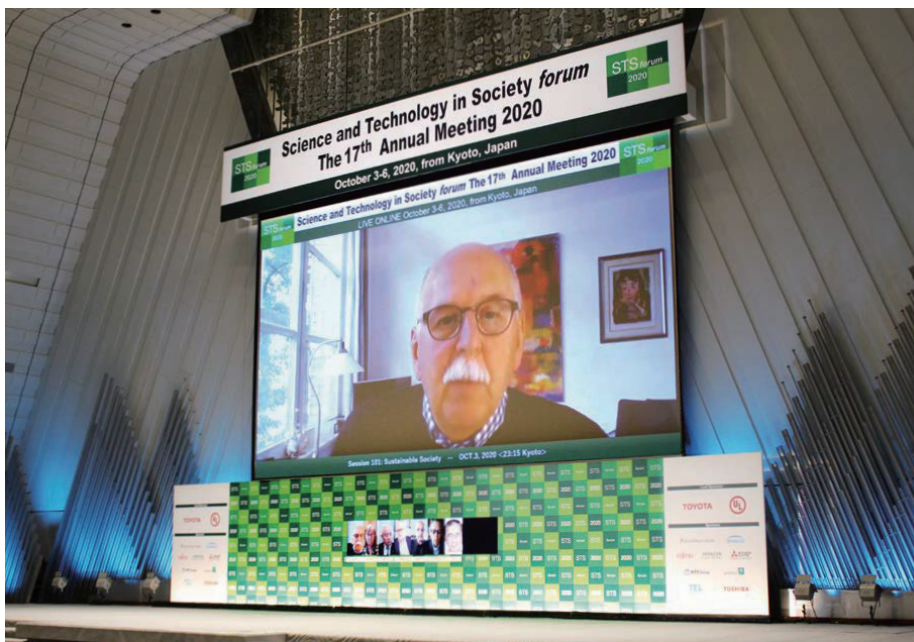
Dr. Reddy cited a report by the Wellcome Trust that indicates that levels of public trust in science are reasonably good, though there are regions where this is under threat. The scientific community is facing many challenges posed by anti-scientific or pseudo-scientific rhetoric. Unfortunately, some scientists or science communicators have made the mistake of a dismissive approach to people who are skeptical about science. More care needs to be taken to ensure effective engagement of the public and foster greater receptiveness and trust from citizens.

Q&A Session

A question was raised from the audience about the challenges for developing countries to use more sustainable energy sources. In particular, these countries are striving to improve living conditions and may not always have easy or affordable access to sustainable resources.

Dr. Benson pointed out that are many people around the world living with under 100 gigajoules of energy per person per year, which is the level around which the human development index seems to stabilize. Countries such as the United States are well above this level and should reduce their energy consumption, while systems should be put in place to ensure that developing countries get the energy they need. Dr. Benson suggested that a hybrid system that combines renewable energy and fossil fuels, particularly natural gas, which is the cleanest fossil fuel, may be most effective.

Dr. Molina agreed but believed that natural gas would be just a transitional solution. Ultimately, humankind needs to stop emissions such as greenhouse gases and short-lived climate pollutants. This is particularly difficult for developing countries, which are trying to improve standards of living. To that end, the developed countries, which are responsible for having polluted the planet, should help the developing countries financially.



Dr. Benson concurred with the importance of reducing emissions to zero, but did not believe that current renewable energy sources are sufficiently robust to develop an industrial economy. Developing countries have the right to be able to develop an industrial base required for achieving a certain level of quality of life.

Mr. Brady shared work being done by Underwriters Laboratories to study and improve the safety and performance of various technologies, including fuel cells and photovoltaic panels.

Dr. Kleiner added that Germany has achieved 50% renewables in the country's energy mix.

Next, Marcia McNutt asked if there are ways to intentionally continue the reduction in travel that has occurred under the pandemic and reduced CO₂ emissions.

Dr. Reddy highlighted how COVID-19 has forced people to work and live in different ways, and this has revealed some efficiencies that could lead to widespread change in working styles and reduced travel even after the pandemic is brought under control.

Dr. Rockström did not think society would revert to the pre-COVID-19 state. At the same time, it will be necessary to actively ramp up incentives to discourage business travel, such as businesses putting in place policies to prohibit air travel if train alternatives are available, or governments employing carbon pricing policies.

Dr. Molina cited new technologies related to biomass-based aviation fuels that could greatly reduce the emissions from air travel.

Next, a question was asked about the role that laws and regulations could play.

Dr. Benson believed that strong policies can be very effective. However, if these policies are seen as imposing a heavy price on citizens, this can lead to public backlash. It is important to maintain public buy-in.

Mr. Brady reiterated the importance of education, including education of policymakers, believing this to be a key step to bridge pure research and good policy.

Dr. Molina pointed out the rise in populism in recent years and the importance of educating the public. At the same time, policymakers need to reach international agreements on common global efforts.

Dr. Rockström supported the importance of education, but reemphasized the need for urgency, believing that there would not be time to educate the next generation. He also noted that the EU has set a pathway for decarbonization in law, and hoped that other countries would follow suit.

Dr. Kleiner wrapped up the discussion by reiterating the need for more urgent and decisive efforts to achieve sustainability and new ways of living, including applying new technologies and integrating natural and social sciences. Overall, achieving sustainability is a global challenge that requires global solutions.

Dr. Mario J. Molina, who participated in this session, passed away on October 7, 2020, local time, in Mexico, and the members of STS forum wish to hereby express our sincere condolences on his passing.

Science and Technology in COVID-19 Pandemic

[Chair]

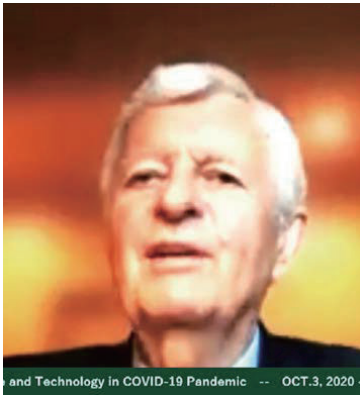
McKinnell, Henry A., Chairman, Moody's Corporation; Chairman Emeritus, Pfizer Inc., U.S.A.

[Speakers]

Fauci, Anthony S., Director, National Institute of Allergy and Infectious Diseases (NIAID), U.S.A.

Jamieson, Kathleen Hall, Elizabeth Ware Packard Professor of Communication & Director of the Annenberg Public Policy Center, Annenberg School for Communication, University of Pennsylvania, U.S.A.

Remarks



McKinnell, Henry A.

Dr. Henry A. McKinnell opened the session by wondering how people in the sciences, government and business are supposed to understand such a critically important but complicated topic as COVID-19 and science and technology, one with sometimes conflicting opinions, many without any scientific basis, or even opinions with conflicting scientific basis. Dr. McKinnell explained that his approach has always been to consult experts such as his fellow panelists.

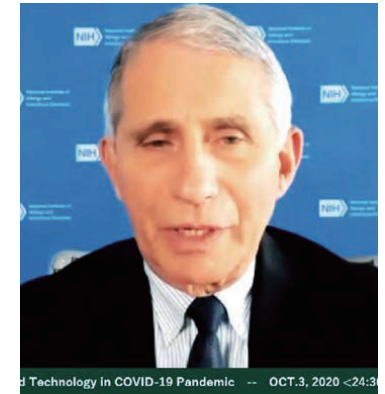
Dr. Anthony S. Fauci stated that COVID-19 has been the most serious respiratory disease pandemic in the last 102 years. It emerged in China in Wuhan

and spread throughout the world. There have been about 30 million cases of infection and about 1,000,000 deaths throughout the world. The disease is highly efficient in its spread and has a high degree of morbidity and mortality among certain subsets of people. Various countries are handling the pandemic differently but generally they have closed down society. However, that cannot go on indefinitely because it has a deleterious effect on the economy and other important services. The challenge is to reopen society in a careful and prudent way to prevent a resurgence, including taking simple public health measures. Another big issue is treatment and vaccines. Some important advances in treatments have been made and a number of clinical trials for vaccines are ongoing. Hopefully, it will be possible to get the pandemic under control and eliminate it towards the end of 2021.

Prof. Kathleen Hall Jamieson offered suggestions for how scientists and the press should communicate about COVID-19 vaccination. First, they should communicate the standards used to assess scientific evidence and increase the knowledge of the public about what certain words mean about the quality of the science. Second, they should communicate how the evaluation of vaccine evidence is protected from political influence, such as the fact that independent reviews are conducted. Third, they should create realistic expectations, including making it clear that different vaccines have different levels of efficacy, that the virus may mutate, and that practices such as mask-wearing and social distancing may need to continue even after a vaccine is developed. Fourth, they should communicate the fact that widespread vaccination within someone's local community is more valuable to them than say the nation or even the state or county. Lastly, they should encourage the public to rely on trusted individuals to certify the safety and effectiveness of vaccines.

Discussion

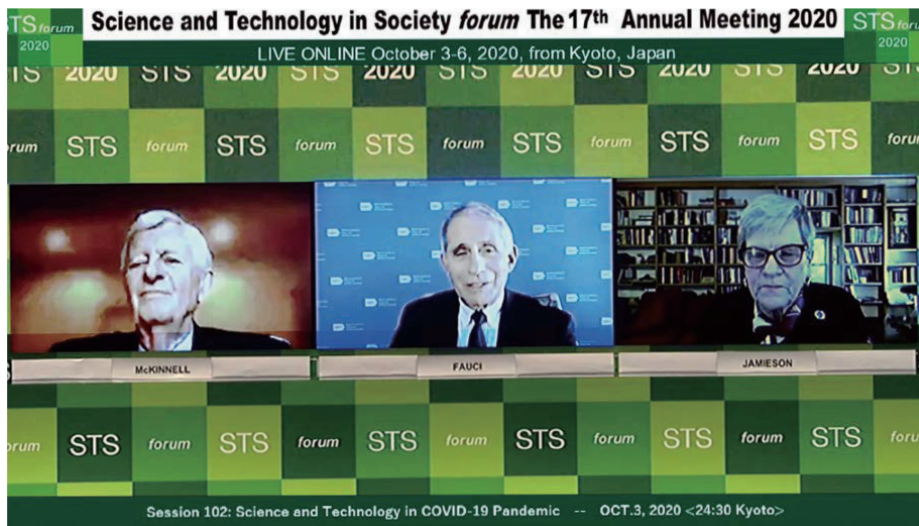
Dr. McKinnell highlighted the enormity of the challenge posed by the COVID-19 pandemic. He believed that the key to tackling such huge challenges is to consult the experts and ask, firstly, for how their advice can help, and secondly for the evidence on which their advice is based. It is also useful to have a framework for analysis such as the one posited by the Science and Technology in Society *forum*, namely that it is necessary to discuss both the lights and shadows of science and technology, and how these interact with society. Dr. McKinnell suggested that the lights related to SARS-CoV-2 and COVID-19 include the early identification and genome-typing, and the shadows include the publication of research results before peer reviewing.



Fauci, Anthony S.



Jamieson, Kathleen Hall



Dr. Fauci spoke about the development of the basic science surrounding SARS-CoV-2 and COVID-19, pointing out that science builds on prior knowledge and experience. The scientific community has much research related to a number of previous coronaviruses, including two previous pandemic coronaviruses, the ones that caused severe acute respiratory syndrome and Middle East respiratory syndrome. Advances in sequencing technology have made it possible to rapidly sequence this new pathogen after it was identified and initiate development of a vaccine a few days later.

As for the rapid reporting of information on developments related to COVID-19 research, this has positives and negatives. The positive effect is the speed with which information is disseminated to the public, but the negative aspect is that the information is being released before it is peer reviewed, and in some cases, this information has to be subsequently modified or retracted. Nevertheless, the net effect, from a scientific perspective, is a positive one, as long as scientists realize that they must ultimately revert to properly peer-reviewed information.

Dr. McKinnell then asked about how society has dealt with the rapid and sound development of the basic science, and also the chaotic disclosure of various non-scientific information alongside that.

Prof. Jamieson pointed out that the public believes that all will be well when a vaccine is developed, suggesting that it has high confidence in the scientific community. Unfortunately, the public may be overestimating the efficacy of the vaccine and how quickly things will go back to normal. More broadly speaking, the public generally fails to appreciate that science is provisional and iterative and that it has uncertainty. Western culture has framed science as one of discoveries and has neglected the many failures and mistakes that also occur, as well as what can be learned from that. This has warped the public's perception and expectations.

Dr. McKinnell wondered how scientific progress could be communicated more effectively and how some order can be brought to the disclosure of such information.

Dr. Fauci agreed that it is key to improve scientific literacy and that a major issue is that people do not understand the iterative nature of science. In a fast-moving situation, it is especially difficult to convey that science is not a linear process, but a series of successes and failures that scientists build upon.

One way to address this issue is education. At the same time, scientific communication needs to be improved. Many people have been putting out information that is based on very little data or none at all, and are instead based on anecdotes or impressions. Anecdotal information can be positive in that an anecdote can trigger a study that proves or disproves that information. However, an anecdote in and of itself can cause confusion. Currently, this has manifested itself in people promoting certain therapeutic interventions based on no scientific data.

This causes confusion among the public, which cannot be expected to be able to tell which information is valid and which is not. One issue that is often seen is that of false equivalency, whereby the opinion of an expert and that of a non-expert are given equal standing by the public.

Prof. Jamieson mentioned an example of Dr. Fauci dismissing a medical study that was poorly done and being contradicted by a member of Congress who argued that it was peer-reviewed, thinking that this trumped Dr. Fauci's point that this was not a randomized, placebo-controlled, double-blind clinical trial. Scientists need to communicate to the public and the media about the standards by which science evaluates evidence.

Dr. McKinnell asked what the path forward would be. He wondered if there is room for collaboration between the public and private sector for communication. He also asked about the roles and responsibilities of medical journals and the media.

Dr. Fauci believed that the media has a very important role to play and that there are many capable scientific reporters. However, scientific information and analysis is not suited to the 24-hour news cycle. Dr. Fauci agreed that governments can also collaborate with industry, and believed that one approach that is effective is to focus on communicating the truth based on science, rather than just trying to promote or sell a product. More such efforts are needed. Science literacy must also be improved.

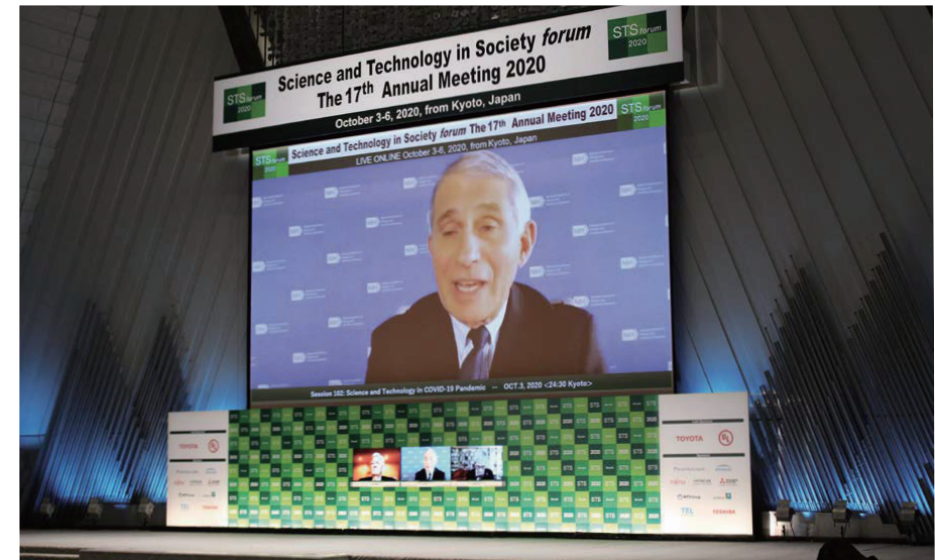
Prof. Jamieson cited the example of the recent measles outbreak in the United States and how it showed in real-time how people who followed the mainstream media increased their knowledge about the efficacy of vaccines and were less likely to believe the misinformation, while the opposite was true of those who mainly followed social media. This is similar to the case of COVID-19. People who tend to have less faith in experts and more trust in themselves are less likely to follow practices such as social distancing or wearing masks and more likely to believe conspiracy theories.

More scientists and experts need to be actively involved in a wider range of communication channels, including social media. In all channels where misperceptions are being spread, there needs to be a person who is disseminating true and accurate information. This includes members of the media who must hold those spreading misinformation accountable. It is also important to rapidly post good scientific corrections whenever misinformation is posted on social media, before there is time for that misinformation to spread.

Next, Dr. McKinnell turned to the development of technologies and asked how the public could be prepared for the fact that 80% of these will fail.

Dr. Fauci believed in being transparent with the public. It is just the nature of science that many of these technologies will fail. In fact, knowing how many do fail should make the successes even more impressive and reliable. One way to do that is to encourage journals to publish more unsuccessful data.

Prof. Jamieson pointed out that it is also necessary to inform the public that it will be very difficult to ensure 100% efficacy. Furthermore, citizens need to understand that practices



such as masking and social distancing may still be required when an effective vaccine has been developed. Furthermore, they need to understand that it is not the overall level of immunity in society that is important, but the level in their respective communities. Creating realistic expectations now is critical for people's perception of science and expectations for future behavior.

Dr. Fauci said that he is often asked when things would go back to "normal" with many believing that this will come with the development of a vaccine. He cautioned that the need for masking, social distancing and avoiding crowds may continue for some time alongside the administering of vaccines.

Dr. McKinnell turned to the development process and how to determine whether or not to move forward with a particular vaccine. He pointed out that it is easy to accept or reject a vaccine based on its level of efficacy, which is fairly clear-cut. What is much more difficult is potential safety issues. Dr. McKinnell wondered what a prudent way forward would be.

Dr. Fauci agreed that this will certainly be an issue that the world must deal with. People are not adequately aware of the need to deal with safety issues. There have been many cases in the past where a vaccine has seemed promising, but after a few months of being

administered, its problems and side effects are revealed. A careful decision needs to be made, balancing the urgency of the need for a vaccine, and also when it is actually safe to release the vaccine. That is why there are independent boards that make those decisions, such as the Data and Safety Monitoring Board. One classic example was the 1976 swine flu outbreak, where it turned out that the disease was not actually much of a threat and the vaccines developed actually caused Guillain-Barre.

Dr. McKinnell added that the first polio vaccine was another example. He then asked Prof. Jamieson about how to communicate these complicated issues to the public and gain citizens' trust.

Prof. Jamieson agreed that the message is complicated. She pointed out that the public usually thinks of a treatment as being categorically safe or risky. The reality is that almost all treatments have some risk, and people need to recognize that with all treatments, an assessment is made of benefits against the risks. The danger is that if the public learns that a treatment has side effects, it may dismiss the treatment entirely, without understanding the actual implications. When the right vaccine is ready, the message needs to be framed as the vaccine being certified as being as safe and effective as it needs to be, and that taking it is better than getting the disease. This message needs to be sent to the public and media. The integrity of the science also needs to be reinforced to them, including the rigor of the science and the existence of independent review boards.

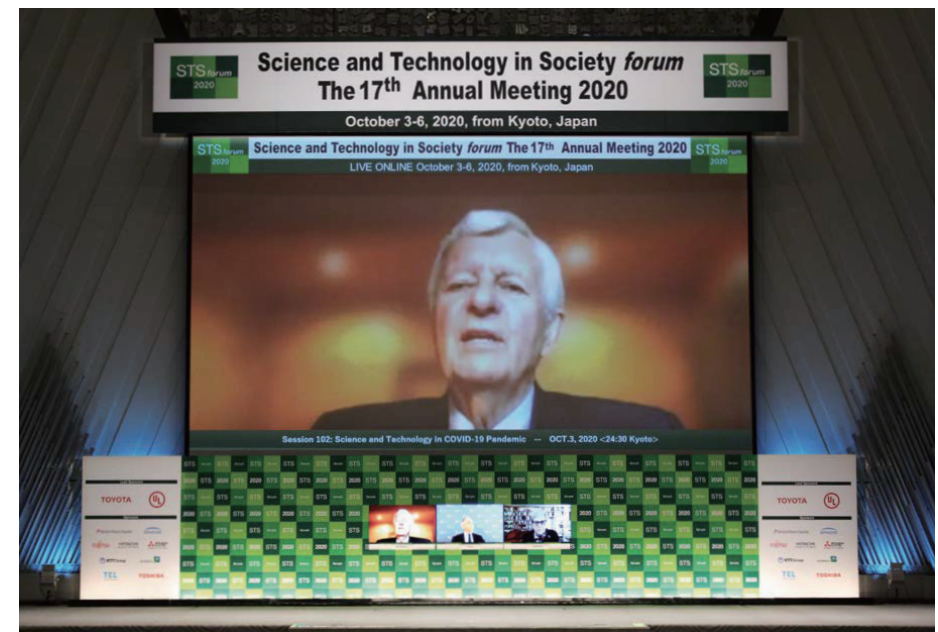
Dr. McKinnell believed that it is inevitable that, at some point, the political establishment will criticize the scientific authorities for not releasing a vaccine soon enough.

Q&A Session

A question was raised about the reluctance of some parts of the public against wearing a mask, and how this might carry over to a vaccination.

Dr. McKinnell noted that during the 1918 Spanish flu pandemic, there was a similar split in the public about the wearing of masks. He noted that the American public in particular seemed to be resistant to being told what to do with their bodies.

Prof. Jamieson suggested that people who are skeptical of the efficacy of, say masks, need to hear from someone that is credible in their community, such as their pastor or their family physician, that this is the right thing to do.



Dr. McKinnell said he saw a statistic that 65% of young doctors would not prescribe a vaccine that was approved by the Food and Drug Administration under emergency use authorization.

Dr. Fauci pointed out that, before COVID-19, there was already pushback against vaccinations in many communities around the United States, as well as an anti-scientific movement. Another problem is mixed messaging. Dr. Fauci agreed that it is important to have trustworthy people in communities spreading the right message. Even before an effective vaccine is developed, community outreach is required to ensure that when the vaccine is ready, it can be rapidly deployed. The National Institute of Allergy and Infectious Diseases (NIAID) has the infrastructure for doing so and is making such efforts.

Prof. Jamieson reiterated the importance of communities and also suggested the term “community immunity” to replace “herd immunity.” The latter term can create misperceptions and the former highlights the need for members of the community to protect each other. She also wished to change the name “Operation Warp Speed” because it creates

the false perception that the process is moving in an excessively fast and out-of-control manner. Instead, she suggested the Safe, Effective Vaccine for All campaign or SEVA.

Dr. McKinnell asked how trust could be built in communities that are naturally skeptical of the medical community, particularly disadvantaged communities such as the African-American community.

Prof. Jamieson agreed that it is very challenging. The African-American community has many reasons, historically, to be skeptical of the medical system. Hopefully, prominent African-Americans, such as the US Surgeon General and the African-American media, scientific, and celebrity communities are able to get the right message out to the African-American public.

Dr. Fauci said that he has been trying to reach out to socially influential people particularly in the African-American and Latino communities, on a wide range of non-traditional media platforms, and stressed the huge reach these efforts could have in minority communities.

A participant made the observation that one reason for the prevalence of mask-wearing in Asia is because people in Asia are highly averse to possibly infecting another person, and wondered if it would be possible to reframe mask-wearing as being an act of patriotism that is designed to protect others.

Prof. Jamieson said that studies of the measles outbreak in the United States showed that people were more likely to believe misinformation if they had high exposure to it on social media. However, having conversations about it with family members tended to lead people to dismiss the misinformation. As for the COVID-19 situation, women are more likely to wear masks, and perhaps these women could be encouraged to talk about it with the men in their households.

A question was also raised about the role of traditional medicine.

Dr. Fauci cautioned against dismissing “traditional medicine” because it is a very broad term and there are cases in which traditional practices actually have positive effects. For example, one of the most effective antimalarial medicines was a part of many traditional medicines.

Dr. McKinnell asked Dr. Fauci for his medical advice to people for protecting themselves from COVID-19.

Dr. Fauci first provided advice from a public health perspective. He advocated wearing masks, social distancing, avoiding crowds, doing activities outdoors rather than indoors, and washing hands. In terms of personal health, he recommended following practices that promote good health in general, including good sleep, good nutrition, avoiding stress and avoiding excess, including consumption of alcohol.

Dr. McKinnell asked Prof. Jamieson whether she was optimistic or pessimistic about being able to send the right message.

Prof. Jamieson believed that there are a number of excellent scientific communicators and what is needed is more of them operating in many different channels.

Dr. McKinnell asked when Dr. Fauci thought a vaccine would be available.

Dr. Fauci believed that a vaccine could emerge in November or December, while it is conceivable that one could be available sooner. If that is the case, a small number of doses may be available in December that could be given to higher-priority persons, which would usually be healthcare workers and more vulnerable members of the population. More doses would then be available in the following months and hopefully there would be enough to cover everyone that needs a vaccine. Still, there is no guarantee. Ultimately, the key is that the vaccine must be proven to be effective and relatively safe according to the clinical trial results.

Science and Technology Education for Society

[Chair]

Tan, Eng Chye, President, National University of Singapore (NUS), Singapore

[Speakers]

Hagiuda, Koichi, Minister, Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan

Anyang Agbor, Sarah Mbi Enow, Commissioner, Human Resources, Science and Technology, African Union Commission (AUC), Ethiopia

Brodjonegoro, Bambang PS, Minister, Ministry of Research and Technology; Chief, National Research and Innovation Agency, Indonesia

Andrews, Karen, Minister for Industry, Science and Technology, Ministry for Industry, Science and Technology, Australia

Cauce, Ana Mari, President, University of Washington, U.S.A.

Remarks

ONLINE October 3-6, 2020, from Kyoto, Japan



Tan, Eng Chye

Prof. Eng Chye Tan stated that COVID-19 has greatly impacted the world, not only in terms of industries and jobs, but also produced greater social anxiety as to what the future might hold. More than ever, the scientific and technological communities must examine how to make the future safer and stronger. In particular, higher education can play a constructive role in promoting recovery and helping to prepare for the future.

Mr. Hagiuda Koichi believed that the COVID-19 pandemic has made clear that human activity from anywhere has a global reach. Furthermore, he considered science, technology and innovation (STI)

to be essential for overcoming this crisis and maintaining social development. Education is essential to STI and is the foundation of all nations. Education must be maintained, even under the current circumstances, with the necessary measures to ensure the safety of students. The Japanese government is running a combination of online education, through its GIGA School Program, as well as in-person learning. Japan is also fostering young researchers who will play important roles for the future. In addition, the pandemic

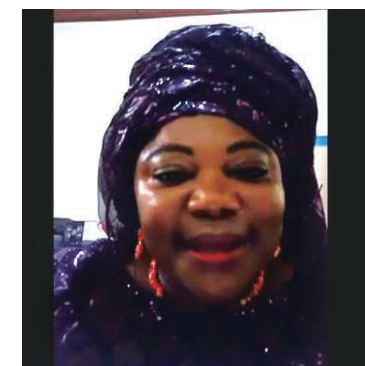
has demonstrated the importance of knowledge not only from science and technology but also from the humanities and social sciences. Japan will utilize insights from a wide range of disciplines to resolve the complex problems in society, while continuing to promote international cooperation.

Prof. Sarah Mbi Enow Anyang Agbor shared African perspectives on the role of science and technology in the post-COVID-19 era. Africa is paying special attention to science and technology education for society. Science and technology are fundamental in leading national development and supporting social economic needs. They are an instrumental enabler for faster socio-economic development and technological progress. However, upfront access to capital and appropriate investment are also needed to fully harness STI for socio-economic development and spur industrialization. In addition, there is a need to strategically invest in human resources development, invest in physical, economic and scientific infrastructures, invest in innovation and entrepreneurship development, and create an enabling environment for STI.

The African Union has positioned human capital development through science and technology education as a key priority area for its long-term people-centered Agenda 2063. It has called on its 55 member states at different development levels to strongly focus on empowering their human resources base so as to effectively tackle development challenges. Africa has an acute shortage of the critical number of researchers and innovators, but its demography presents a huge opportunity. Investing in people is therefore critical for creating a sustainable future for Africa, one that provides economic security and contributes positively to African socio-economic development, while simultaneously preventing severe brain drain. It is also necessary to break down barriers that create fragmented education and systems by strengthening international cooperation and addressing weak levels of investment. Furthermore, critical STI capacities are



Hagiuda, Koichi



Anyang Agbor, Sarah Mbi Enow

needed, including improvement of physical research infrastructures and financial resources. In particular, high-capacity data communications infrastructure would be able to connect the continent and break barriers that constantly isolate African researchers.



Brodjonegoro, Bambang P.S

Prof. Bambang P. S. Brodjonegoro shared his thoughts on science and technology education for the post-COVID-19 era, especially in the context of Indonesia. Technological innovation will continue and the value of increasing human knowledge will remain undiminished in the post-COVID-19 era. Higher education is a vehicle for ensuring progress in science and technology, as well as social welfare and the economy. As part of that, universities have two primary roles: education and research. In addition, they are now expected to build cultural knowledge and provide technology transfer, while also fostering economic development. In relation to

COVID-19, Indonesia's Ministry of Research and Technology quickly formed a resource innovation consortium to accelerate the response to the pandemic. To prepare for the future, the Indonesia government is promoting data, technology and human literacy to foster lifelong learners equipped with the six Cs: collaboration, critical thinking, creative communication, computational thinking, and compassion.



Cauce, Ana Mari

Prof. Ana Mari Cauce noted that COVID-19 has laid bare problems that have been in society for a long time. One that is especially relevant today is the digital divide, as more aspects of life are being done remotely. In the United States, the consequences of this divide have been particularly pronounced for African-American, Latino, and indigenous populations. It is critical that equity be an integral part of discussions of science and technology education. Most sciences have strong underpinnings in data, information, and computer sciences, as well as statistics, and access to these disciplines should be made available in a fairer and more equitable way

to women and underrepresented minorities. The University of Washington is making strong efforts in that regard, including opening up courses in these disciplines to more students. It is also creating more options for students with majors in other areas to obtain minors or concentrations in data science fields. While recognizing the importance of scientific research and discovery, the university is also making sure that students and researchers do not lose sight of the ethical, social and human implications of that work.

Discussion

Prof. Tan began by stating that the theme of this session is important and urgent. COVID-19 pandemic has had a widespread impact on the world, disrupting economics and jobs, causing over 1 million deaths. How can science and technology, particularly in universities and research institutes, help the world recover and build a safer and stronger world?

Mr. Hagiuda spoke about the important role of education. The COVID-19 pandemic has reaffirmed the interconnectedness of countries around the world, and the need for international cooperation in STI to overcome it. Education is the foundation of a nation, and must be maintained, even in the face of the current crisis. Governments need to work out how to balance education and efforts to prevent the spread of infections.

In higher education, Japan is promoting remote learning. However, social interaction is also an important element, and a hybrid model combining online and in-person learning is being implemented. In research, the Japanese government has also been promoting remote solutions and automation of research. Furthermore, human resources in STI are essential for tackling issues faced by society and Japan is working to foster the scientists of the future, including measures to allow researchers to pursue independent research for 10 years.

In addition, the current pandemic has also highlighted the importance of humanities and social sciences for tackling socio-economic issues, and Japan is making renewed efforts to promote these fields as well. Japan hopes to work together with other countries in all these fields to overcome the COVID-19 crisis, as well as other societal challenges.

Prof. Brodjonegoro said that one important lesson for Indonesia has been the need for accelerated digital transformation, to adapt to the less-contact economy. Indonesia has been promoting online education, which has come with some struggles. The post-pandemic economy is also likely to change and less-contact economic activities are likely to continue. The government recognizes the need to help communities adapt to this new



Andrews, Karen

type of economy. At the same time, it is necessary to ensure that efficiency is maintained, even in less-contact economic activities.

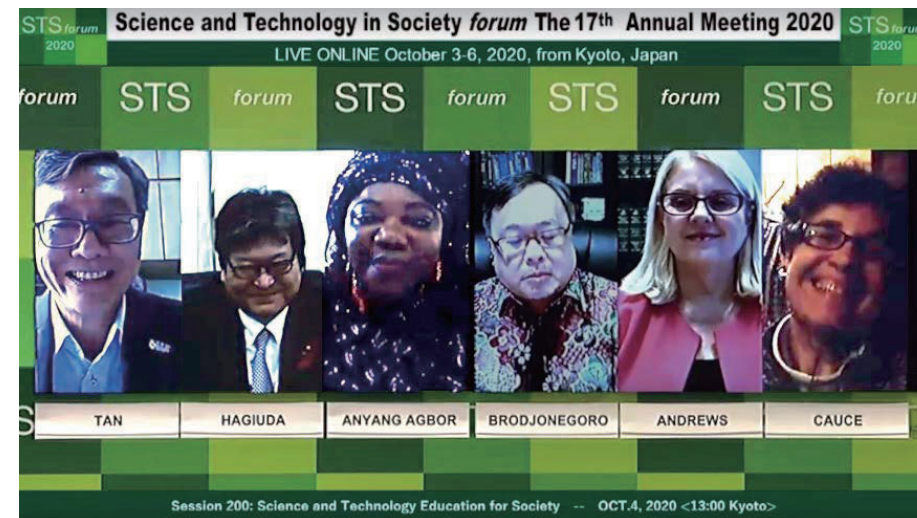
Another lesson is that the pandemic has been a boon to research. In normal times, researchers tend to be more focused on their own areas of interest. COVID-19 has proven to be a common enemy that has prompted researchers in different fields to conduct collaborative, interdisciplinary research.

Indonesian universities are also working on developing a vaccine for COVID-19, while of course collaborating with other countries' efforts. Nevertheless, it must develop its own vaccine to ensure that it can provide coverage for its 270 million-person population.

Ms. Karen Andrews emphasized the importance of education in science, technology, engineering, and mathematics (STEM) fields. Science and technology are key to the future prosperity and wellbeing of society. This has been brought into sharp focus by the pandemic. The pandemic has also highlighted the value of the STEM-educated workforce, particularly scientists and researchers. Reaffirming the importance of STEM fields, Australia is making concentrated efforts to promote education in these fields, both in terms of university-level academic education and vocational education.

One problem posed by the pandemic in terms of education is that students have to do their learning remotely. Another is increased competition for domestic university places as students are unlikely to be able to travel the globe for their education. This poses not only the challenge of being able to adequately train students graduating from high school, but also providing enough employment opportunities for this year's students when they graduate from university.

Australia is also focusing on creating workers for the jobs of the future and delivering job-ready graduates. In addition, Australia is promoting all STEM fields equally and is also encouraging more women to study and work in those fields.



Prof. Cauce stressed the importance of international collaboration. The COVID-19 pandemic has laid bare many existing problems in society, one of which has been international barriers that have hindered an organized, international response. It has also more clearly revealed racial divides in the United States, particularly the disproportionate impacts borne by African-American, Latino, and indigenous communities, as well as the digital divide, whereby the aforementioned communities are more likely to be disadvantaged.

Conversely, the speed with which research universities have leapt into action and made many advances in the basic and applied science in relation to COVID-19 has been very positive. STEM fields have received the most praise, but the impact of information and data sciences should also be recognized. Many universities, including the University of Washington, are working hard to ensure greater access to STEM majors, including making STEM majors available to more students, as well as making available more opportunities to study data and information sciences to students in non-STEM majors, given that data and information science are increasingly important to society and relevant to different fields.

Another effort that the University of Washington is making is to foster the ability to spot misinformation. In addition, it is striving to ensure that students in scientific fields do not lose sight of the human, ethical and social implications of their work.

Prof. Agbor expressed her belief that science and technology are fundamental to promoting socioeconomic advancement and needs. All sectors should be able to benefit from technological progress. To that end, it is necessary to ensure access to capital and appropriate investment.

Furthermore, it is important to strategically invest in human resources development to enhance competencies as well as to invest in innovation and entrepreneurship. The African Union has developed the Science, Technology and Innovation Strategy for Africa 2024. One key aspect of that is development of human capital through science and technology innovation. Investment in STI is essential for tackling Africa's developmental challenges and ensuring its future prosperity.

Currently, Africa has an acute shortage of researchers and innovators. It needs a million more of them. Fortunately, Africa's demography provides huge human resources potential and this can be unlocked with adequate investment. Strategies are also needed to prevent brain drain and attract prominent African intellectuals to the African continent. It is also important to implement measures to break down barriers that cause fragmented education.

Lastly, Prof. Agbor stressed the need to empower African countries to undertake science and technology, by building and improving infrastructure to that end, including developing the necessary networks to support the exchange of data and information, remote education, and telemedicine. Science and technology education for society is a right and each and every country should be able to participate in it.

Prof. Tan asked the panel members for their thoughts on resolving or mitigating the digital divide and other disparities.

Prof. Brodjonegoro said that one challenge in Indonesia is network connectivity. The Indonesian government is providing subsidies for students who have poor connectivity due to financial constraints. It is also setting up temporary network connections for areas with underdeveloped network infrastructure to ensure that no students are left behind.

Prof. Tan believed that many research communities have responded well to the pandemic, in part because they have long recognized the value of international cooperation. This has ensured the rapid and open sharing of information. It is hoped that this connectedness and sense of collaboration can be expanded to other fields as well.

Ms. Andrews called for greater collaboration among academia and industry. The Australian government is working to improve engagement between university researchers and industry, which has been constrained by the current situation.

Next, Prof. Tan turned to the economic recession caused by the COVID-19 pandemic and asked the panel members for their perspectives on the kinds of actions that can be taken to help companies, as well as students looking for employment.

Mr. Hagiuda agreed that there has been an undeniable and inevitable adverse economic impact. The Japanese government is providing support to businesses to maintain business continuity and employment. It is also providing rent subsidies for businesses forced to close temporarily by the pandemic. In addition, it is encouraging corporations to carry out the usual activities to recruit and employ new university graduates. Nevertheless, this year's graduates will likely face a more challenging situation than other years, and the government will continue to consider additional support, such as opportunities for recurrent education.

Prof. Brodjonegoro said that most businesses in Indonesia are small and medium-sized enterprises (SME). A survey found that SMEs with digital exposure were more likely to survive the current crisis. This reinforces the importance of promoting the digital transformation of businesses.

Ms. Andrews answered that the Australian government has been providing financial support to people who have lost their jobs, as well as support for businesses that have suffered a significant downturn so they can in turn maintain the employment of their workforce. At the same time, it is also focused on the future and setting people up to be able to live and work with COVID-19.

Q&A Session

Mr. Keith Williams, former President and CEO, UL, raised a question regarding how governments are helping university researchers connect with angel investors so as to promote new businesses and innovation.

Ms. Andrews answered that the Australian government is also aware of difficulties for researchers in securing finance for the commercialization of research innovations. To address this, the government is implementing various programs, including those with private equity support.

Prof. Cauce said that the US government has provided stimulus funding that has helped support universities. Still, universities need to strongly make the case to the government that universities are partners for the government in achieving a recovery from this crisis. This is because universities produce skilled and knowledgeable graduates for the workforce and make critical discoveries for overcoming COVID-19 and other societal challenges.

Next, Mr. Williams asked about the education gap in the United States and how universities can apply lessons learned from COVID-19 to overcome this gap in their own communities.

Prof. Cauce replied that the University of Washington is already promoting outreach activities and the pandemic has revealed opportunities to better harness digital tools to that end. The university is also providing various supports for low-income university students, as well as pre-university students.

A participant then asked about future advances in AI and automation, noting that while this will promote efficiencies, it will also raise the need for greater creativity and craftsmanship. How can these qualities be fostered in STEM education?

Ms. Andrews believed that the technologies of the fourth industrial revolution will continue to grow in importance. Students need to be prepared for this future, including the potential implications and societal impacts. Technology should be introduced at a pace that allows society to understand the implications and not feel threatened or left behind.

Prof. Brodjonegoro believed that governments must foster strong and close collaboration between academia and industry, which is key to promoting innovation. Universities must also focus on generating more start-ups.

Mr. Hagiuda said that Japan formulated a national strategy for incorporating AI into society. It is also promoting efforts to develop human resources that can support the digitalization of society and greater utilization of AI. This includes fostering greater digital literacy. In addition, Mr. Hagiuda believed that there are also negative aspects of digital technologies and Japan aims to foster human resources who recognize that AI and other technologies are merely tools and are able to utilize them for good. Mr. Hagiuda also said that face-to-face communication is an important element of education.



Prof. Cauce added that STEM fields can be very competitive and that sometimes creates a fear of failure among students. That is why the University of Washington is helping students to fail “forwards.” Part of that is to reframe how people think about the STEM fields, from thinking about weeding students out of these fields, to feeding more students from diverse backgrounds into them. This is absolutely critical for innovation.

Science and Technology in Business

[Chair]

Sasaki, Nobuhiko, Chairman and CEO, Japan External Trade Organization (JETRO), Japan

[Speakers]

Bulgurlu, Hakan, Chief Executive Officer, Arcelik, Turkey

Gonokami, Makoto, President, The University of Tokyo, Japan

Kadri, Ilham, Chief Executive Officer, Solvay, Belgium

Krishnamoorthy, Shankar, Executive Vice President in charge of Strategy & Innovation, Industrial Development, Research & Technology, and Procurement, ENGIE, France

Mohr, Catherine, President, Intuitive Foundation, U.S.A.

Wongtschowski, Pedro, Chairman, Board of Directors, Ultrapar Participações S.A., Brazil

[Commentator]

Gilchrist, Moira, Vice President Strategic & Scientific Communications, Global Communications, Philip Morris International Management SA, Switzerland

Remarks



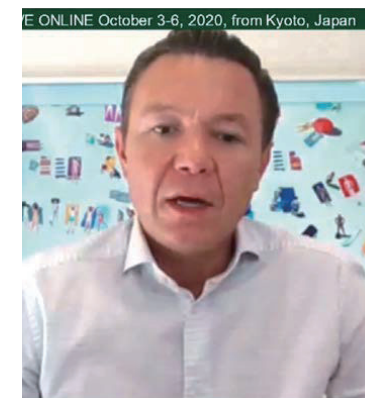
Sasaki, Nobuhiko

Mr. Nobuhiko Sasaki pointed out that although each country has been devoting every effort to preventing the spread of infection, COVID-19 has nonetheless had a great impact on the business environment and the global economy. Businesses have been forced to implement various changes including increased remote work to limit social contact, preparing network environments to bolster remote access, and changing business operations to reduce face-to-face activities. Companies are moving beyond existing business to expand into new areas, and have begun restructuring and diversifying their supply chains. JETRO has been supporting Japanese companies to meet and collaborate with overseas companies,

while also assisting small and medium-sized enterprises to expand overseas, including effectively utilizing digital tools to facilitate participation in online business meetings and virtual trade fairs, as well as to support digital marketing and content creation. To overcome the environmental changes brought about by COVID-19 and achieve business growth, there is an even more considerable need for collaboration between industry, government and

academia to utilize the wisdom of science and technology in business activities. Such collaboration will also contribute to the achievement of the sustainable development goals (SDGs).

Mr. Hakan Bulgurlu believed that the pandemic has brought people together and promoted close collaboration across industries and countries. The whole world has come together to fight the virus, for example through a massive effort to develop vaccines and make them available at affordable prices to consumers and people who need them the most. Arcelik has also done its part, focusing, in the early days of the pandemic, on creating ventilators to save the lives of people in intensive care. In two to three months, the company was able to produce 5,000 units and send them all over the world. This was only possible by working with new partners, such as aeronautics contractors. This demonstrates the power of collaboration. However, the pandemic is nothing compared to the challenge posed by climate change. Every single human being, let alone business leaders, has the responsibility to act and combat the coming climate crisis. This will require every ounce of science and technology that humankind can muster globally, without borders, without company limitations and without industry limitations.



Bulgurlu, Hakan

Dr. Makoto Gonokami pointed out that, in addition to COVID-19, the world also faces rising international tensions, social fragmentation, and global warming and extreme weather. These problems were created by current economic systems and the University of Tokyo's mission is to solve them and build an inclusive society. Value is moving from goods to knowledge and the fundamentals of capitalism must be updated accordingly. There needs to be a new economic mechanism where social significance is correctly valued. To contribute to creating such a knowledge-intensive and inclusive society, the University of Tokyo established the Center for Global



Gonokami, Makoto

Commons, which aims to collaborate with diverse stakeholders to drive change of our social and economic systems to safeguard the global commons. The Japanese government is now planning to expand universities' missions so that they can be used to create new economic value through industry-academia collaboration and encouraging companies to incorporate environmental, social and governance factors into investment decisions, which have much in common with and will contribute to the SDGs. As part of such efforts, the University of Tokyo will issue a 40-year bond as a social bond. Through this and other initiatives, the university will promote sustainable growth and strive to create new values for the post-COVID-19 world.

ONLINE October 3-6, 2020, from Kyoto, Japan



Kadri, Ilham

Dr. Ilham Kadri began by stating that no company will have a future if it does not raise the bar on sustainability and that there is no sustainability without chemistry. Solvay has built a strong foundation in sustainability and through its purpose – bonding people, ideas and elements to reinvent progress – it strives to create sustainable shared value for all. Reinventing progress requires even greater collaboration than before, through open innovation with stakeholders all over the world, but it also requires a bold approach to sustainability. Solvay's holistic sustainability strategy, called “Solvay One Planet,” takes into account not only what the company can

do for the climate and resources, but also how it can contribute to a better life for its employees and the communities in which it operates. Solvay One Planet is good for the people, the planet and profitability. As chemistry can be found in day-to-day products and is an enabler everywhere, including in projects like the recycling of batteries for electric vehicles, it is fundamental to realizing a circular economy.

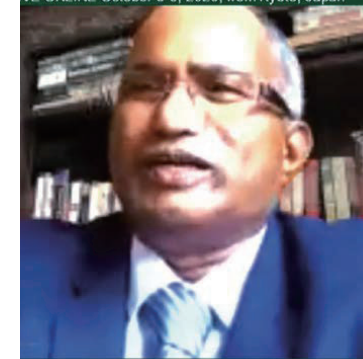
Mr. Shankar Krishnamoorthy stressed that the challenges of COVID-19 are nothing in comparison to the challenges of the climate crisis. To address this crisis, trust and collaboration are essential. Trust is key to running a business and has helped ENGIE to have an open discussion with employees about the challenges the company is facing, the challenges the whole world is facing, what is expected of them, and what needs they want the company to accommodate. Meanwhile, collaboration with suppliers and business partners ensures that everybody helps one another. In fact, the COVID-19 crisis has encouraged

greater collaboration and shown the world that working together is essential for building a better tomorrow. While the pandemic has obviously had an enormously negative impact on the whole planet, it has also reinforced the importance of certain values, including trust, collaboration and ethical treatment for all.

Dr. Catherine Mohr explained that the Intuitive Foundation is a philanthropic and research funding organization for Intuitive Surgical, the maker of the da Vinci surgical robot. Intuitive Surgical makes an entire family of surgical robots of which there are thousands in hospitals around the world. The most critical aspect of the robots is the high precision reproduction of the surgeon's hand motions while making small incisions that allow the patient to heal faster than the large incisions of traditional open surgery. The very nature of the company's highly specialized high-tech components necessitates a global supply chain that was impacted in waves by the COVID-19, but medical devices are essential businesses and the company had to scramble to figure out how to keep its workers and suppliers operational and safe, often ahead of directives from local governments. This drove innovation in providing distance learning and simulation-based training and has also promoted greater collaboration with local training programs. The Intuitive Foundation also funds the Global Surgical Training Challenge aimed at building high-quality open-source surgical training materials for surgeons from low and middle-income countries.

Dr. Pedro Wongtschowski pointed out that the COVID-19 pandemic has given humankind a series of very important lessons. It has indicated that infrastructure in science is a must for any country. In response to the pandemic, governments had to have scientific and technological infrastructure in place to be able to react in a very fast and proper manner.

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Krishnamoorthy, Shankar

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Mohr, Catherine



Wongtschowski, Pedro

Meanwhile, businesses had to adapt to new conditions, protecting workers and collaborators, while at the same time maintaining operations. Those businesses that coped well had the necessary people, structures and processes in place for crisis management. The pandemic has taught companies that preparation is a must and that companies must be able to adapt to changing conditions. It also showed that digitalization is essential. Furthermore, governments should be strongly encouraged to invest heavily in science and technology to be prepared to cope with major challenges such as those the world is facing now.

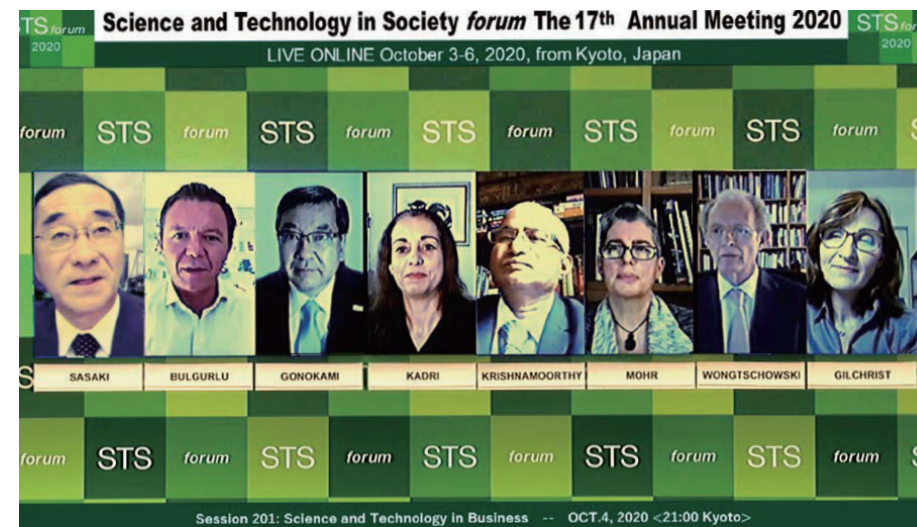
Discussion

Mr. Sasaki posed questions to the panel members about their efforts to promote sustainability. He first asked Mr. Bulgurlu about the challenges his company has faced in producing ventilators.

Mr. Bulgurlu explained that in the early days of the COVID-19 pandemic, there was a dire need for mechanical ventilators, which are complicated to produce. Arcelik brought together a global collaborative team with a number of different companies, public organizations, and medical institutions and was able to produce 5,000 units in three months, for no profit. It also open-sourced the design of a ventilator, which was then manufactured in South Africa. One of the challenges is that because ventilators are health devices, there is no room for error. It was only by collaborating with health and medical organizations that it was possible to meet this requirement.

Mr. Sasaki then asked about the efforts of the University of Tokyo to create a sustainable future and its relationship to reshaping society and the economy.

Dr. Gonokami believed that alongside the COVID-19 and climate change crises, human society is also undergoing rapid digitalization, which has the potential to improve society and reduce disparities, but could also do the opposite. Japan has come up with the concept of Society 5.0, where diversity is valued and everyone can achieve their full potential. The University of Tokyo views universities as platforms for social change and has established



the Center for Global Commons, as well as issued social university bonds for promoting upfront investment in a better future. Furthermore, it has set up a new partnership scheme for organizational-level industrial collaboration to create a future vision. Overall, the role of universities is to take the lead in society and pave the way forward.

Mr. Sasaki wanted to know more about how Solvay is incorporating society in its effort to promote a circular economy.

Dr. Kadri expressed her belief that society cannot exist without the environment, and society is facing many problems related to the environment, including climate change, loss of biodiversity, and water and food shortages. Humankind must reinvent how it views progress in a more sustainable way. To that end, Solvay's vision is to create sustainable shared value for all and science and technology will be key to that. Through Solvay One Planet, the company is also tackling climate change, overcoming resource challenges, and creating better lives. Solvay includes society within the scope of all that it does, including supporting health and social organizations during the pandemic and developing a sustainable value chain. Lastly, Dr. Kadri stated that sustainability is businesses' license to operate.

Mr. Sasaki highlighted Mr. Krishnamoorthy's point that trust and collaboration are essential for tackling global challenges, and requested examples from his work.

Mr. Krishnamoorthy explained that trust and collaboration has enabled ENGIE to develop businesses in a way that is useful to mankind. They have helped enable the company to be involved in large-scale ventures that would not be possible by one company alone, particularly those involving companies that would normally be competitors. ENGIE considers it its responsibility to work with companies and universities to decarbonize society. To that end, it has worked with competitors to construct large-scale ocean windfarms in multiple countries, or to develop photovoltaic technologies. It has also collaborated with various universities and corporations to develop new business models that contribute to decarbonization.

Next, Mr. Sasaki inquired about how the Intuitive Foundation can improve healthcare in low and middle-income countries.

Dr. Mohr explained that her company develops surgical robots that are able to carry out minimally invasive surgeries and conduct advanced imaging in the case that the surgery would otherwise be too complex to be conducted minimally invasively. Minimally invasive surgery means patients spend less time in hospital and are able to get back to work more quickly. This is particularly valuable in low and middle-income countries where there are often weaker safety nets and people can ill afford to miss work for prolonged periods of time. Another advantage is that it also helps reduce the number of people in hospitals and intensive care units, which is especially important amid the current pandemic where hospitals are being overburdened.

Mr. Sasaki asked Dr. Wongtschowski about the kinds of changes for businesses that he has seen during the pandemic and those he expects to see moving forward.

Dr. Wongtschowski said that, in the immediate response to COVID-19, most businesses took action to protect workers, suppliers, customers, and cash flows. They also took steps to ensure they could continue to operate. However, the pandemic posed many challenges for production plants in particular, such as being forced to operate with fewer people or being unable to access certain raw materials. Therefore, companies with good crisis management plans were able to cope better than others. Looking forward, it is unlikely that people will continue working from home into the long-term. Remote work comes with problems such as reduced productivity and lack of creativity, which is often triggered by interaction with others. Businesses will need to bring people back into the office in a safe way and maintain an environment conducive to creativity.

Mr. Sasaki noted that open innovation has been progressing under COVID-19, often with the aim of tackling societal issues. However, more fundamental issues such as climate change remain. Mr. Sasaki then invited Mr. Bulgurlu to comment on the types of innovation that will be essential for the coming climate crisis.

Mr. Bulgurlu believed that climate change would be far more devastating than COVID-19. Climate change is progressing at such a speed that humankind's ability to mitigate it is declining even faster. Mr. Bulgurlu explained that he recently climbed Mt. Everest to raise awareness about climate change, and part of the reason he chose to do that was because the glacier basin at the foot of Mt. Everest is home to the largest glaciers remaining in the world. Nevertheless, they have reduced in mass by 50% in the past 40 years, with the remaining 50% projected to be lost in the next 60-70 years. When that happens, 2 billion will lose their water source and be forced to move, triggering the largest mass migration ever seen.

As for open innovation, Mr. Bulgurlu believed that, until now, many businesses thought of sustainability as a matter of spending money and losing profit, but Arcelik, which has become completely carbon neutral, has proven that this is not the case. Consumers today are willing to pay more for the products of companies that they believe are doing the right thing. Companies have a responsibility to innovate and tackle societal issues, and key to doing that is collaboration across sectors and industries, open-source technologies, and incentivizing employees to act sustainably.

Mr. Sasaki asked Dr. Kadri for her thoughts on the overall design of open innovation.

Dr. Kadri pointed out that Solvay pioneered open innovation in the early 20th century, with the founder of the company bringing together many brilliant minds to do so. Solvay continues to collaborate with top researchers from universities and research organizations around the world, working to apply fundamental science into solutions that can be applied for society's progress. Digital transformation will also likely revolutionize and accelerate these efforts. Solvay applies virtual engineering, simulations and modelling with its customers for example at its new Material Science Application Center in Brussels. Open innovation and collaboration today require collective inputs from many key stakeholders as is shown in the European Battery Alliance or in Solvay's circular battery consortium. Designing successful future open innovation will require tough choices to ensure urgent and efficient action.



Mr. Sasaki asked about ways to build trust in new government-industry-academia collaboration.

Mr. Krishnamoorthy underscored the importance of face-to-face meetings and conversation, speaking the truth, and taking a longer-term view rather than trying to score a quick win. Furthermore, it is necessary to set appropriate targets based on careful consideration and then working out fairly and in detail how to share the benefits with others.

Mr. Sasaki wondered what kinds of knowledge are required of human resources who will spearhead the future and asked how universities and society can foster those qualities.

Dr. Gonokami stated that the world is in a time of change, and in such a world, one must not rely only on the knowledge of the past, but also find the creativity to achieve breakthroughs in diverse fields. Collaboration between universities and industry is essential for that. The leaders of the future need a bird's eye view of diverse fields and timescales. Entrepreneurship is also required for applying such a view in society. The University of Tokyo is promoting collaboration with industry both in Japan and abroad, to keep students and faculty connected to broader society.

Mr. Sasaki then invited Dr. Moira Gilchrist to comment on how to balance the positives and negatives of science and technology to form a sustainable future for humankind.

Dr. Gilchrist believed that there are three keywords for this. The first is responsibility. Businesses must take responsibility to acknowledge the problems that their products and operations can cause. The second is innovation. Problems cannot be solved without innovation. The third is collaboration. Without collaboration, it is not possible to move forward. The journey of Philip Morris International in the past decade embodies these three keywords. It has made the decision to fundamentally transform its business and shift away from selling cigarettes, the product that has made it successful. This endeavor would not be possible without those three keywords.



Gilchrist, Moira

Q&A Session

Dr. Ismail Serageldin, Founding Director Emeritus, The Library of Alexandria, Egypt, asked the panel to comment on the potential for greater use of nuclear energy in the future or greater application of niche types of innovation in nuclear energy. He also wanted to know if it will be possible to maintain certain industries, such as auto-manufacturing and steel-making without conventional fuels.

Mr. Krishnamoorthy pointed out that, besides safety and security concerns, cost and time are other factors hindering greater adoption of nuclear energy. In this regard, a promising development has been small modular reactors and the construction of the first such reactor has been approved. It is hard to predict how this will play out, but there are certainly other technologies being developed for enabling the greater use of nuclear energy. Mr. Krishnamoorthy also pointed out that hydrogen offers a lot of potential in terms of the greening of energy consumed by certain industries.

Dr. Kadri said that Solvay believes that electric and hydrogen systems can co-exist and will be essential for cleaner mobility, an area where Solvay plays a key role. As part of Solvay's objectives to accelerate the reduction of greenhouse gas emissions, Solvay has also announced that it will no longer use coal and is shifting to renewable energy sources such as biomass.

Mr. Sasaki wrapped up the session by saying that he was encouraged by the discussions, which reminded him of the need to bring together knowledge and wisdom from a range of stakeholders to be able to tackle issues of a global scale. Furthermore, they reaffirmed to Mr. Sasaki the important role played by STS *forum*.

Global Health: Lessons from New Coronavirus Crisis

[Chair]

Fineberg, Harvey V., President, Gordon and Betty Moore Foundation, U.S.A.

[Speakers]

Collins, Mary, Provost, Okinawa Institute of Science and Technology Graduate University (OIST), Japan

Gao, George Fu, Director-General, Chinese Center for Disease Control and Prevention, China

Gerberding, Julie Louise, Executive Vice President and Chief Patient Officer, Strategic Communications, Global Public Policy, and Population Health, Merck & Co., Inc., U.S.A.

Hayashizaki, Yoshihide, Program Director, Preventive Medicine and Diagnosis Innovation Program, RIKEN, Japan

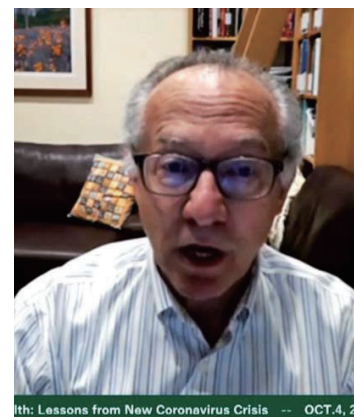
Roberts, Richard J., Chief Scientific Officer, Department of Genome Biology, New England Biolabs, U.S.A. [Nobel Laureate 1993 (Physiology or Medicine)]

[Commentator]

Swarup, Renu, Secretary, Department of Biotechnology, Ministry of Science and Technology, Government of India; Chairperson, Biotechnology Industry Research Assistance Council (A Government of India Enterprise), India

Remarks

To begin, Dr. Harvey V. Fineberg pointed out that the COVID-19 epidemic is actually one of a series of emerging infections over the past century, including Zika, Ebola and severe acute respiratory syndrome (SARS) in just the last twenty years. While the current crisis is a public health crisis,



Fineberg, Harvey V.

it is also a medical care crisis where medical systems can be overwhelmed or lack the necessities to care for patients and protect healthcare workers. In addition, it is also an economic crisis in countries individually and globally, a social crisis, a crisis of confidence, in the public's mind, in expertise in science and leadership, a crisis of global relations, and a crisis of confidence in international agencies. Another problem is that the disease has expressed itself differentially in different countries and the responses in each country have been very different as well. Hopefully, moving forward, it will be possible to derive important lessons from the experiences of different countries.



Collins, Mary

Dr. Mary Collins began by explaining that she lives in Japan's most southerly prefecture, Okinawa, the main island of which is some 1,500 kilometers from Tokyo. It is no coincidence that the only countries to remain COVID-19 free have been small island nations. One might assume that Okinawa has similarly been relatively free of COVID-19 cases. However, Okinawa has a population of 1.5 million and has had 41 COVID-19-related deaths, which is sadly the worst death rate per million in Japan, but much better than the rate in other countries. Medical facilities have not yet become overwhelmed and at the moment cases are largely brought by

travelers from mainland Japan. The Okinawa Institute of Science and Technology has been performing clinical PCR testing since April and working with the prefectural government to develop and implement suitable rapid testing. A positive aspect of the situation in Okinawa is that there is a strong focus on individuals fitting into the community, which means everyone is anxious to follow instructions.



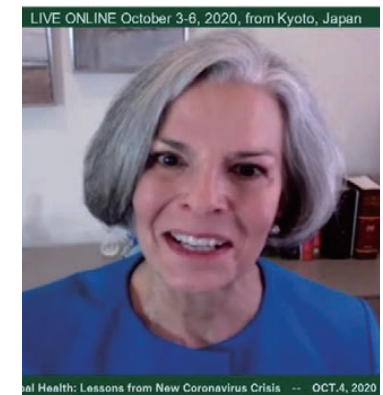
Gao, George Fu

Prof. George Fu Gao noted that over the past decades, humankind has encountered many viruses and diseases but none like COVID-19. For a long time, people talked about the potential for another pandemic, but no one could have imagined that it would be like what the world is experiencing now. While there were some lessons that could be learned from past pandemics, the world was not ready for COVID-19. This pandemic emerged because of human behavior. For example, increased human travel has created new virus pathways spanning continents. As for the lessons to learn from this pandemic, the first is for scientists to work together

and share their data and experiences. Second is the need to respect Mother Nature. In addition, one of the most important lessons is to prevent or correct misinformation. For that, public understanding and public engagement is required. Above all, the world needs solidarity and to work in unison.

Dr. Julie Louise Gerberding stated that the global pandemic has taken a toll not only on individuals and communities but also on healthcare systems and economies, and expressed concern about a potential backlog of people who have had to defer their routine healthcare during this time and are therefore not getting vaccinations, cancer screenings and other important preventative care, creating an additional burden of morbidity and potential mortality. Societies need to work to avoid the spread of this disease and minimize the impact if health systems falter even further. This will require multi-sector and multilateral public-private partnerships.

For the future, there needs to be better local preparedness and stronger international cooperation, including a network of global security that builds capabilities to detect and respond to the next infectious disease outbreak. One positive to emerge from the crisis is the effort of the pharmaceutical industry, which has been stepping up and coming together to combat this pandemic. Still, better preparation for the future is needed, and one model worth learning from is the Coalition for Epidemic Preparedness Innovations.



Gerberding, Julie Louise

Dr. Yoshihide Hayashizaki believed that there were two reasons the new coronavirus caused a pandemic. The first is that most people who are spreading the virus are asymptomatic. The other is that even symptomatic people start shedding the virus before the onset of symptoms. As a result, the response to COVID-19 has changed from the first wave to the second wave. In the first wave, the focus was on definitive diagnostics of symptomatic patients without false negatives. In the second wave, the focus was on the tradeoff between the recovery of economic activity and the containment of COVID-19. To do that, it is necessary to detect a few positive persons from a large number of the healthy people. The speed of the testing for that is very important for maintaining economic activity. One method is a snapshot test with timestamps. For such testing to be effective, it needs to be high-speed, high-sensitivity and portable.



Hayashizaki, Yoshihide



Roberts, Richard J.

Dr. Richard J. Roberts explained that New England Biolabs (NEB) has, for many years, been developing a very rapid LAMP test for viral sequences. For COVID-19 it put together a test that can be done in about 30 to 45 minutes that gives a color output if COVID-19 is present. NEB is working with the Gates Foundation to make this test available to people in developing countries, as it is ideal when lacking the resources that are necessary to do a PCR test. Another important challenge for tackling COVID-19 is developing a vaccine. One difficulty for that is to find enough people who actually get exposed to the virus. Challenge trials can be useful in this regard.

In addition, once a vaccine is developed, it is essential to make sure it is accessible to developing countries as well, by sharing technology and reagents, and allowing scientists in developing countries to manufacture their own vaccines if necessary.

Discussion

Dr. Fineberg first asked the panelists what concerned them the most about the COVID-19 pandemic.

Dr. Collins said she was very worried that people are taking the vaccine as a given. She pointed out that the pathogenesis of the virus is very complex and different among individuals. She also noted that there is a history of vaccines for respiratory diseases sometimes exacerbating the disease, as well as the potential for vaccine-driven mutations of the virus.

Dr. Fineberg asked Dr. Collins if she was concerned about the duration of protection and the possibilities of enhancement.

Dr. Collins said she was less concerned by that, noting that there is data showing that people have cross-reactive T-cell responses to SARS-CoV-2 infections and antibody measurements following disease also seem more robust than previously suggested.

Prof. Gao expressed his worry about potential combined infections of COVID-19 and other respiratory viruses, such as adenovirus or respiratory syncytial virus, in the northern hemisphere in the coming winter season. This could be a serious problem.

Dr. Gerberding echoed the concerns expressed by Dr. Collins and Prof. Gao, while also adding a sociological aspect, noting that people seem to be fatigued by complying with practices for preventing the spread of infections. This, combined with the rise of additional respiratory diseases in winter, could significantly increase pressure on healthcare systems. She also believed the world was at risk of further nationalization and deterioration of the international collaboration that is necessary to bring the pandemic under control.

Dr. Hayashizaki stressed the need to maintain a balance between easing restrictions on economic activities and measures to prevent the spread of disease. He also expressed concern about the spread of other infections in the coming winter season, as well as the spread of misinformation. In addition, Dr. Hayashizaki called for the sharing of information across all sectors, both public and private.

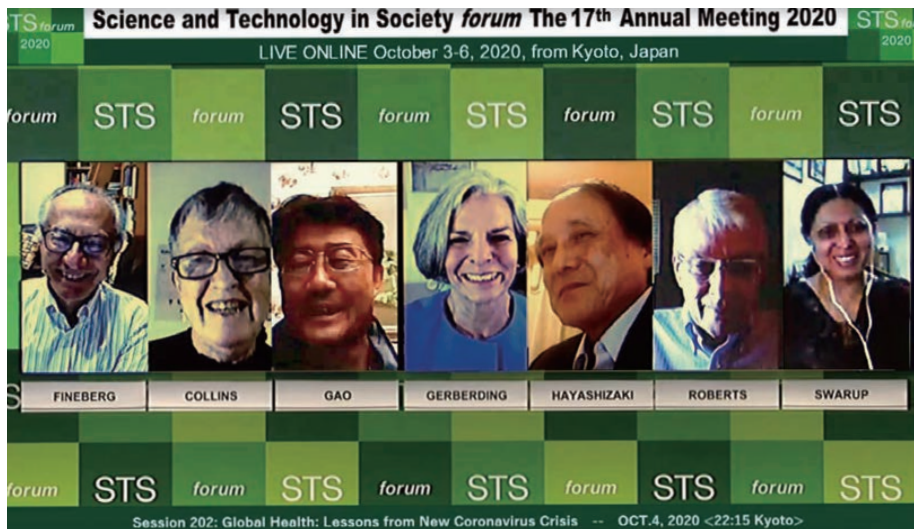
Dr. Roberts expressed dismay at the politicization of the COVID-19 issue in certain countries. In many countries, politicians have not listened to the science. The lesson is that it is important to elect politicians who are prepared to listen to scientific experts. International cooperation is also very important, and scientists have always been very good at this. That has not, however, been true of the politicians in this crisis.

Dr. Ren Swarup highlighted the importance of understanding the virus, which is key to controlling the transmission of the disease and infections. She echoed the need for global cooperation and the sharing of information. Furthermore, she stressed the importance of maintaining a science-based approach and engaging citizens.

Dr. Fineberg then asked Dr. Collins for her thoughts about the differential expression of the disease, including why this is happening and how it can be tackled.

Dr. Collins expected to see genetic studies being conducted in the coming years and believed that the findings could be very impactful. She also made the point that, as a non-Japanese person living in Japan, she has noticed the very high levels of personal and social hygiene in the country and thought that this may be worth studying going forward as well. It is important to be aware that there are different levels of social contact and correspondingly different levels of the spread of infection.

Dr. Fineberg noted that a recent study showed that a very small percentage of infected persons seems to be responsible for the vast majority of the spread of infections.



Prof. Gao commented that there are three key points for dealing with any emergency outbreak. First, everything must be science-based. Second, when implementing any strategy policy, it is vital to gain the understanding of the public, including policymakers. Third, any decision should be made at the policy level and must be well-organized. Based on that, scientists must focus on the science and finding the truth, sharing their data and findings with their colleagues, and collaborating with the public and policymakers.

Next, Dr. Fineberg asked Dr. Gerberding for advice for promoting international collaboration under the current global circumstances.

Dr. Gerberding shared her own experience of scientific collaboration between the US and Chinese Centers for Disease Control and Prevention to prepare for pandemic influenza. Such collaboration is the foundation of global health security and can cut through political obstacles. While science is the foundation, good communication of that science, to policymakers and the public, is also essential. Trust in scientists and science seems to be at an all-time low, at a time when scientific leadership is most needed. Much work needs to be done to improve it, but lots of lessons have been learned in the meantime about how that can be done.

Dr. Fineberg invited Dr. Hayashizaki to share his views on scientist-to-scientist cooperation.

Dr. Hayashizaki pointed out that the news has, obviously, been centered on COVID-19, but news reports are not always scientifically-correct. In fact, sometimes, they can be very inaccurate. Scientists in Japan have been working together to point out publicly which pieces of information are scientifically correct or incorrect. As an example, Japanese scientists found that various ineffective sterilizing reagents were being advertised and decided to conduct experiments, with open data, to prove which were effective and which were not.

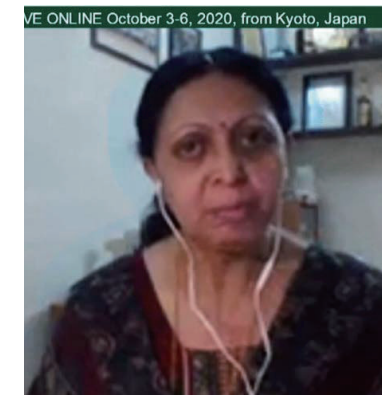
Dr. Fineberg asked Dr. Roberts for his views on scientist-to-scientist collaboration in the face of the current geopolitical realities.

Dr. Roberts believed that many scientists are not good at communicating science to the public, especially to politicians. This must be corrected, for example by teaching future scientists about effective public communication at university. International collaboration among scientists is also fundamental and should be encouraged, not discouraged.

Dr. Fineberg asked Dr. Swarup for her thoughts on scientist-to-scientist cooperation across national boundaries.

Dr. Swarup said that science knows no borders and that scientists have built up strong collaborative foundations over many years. In such times of crisis, these cooperative relationships are essential. She also highlighted the importance of science-based communication, if not necessarily by the scientists themselves, then from science communicators. Efforts also need to be made to ensure the media and public are aware of the excellent science that is being generated.

Dr. Fineberg then asked the panelists to comment on where they find the greatest hope going forward.



Swarup, Renu

Prof. Gao said he was optimistic about the speed with which the development of vaccines is progressing. Many candidate vaccines have been developed which is reason for hope, even if caution is of course required.

Dr. Gerberding believed in the power of science, including the many developments that are underway, and saw hope in the level of global cooperation taking place.

Dr. Hayashizaki thought the experience of COVID-19 itself is the greatest reason for hope. This is the first time that Japan has experienced such a pandemic and many lessons were learned, including the development of an emergency protocol for easing regulatory restrictions, the creation of new diagnosis kits for rapidly detecting the virus, and efforts to develop vaccines and antiviral drugs quickly.

Dr. Roberts said he had eternal hope in science, pointing out that many scientists that were not working on COVID-19 previously have come together to work on it now. The crisis has also demonstrated how things can be done better than in the past, such as testing or vaccine development.

Dr. Swarup found optimism in how the scientific community has come forward and acted rapidly to tackle this crisis. This includes not only researchers and governments, but also corporations and start-ups.

Q&A Session

Dr. Ismail Serageldin, Founding Director Emeritus of The Library of Alexandria, pointed out that there is still an enormous economic cost associated with social distancing measures. Many countries have responded by launching massive domestic stimulus programs. However, little is being done to provide financial support for lower-income countries. Many of these countries also face problems such as weak infrastructure, burgeoning populations and inadequate healthcare capacity. Dr. Serageldin suggested that these are fundamental factors that should be considered when developed countries deploy science. In fact, given the interconnected nature of the world, it is in developed countries' interest to eradicate the disease everywhere.

Dr. Roberts agreed and shared that NEB has developed a cheap rapid LAMP test for COVID-19 and is making it available through the International Centre for Genetic Engineering and Biotechnology to resource-poor countries, including reagents and the methods for



diagnosis. He expressed his hope that this would set an example and that other companies will take similar steps.

Dr. Hayashizaki shared that, through its experience, Japan learned the importance of developing new test kits and markers that are rapid, portable and highly sensitive, and making them widely available.

Dr. Gerberding commented that the pandemic has forced humankind to confront the great socio-economic and health inequities that exist in the world, and reinforced the need to think globally when trying to tackle this issue. She also explained that Merck is working to develop vaccines that can be deployed globally at affordable prices. This cannot be achieved by one company alone or even many companies, and is only possible through wide-ranging collaboration among companies, countries, and international organizations.

Prof. Gao likened the interconnectedness of country's health security to an apartment building where one apartment is on fire. The people in the other apartments must put out that fire or their apartments will catch fire as well. In the same way, all countries and their people share one planet, and their wellbeing is interrelated.

Dr. Collins believed that there is huge potential for developing faster, cheaper home testing. Much ingenuity has already been directed at such efforts but more still could be done. Dr. Swarup believed that the world has been talking about global access for a long time and this crisis is an opportunity for humankind to work collectively to demonstrate that. More developed countries should work with their neighbors and others to develop healthcare capacity.

Dr. Fineberg concluded by reiterating the importance of science and of a global attitude, whereby all people and countries recognize that they are in the problem together as one world. He also saw promise in the sharing of diagnostic knowledge, basic scientific knowledge and vaccines. At the same time, Dr. Fineberg noted the continued challenge posed by underlying discrepancies in countries' capacities to deal with public health crises.

Improving Preparedness for Pandemic Diseases: the Role of S&T

[Chair]

Wallberg, Harriet, Professor and former President, Karolinska Institutet, Sweden

[Speakers]

Chen, Chien-Jen, Academician / Distinguished Research Fellow, Genomics Research Center, Academia Sinica, Taiwan

Cueni, Thomas, Director General, International Federation of Pharmaceutical Manufacturers & Associations (IFPMA), Switzerland

Hamburg, Margaret A., former Commissioner, US Food and Drug Administration (FDA); Immediate past Board Chair/President, American Association for the Advancement of Science (AAAS), U.S.A.

Hanafi, Sari, President, International Sociological Association; Professor, Department of Sociology, Anthropology & Media Studies, American University of Beirut, Lebanon

Ligner, Emmanuel, CEO, Cytiva, U.K.

Tan, Chorh Chuan, Chief Health Scientist, Ministry of Health (MOH); Executive Director, MOH Office for Healthcare Transformation, Singapore

Yamanaka, Shinya, Director and Professor, Center for iPS Cell Research and Application (CiRA) Kyoto University, Japan [Nobel Laureate 2012 (Physiology or Medicine)]

Remarks



Wallberg, Harriet

Prof. Harriet Wallberg noted that even though pandemics have been featured in human history for thousands of years, the COVID-19 outbreak took the entire world by surprise. The worldwide search for strategies to combat this new virus is still ongoing. Clearly, most countries were not well prepared for the pandemic, as evidenced by struggles to provide healthcare workers with the right protective gear or implementing a well-balanced lockdown. Scientists are struggling to find treatments as well as vaccines; however they have also been instrumental in many other ways, including studying why some people are more susceptible to the virus and what treatments should be given to certain people.



Chen, Chien-Jen

Dr. Chien-Jen Chen believed that there were many inadequacies in the global response to COVID-19, including delayed border quarantines, insufficient tracking systems, inefficient isolation and quarantine of confirmed cases, and inadequate social distancing. Meanwhile, according to rankings by some news outlets, Taiwan's was the best at coordinating containment and economic stimulus. Its rapid response to COVID-19 was based on past experiences of containing severe acute respiratory syndrome (SARS) and H1N1. Taiwan did not lock down any city nor carry out mass screening but used many smart technologies to control the disease,

including surveillance using ICT and AI technology, quick announcement of travel warnings using cellular broadcasts, stringent border control, and tracking of cross-contacts using ICT technology and big data analysis. Looking ahead, scientific discoveries and technological development may improve future preparedness for pandemic diseases, particularly new biomedical technologies in four categories: diagnosis and therapy, disinfection, healthcare, and telemedicine. It is hoped that all such advancements will be shared internationally to contain any future global pandemic.



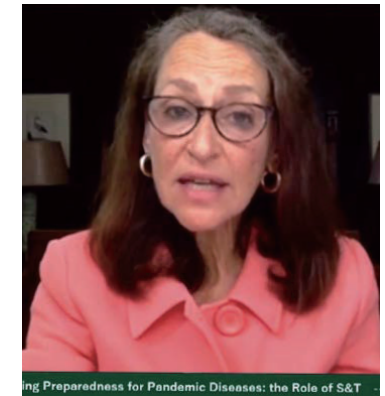
Cueni, Thomas

Mr. Thomas Cueni shared five lessons from the COVID-19 pandemic. First, the pharmaceutical industry had to understand that this is not business as usual. This is a challenge where industry had to step up and recognize its responsibility, with its scientists and engineers holding the keys to containing and ending COVID-19. Indeed, pharma companies have been working with academia, regulatory agencies, governments and international organizations to that end. Second is the importance of translational research and applying basic science and basic research into scalable solutions and treatments, exemplified by mRNA technology for

COVID-19 vaccines. Because of their versatility and scalability, mRNA vaccines have the potential to bring us closer to the vision of an ever-warm vaccine plant. The third lesson

is the continued need to rely on new and better treatment options, particularly translational research on monoclonal antibodies (mAbs), with a similar potential for use in future pandemics as mRNA vaccines. The fourth lesson concerns the importance of basic science. Lastly, various institutional partnerships for pandemic preparedness involving the private sector early on are important, as we realized the importance of the private sector in the current pandemic, in R&D, in scaling up manufacturing capacity, and in deployment. There will undoubtedly be future pandemics and academia, international health organizations, governments, industry and civil society must work together now to ensure that the world is never caught so unprepared again.

Dr. Margaret A. Hamburg stated that the COVID-19 crisis is tragic in part because it was predictable. A lasting lesson of the current crisis is the need to invest in infectious disease and pandemic preparedness. Furthermore, science offers the path forward and collaboration can change the trajectory of the pandemic. Countries that have handled the crisis best tended to have strong leadership, rapid response, a defined strategy and plan, clear and consistent public communication, and strong scientific expert input. The crisis has also demonstrated the importance of fundamental tools of public health disease such as surveillance, testing, case-finding, isolation, contact-tracing and quarantine. The next pandemic could be far worse unless society steps up to the challenge by investing in key areas such as disease surveillance and early warning, infrastructure for public health and health care, and the development of essential medical countermeasures. Additionally, no country is safe unless all countries are safe, and the fruits of science must be shared.



Hamburg, Margaret A.

Prof. Sari Hanafi believed that while the global crisis may have prompted fresh strategies to reinforce exploitation and increase the reach of people's greed and selfishness, it has also given humankind an opportunity to explore and provide new ways of understanding and reclaiming its social justice and humanity. He expressed his hope that there may be possibilities for transcending new liberal capitalism and reconnect individual society and nature, emphasizing two tasks. The first is to take an active approach in fighting against the disease of Anthropocene and the second is to connect science to moral philosophy. Human



Hanafi, Sari

consumption is depleting resources that the Earth cannot renew and COVID-19 is one outcome of this consumerism, with the virus being transmitted from a non-domesticated animal to human beings through such consumption. This ferocious consumerism must be reconsidered. In addition, scientists also need to rethink economic exchange, redistribution and reciprocity, with the aim of establishing controls against speculation, preventing the concentration of wealth in a few, and promoting the mutual exchange of goods and service with consideration for moral obligations and concerns.



Ligner, Emmanuel

Mr. Emmanuel Ligner stated that as a result of COVID-19, this is an unprecedented time and speed is at the center of every action and decision. COVID-19 has created an intractable pressure on industry leading to an incredible number of collaborations between academia and very large companies, and even among large companies that would normally be competitors. Governments have also been helping scientists and manufacturers. Furthermore, regulators are accelerating the approval of diagnostic or clinical trials in an unprecedented manner while maintaining safety standards. The lesson to learn from the current pandemic is the importance of

less politics, more global action and more private-public partnership. However, beyond the research, development and manufacturing of a therapy, diagnostic or vaccine, it is necessary to think about many other factors, such as transport, infrastructure, the constraints of remote working, the capacity of healthcare systems, and how to leverage the potential of big data and AI. These are all very challenging questions for society, scientists and industry.

Prof. Chorh Chuan Tan said that COVID-19 has demonstrated the critically important role that science and technology play in preparing for and responding to epidemic threats. In particular, he highlighted three points. The first is the need for long-term investment in basic research, rapid translation to support epidemic response, and platforms and enablers

that help turn basic science discoveries into innovations. Second is the importance of investing in preparedness beforehand to have the best chance of responding effectively to an epidemic. Third is to actively promote transdisciplinary research and find new ways for it to be applied across different sectors, including traditional biomedical and clinical sciences but also behavioral and social sciences, data analytics and modelling, environmental transmission research, and public health expertise. The COVID-19 pandemic is a crisis of unprecedented scale and impact. At the same time, society is learning many important lessons that, if applied successfully, could ensure better preparedness for future epidemics.

Prof. Shinya Yamanaka pointed out that no country can escape from COVID-19. The virus is nearly identical in each country, apart from perhaps a few mutations. However, each country is taking a very different policy and strategy and also experiencing very different results. The main differences in each country's response is the level of stringency, such as travel restrictions and school closures, and testing capacity. What is interesting about Japan's case is that it took a relatively mild policy and also had a relatively limited capacity for PCR tests, and yet Japan is suffering a much lower number of deaths compared to many other countries, including those with stricter policies. There may be some unknown factor or factor X that can explain this discrepancy, and many scientists have been trying to understand what it might be. In any case, different countries and their scientists should learn from each other and try to come up with a better idea of how to overcome this common threat.

Discussion

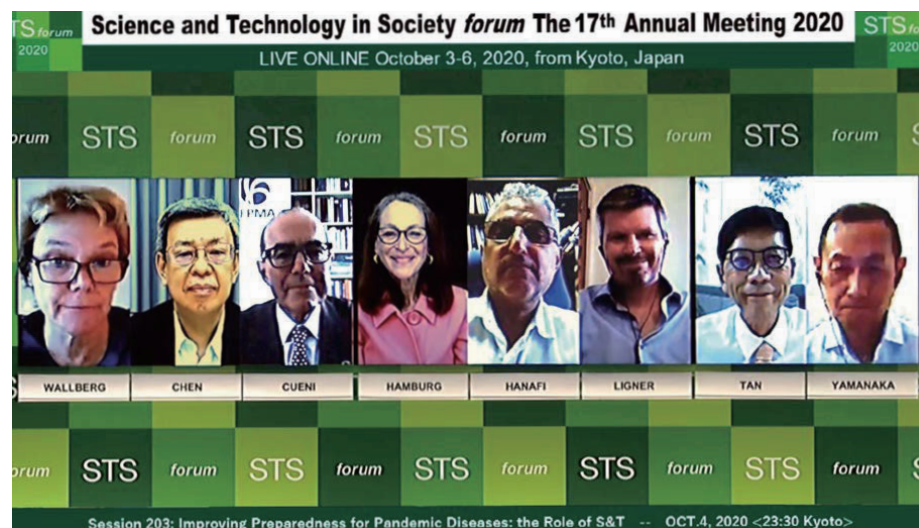
Prof. Wallberg asked the panelists if they thought the spread of COVID-19 could have been prevented or better controlled.



Tan, Chorh Chuan



Yamanaka, Shinya



Dr. Chen thought all countries failed to respond rapidly and adequately at the beginning.

Mr. Cueni believed that the world was badly prepared and utterly failed to respond. This response was better and faster than in the past but still not adequate.

Dr. Hamburg echoed those sentiments. In particular, she thought the world failed to implement practices that it knows should work well, such as a global system of disease surveillance and rapid reporting, resulting in a devastating impact on society. However, what has been successful has been the rapid mobilization of the biomedical community.

Prof. Hanafi agreed that the response has been insufficient. There is a tendency for people to want to adhere to business as usual, but perhaps the pandemic has provided an impetus for people to rethink social systems, including the relations between humans and nature, and excessive focus on consumerism.

Mr. Ligner thought that the response was inadequate and that the Western countries, which had more time to react, failed to act quickly enough. The world also failed to prevent the issue from being politicized. On the other hand, the large number of ongoing projects for the development of a therapy or vaccine, etc., has been promising.

Prof. Tan believed that biomedical research and the responses of some countries have been somewhat positive, but overall, the response of the global community was insufficient. In particular, the world was under-prepared and failed to apply lessons learned from previous pandemics.

Prof. Yamanaka concurred that the global community failed, at least initially. However, it has been doing better since, both in terms of administering treatment and developing a vaccine.

Prof. Wallberg then asked about the lessons learned, noting in particular the role of testing.

Dr. Hamburg said that testing is essential and must be linked to public health measures. Countries that responded well rapidly implemented testing strategies and contact tracing. Dr. Hamburg also believed that it is necessary to have a wide-ranging portfolio of tests for different purposes.

Prof. Wallberg noted that many Asian countries were able to ramp up testing rapidly.

Prof. Tan agreed on the central importance of testing. Testing is a key part of the public health response and has to be linked to effective contact tracing and public health actions. The rapid innovation and development of diagnostic tests and their application to a wide range of use cases has been welcome. One challenge, however, is that each country had to conduct its own clinical validation of tests. It would have been helpful if there was a more coordinated global effort to do this for common test kits.

Dr. Chen explained that Taiwan did not conduct mass testing and instead focused on careful contact tracing and tracking, based on which targeted testing was conducted or quarantine measures implemented. These three types of measures must be combined for an effective response.

Prof. Yamanaka said that the testing capacity in Japan has been limited compared to many other countries. Therefore, the country had to stick to a targeted testing policy. Fortunately, the results, at least in terms of number of deaths per capita, has been better than some other countries. Japan is trying to raise testing capacity, but it remains low. At the same time, raising capacity and maintaining it at high levels can be very costly. Therefore, in preparation for future pandemic, Japan must think carefully about its testing strategy.

Q&A Session

The first question from the audience concerned whether or not there is a need for at-home testing.

Dr. Hamburg answered that there is a need for a variety of testing strategies. At-home testing can provide value, but it needs to be recognized that such testing may be less accurate. Therefore, it needs to be part of a broader strategy that includes further testing and assessment. Different tests can be employed in different settings to provide useful information and a better understanding of the situation on the ground.

Dr. Chen suggested that at-home testing needs to be very accurate. Otherwise there are risks of false positives or, worse, false negatives. Such testing must be carefully examined and validated.

Prof. Tan added that it depends on the incidence of infection in a community and also the public health measure that would follow on from a positive test.

Mr. Ligner noted that once a vaccine is developed, it would be important to have rapid testing to confirm that it is working properly. In addition to rapid testing at home, having such testing for the workplace is also necessary for keeping businesses and the economy going.

Prof. Wallberg then turned the discussion to lessons learned about how people have responded to the crisis.

Prof. Hanafi pointed out that social distancing may have long-term implications on people's behavior and relationships. This is especially true for children and will affect their social development. He also noted that the pandemic has made people sense that their liberty is being restricted.

Dr. Hamburg reported rising rates of depression and addiction-related behaviors in the United States. She also noted the value of social interactions for children, especially as we think about schools reopening. The pandemic has reinforced the importance of social interaction for wellbeing. Additionally, Dr. Hamburg pointed out the harmful effects of the politicization of COVID-19-related issues.



Dr. Chen stressed the importance of transparency in communication and engagement of the public to foster trust and a sense of solidarity.

Next, Prof. Wallberg raised a question about the impact on and role of business, including in relation to the development of a vaccine.

Mr. Cueni highlighted the important role of industry in the current pandemic. He pointed out that the industry was able to respond with unprecedented speed and collaboration based on a strong innovation-based eco-system drawing on the industry's strengths: know-how and skillsets for researching, developing, and manufacturing, at scale, tests, treatments and vaccines. At the same time, companies understood that this is not business as usual and that society expects tests and so on to be available, affordable and accessible, including for developing countries. Mr. Cueni also commended regulatory agencies and industry for maintaining high levels of scientific rigor and standards in developing vaccines, rather than sacrificing regulatory science and safety for the sake of speed.

Dr. Hamburg added that regulatory authorities have been collaborating with each other as well as in partnership with the research community and industry to accelerate studies without sacrificing safety and quality.

Prof. Wallberg asked Mr. Ligner to comment on the role of industry as well.

Mr. Ligner was impressed by the level of collaboration that has taken place in the biomedical sector. Nevertheless, greater vaccine development capacity is required, including capacity in the supply chain and logistics. Mr. Ligner also pointed out such sudden increases in demand are not currently factored into company's business continuity plans and should be included going forward.

Prof. Wallberg concurred that the level of international collaboration between industry and academia is to be lauded.

Prof. Tan agreed on the importance of the role of industry, not only by developing treatments and vaccines that can directly address the disease, but also by coming up with innovations that can help facilitate non-pharmaceutical measures such as better social distancing and safe management.

Next, Dr. Marcia McNutt, President, National Academy of Sciences, U.S.A., raised a question about potential overreliance on testing and the danger of false negatives.

Mr. Cueni cited the importance of regulatory agencies working together to validate the quality of tests, even in the face of pressure to release tests more rapidly. Bearing in mind political pressures, it was important to move as fast as possible but as slow as needed in the development of tests, treatments, and vaccines, and industry was fully committed to the highest regulatory standards.

Dr. Hamburg concurred, sharing that she faced similar pressures when she headed the US Food and Drug Administration. A test is only valuable if it is accurate. Dr. Hamburg also pointed out that the application of regulatory standards must be consistent and that tests must be reliable.

Mr. Ligner asked for the panelists' views on how sample collection could affect the reliability of a particular type of test.

Dr. Hamburg agreed that this is an important factor and noted that in the development of new diagnostics, simpler sample collection has been taken into account.

Prof. Yamanaka thought that sample collection is particularly important for home testing, to ensure that the sample self-collection is properly performed. In addition, he felt that people need to be better educated about the limitations of testing and the implications of test results.

Next, Prof. Wallberg posed the question of how to prepare for more contagious pandemics in the future and how global collaboration could contribute to better preparedness.

Prof. Tan believed that much greater global collaboration would have helped to bring COVID-19 under control earlier, such as better coordination of responses and air travel, as well as the sharing of information and practices. This would require additional levers for the World Health Organization, as well as public-private initiatives with sufficient funding so as to enable rapid responses where they are most urgently needed. A more multilateral approach to vaccine allocation is also critical.

Prof. Hanafi noted that, because of the interconnected nature of the world, no country can go into a slow-growth economy without consulting the rest of the region or even the globe. The tendency for countries to seek to maximize economic growth above all else is an overarching cause of such pandemics, as it is the reason that human society is infringing on nature. Societies need to rethink the emphasis they place on growth. People also need to change the way they think about vacations. There is a tendency to associate holidays with international travel, and such hyperactivity is another reason for the global spread of COVID-19.

Dr. Hamburg believed that COVID-19 will change how people think about their lifestyles and how countries relate to each other. Against COVID-19, the world has mobilized and then may be becoming complacent. It cannot afford to do this in the face of more serious threats, nor to ignore the lessons from the current crisis. Countries should also recognize that it is in their vested national interests to work together to address such emerging global issues, and to work constructively without pointing fingers.

Dr. Chen stressed that no country can fight a pandemic alone. He called for greater collaboration through prudent surveillance and transparency.

Mr. Ligner supported Dr. Chen's comments and added the necessity to educate the next generation, particularly in relation to hygiene and digital tools.

Mr. Cueni emphasized the importance of truly global multilateral public-private partnership for preparing for the next pandemic, as well as the recognition that no country is safe until all countries are safe.

Prof. Yamanaka pointed out that SARS, MERS and SARS-CoV-2 were derived from bats and suggested that transparent international viral research on bats and other species could be very valuable going forward and could help predict the next pandemic.

Summing up the discussions, Prof. Wallberg pointed out that this will surely not be the last pandemic the world faces and highlighted the importance of surveillance, international cooperation particularly among governments, and science and technology, including both basic research and applied research, as well as industry-academia collaboration.

Cooperation and Collaboration in Science and Technology

[Chair]

Hassan, Mohamed Hag Ali, President, The World Academy of Sciences (TWAS), Italy;
President, Sudanese National Academy of Sciences (SNAS), Sudan

[Speakers]

Gianotti, Fabiola, Director General, European Organization for Nuclear Research (CERN), Switzerland

Yamakawa, Hiroshi, President, Japan Aerospace Exploration Agency (JAXA), Japan

Le Gall, Jean-Yves, President, National Centre for Space Studies (CNES), France

Hashim, Abdul Rahim Hj., Joint Chairman, Malaysian Industry-Government Group for High Technology (MIGHT); Vice-Chancellor / President, Universiti Malaya (UM), Malaysia

Neher, Erwin, Research Director, Emeritus, Department of Membrane Biophysics, Max Planck Society, Germany [Nobel Laureate 1991 (Physiology or Medicine)]

Pan, Jiaofeng, President, Institutes of Science and Development, Chinese Academy of Sciences (CASISD), China

Sindi, Hayat, Chief Scientific Adviser to the President, The Islamic Development Bank (IsDB), Saudi Arabia

[Commentator]

Cassim, Monte, President and Professor, Shizenkan University; Representative Executive Director, Sri Lanka-Japan Collaborative Platform (SL-JCP), Japan

Remarks



Hassan, Mohamed Hag Ali

Prof. Mohamed Hag Ali Hassan presented on cooperation and collaboration in science and technology, including the drivers and facilitators of cooperation and collaboration in STI and broader issues, such as the long-term impact of COVID-19 on cooperation, education and research. He focused on the importance of global partnership in realizing STI for the SDGs, the role of international and regional scientific organizations, the use of science diplomacy to improve collaboration, the role of frontier technologies and the cross-border collaboration of individual scientists.



Gianotti, Fabiola

Dr. Fabiola Gianotti presented on the inherent multi-lateral nature of science, and its role as tool for innovation and its unifying nature. She spoke on the role that CERN has historically taken in promoting unity and peace, and its participation in the effort to addressing the emerging pandemic, as well as the media recognition science has received for its efforts during COVID-19.

Dr. Hiroshi Yamakawa gave a presentation on the reality of outer space and its indispensable role in our daily lives, the advanced technologies required for the study of space and how they could impact the post-pandemic society and benefit remote communications in rural areas. JAXA has engaged in collaborative studies on the effects of the pandemic countermeasures, and foresees the necessity of automation technologies in the future.



Yamakawa, Hiroshi

Mr. Jean-Yves Le Gall's presentation highlighted the benefits of space research collaboration on innovation, through the use of space assets to mitigate climate change and space exploration as well as the role of space on COVID-19 recovery. The Space Climate Observatory (SCO) uses data to propose practical solutions to policy makers on climate change consequences. Space exploration also requires international cooperation and is an opportunity for cooperation with government and the private sector.

Dr. Abdul Rahim Hj. Hashim gave a speech on the opportunities and impact of novel and emerging technologies on the environment, industry and people's lives. Malaysia has focused on increasing its human capital in science and technology, and developing various emerging technologies, leveraged for sustainability in collaboration with universities, industry government and global partners.

Prof. Dr. Erwin Neher discussed the conflict between cooperation and competition in science and technology. In basic science, researchers compete for priority in publication of new results. They have to weigh the advantages of cooperation against the danger of giving away novel insights to competitors. Prof. Dr. Neher argued for the benefits of cooperation and concluded that it is even more important in the present situation surrounding the COVID-19 crisis, where true cooperation would yield the best results and deliver vaccines and cures as fast as possible.

Prof. Jiaofeng Pan gave a speech on the threats of COVID-19 and its impacts on science and technology cooperation. Due to the pandemic, the Chinese Academy of Sciences has conducted research into and screenings of emergency medicines, vaccines and antibodies in cooperation with international institutions. It also led multiple regional and international cooperation research projects to face major global and regional challenges.

Dr. Hayat Sindi gave a presentation on the worldwide responses to COVID-19 and efforts to discover solutions to the pandemic. Human capital will develop the capacities for local and national vaccine building, therefore the current models and systems which restrict our human capital must be reorganized and reformed. Thus, the Islamic Development Bank put science and technology innovation at its core in improving expertise in developing countries and created a platform to engage all stakeholders.

Discussion

Prof. Hassan posited four questions to the panel which are core to the theme of cooperation and collaboration in science and technology. Firstly, Prof. Hassan inquired as to how to promote collaboration through multilateral and international organizations to combat the COVID-19 pandemic. Secondly, what is the long-term impact of COVID-19 on international



Le Gall, Jean-Yves



Hashim, Abdul Rahim Hj.



Neher, Erwin



Pan, Jiaofeng

cooperation in educational research, and how online education platforms based on advanced digital technologies could be made available everywhere to ensure quality education for all? The third question was on the challenges and best practices on how to promote collaboration between academia, industry, government and society in developing and scaling technologies to combat COVID-19, including testing, tracing, treatments and vaccines, and also how to overcome these challenges. And lastly, on the challenges and opportunities for international collaboration to help build and sustain science and technology innovation capacities in low- and middle-income countries, what lessons can be learnt from best practices including the role of diaspora science?

Prof. Hassan highlighted the broader topics broached thus far. Namely, the role of intergovernmental organizations and academies of science, the role of space science and technology in addressing the global impact of climate change and other global issues such as the COVID-19 pandemic, and academia-industry-government cooperation.

Dr. Gianotti further elaborated on the examples of technologies developed by CERN that serve COVID-19 scientists and health workers. With fundamental research being a main driver of innovation, because it requires very complex instruments, and therefore the development of advanced technologies which are of benefit to wider society, CERN has contributed to wider society via developing technologies such as the World Wide Web, which has completely changed the way society accesses information, as well as the use of accelerators to treat cancer and other applications. Concerning COVID-19, CERN has been very active in helping society in three ways. Firstly, it deployed its chemical and mechanical laboratories to build much needed sanitizing gels, masks, and face shields for local populations, schools, and hospitals. It also developed an advanced low-cost ventilator, suitable to be used in developing countries. Furthermore, CERN placed

its massive computing resources at the service of researchers engaging on the front lines of the pandemic.

Notably, CERN developed an open-access platform, which is a repository with tools which allow for the storage and navigation of data. The platform, Zenodo is used by immunologists, virologists and epidemiologists to store data. CERN continues to promote open access in technology, publish results in open-access journals, develop open software and open hardware, and make data available. Fundamentally, openness is one key for a more sustainable world to reduce inequalities. Thus, when education in science is available to all, it will contribute to reducing the gap between developed and developing countries and those who have access to learning and those who do not. The best thing science and technology can do for human beings is to empower them through education and knowledge.

Dr. Yamakawa explained how high-speed communications and satellites can provide remote medical care and online education for all, especially in communities without infrastructure. Space systems can contribute to our daily lives through their functions in observation, communications and navigation. Its communication capability would provide online medical services, and educational services. Eventually, providing high speed communications satellite services for rural communities in remote areas without communication infrastructure helps tackle the digital divide.

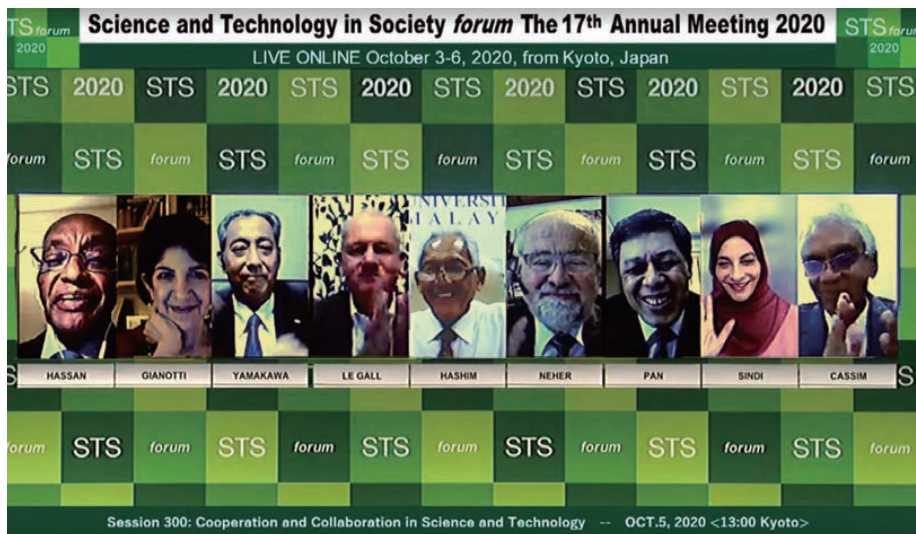
These health and education services require, at minimum, a “terminal” for communication with satellites. This enables patients and students to talk with doctors and teachers. High speed means a higher data rate, resulting in a higher quality of communication with more information. For the online medical service using the mother tongue of the patients is



Sindi, Hayat



Cassim, Monte



assumed and therefore, training is essential for adoption in communities. For education, video recorded classes can be provided, but real time classes are more efficient. For these rural communities, maintaining “real time” communication with “low latency” and “multi-device” connectivity is very important.

The COVID-19 environment accelerates digitalization although may at the same time lead to further expansion of the digital divide. The lack of a communication environment would lead to inequality and a lack of opportunities. There is a growing number of commercial space system entities, placing hundreds of communications satellites in orbit for high-speed internet services. These space systems would help mitigate the digital divide among those with and without communications infrastructure.

Mr. Le Gall explained the objectives of the Space Climate Observatory in monitoring the impacts of climate change. The Space Climate Observatory is a response to step up international coordination to evaluate and monitor climate change. It is to become a key tool to inform preparedness, adaptation and resilience at local levels. The Space Climate Observatory initiative is carried out at a scale never seen before to mobilize international space expertise for vulnerable territories. It combines and disseminates relevant data and information on national and regional impacts on climate change, using space technologies, in situ measurements, and models cross correlated with socioeconomic data.

Also, the Space Climate Observatory produces territory vulnerability indicators from case studies, which are tools for the national and local scales and takes advantage of artificial intelligence. Its long-term objective is to give policy makers the information on the state of the planet and to monitor with high resolution the impact of policies on climate change. Since its launch in 2019, 23 organizations have signed the joint declaration of interest in the program. The first meetings of the participants were in Washington D.C. in 2019 and then Abu Dhabi in 2020.

In 2020, SCO's international charter and more pilot projects will be launched. 14 projects have already started and the second call for projects is ongoing. The next step is moving forward with regional SCO Africa and SCO Pacific to empower vulnerable nations without space agencies to join, and to launch pilot projects. France is fully mobilized at the highest level with the Space Climate Observatory.

Dr. Hashim gave further explanation on how collaboration between government, industry, universities, and global partners can leverage emerging technologies. One example is Universiti Malaya's industry collaboration in producing nanoparticles for rubber gloves, which include magnetic properties for use in food, medical and the pharmaceutical industries. This involves a problem-solving approach with industry gaining seed funding from government and UM's collaboration with various universities around the world in nanotechnology and catalysis research. Universiti Malaya came up with a pilot plant producing additives for the production of 200,000 pairs of gloves a day and is now a major player in glove production with the industry also building similar production plants at their premises.

The other example is with Malaysia Industry Government Group for High Technology which is engaged in a demonstration project for smart grids for the sustainable cities development project, started in 2016 under the global environment facility, GF6. Here, private universities came on board as partners with strategic government partners and government came up with new regulations to get the project running. Focused on the historical city of Malacca, now the project is running it has impacted the community as a whole. The approach of the quadruple helix, involving universities, government, industry, the communities at large, and global partners, is a way forward to advance emerging technologies and getting everyone involved.

Prof. Dr. Neher explained that scientists in basic research are faced with tension between the advantage to collaborate and the risk of giving away insights which might lead to a

breakthrough or discovery. Science bestows recognition and reward to that person who is first in publishing a breakthrough discovery. Prof. Dr. Neher focused on the aspects of encouraging and enabling. Encourage means to have organizations place upmost focus on encouraging researchers to undergo collaboration, because collaboration is an advantage in the sense that it brings about new findings and new combinations of ideas. Organizations should encourage their researchers to collaborate in spite of the risks, which requires a climate of trust. Also, they should relax rules about reporting on results and the use of funds from ongoing grants, such that researchers have flexibility to reorient their research goals towards the urgent requirements of the COVID-19 pandemic.

More specifically, the COVID-19 pandemic has put us into a situation where researchers with relevant expertise have to be able to adapt their research on a short time scale of weeks and months. A researcher with specialty in a field relevant for understanding COVID-19, must be able to switch projects in a few weeks. However, in the current status quo, researchers are funded by government grants and are required to produce results and meet milestones within a certain period. Despite this, in the face of the pandemic, he or she must be able to switch and redirect resources to solve a problem and bring expertise and advantages to solve problems related to COVID-19. Organizations should entrust researchers in the sense that they can flexibly develop programs and collaborations. Organizations are inherently much less flexible than the individual researcher. Therefore organizations should announce or promote that researchers have the freedom to at least temporarily redirect their efforts to solve emerging global issues.

Prof. Pan elaborated on examples from the Chinese Academy of Sciences on cooperation relating to the COVID-19 pandemic. China established science and technology cooperation relations with over 150 countries and regions. Hundreds and thousands of Chinese scientists and scholars travel abroad in line with academy agendas each year. Moreover, the academy publishes, through international cooperation, more than 100,000 papers and is ranked 3rd in the world. Attaching high importance to international science and technology cooperation, the Chinese Academy of Sciences has set up ten overseas science and education cooperation centers, i.e. the Sino-Africa Joint Research Center in Kenya focused on food security issues in Africa, and the China-Sri Lanka Joint Center engaged in water treatment in Sri Lanka.

Furthermore, the Chinese Academy of Sciences has organized regional and international cooperation research grants and projects to deal with the global and regional challenges.



Through its alliance with international science organizations joint efforts were made to battle against the COVID-19 pandemic through the Belt and Road region.

For instance, its research on COVID-19 epidemic and vaccines, using microbiology to select antibodies in single cells sequencing technology. It is developing monoclonal antibodies with the private sector. Deep and intensive science and technology cooperation is the inevitable choice for addressing major global challenges in the post-pandemic era, achieving breakthroughs for major infectious diseases and offering science and technology solutions to the common challenges of mankind. Chinese Academy of Sciences will continue with an open mind to carry out intensive and in-depth cooperation with counterparts from all over the world, to make more contribution to the global fight against the pandemic.

Dr. Sindi developed on the activities of the Islamic Development Bank in solving problems that look to reach the SDGs and its successful projects. The ISDB has long-term commitments to supporting the SDGs as well as supporting its 57 member countries. Its valued partnerships with government, innovators, academic institutions, and wider society increase the benefits of science and technology in its member countries. With science and

technology and innovation at the organization's core, it promotes STI through its funds and engagement platforms, partnerships with UNESCO, and empowers women to learn skills for artificial intelligence through its scholarship program.

Its Transform Fund Call for Innovation, is a multimillion-dollar endowment fund now engaged in supporting low-cost treatment, low-cost diagnosis, and low-cost prevention for COVID-19. It also seeks cooperation worldwide on how to increase capacity building and strength of health systems. In Sierra Leone, an inventor and recipient of the fund invented a platform to train healthcare workers which can reach rural areas and help with treatment. COVID-19 has had a significant impact on agriculture and educations. Therefore, the fund is also engaged in strengthening e-learning for teachers and students to have facilities to learn and ensure children go back to school.

Prof. Cassim noted that scientists have come of age in the crisis by delivering sound transformative ways of doing things which help people all over the world. The catastrophes of COVID-19 and climate change are addressed differently as the former is seen as requiring a rapid response, though the latter is seen as having slow onset. Scientists have shown how the world can rally around such a rapid response, but also must leverage this to challenge slow onset problems like climate change, especially as such problems might become rapid after a tipping point. COVID-19 might also have a slow onset afterwards affecting a loss of biodiversity. Scientist's voice must be heard engaging with public sector and public to enable them to become champions of science at this critical crossroads, engaging in citizen science, with transparency, trust and collaboration, and amplifying the communication of science.

Hence, science can with the polity of the public transform society in a way that has never been seen before. There are ample opportunities in digital transformation, space science, and quantum computing, as well as cooperation through public private partnerships as seen in Japan, CERN, JAXA, CASIS, Max Planck, MIGHT, and ISDB. Humankind should work together to envision, enquire, enable, empower, enliven, and bring joy to the world through cooperative efforts.

Q&A Session

Dr. Sindi agreed with Prof. Cassim's comments on climate change and brought up ISDB's efforts to tackle climate change as its member countries have been hit badly by natural disasters, COVID-19, and food security issues. ISDB is committed to adopting the right

policies and championing science, technology and innovation in each member hub. Through these hubs the bank remains closely engaged with the challenges and problems. ISDB seeks more funding and collaboration especially for multidisciplinary programs, more collaboration for STI-based innovation, nurturing economic growth to eliminate inequality.

Mr. Le Gall added additional comments to Dr. Sindi and Prof. Cassim's comments on climate change, highlighting the SCO's outstanding progress against climate change through all its related space organizations. He noted particularly its data from satellites and its statistics which are being used to monitor the pandemic observed reductions in polluting gases.

Prof. Pan also commented on effort towards climate change by the Chinese Academy of Sciences. It launched the Startup for Environment International program which includes more than 30 institutes from more than 20 countries and regions. It conducts research on the resources and environment of Belt and Road region on both a regional and global scale, promoting a synergistic response for sustainable development. The Digital Belt and Road International Scientific Plan was also launched, which acquires compressive data from space and ground, ensuring the sharing of the Earth's big data, providing support for responses to regional environmental changes.

Dr. Ismail Serageldin, Founding Director Emeritus of The Library of Alexandria highlighted three points in response to the panel discussion. Firstly, a movement for openness in science has occurred since COVID-19, not just for published results, but for open access to data, open source programs, open methodology, open peer review, and open access and education resources, although some resistance remains. Furthermore, this openness should be called for also between disciplines, between social and natural sciences, and with the humanities. In addition, he brought attention on the methods to include a participatory discussion with civil society, media and governments. The new technologies that are being developed also have ethical dimensions and public confidence and perception is going to be very important going forward.

Prof. Hassan added his agreement on the need for inclusiveness and innovation from business, communities, government and the public to scale up science and technology innovation.

Dr. Gianotti noted that to help the fight against the virus and help save lives, fundamental research and competences and expertise from researchers are critical. Currently, CERN is in

collaboration with the “One Health Centre of Excellence” at the University of Florida, helping them with its computing skills to analyze different kinds of data for the pandemic in order to understand how the virus spreads. Open science, in all its facets, and developing tools available to all are the keys to addressing global societal challenges.

Dr. Bruce Alberts, Chancellor’s Leadership Chair in Biochemistry and Biophysics for Science and Education of University of California, San Francisco (UCSF) spoke on US-China collaboration in science, the importance of strong in communication and trust between the countries, and contrasted this with the current trade and political atmosphere.

Prof. Pan agreed with Dr. Alberts and placed emphasis on the cooperation with research institutes in the US. Furthermore, he spoke of the importance of open-mindedness in fundamental research and education, and called for the development of new models and new approaches for science and technology in the post pandemic era.

Prof. Hassan noted that scientists from different nations never stopped collaborating during the pandemic, and Prof. Pan confirmed this.

A participant asked Prof. Dr. Neher on how to reduce carbon dioxide while supporting economic development in developing countries.

Prof. Dr. Neher responded that this question is not within his field of expertise. However, he thinks, that efforts are needed in two areas, in a technological approach on how to serve the energy demands with climate-neutral technologies, and a social science approach to persuade society to use such technologies, even if they are more costly.

Prof. Hassan commented that international collaboration needs to be intensified to defeat the COVID-19 pandemic. This is being hampered by rivalries and conflicts in trade and technology, and vaccine nationalism. International collaboration is also desperately needed to strengthen healthcare systems in low- and middle-income countries, using cutting edge technology, and called for strengthening and support for epidemic preparedness and innovation.

Global Governance of Information

[Chair]

Kumar, Ashwani, Senior Advocate Supreme Court; former Union Minister of Law & Justice; former Member of Parliament (Rajya Sabha), Supreme Court of India, India

[Speakers]

Copan, Walter G., Director, National Institute of Standards and Technology (NIST), U.S.A.

Barclay-Platenburg, LeAnne, IT Risk Advisory Lead Consultant, Risk Advisory Services, PKF O’Connor Davies; Part Time Lecturer, School of Communication and Information, Rutgers University, U.S.A.

Kudelski, André, President, Innosuisse - Swiss Innovation Agency; Chairman of the Board and Chief Executive Officer, Kudelski Group, Switzerland

Murai, Jun, Distinguished Professor, Keio University; Co-Director, Keio University Cyber Civilization Research Center, Japan

Parikh, Sudip S., Chief Executive Officer, American Association for the Advancement of Science (AAAS), U.S.A.

Thompson, Herbert Hugh, Managing Partner, Crosspoint Capital Partners, U.S.A.

Zia, Leila, Head of Research, Wikimedia Foundation, U.S.A.

Remarks

Dr. Ashwani Kumar presented on the challenges that COVID-19 has compounded on global issues such as poverty, climate change, the digital divide, social and economic distress, human rights and the decline of democracy. Challenges in equality, public health and information management are at the forefront in world driven by information. He called for fairness, privacy and trust to be addressed regarding global governance of information, with notable areas of concern being cross-border flow of information, multi stakeholder governance, threats to public order, data monopolies, and nefarious use of information by criminals and states.



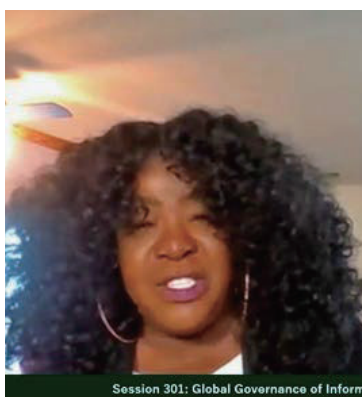
Kumar, Ashwani

Dr. Walter G. Copan spoke on the role the U.S. National Institute of Standards and Technology (NIST) plays in enhancing industrial competitiveness



Copan, Walter G.

and improving quality of life through its work in measurement science and standards. In response to COVID-19, this work benefits clinicians and researchers by improving data analysis of and testing for SARS-CoV-2. Also, post-COVID-19, NIST foresees many benefits for society in artificial intelligence, telemedicine, quantum computing, and advanced communications; however, the new technologies of this era pose new risks including ethical, privacy and cybersecurity challenges that must be addressed.



Barclay-Platenburg, LeAnne

Dr. LeAnne Barclay-Platenburg gave a presentation on building broad frameworks of reference for ethical personal data use. She provided particular focus on the use of personal data standards, examples of personal data misuse, examples of data governance regulations and frameworks, and the management of ethical risks. Dr. Barclay-Platenburg highlighted the possible guidelines for creating management of ethical risks associated with personal data.

Mr. André Kudelski presented on global governance of information, with information seen as a critical resource post COVID-19. He brought attention to the disruption, changes and challenges brought about by COVID-19, as well as the business risks and

opportunities for innovation. While the pandemic has led to positive innovation in the area of information technology, there are also 'shadows' that accompany these technological developments. To move forward amid these changes, proper governance of information must be addressed.

Prof. Jun Murai spoke on the change brought about by the COVID-19 pandemic and the impacts on digital transformation policy. The decisions for these policies were sought from digital data from society, thus access to data for digital governance is key. He also highlighted the importance of multiple disciplines and multiple stakeholders, and horizontal

data platforms on providing actionable data to support government decisions.

Dr. Sudip S. Parikh gave a speech on the background of the American Association for the Advancement of Science and its promotion of the scientific workforce, research integrity, science communication, and science in policymaking and diplomacy. Its mission includes sharing and learning through international fora, and currently, it is targeting its efforts on accurately conveying scientific findings and news to the public quickly and accurately.

Dr. Herbert Hugh Thompson presented on the ubiquity of information and whether its foundations are based in facts. With smartphone and smartwatch technology being commonplace, sensors and software based data gathering tools are constantly analyzing our behavior. This gathered data may offer significant insights and allow the owner of the data opportunities and depth of influence on individuals, especially when the effectiveness of machine learning on influencing people is taken into account.

Dr. Leila Zia gave a speech on the global governance of knowledge, and the stakeholders involved in constructing and accessing the knowledge. She also spoke on the processes in curating knowledge, and the processes involved in credibility assurance. Dr. Zia highlighted the Wikipedia model and its structured editing processes, transparency, credibility, and consensus building process.

Discussion

Dr. Kumar began the discussion by describing the new world that is upon us all and its links to innovation. This era offers a pivotal moment for science as it must contend with fate and foreshadowing as human civilization evolves.



Kudelski, André



Murai, Jun



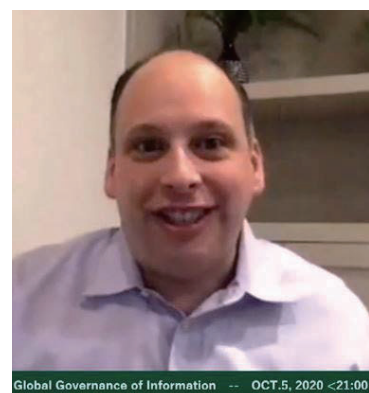
Parikh, Sudip S.

In this era, the challenges presented by the abuse of information technology and artificial intelligence by the surveillance state or private actors, abound. To combat this, there is a need for a global governance machine based upon universally accepted ethics, laws and human rights, and stable societies. Technology must never remain untamed. The relationship between the monster and invention cannot be reversed. An untamed technology allowed to run amok could demolish the value systems we have come to cherish and to respect.

Therefore, humanity must face and address these issues by installing the correct frameworks, collaborating with public and private entities, ensuring the right to freedom dignity and inclusion. Democracy is an invaluable right, and to protect it humanity must ensure boundaries for technological expansion.

Dr. Kumar posed the question of the panelist's thoughts on the technological safeguards to protect rights from an invasive state.

Dr. Copan elaborated that establishing the criteria for trust in artificial intelligence is critical for the next stage in various industries. There is progress so far on developing definitions for trustworthy and



Thompson, Herbert Hugh

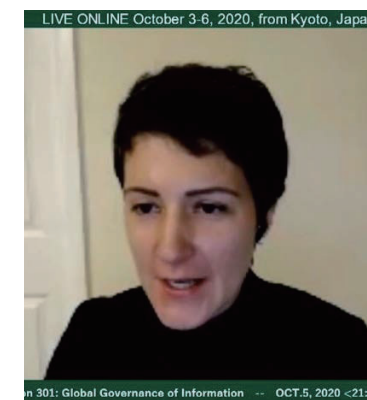
explainable artificial intelligence, but much work remains to be done on how to turn them into technical requirements for testing and validation. This will require the development of tools, measurements and standards for performance assessment, and to ensure that desired ethical outcomes can be validated. They also require the international community of expertise to come together in addressing the challenges of artificial intelligence use, such as in identifying the vulnerabilities to technology such as deep fakes. Dr. Copan stated that NIST is working to launch a test bed for artificial intelligence vulnerabilities. Technological advances cannot lull us into complacency. Vigilance and the evolution of tools is required by the international community.

Dr. Barclay-Platenburg explained the nuances of difference in creating universal frameworks and regulations for global governance of information. Presently, the global regulatory regime encompasses the EU GDPR and other regulations. Dr. Barclay-Platenburg posited that organizations with a footprint in the EU and the United States for example, are required to be in compliance with the GDPR. In the United States, more than likely, entities have EU residents in their database. In the EU, and others, an entity may likely have US residents' personal data in their database. If entities collect and store personal data, they must have logical reason to do so and the technology to enable it. Therefore, these entities can be subject to regulatory structures. The size and type, however, should differ as between corporations and small island states, each has very different capacities.

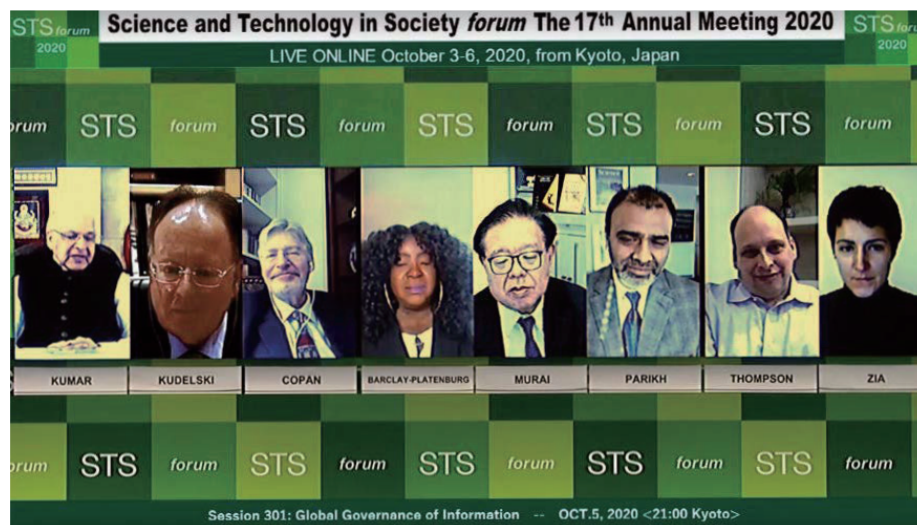
A large corporation may use the advantage of its technology because of its size, but small homegrown applications in tourism on small islands clearly require different technologies. Complying with GDPR requirements may give a competitive advantage by boosting consumer confidence, but also implies costs of auditing and staffing. Data regulation may also enable efficiencies. Data collection must be done in an ethical manner. Effective data management should be part of a structure of management to ensure ethical and fair data use.

Mr. Kudelski commented on ways to promote horizontal and logical dissemination of information in the post-pandemic era. Typically, large disasters in history have highlighted the positive and negative aspects of a technology. In the case of COVID-19, the pandemic has demonstrated that information technology is critical. It provides the only way to maintain effective communications between countries and continents when major travel restrictions and lockdowns are in place.

Nevertheless, the classical regulatory system for information technology is too slow, and that has an impact on innovation. Structurally, information technology has no borders. The positives are that people are able to discover information globally, but on the negative side, there are also bad actors who can hack IT systems globally. Fundamentally, classical static rules cannot adapt well to the fast-moving nature of innovation in information technology.



Zia, Leila



Thus, there is a need globally for a framework that is flexible and responsive and encourages collaboration between public and private actors. Such a framework is needed not only to address hacking, but also to ensure that government support is available to the private sector sufficiently in time to address the risks. Likewise, the private sector can provide guidance on the framework. The regulatory system must preserve innovation and allow innovation to happen between different countries and regions. Lastly, classical public-private partnerships can help by providing a boost in transferring technology from the public academic sector to the private sector.

Prof. Murai explained the dilemma that remains from the move towards the digitalization of public services between private and personal data. A vision backed by research, Japan's future 2040 vision of the development of humankind, stated that everything can be done from home, even shopping, medical care and living. Japan experienced this future vision already this year because of COVID-19. Japan just changed prime minister during COVID-19 and is targeted on the next 20 years of digital strategy. All of these developments toward digitalization have their background in the development of the Internet. The Internet was to create a global space. It is a single space for human beings and the first of its kind. Another space is the international space which is built with nation states and country-country relationships. Due to the global nature of our problems, working on a merging of the global space and international space is essential.

Prof. Murai continued to extrapolate on this concept of spaces stating that the responsibility must be on both, but the management of the global space had not really occurred. The horizontal connection of the former silos has to be connected by the Internet. Health care, natural disasters, and global warming all cannot be solved by a single policy. Therefore, humankind needs a multi-stakeholder paradigm.

He also explained that in order to share data, the interoperability of the data is important and the data has to be defined clearly and understood. There has to be a data structure where we share data including the origin and ownership. These are the ideas for a new data sharing society being managed for the future. It is very interesting that private data use in the past 30 years has been focused on business and target customer markets. But now after COVID-19, we started to think private data is for communities and people's lives. Japan has rich experience in the way that the natural disasters allow for placing special emphasis on digital technology.

Dr. Parikh identified that the communication of science and use of preprints needs careful consideration so that incorrect information is not spread. The world and scientific enterprise has pivoted towards understanding and controlling COVID-19, leading to remarkably swift timelines to discovery. It took only two months between virus discovery to the publication of the viral entry protein structure, which enabled further research on therapeutics and vaccines. At the *Science* family of journals, papers are peer-reviewed and highly curated based on the importance and strength of the findings. In the last six months, *Science* magazine has received over 1500 COVID-19-related submissions but accepted roughly 4%.

As this pandemic has revealed with urgency, it is not enough for scientists alone to be communicating about their findings. At the *Science* family of journals, we provide journalists—science reporters and general interest reporters—with the information they need to report on what science is revealing about COVID-19.

Dr. Thompson commented that the STS *forum* was founded on the idea of the light and shadows cast as a result of us making technological progress. This can be seen playing out in the abundance of availability of data. Often data is gathered for one purpose but later used for a different purpose. The average person's activities on a mobile device from its sensors and behavior data from internet interaction can create a deep picture. The data is often analyzed by algorithms.

But the challenge is that algorithms present ads to users with the highest likelihood of advertising success. If for instance the algorithm understands that the user is depressed, the algorithm automatically sends the right ads which would be alcohol or a vacation in Las Vegas. However, clearly these suggestions might be completely wrong for morality standpoint. This improving of mortality on data sets is essential. Humankind is gathering more data now than it ever has in the past.

Dr. Thompson challenged what will happen when the data is gathered. There are also challenges with how this data is used when it was collected, and what the beliefs of the individual were on how and when this data might be used. The old adage is that knowledge is power, and thus, information is power. The more details are known about someone, the more external entities can present a set of ideas to change their point of view and influence them.

Dr. Thompson questioned how humanity resolves that conflict between mathematics and morality, and what should be done with the broad range between ethical and legal norms that humankind has come to accept. Man must remain the measure of all things. He also questioned how humanity ensures that while it advances, that its privacy and its dignity will not be compromised.

Dr. Zia explained the difference between knowledge and information and how it applies to the Wikipedia framework. Knowledge is defined as justified through belief. Whereas, for information, people are not necessarily part of the equation. This is essential for Wikipedia, because Wikipedia is not just about content. The way people decide to share knowledge with themselves and the world matters. They learn from each other, they share with each other, they try to combat bias that might exist.

Q&A Session

Dr. Kumar commented on the fact that while it is understood that technology outpaces the law, how can the international community reconcile the fact that it is virtually impossible for law to remain in advance of technology.

Prof. Murai brought his opinion to bear on the topic stating that law is a nation's entity, and that it is the collections of governments and countries which operate in the international sphere. Whereas cyber space operates in the global sphere. Furthermore, the issue from global governance is difficult to solve because there is no single governance in the global space yet. He added that this is really important to have opportunity to discuss and share.



Laws might not be consistent across nations which is another reason why data access and interoperability is critical.

Mr. Kudelski spoke of one idea that could be considered, namely, a “soft evolutive law.” Fundamentally, the legal system is built to be reliable over the long term. However, to keep pace with technology, humankind needs a legal system that can adapt faster—something closer to the speed of information technology. To achieve that end, a system to enact a “soft evolutive law” would be required. To explain, he gave the example of treatment for disease, where aggregate health data could be used while maintaining individual privacy. With emerging diseases like COVID-19, there is a risk that the standard legal process may be too slow and lack the agility needed for quick action.

Dr. Copan further added to the topic of a fast responding framework addressing data privacy, stating that the international community must be able to come together on the basis of agreed principles that also enable ongoing innovation without stifling it. Human based ethical decisions that will be taken or supported by systems need to be measurable, and ethical outcomes need to be verifiable. The framework needs to be broad enough to enable the ultimate range of intended uses. The OECD and the Global Partnership for Artificial Intelligence has investigated this area.

Dr. Thompson commented on the ability to understand technology and concepts of data governance. The international scientific community needs to focus on cultivating great explainers of technology. For legal and societal decisions to progress around data, they should be explainable to laymen. In these educational efforts, it is young scientists who should be able to do so.

Very few people understand what DNS and BIND are and what they do, but they are essential technologies for society. The scientific community as a whole can do a much better job equipping people who have the knowledge to understand technologies such as these. A solid example of these communicators is a program in Korea which takes young promising pupils with their aptitude on science, but focuses a third of their studies on communication training.

Dr. Zia added to the discussion that it is important to not just aim for more and more data, but to think in reverse, operate on leaner data, and think about the question that is being answered.

A participant asked Dr. Thompson about the fact that criminal and rogue enterprises are often the first adopters of technology, they ignore mortality and operate transnationally in the shadows.

Dr. Thompson responded that any invention in science cannot have an intent behind it. Machine learning can be used very actively by criminals and nation states, because it can help protect and compromise a corporation or country. He added that knowledge tends to proliferate so now stakeholders must recognize that all actors make progress together. Therefore, principles on governance and law enforcement should be set at a high level so that pressure can be applied on groups weaponizing that progress, namely, cybercrime groups or those causing ill.

Mr. Kudelski added that laws and regulations should not penalize the good actors, who need to be able to act as fast as the bad actors.

Dr. Kumar wrapped up the thoughts of all the participants in expressing his gratitude to Chairman Omi for his inspiring leadership, and envisioned that the history of scientific thought will give a very special recognition to the STS *forum* and Chairman Omi.

Basic Science, Innovation and Policy

[Chair]

Nemer, Mona, Chief Science Advisor, Government of Canada; former Vice-President of Research and former Director of the Molecular Genetics and Cardiac Regeneration Laboratory, University of Ottawa, Canada

[Speakers]

Becker, Katja, President, German Research Foundation (DFG), Germany

Dabbar, Paul, Under Secretary for Science, U.S. Department of Energy (DOE), U.S.A.

Isaksson, Darja, Director General, VINNOVA (Swedish Governmental Agency for Innovation Systems), Sweden

Gross, David J., Chancellor's Chair Professor of Theoretical Physics, Kavli Institute for Theoretical Physics (KITP), University of California, Santa Barbara; Past President, American Physical Society, U.S.A. [Nobel Laureate 2004 (Physics)]

Panchanathan, Sethuraman, Director, National Science Foundation (NSF), U.S.A.

Viswanadhan, Krishnan, Senior Vice President, Global Cell Therapy Franchise, Bristol Myers Squibb, U.S.A.

[Commentator]

Paquet, Jean-Eric, Director General, Research and Innovation, European Commission, EU

Remarks



Nemer, Mona

Dr. Mona Nemer spoke on the responses to the COVID-19 pandemic and the unprecedented worldwide collaboration and sharing of data and the broader impact on science and research. She raised the following questions on the topic: (1) What are the consequences of research innovation and collaborative efforts? (2) What is the optimal balance between basic, mission oriented and applied research? (3) What is the role of public funding? Should it be oriented towards basic or translational research? (4) And, what is the role of governments in innovation? What is the right balance and some best practices and lessons learned? (5) What contributions should we expect from academia, industry and government as we navigate this unprecedented global crisis?



Becker, Katja

Dr. Katja Becker presented on the critical demand for research and knowledge in the face of the pandemic, loss of biodiversity and other issues. The response to such disasters relies on the current knowledge available. This knowledge comes from promoting basic research, therefore, promoting basic research is the best possibility for a resilient future. There is also a responsibility to ensure current knowledge does not lead to misinformation or confusion, and to ensure safety and progress in the short to medium term. The German Research Foundation called for multidisciplinary research into pandemics, in combination with this can draw on its past research into coronaviruses to generate rapid and reliable results in vaccine development.



Dabbar, Paul

Mr. Paul Dabbar gave a presentation on the US Department of Energy and National Laboratories Research Priorities. The department has received budgetary increases, allowing for continued funding for the ITER project and the LHC at CERN, a deep underground neutrino experiment in collaboration with Fermilab, the Rubin telescope in Chile, a telescope in the South Pole Station, and a detector deployment on the future Artemis permanent moon base. In addition to other various laboratory upgrades, work has also begun on the Electron-Ion

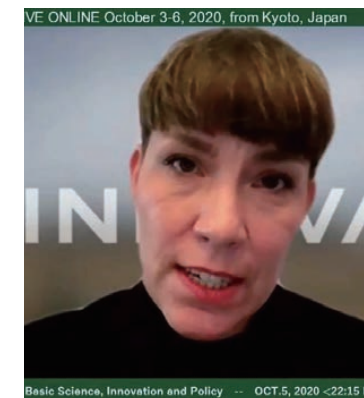
Collider at Brookhaven Laboratory. Also, the department is engaged on a new strategy for secure and reliable supplies of critical minerals, and seeks to tackle the issue of plastic waste, and is enhancing artificial intelligence research.

Dr. Darja Isaksson gave a speech on the changes in behavior in response to COVID-19, and the capability to change towards a common goal, as well as the multiple levels of decision making and responsibility for the crisis. She also drew light to the innovations that came about in response to the challenges in healthcare and that now investments into science and technology innovation at the policy making level, and into physical and

digital infrastructures, across borders and regions. Dr. Isaksson warned of the risk of returning to the old normal, and that future generations would pay the price for errors and poor decisions made today.

Dr. David J. Gross, presented on contrast between the power of science in the reaction to the COVID-19 crisis and the willingness of some politicians to ignore scientific truth. He also noted that in global warming, science identified the problem many years ago, yet politicians have shown willingness to ignore truths in this respect as well. Dr. Gross also brought up the threat of nuclear annihilation and attempts by certain actors to exacerbate the nuclear arms race. Nationalism and the construction of national barriers was also a concern of his as science can contribute a lot to these issues, but the solutions themselves may not only be scientific. The scientific community might need to engage in political solutions also.

Dr. Sethuraman Panchanathan spoke on the progress addressing the pandemic being made possible by decades of investment in basic research. These discoveries for fighting COVID-19 were made years ago without awareness of the role they would play in 2020. Advances in mathematics, computation, data science as well as mobile phone technology enabled scientists to track and model the disease. Advancing knowledge post COVID-19 will critically depend on not only continuing but also expanded investment in basic research. Progress to advance the frontiers of knowledge will continue to rely on international collaboration, as will our ability to make full use of science and technology to enrich people's lives. The lessons of fighting the COVID-19 pandemic can help enhance that work. How do we define problems with the intensity needed to make rapid progress? How do we create robust systems for shared problem solving? How do we maintain research integrity and transparency while also benefiting from agility? These are just some of the questions that will shape the future of the research community.



Isaksson, Darja



Gross, David J.



Panchanathan, Sethuraman

Dr. Krishnan Viswanadhan gave a presentation on basic science, innovation and policy and progress in the industry in response to COVID-19; namely, fast tracking, discovering new medicines, scaling up and sharing manufacturing facilities, repurposing existing treatments, etc. He commented on Bristol Myers Squibb's actions in response to the pandemic such as collaborations, sharing of expertise and facilities and clinical trials. Dr. Viswanadhan also commented on the use of CAR T-Cells for cancer treatment, and the effect that COVID-19 has on this treatment via competition for hospital beds, viral vectors and global supply chains.

LINE October 3-6, 2020, from Kyoto, Japan



Viswanadhan, Krishnan

Discussion

Dr. Nemer offered her congratulations to the winners of the Nobel Prize in Physiology or Medicine 2020, Harvey J. Alter and Charles M. Rice and Michael Houghton, for the discovery of Hepatitis C virus. She also stated that research, knowledge and innovation are key to addressing the world's most pressing challenges. Investing in fundamental research today prepares us for the unknown challenges of tomorrow. The pandemic has shown that humankind is capable of changing its behaviors, research and R&D. The impact of COVID-19 has been felt on even industries not directly involved. It is clear that

science and technology remain at the forefront of innovation, and in this age, the scientific community needs to find a way to break through misinformation and reach the politicians.

Dr. Panchanathan stated that COVID-19 has shown the promise, the potential and impact of science and technology. Work done by our scientists across multiple disciplines over decades has made possible many of the strategies we see today. One example is the work of National Science Foundation-funded researcher Dr. Rommie Amaro at the University of California at San Diego who uses state-of-the-art computational techniques to investigate complex biological systems. In 2009, Dr. Amaro used high performance computing facilities

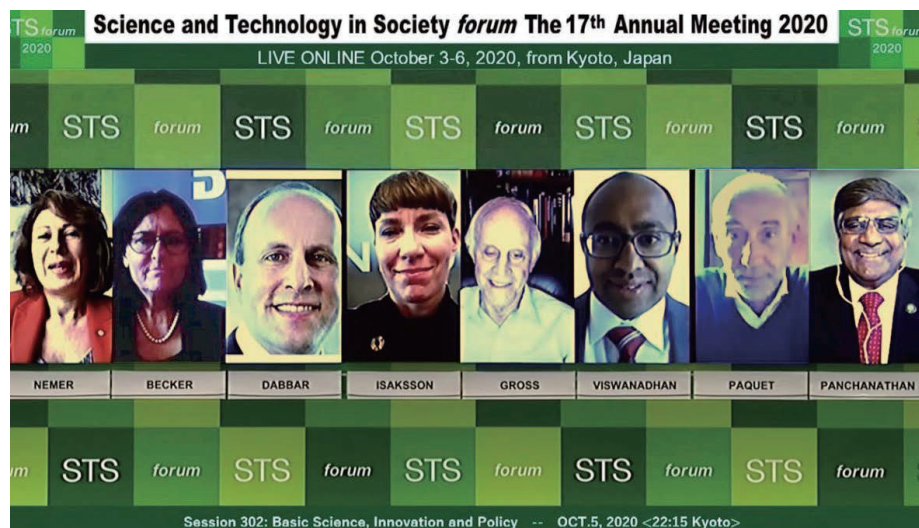
to model the H1N1 virus. In 2020 she pivoted her work to modeling COVID-19, using the latest NSF-funded supercomputer, Frontera. The rapid research pivot and multiple years of HPC development and expertise comes together from basic research. Thus, humankind must invest in basic and curiosity-driven research.

Dr. Panchanathan identified five key lessons for research from COVID-19. First, we must continue to invest in basic and curiosity-driven research that helps us understand, design and develop solutions to shared challenges. Second, proactive thinking and pursuit of research around impactful areas such as resilience to all emergent phenomena is very important. Third, interdisciplinary fusion and convergent science makes possible innovative solutions. Fourth, translational research not only informs but, more importantly, inspires basic research. Fifth, global challenges require global collaborations that bring together global inspiration and global context to find sustainable solutions. The National Science Foundation is committed to building on these lessons as we move toward the future.

Dr. Becker commented on the mission of the German Research Foundation in the short medium and long term. Although there have been extra funds allocated to COVID-19 research and vaccine development, there has not been a dramatic shift of funds. The German federal government understands the needs for broad research targets. Its policy is to remain steadfast to the broad swathes of science in a bottom up mode. The foundation has allocated strategic funds to the pandemic. These funds are not only for the biomedical aspects but also for interdisciplinary research. The relatively quick success in fighting COVID-19 is only possible because the funding of basic research on fundamental research on viruses. The nation spends 90 billion euros on R&D and two thirds of that come from private sector. The German Research Foundation's role, with roughly 12% of the public sector's one third, is to fund basic science, not with direct impact, but the creation of new knowledge which can be used to tackle and handle any new crisis. COVID-19 research is profiting from this kind of research now, because of the energy and curiosity basic researcher's represent.



Paquet, Jean-Eric



Mr. Dabbar added his comments on the funding capabilities of the U.S. Department of Energy for COVID-19-related projects and otherwise. The department is in a positive place funding-wise and is able to significantly support the 17 national labs and the university grant programs. The DOE lab complex focuses on the big 4 areas of science, chemistry, physics, materials and biology, with people all over the U.S. For COVID-19 research, there are two major areas of focus, namely computational science and imaging at light sources. Materials work has been on ventilators and other equipment. The White House and DOE formed the COVID-19 HPC consortium, with IBM and other private companies, around drug discovery and its acceleration. It started as a U.S. endeavor and is now global. The U.S. Japan, Switzerland, the EU, and Sweden have joined the HPC and in the private sector, Google, IBM, Amazon, BP, Nvidia, AMD, and many others have joined.

He also commented that the department had improved its review process to allocate supercomputing capacity, and that now the average is 3 days for proposal turnaround. Our light imaging laboratories have been supporting research and therapeutic level work on vaccines, this process uses artificial intelligence and links back to supercomputing.

There is a significant amount of these projects in research in various phases. There is a long history of leveraging the computational sciences at the national laboratories. In fact, research support for other projects is also up by 31 percent. And the laboratories

have started on various upgrades and even broke ground on the Electron-Ion Collider at Brookhaven. Mr. Dabbar also mentioned that it has been fascinating to watch the contributions of mathematics and physics to the pandemic, as it shows the impact of the other sciences.

Dr. Gross further elaborated on the possible reasons for the lack of understanding of science at the policy level. He mentioned that he saw great pride in the openness and determinism in the scientific community in the face of the COVID-19 crisis despite strong national interests. While some in the scientific community need little equipment to carry out research, such as in theoretical physics, others have no doubt had work disruptions. However, science has yet to fully solidify itself as an authority even in the most scientifically advanced countries. The scientific community should identify what is lacking in its institutions and national governments that make it possible for politicians to ignore scientific fact and cause immense harm.

Dr. Gross also highlighted that how the world handles this crisis will inform how it handles the other major crisis facing humanity including climate change and global warming, which bear similarities in that the wider response from society has been wanting despite clear scientific evidence as an incentive.

Dr. Nemer agreed with the connections drawn by Dr. Gross on the similarities of the COVID-19 crisis to climate change regarding societal response.

Dr. Isaksson spoke broadly on the ability for leaders to effect change in view of the impending crisis of climate change as well as in reference to the COVID-19 pandemic. The recent interest of governments in fundamental research and digital research infrastructure is very welcome but it also highlights the need to address regulatory issues related to digital transformation. The ability to turn research to innovative solutions has been wanting. Research on systems innovation show that there is a need for increased directionality on common goals to enable more agency and mobilization. The scientific community also needs to develop practices on supply and demand for regulatory uptake.

Sweden's national long-term public private partnerships are in place and they have enabled more effective research and engaged actors and increased technology transfer. It is also encouraging on how they can act of mobilization of transformation in industry and society.

One program, Viable Cities, is close to the EU mission boards on climate neutral and smart cities.

This program prepared an MLU on climate contact for 2030 between national funding agencies and cities. This can help scale innovation and provide benefit from the EU investments in transformation. Also, foreign government partnership programs in lifelong learning, digital transformation, and life science, sustainable industry have also been beneficial for innovation. One example of a systems approach that is in place is Hybrit which is enabling fossil-free steel production, and circular material flows. Similar efforts have been seen in creating new value chains in battery production to the energy systems and transformation and mobility. Therefore, investing is showing promise and it is clear to see that these investments must be done wisely.

Dr. Viswanadhan commented on the incredible responsibility the scientific community has in how to affect the pandemic. The learnings that have occurred through COVID-19 have served as a catalyst. The first is the impact on digital capabilities. It was not appreciated how digital capabilities will play a role effective going forward, for treatment and clinical trials. Also, remotely working together has become the norm in this virtual world. One of the key components to protecting public health is that society needs to consider how it prepares itself for future pandemics, through contingency planning, building processes, drug supply, and manufacturing capabilities.

Therefore, consideration should be placed on creating that innovation ecosystem to drive the progress and swift responses. Global society has not been adequately prepared. Moreover, there is progress in the development of basic research and translational medicine. The speed of innovation could be accelerated in a way that people have not experienced before. This underlines why and how science and technology is so critical, for humanity to scale up and share. There is a real opportunity to utilize COVID-19 for how to drive innovation across the globe.

Director General Jean-Eric Paquet began by delivering remarks on the status of basic research. It is clear that investments that are made in society in basic science pay off, and the knowledge in Europe that for example, the European Research Council invested in is being deployed. An example is the European virus archive which is critical in the fast response to COVID-19. All in science are aware that there needs to be a proper balance between applied and fundamental research. It is important to ensure that society learns the



lessons on its individual and collective response to COVID-19 as was done for example on the Ebola case a few years ago, and also with investment in vaccines.

DG Paquet also commented on connecting the knowledge and science and innovation. The European Innovation Council, established a year ago, did a call for proposals on COVID-19 responses. Companies and startups presented innovations and solutions, for vaccines and treatments. Now, these innovators are funded and the results should be coming in the next few months.

He also commented that never before has science been so visible and so positively seen by many in the first phase of the pandemic. In the second phase of the pandemic, there is a controversy in scientific opinions, and the scientific community as a whole should carefully reflect on that. Science advice can demonstrate that science is not absolute, but still bring knowledge of a credible nature into the public discussion. The lines are very blurred in European society which could have consequences.

DG Paquet also commented on his enthusiasm for open science and data. In regard to data, the European Science Cloud on COVID-19 was established with tens of thousands

of scientists using the platform. In the scientific response to COVID-19, there are many global efforts. In Europe there was the European Research Area Action Plan for alignment of member states. However, there is also scientific nationalism, which is fragmenting the response. At the global political level there was a strong response but more could have been done in the middle in terms of unified response.

Q&A Session

A participant raised a question on the crunch felt in lower and middle income countries, and asked if DFG has strong collaboration in these regions. The participant also questioned how to develop basic research.

Dr. Becker answered that budget crunches are also to be expected in European countries. And, that there is a risk, that lower- and middle-income countries are by far more effected by this crunch and the gap in science and technology capacity increases, which is worrying. DFG is actively fostering cooperation with countries of the global south because it is aware what is happening there. Everything on this planet is interconnected. Concerning the negotiations with governments in low- and middle-income countries, the COVID-19 crisis is an example of the importance of a large knowledge tank to prepare for another crisis. From this it can be seen how important real interdisciplinary research is at its best. A medical problem such as COVID-19 has great influence on society, economies, and on ethics, and in order to be prepared for the next crisis, it is important to be fully invested in interdisciplinary research.

Dr. Isaksson commented on how important it is to translate knowledge to action on the ground, and to do so with the ability of policy coordination. She added the need to challenge regulations on national level and work practices on a local level. There are numerous examples of factories changing production, digital efforts in preventing the spread of the virus however in many of these areas a physical work practice problem or regulatory problem was an obstacle.

Mr. Dabbar added his comments of worry about disparity globally and disparities from a clean energy point of view, with some entities with bigger and greater resources. The solution to this dilemma is through collaboration and inclusiveness.

The department is the largest basic researcher in new energy types and is engaged in several new initiatives such as in the Storage Grand Challenge, next generation solar technology,

plastics, critical materials, the Artemis program to take us back to the moon from which to launch to mars, and the National Quantum Initiative. For these initiatives people are invited from around the globe, and the leaders from these initiatives are from mid- and small-sized countries. In the department's high energy physics facilities, there is a broad consortium from big and small countries. Similarly the new collider also has contributions from countries both big and small to participate in the science and discovery.

Dr. Gross also added his thoughts on international cooperation digitally advancing rapidly. This will enable the disadvantaged to become advantaged. However, increasing nationalism and the closing down of international cooperation will have the opposite effect. Openness is increasing under threat from nationalism and economic competition.

Dr. Nemer expressed her hope for the future with the help of all, through collaboration among scientists and policy makers. Government has to be an enabler, and scientists have to provide information and advice as well.

Shaping the Post COVID-19 Society

[Chair]

Holliday, Jr., Charles (Chad) O., Chairman, Royal Dutch Shell plc, Netherlands; former Chairman of the Board, Bank of America; former Chairman and Chief Executive Officer, DuPont, U.S.A.

[Speakers]

Bachelet, Michelle, United Nations High Commissioner for Human Rights, Office of the High Commissioner for Human Rights (OHCHR), Switzerland

Mayaki, Ibrahim Assane, Chief Executive Officer, African Union Development Agency (AUDA-NEPAD), South Africa

Dvorkovich, Arkady, Chairman, Skolkovo Foundation, Russia; President, FIDE, Switzerland

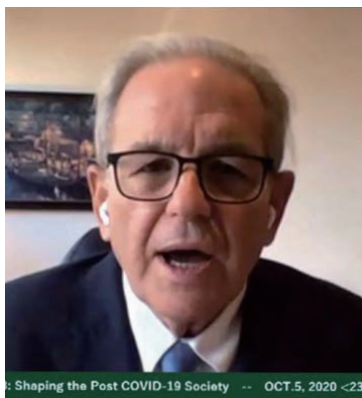
Yumkella, Kandeh, Member of Parliament (MP) & CEO, The Energy Nexus Network (TENN), Sierra Leone; Advisor, International Energy Agency, France

DeParle, Nancy-Ann, Managing Partner and Co-Founder, Consonance Capital Partners, U.S.A.

Roese, John, President & Chief Technology Officer, Corporate Technology Organization, Dell Technologies, U.S.A.

Sicilia, Mike, Executive Vice President, Oracle Global Business Units, Oracle Corporation, U.S.A.

Remarks



Holliday, Jr., Charles (Chad) O.

Mr. Charles O. Holliday, Jr. spoke on two themes. The first theme was the speed of change, and the second, values. For speed of change, the entire world of 7.7 billion people has changed drastically most of its activities. Shell learned from operations in China and expanded on them by transferring the learning to other regions while adapting to geographies, cultures and weather patterns. This constant learning and adaption is vital, especially to prepare for the next pandemic. Secondly, it is clear that humankind only really knows its values, when the values are tested. In the COVID-19 pandemic, humankind's values are tested every day. With some people being disproportionately affected by the pandemic with loss of shelter and food, it is up to others to provide support.

Ms. Michelle Bachelet presented on the dependence on digital technology highlighted by the COVID-19 crisis. Digital technologies enable changes to work and communications as well as efforts to combat the virus such as digital contact tracing, artificial intelligence and telemedicine. The digital divide is sharply revealed by the pandemic which marginalizes the disenfranchised. For the recovery from the pandemic, these challenges must be surmounted. Along with human rights and freedoms, access to these technologies must be guaranteed to enable communities to tackle the pandemic. If the cautions of these technologies are not heeded, they could lead towards surveillance societies and restrictions on freedoms. In addition, the recovery should enable universal access to resilient healthcare without discrimination.



Bachelet, Michelle

Dr. Ibrahim Assane Mayaki spoke about the critical risk and opportunities in the post-COVID-19 society in both a global dimension and an African dimension. Globally, the risks are in reduction of multilateralism, and the capacity of regions and countries to work together to fight the pandemic. International solidarity is lacking. The opportunities lie in revision of economic growth models in order to become more integrated. In Africa, organization was very fast, however the social and economic aspects came to the forefront. Lockdowns caused unemployment and increased inequalities. The issues should be tackled by taking into account a regional dimension in designing and implementing policies. At the same time, African policy makers are rediscovering the importance of local communities especially with regard to fighting pandemic.



Mayaki, Ibrahim Assane

Mr. Arkady Dvorkovich gave a presentation on shaping the post COVID-19 society with respect to the opportunities present in Russia and worldwide. Amid the significant changes in society enabled by digitalization, Russia has seen response from its technology sector. In this sector, The Skolkovo Foundation has been running for 10 years and includes a



Dvorkovich, Arkady

number of startups, industrial partners and research institutes and universities. One example of these responses is a new treatment approach that helped treat COVID-19 in Russian hospitals and also in other countries. To further enable its support, the foundation started fast-track procedures that provided grants and new products and services. The foundation also launched online business missions to enable start up to find partners.

Dr. Kandeh Yumkella emphasized the extremely rapid economic impacts felt by Africa in the face of the COVID-19 pandemic, even before health impacts and infections were seen. This was due to the global supply chain disruption; one that was particularly felt in vulnerable countries. The post-pandemic society must be better and more climate resilient than that of today, it must also provide clean cooking solutions for the millions who are still lacking. The lack of clean cooking facilities cause trillions of dollars in economic impact and climate change due to the use of charcoal and firewood, as well as its negative impacts on women. The post-pandemic society, therefore, in Africa, must include sustainable resilient communities, and reduce the number of women and children who are dying from lack of healthcare access and clean air. To do this, Africa needs energy

solutions which that promote job creation and provide clean cooking fuels.

Ms. Nancy-Ann DeParle spoke about shaping the post COVID-19 society in the short and long term. In the short term, large businesses in the U.S. will be mostly recovered. Society has realized that it is unified in this challenge, and in the U.S., is also beginning to take action regarding racial tensions. Innovation will be focused on what adds value, not simply new iterations in terms of materialist consumption. For example, in health care, telehealth is now a vital component of providing care, not just an adjacent consumer strategy. She also questioned if there will be a return of workers to offices in the long term. She foresees a

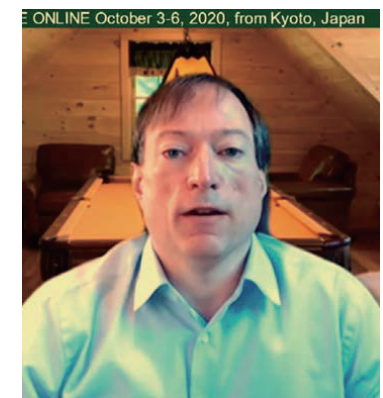
continued use of masks especially for air travel. There will be a rebirth for society in terms of economic, artistic and policy innovation. In addition, there will be a rebuilding of business models and institutions as society prepares to face another pandemic.

Mr. John Roese spoke on the disruptions seen during the COVID-19 pandemic. Companies with digital transformations underway before the pandemic transition far better than those with less digital infrastructure. Furthermore, the virtual world is fundamentally still at a basic level as all professions worldwide use nearly exactly the same digital tools, and there are aspects missing from digital interaction in terms of mixed work and learning via observation. Society might be more responsive to digital innovation because of the experience of the pandemic, and simultaneously, technologies such as 5G, and artificial intelligence will continue to advance rapidly. This will lead to a faster transition to the fourth industrial revolution, resulting in better GDP, health outcomes and education, and a reduction in poverty. The challenges in progress stem from closed cloud systems, a lack of 5G providers, and a lack of transparency in artificial intelligence technology, as well as the ever-present risk of increasing disparities.

Mr. Mike Sicilia spoke on his hopes for the continued innovation and progress seen in society during the pandemic, especially he noted that the pharmaceutical industry is engaged in clinical trials at a rapid pace. Rapid changes and adjustments were also seen in other business sectors. He expressed his hope for the new models for doing business that will emerge from the challenges. Governments have adapted cloud technologies for real-time tracking but challenges remain in making data-driven decisions due to slow data transfer. Oracle has collaborated with governments to introduce artificial intelligence and machine learning for greater insights from their data. Post-COVID-19, society should remember that



DeParle, Nancy-Ann



Roese, John



Sicilia, Mike

its achievements are greater than its struggles. The human spirit shown during the pandemic will help it face other challenges, like water scarcity.

Discussion

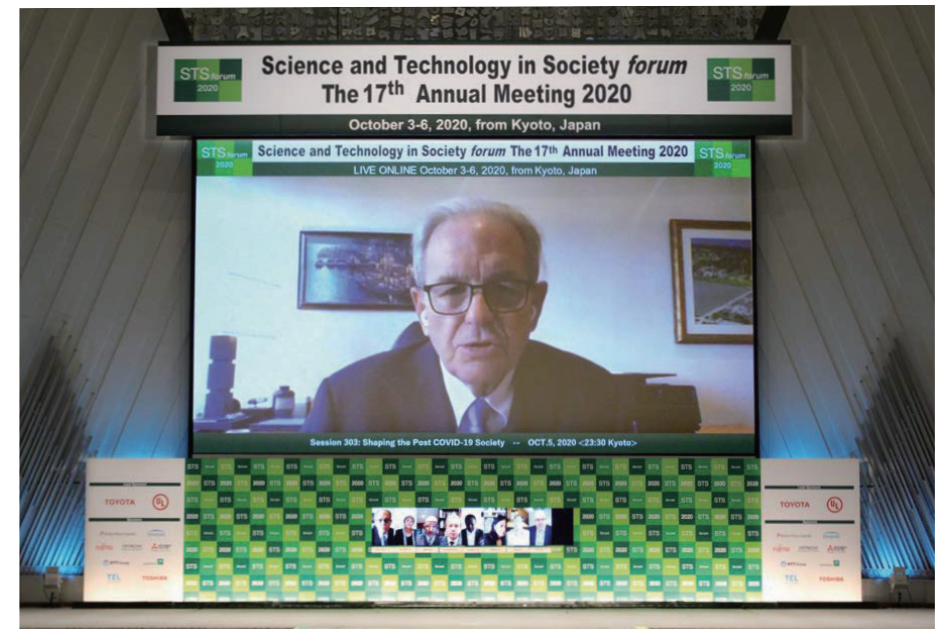
Mr. Holliday began the discussion by addressing comments on the lessons from COVID-19. During COVID-19 there has been tremendous learning, a fast deployment of resources, and creating vaccines at an incredible rate. These lessons can be applied to pandemics in the future but also to other challenges such as climate change. Furthermore, humankind's values and ethics have been tested

and what is important to each individual in life is clearer than ever.

Ms. Bachelet commented that addressing the digital divide is essential. Society has the opportunity to learn lessons from the virus and should not return to day zero. Society can be rebuilt better than before. The virus can infect anyone, but it predominantly affects the most vulnerable. So, society must be built back by addressing these inequalities. Therefore, human rights must be at the center of how people respond. This new society should also include comprehensive social protections systems, and have no discrimination of any kind to be better able to respond to future shocks. Also, civil society has a vital role to play in building a more resilient society. The fabric of society itself will change as social contracts adapt to create opportunity for all and respect for human rights. No one will be safe unless everyone is safe, therefore, the vaccine should be a global public good that is accessible and affordable for all.

She also added that the Office of the High Commissioner for Human Rights' role in vaccine distribution will be indirect through the WHO and the member states, however, the problems in the distribution will be political and market-based in nature.

Dr. Mayaki added his comments on decentralization, coordination, and risk prevention, and drew on the lessons on the African context. As society works in a post pandemic recovery process, decentralization will be key. This global virus has revealed global realities. If local solutions are not owned by local communities then fighting the virus will not be successful. These are lessons learned from the Ebola period. Therefore, solutions need to be



decentralized. In terms of coordination, many governments found out the necessity to coordinate with the private sector in terms of providing locally manufactured protection gear. Thirdly, on the prevention of risk, coping with several epidemic risks is not enough, instead governments need to mainstream a capacity of risk prevention. Through the behavior of public actors and private actors, it was seen that risk prevention is not only a sectoral issue, it is multi-sectoral.

Mr. Dvorkovich focused his comments on the real need for regulatory fast tracks to reproduce and transfer digital technologies. Governments tend to be reluctant to act rapidly on regulations. What is needed is a parallel dialogue in society among all major stakeholders to introduce regulations quickly. Central powers need to balance local solutions and coordinated actions. Secondly, on the digital divide and digital infrastructure divide issues remain. Even in the chess world, there were issues in running online championships. These challenges are seen in telemedicine and other major industries too. Finally, the fundamental and biggest challenge is education to prepare for the future. As it is educated people who will apply these technologies.

He also added that Russia's example to emulate from during the crisis would be its coordination with the private sector and daily coordination at central and local levels with all major stakeholders.

Dr. Yumkella commented that the COVID-19 pandemic quickly demonstrated how interconnected humanity is. Africa immediately suffered the economic impact within three months because supply chains were interrupted. Dr. Yumkella agreed with Ms. Bachelet's comment that no one is safe unless we are all safe. The new medications and vaccines will appear more quickly in richer developing countries. Africa faces several issues in rebuilding from the pandemic, notably, the lack of electricity in rural clinics, and the inability to quarantine without clean water. He also expressed his hopes for a greater transition to reliable energy for developing countries. A recent report by the University of Loughborough showed that 4 billion people lack energy services. Energy will be crucial in the post COVID-19 era and governments must ensure energy and access for the poorest of the poor.

Dr. Yumkella remarked that the positives are the multi-lateral instruction and the major powers funding of poor economies. These economic impacts are so serious that they could lead to security issues. In addition, there are remaining challenges in energy solutions funding, clean cooking solutions, and pulmonary diseases for women and children.

Ms. DeParle stated that there is a critical need to restore trust in institutions, especially in the U.S., where the CDC, NIH, and FDA have been undermined during this pandemic. She stated trust in vaccines was also low, and that restoring trust in the institutions based on science and fact is important to building the foundation and resilience to face the next pandemic. The foundation for the work to rebuild is in reconstructing and articulating core values, community, equity, transparency. As the world has been locked down there has been plenty of time for reflection, and society must decide if it is coming back further apart, more polarized, or more unified. In her view, we must be more unified to build a bulwark against another pandemic.

On the particulars of the U.S. healthcare system, Ms. DeParle commented that the Affordable Care Act (ACA) has been foundational in providing basic and equitable level of care to all because of its protection of those with preexisting conditions. Before the ACA was enacted, millions of Americans could be denied affordable coverage if they had a preexisting illness or condition such as cancer or heart disease.

Mr. Roesse contributed to the discussion by bringing up how society treats the digital experience in the COVID-19 era. The current state of digital infrastructure leaves people without the correct tools, as everyone essentially has the same tool. In reality, the virtual experience is going to be primary. Sectors like education and healthcare will need a complete reform because of this. Dell is focused on various areas especially smart mobility in order to automate distribution networks and healthcare to protect human beings, and is focused on the horizontals between every industry.

Mr. Sicilia expressed his hope for society post COVID-19. Oracle has 93 clinical trials for COVID-19 running. The problem has shifted to how to get these treatments out to people and produce enough. One thing that remains of concern is that humanity should not forget how unprepared it was. In the early stages, simple mistakes in data management became huge disasters. The quality and fragility of the world's information systems was also clear. The systems are old and fragmented. The policy makers have difficulty making data-driven decisions. Oracle is also working with governments worldwide, especially in sub-Saharan Africa to improve the decisions being made. The same pace of innovation from technology, cloud computing, and machine learning can be applied to other big problems like water scarcity and climate change. Local authority and local distribution is key for fair and equitable distribution. There is a value in national policy makers in being able to consolidate data quickly for local distributors.

Mr. Sicilia also added that the issue preventing rapid innovation is not money, but old systems.

Q&A Session

Mr. Roesse commented that the ability to get technology democratized has been a challenge. The data that we have should produce better outcomes. One limiting factor here is getting the data into the right hands, to the people who can deliver it as a service and model at local levels.

Ms. DeParle pointed out that much of the information technology in healthcare is aging and the current systems are not interoperable, leading to burdens on consumers and clinicians. This pandemic has revealed the weakness in those systems. However, healthcare systems have done a really good job in distributing knowledge and experience of the best treatments from six months ago. Fewer people with COVID-19 are now being ventilated and there are better outcomes than in the past. The information behind these successes needs to be disseminated across the world and technology is helping with this.

Dr. Mayaki elaborated on the inability of the micro and small sized businesses to access pandemic relief funds due to operating in the informal sector. Also, in kind, these entrepreneurs are early adopters of technology and therefore digital transformation by governments themselves is fundamental. Furthermore, primary healthcare needs far more investment.

Mr. Dvorkovich highlighted the misaligned incentives of the medical industry for treatment not prevention. Secondly, he also spoke on the relationship between the two priorities, the environment and climate, and access to energy, and the inherent contention here. Coal is still cheaper and developing countries want access to energy as soon as possible. The world must find a solution so that nobody will be left behind.

Mr. Holliday enquired as to the Russian COVID-19 vaccine regarding distribution.

Mr. Dvorkovich responded that there are currently two vaccines being tested, however the production of the vaccines is a challenge. The facilities are not sufficient to produce enough vaccines for everyone. Only two or three countries can produce that equipment relatively quickly. Therefore, the government will identify the biggest risks groups and deliver them the vaccine first.

Ms. Bachelet added her thoughts on data. Many countries do not have statistics separated by gender. This is of concern because the virus impacts by gender, age, incarcerated people, and indigenous people disproportionately. Intersectionality is also an issue. Therefore, all stakeholders should ensure they are taking a human rights approach in the digital transformation.

A participant asked a question on how fast learning of digital technologies was taking place.

Dr. Yumkella expressed agreement with Mr. Roese on the personalization of learning, particularly concerning support for the poorest schools, for education on cooking solutions. The pandemic has also revealed issues of trust between governments and their citizens concerning abuse of emergency laws.

Mr. Holliday questioned Dr. Yumkella on how he would improve trust.

Dr. Yumkella responded that open-mindedness is the key for improving trust and overcoming emerging threats.

Mr. Sicilia mentioned that there may be more valuable insights in the data on COVID-19, however there are a lot of impediments to sharing the data. Government agencies should ask for external help in deidentifying their data so that it can be shared.

Ms. DeParle added that in the U.S., data from hospitals during the pandemic was first sent to the CDC, and then redirected to another entity within the U.S. Department of Health and Human Services, which may have contributed to trust issues. She also explained the situation behind the U.S. health insurance system and how COVID-19 could be deemed a pre-existing condition without the Affordable Care Act, and thus, the importance of keeping provisions protecting against pre-existing condition exclusions in place.

Mr. Dvorkovich offered an example about data management, where a tool to diagnose lung cancer could use the COVID-19 lung data. This simple change could catch cancer cases far earlier.

Mr. Roese agreed with Mr. Sicilia that government must be aware of that the links between artificial intelligence development cycles and the data privacy regulation cycles are inseparable. Recent regulations hinder artificial intelligence development. Instead, the system should be addressed holistically.

Dr. Mayaki commented on the response of the African continent to the pandemic. The high level of coordination between African governments helped significantly. Multilateralism is being shaken, but in Africa the regional integration process did help.

Dr. Yumkella encouraged greater international solidarity and the strengthening of the WHO.

Mr. Roese shared an observation that those entities which were further down their digital transformation were able to adapt more quickly. This shows the importance of the democratization of data and technology for preventing future pandemics.

Mr. Sicilia shared his optimism on the diversity he has seen, that science and technology will win, and that working together at this pace, will allow humankind to solve any problem.

Energy and Environment

[Chair]

Fall, Chris, Director, Office of Science, U.S. Department of Energy (DOE), U.S.A.

[Speakers]

Kabat, Pavel, Chief Scientist Emeritus, World Meteorological Organization (WMO), Switzerland; former Director General & CEO, International Institute for Applied Systems Analysis (IIASA), Austria

Falk, Jim, Honorary Professorial Fellow, Melbourne Sustainable Society Institute, University of Melbourne; Emeritus Professor, The University of Wollongong, Australia

Whittingham, M. Stanley, Distinguished Professor, Binghamton University, U.S.A. [Nobel Laureate 2019 (Chemistry)]

Tsunakawa, Satoshi, Chairman, Toshiba Corporation, Japan

Bigot, Bernard, Director-General, ITER Organization, France

Luers, Amy, Global Director, Sustainability in the Digital Age; Senior Advisor, Future Earth, Canada

Ishwaran, Mallika, Senior Economist and Head of Policy Strategy, Shell Scenarios, Group Strategy, Shell International, Netherlands

Tanaka, Shigehiro, Vice-Minister for International Affairs, Ministry of Economy, Trade and Industry (METI), Japan

[Commentator]

Godrej, Nadir B., Managing Director, Godrej Industries Limited; Chairman, Godrej Agrovet Ltd, India

Remarks

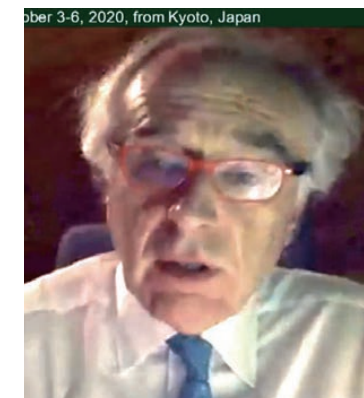


Fall, Chris

Dr. Chris Fall presented on the opportunities and challenges posed by the pandemic, and its impact on a sustainable future. The pandemic has brought sickness, death, and changes to society and work. Nevertheless, the disruption to economic activities has also brought cleaner air to many regions, showing a glimpse of the future. Some of the changes in ways of working and living also have proven to be more efficient in some cases. It is not yet certain that any benefits brought by the opportunities of the pandemic will be permanent. It is also

uncertain that our shared goal of an easier, more sustainable world will be easier or harder to realize.

Dr. Pavel Kabat gave a presentation on whether the international community can capitalize on the opportunities presented by the multitrillion-dollar post-COVID-19 economic recovery packages. The climate in 2020 is one of the hottest ever. Reductions in emissions due to lockdown measures have not led to any significant decrease in the concentrations of atmospheric greenhouse gases. Current environmental policies are not in line with achieving the Paris Agreement. Despite this, the technical potential is ready with renewable energy now in the same or even lower price range as fossil fuels. To achieve real and effective steps to tackle climate change, transitions need to be made also at the institutional, governance, social, cultural, and behavioral levels, in multisectoral, multilateral approaches.



Kabat, Pavel

Dr. Jim Falk spoke on whether post-COVID-19 societies would be more receptive to change. Both for COVID-19 and climate change, governments tend to act too late. Current reports suggest that ambitions on climate change need to be tripled to keep global warming below 2 degrees centigrade. Despite considerable growth in renewable energy this has been offset by rapid growth in energy use. Vast remaining reserves of fossil fuels present a massive temptation. On the other hand changes in consumer behavior when responding to COVID-19 may allow for easier acceptance of required behaviors to reduce emissions. There is a key opportunity to direct trillions of dollars of COVID-19 stimulus investment into a new sustainable path of development.



Falk, Jim



Whittingham, M. Stanley

Dr. M. Stanley Whittingham presented on the future generations' cleaner and sustainable world. In light of the environmental reprieve from the pandemic, reverting to the old normal must not occur. Smog and pollution has reduced due to the reduction in human activity. The changes to continue such reductions could include reducing meetings and travel, and making use of batteries, electric mobility and renewable energy generation. COVID-19 stimulus packages could accelerate the attainment of a greener world. Furthermore, science and facts should be a greater part of policy making, and electronics waste and plastics waste need to be significantly reduced.



Tsunakawa, Satoshi

Mr. Satoshi Tsunakawa gave a speech on technologies to further progress towards a sustainable world, namely, micro-grid energy management systems, virtual power plants, smart building management systems, and new generation solar-cells. Although the reductions in economic activity during the pandemic brought emissions levels down, there still need to be significant changes to reach Paris Agreement levels. Moreover, the development of the internet of things, 5G and artificial intelligence trend towards an increase in energy demand. A better recovery that considers the global environment is

essential. When aiming for a "better recovery," it is important to improve energy efficiency in terms of both energy supply and consumption, and to effectively utilize renewable energy.

Dr. Bernard Bigot presented on the ITER project and moving forward in challenging times. The pandemic affected all 35 countries contributing to the ITER project. The project took immediate action at the start of the pandemic with a continuity plan to enable the project to continue high priority activities while a large proportion of staff shifted to remote work. The equipment deliveries were not significantly delayed and major pieces of equipment were installed starting in May 2020, including firstly Cryostat Base. In the assembly ceremony,

world leaders spoke via videoconference. This is an example of overcoming organizational difficulty through communications technologies and effective project management.

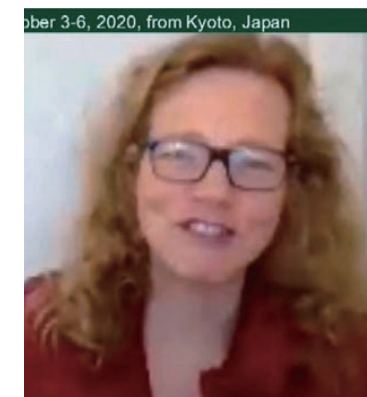
Dr Amy Luers gave a speech on tackling the climate crisis and disruption as an opportunity for systems change. Cross sectoral formal rules, social norms, power structures and mindsets amplify carbon production systems. It is in these systems where society must affect change. Changing norms and rules has been shown to have the most impact on systems change. COVID-19 has disrupted social norms, rules and mindsets. This new recognition of humanities interconnectedness and changes in norms has the power to be truly transformational. Digital disruptors such as transparency, intelligent systems, mass collaboration and mixed realities, help shift mindsets and affect change and can be used to realize a sustainable future.

Dr. Mallika Ishwaran presented on Shell's support of the Paris Agreement goals and its ambition to becoming a net-zero emissions energy business by 2050. Shell's global scenario, Sky, sets out a technically and economically possible route to reducing climate change. Nevertheless, this route is challenging because it requires a fundamental change in both the production and the use of energy. Making progress on this pathway requires consumers, businesses, and governments working together to drive change. COVID-19 has made an ambitious decarbonization pathway more challenging. However, as governments look at ways to restart their economies, this provides an opportunity to put the world on a more climate friendly growth path.

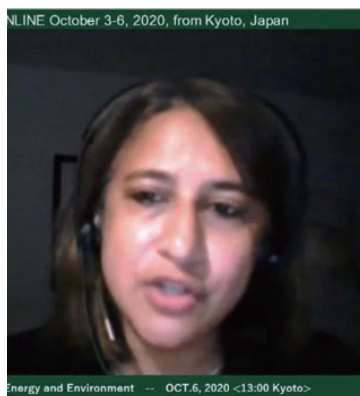
Mr. Shigehiro Tanaka referred to the CO₂ emission reduction as a result of the impact of COVID-19 and that it is not an economically sustainable way to achieve the future goal of climate change. Therefore, introducing an idea, which was proposed in G20 presidency



Bigot, Bernard



Luers, Amy



Ishwaran, Mallika

last year, of achieving both emissions reduction and economic growth at the same time, through innovation, is a key to the countries all over the world. In order to do so, importance of realizing an investment environment which focuses on companies with environmentally innovative activities and projects was pointed out as well. Japan is also pursuing a strategy for a beyond zero emissions goal by establishing the Global Zero Emission Research Center and initiating Tokyo “Beyond Zero” Week to deepen discussions among world leaders.

Discussions

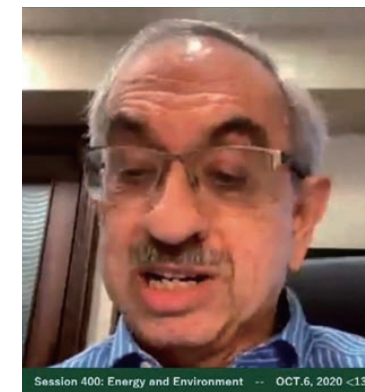
Dr. Fall began the discussions by noting that everyone is connected virtually this year and avoided the impact of the travel to Kyoto. The pandemic has been a tragedy in many respects, with loss of jobs, freedom of movement, and loved ones. Despite this, the air is clean and clear. The potential for a global reset could create a new normal and lock in gains for the environment. A number of themes have emerged from the speeches of the illustrious panelists. Dr. Fall highlighted the following questions. How to use technological solutions, massive global stimulus programs, and levers for effective change? Will COVID-19 make our shared goal of a cleaner and sustainable world easier or harder to realize?



Tanaka, Shigehiro

Dr. Kabat commented on the scale of COVID-19 impact, what exactly has this meant for emissions and what strategies and steps for benefits. The environmental situation is not good at all. Carbon dioxide rose by 60 percent. The lockdown led to the reduction of emissions globally back down to the 2006 level. Nevertheless, humankind has a big challenge in the transition of the energy system. The price of kilowatt hour for renewables went down considerably.

Dr. Kabat posed the following questions on the topic: (1) How does all this huge investment into the recovery packages for COVID-19 help tackle the energy systems? And (2) can these packages be translated into a transformation of energy? It will not just be technology or size of investment, but also the seriousness about transformation which must be addressed. Institutional, social, and behavioral change is needed, and when the system comes back, the huge quantity of global emissions will also return. The richest countries produce an overwhelming majoring of the carbon emissions. The challenge humanity faces is big, and unfortunately, COVID-19 itself did not prompt a huge step towards transformation.



Godrej, Nadir B.

Dr. Falk spoke on how COVID-19 may impact institutional and community understanding and summarized the outcomes of the Regional Action on Climate Change Annual Meeting (whose proceedings and statement are at stsforum.org/racc which he summarized as – convergence and integration. The impacts of the pandemic are beginning to converge with the impacts of climate change and other related dynamics. Biodiversity and inequality impacts will reach a peak in 50 years creating cascading challenges. Responding to them requires an integrated approach. Energy solutions which amplify the gap between rich and poor, or destroy biodiversity are counterproductive. We need to build an integrated framework for managing these inter-related risks, requiring strong global collaboration. So far national committed ambition for emissions reduction does not keep global warming below 2 degrees. To do so, all stakeholders need to work hard to strengthen international institutions including corporate coalitions to provide integrated analysis and implementation of renewable energy technology.

Dr. Whittingham commented on whether disaggregation in the workplace has created any opportunity for penetration of batteries, because patterns of life have changed. There are three examples of the success of batteries. One is the TESLA battery in South Australia making a good return on investment. In August, a 250 megawatt hour storage facility opened in San Diego County, and another is in Los Angeles where there are plans for a 1 gigawatt facility. In addition, near Saratoga Springs in New York State, there is a 16 megawatt facility that opened in Summer 2019 which buys power at night and sells back to peak demand,

and has made a profit from the beginning. Furthermore, another application is that villages, isolated from the grid, can build micro grids using solar with batteries. The lowest cost way of storing energy is still pumped hydro, if environmentally possible. However, the impact of COVID-19 has disrupted storage installations, due to reduced funding and the resulting lack of time and staff to issue permits; so everything is delayed.

Mr. Tsunakawa spoke on the positive effects of COVID-19 on energy and the environment. There is increasing demand for environmentally friendly and robust infrastructure. The technologies which enable this are robust grids that cope with the wider use of renewable energy, energy management systems to manage fluctuations, battery energy storage systems that maximize efficiency, and building energy management systems that improve energy efficiency. To expand renewable energy, grids need ways to repress output fluctuations and use peak leveling. Toshiba is using the high performance battery SCiB, a 20-amp product, with a long life and little deterioration in performance, this battery has a high input/output density, wide temp range and low maintenance, its application is in cars and automated guided vehicles.

Dr. Bigot continued the discussion by focusing on ITER and interruptions due to COVID-19. ITER gathers 35 nations to demonstrate hydrogen fusion, to reduce impact of energy consumption on the climate and environment. COVID-19 was not predicated, but ITER was able to mitigate its impact with a continuity plan. Lessons learned are; anticipation, mutual trust, reactivity. For anticipation, ITER used its risk register, whereby all members provide contribution to this. ITER saw the impact very early in China and set up a recovery plan. The ITER program is a 40-year project that has been going already for more than 12 years, so there has been time to build trust in a way to be able to react and prioritize swiftly and rely on people. When ITER saw the pandemic coming, it set up a mitigation plan, implemented safety measures, and the plan has worked quite well so far.

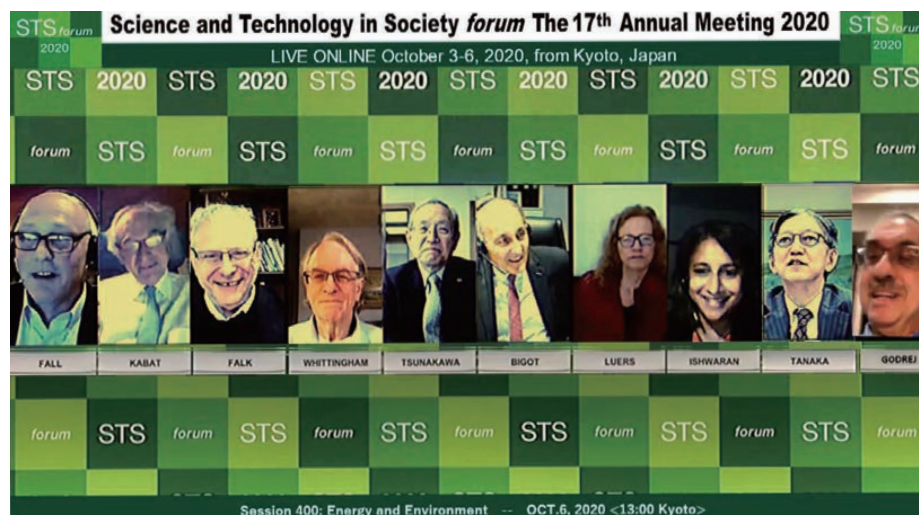
Dr. Luers spoke on the effect of COVID-19 on the opportunity for grassroots organization on energy and the environment. The actions over the next few years will define our future. One opportunity is the investments in the recovery and ensuring they move the trillions of dollars for rebuilding towards a low carbon infrastructure. Social norms have been changed, and society is rethinking how it engages with others. Humankind's values, in terms of materialistic status symbols may change as it focuses on the sustainability issues and issues of climate change. She posed the question of how society can move towards a world how to engage people in conversations and pursue governance in different ways. This pandemic is

a catalyst for this type of rethinking. Furthermore, the digital divide remains a huge issue, although it is surprising how rapidly it is being addressed. Overall, society needs to rethink more broadly the opportunities and challenges and on how it can do things differently.

Dr. Ishwaran commented on Shell's experience in scenario planning. It is hard to predict a global pandemic. Shell has a long tradition in scenario planning to inform our long-term strategy. We recently released a set of three scenarios – called Rethinking the 2020s – which look at different ways COVID-19 could impact the way we live, work, and play, including how it could affect progress towards the goals of the Paris Climate Agreement. One of the scenarios explores how a pandemic could lead to a renewed focus on climate change. Based on our Paris-compliant global scenario, Sky, decarbonizing the global economy in 30 years is a challenging objective, and we cannot afford to lose years this decade because of the pandemic in making progress towards it. The pandemic provides an opportunity to reset and refocus towards the energy transition. The energy transition is inevitable, and at Shell, we have reiterated our commitment to decarbonization and are stepping up our leadership role in developing low carbon technologies, fuels, and solutions to transform not just energy supply but also help our customers transform how and what energy they consume.

Mr. Tanaka touched on the necessity of both immediate support of vulnerable people and long term investment when we recover from this COVID-19 crisis. It is also a huge opportunity to make governments and economies change towards a digitalized society which is one of main policy agendas of Prime Minister Suga. In the environmental policy area, Japan has just announced that it will be phasing down inefficient coal power plants. This has negative employment implications, nevertheless, climate change is one challenge that the country cannot ignore. Initiatives like this do not require capital up front, but simply new ways of thinking.

Mr. Nadir Godrej, Managing Director, Godrej Industries Limited; Chairman, Godrej Agrovet Ltd, India, spoke in verse and enlightened the participants on the lessons learnt from COVID-19 and the challenges and opportunities relating to climate change, as well as summarizing the discussions thus far. Society is now more adept at working from home and other social distancing measures. This offers opportunities to reinvent other societal structures. He encouraged businesses to pursue climate-related initiatives ahead of national policy. Past hopes based on a technological solution have come true, as seen in the drop in solar energy prices. Mr. Godrej states that the energy transition is possible for all industries eventually.



Q&A Session

Dr. Fall opened the questions with a reflection on how COVID-19 had affected his personal and professional interactions.

Mr. Tanaka commented on natural disasters in Japan, such as typhoons, gather grassroots interest as well as the COVID-19 impact. The Japanese government will take necessary actions to respond to these voices.

Mr. Tsunakawa commented on the change in consumer demand. He noted that economic activity is slow and demand will take time to recover.

Dr. Kabat emphasized the balance between grassroots and the regulatory framework which the government should be providing. In France, the calls to engage the public in the discourse changed significantly after a public demonstration. Now, there is a huge platform on directing the changes from government. In Netherlands, leadership is giving more ownership to bottom-up grassroots. The private sectors, too, should be involved. There needs to be recalibration of partnerships, with grassroots, private and public sectors involved.

Dr. Luers commented on Dr. Kabat comments on grassroots. She hoped for a possible tipping point towards not just engagement in grassroots from top down but a paradigm

where the grassroots are listened to and are more involved in decisions. Governance needs to happen in a world where everyone can see and comment on all the issues.

Dr. Bigot also agreed that grassroots is playing an increasing role. In COVID-19, the atmosphere has been cleaner in cities, and now the public is expecting real change.

Dr. Falk noted that more communication capacity did not necessarily alter the power relations that restrain changing planetary course. But the pandemic has accelerated progress along the learning curve on how to use those communications technologies. And as communities and NGOs learn to use these technologies they may become more empowered to assert change in direction of development. If this occurs, post-COVID-19 learnings in IT usage could power an evolution in local, regional and global governance.

Dr. Fall asked whether a big energy company would be able to be a catalyst for the change.

Dr. Ishwaran responded to Dr. Fall by suggesting that is what Shell sees in the future. Shell will continue to build on its capabilities to develop low carbon fuels and technologies like hydrogen and renewables, but the force for change cannot stop at its boundaries. There has to be a dynamic with consumers. Shell sees the need for a systems approach, which includes customers who have to take on these fuels and solutions, e.g., in sectors like road freight, aviation, and shipping. That requires a change in mindset about how Shell operates, asking ourselves what it would take to drive the required systems change and what role we can play in supporting ambitious change.

A participant asked a question on why the focusing of moving to zero emissions as quickly as possible is on production not on advanced technology for users.

Dr. Whittingham explained that technologies were more important a few years ago. Computers are an excellent example of advanced technology reducing emissions. This can be seen, for example, with laptops becoming more heat and power efficient over the last decade, so that they can now be held on one's lap. However, the situation should be addressed from the technology on user side as well as the technology as a whole, but the timing has to be right. Advancements had been made in technology, such as with Exxon's solar production in the US, and the lithium battery, but in the 1970's industry was not interested in investing in that technology for 10 years.

Mr. Tsunakawa commented that reducing urban power consumption is critical and that energy efficiency improvement is a driver of emission reductions. Toshiba supports that with building energy management systems. Mr. Tsunakawa also commented that nuclear will continue to have an important role.

Dr. Fall queried all of the panelists about their views on leveraging the COVID-19 situation for a more sustainable world. The panelists gave many positive responses on this question.



Promoting Inclusive Participation in Science and Technology

[Chair]

Marshall, Larry, Chief Executive, Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia

[Speakers]

Yonath, Ada E., Director of The Helen and Milton A. Kimmelman Center for Biomolecular Structure and Assembly, and The Martin S. and Helen Kimmel Professor of Structural Biology, Faculty of Chemistry, Weizmann Institute of Science, Israel [Nobel Laureate 2009 (Chemistry)]

Monro, Tanya, Chief Defence Scientist, Department of Defence, Australian Government, Australia

Silver, Mariko, President, Henry Luce Foundation, U.S.A.

Diab, Roseanne, Emeritus Professor, University of KwaZulu-Natal; Director, GenderInSITE, South Africa

Oxtoby, David W., President, Executive, American Academy of Arts and Sciences, U.S.A.

Shirahase, Sawako, Professor, Graduate School of Humanities and Sociology, The University of Tokyo, Japan

Simonneau, Denis, Senior Vice President for Institutional Affairs, L'Oréal Group, France

[Commentator]

Duterque, Adeline, Head of ENGIE Lab CRIGEN, Research Centre, ENGIE, France

Remarks



Marshall, Larry

Dr. Larry Marshall presented on the fundamental nature of science as an open method for discovering truth being placed to benefit greatly from scientists of a diverse gender, ethnicity, age, and background. This level of inclusion would help solve the world's great problems, as well as having proven economic benefits of a diverse workforce. Traditional leadership pathways in science serve men well, but not women. To change this, the Commonwealth Scientific and Industrial Research Organisation became a founding member of the Science in Australian Gender Equity program, an organization which promotes gender balance and equality in science.



Yonath, Ada E.

Dr. Ada E. Yonath gave a presentation on inclusive participation in science and technology through the Weizmann Institute of Science. The institute is ranked 6th by the Nature Innovation Index. She developed novel, eco-friendly antibiotics to solve the worldwide problem of resistance to antibiotics. Despite this, it has not yet been able to secure commercial production. Antibiotic resistance is a severe problem causing 700,000 deaths per year globally. Thus, there is a mismatch between the pharmaceutical incentive and social values.



Monro, Tanya

Prof. Tanya Monroe spoke about the importance of inclusion in science and technology. Unless there is inclusion at decision making tables, humanity cannot produce the best science nor decisions. In Australia, women in scientific leadership position are few in number. The Women in STEM Decadal Plan seeks to resolve this throughout the career spectrum. Scientific advancement will come from diverse teams, just as interdisciplinary science helps to solve complex problems.

Dr. Mariko Silver presented on the Henry Luce Foundation's initiative and progress on supporting diversity and inclusiveness in STEM, in particular with a focus on gender. The foundation is the U.S.'s largest private funder of women in STEM in higher education, helping 2800 individuals from 200 institutions through grants. This support of individual women in STEM will enable institutional change long term, but support of individuals is not sufficient. The systems and structures of science and advancement also need to change. Additionally, change must be sought beyond education in the wider field of science and technology which the foundation engages in with its partner organizations.

Prof. Roseanne Diab spoke on the systems level change that can come from more gender diversity and inclusivity in apex science and technology academies. Currently women as

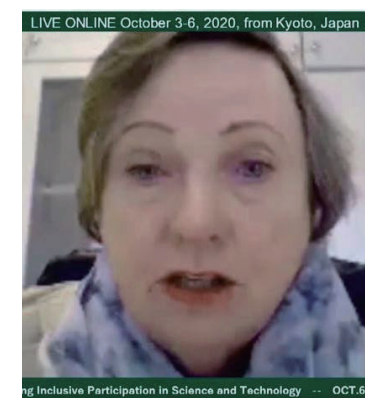
elected members at these institutions is low, averaging about 20 percent, however, GenderInSITE revealed that women's membership has increased from an average of 12 percent in a previous study, and that young academies are significantly more transformed than senior academies. Despite this promising information, many science academies still have less than 10 percent women members. The gender gap is large. Incremental change is slow and unlikely to effect the significant change that is needed.

Dr. David W. Oxtoby gave a presentation on the role of the American Academy of Arts and Sciences in diversity and inclusion. The academy was founded to advance knowledge and the common good. The academy has redirected its effort to focus on COVID-19-related areas such as under-resourced arts organizations, global cooperation, migration, and border spaces. Diversity, equity and inclusion are important to its mission, especially due to the pandemic, as the Academy focuses on building capacity of communication and engagement in the scientific community, shaping the narrative around science, and developing systemic support for science engagement efforts through its Public Face of Science initiative.

Prof. Sawako Shirahase spoke about inclusive participation in the society. Japan is characterized by a high gender gap in wage and status. This has adverse effects on decision-making. The access to internet by gender can be seen to reflect this disparity. Women are also more likely to feel lonely and uneasy during the COVID-19 spread. From this it can be seen that it is not enough to simply note the difference or disparity of those with access to resources. Special consideration is needed to facilitate inclusive participation.



Silver, Mariko



Diab, Roseanne



Oxtoby, David W.

Mr. Denis Simonneau presented on the science and technology being more inclusive of historically disadvantaged groups to enable it to address the challenges of COVID-19 and climate change on humanity. Science at its core is group problem solving, therefore, more diversity will create more diverse perspectives. Women represent only a small part of STEM, despite their significant contributions, and are affected by bias throughout their career. This disparity is seen throughout nations and scientific organizations and even in the outcomes of science itself. The For Women in Science Program sponsored by L'OREAL and UNESCO seeks to change this through its camps and fellowships for girls and women and recognition of women's scientific achievement.

Discussion

Dr. Marshall began the discussion by asking for the permission of those who have walked the land before, in traditional Australian practice. He mentioned that the discussions were being held at a critical moment, as society begins to rebuild after COVID-19, because diversity and inclusion in science and technology can help humanity rebuild better and faster. Diversity and inclusiveness are key drivers of success in science, and therefore, systematic challenges to diversity and inclusion in science and technology must be addressed. Dr. Marshall expanded on the theme discussed stating that diversity differs across regions and domains, and that the opportunities and barriers related to diversity and how to overcome them is to be addressed. Dr. Marshall then introduced the participants.

Dr. Yonath highlighted that Israel is known as a startup nation and that she has many connections to industry as well as her work in science. Although scientists think they can help society a lot, there are often barriers to real scientific progress as she found that she cannot find a way to collaborate with industry in getting antibiotic resistance medicine

into production. Antibiotic resistance is a big killer worldwide. 13000 Europeans die each year. And in the U.S. 1 million are ill with diseases that could have been cured with antibiotics. It is predicted that in 2050, 4 percent of the global budget will be focused on problems of resistance of all types. The industry is producing known natural antibiotics, but spends no resources on creating new antibiotics. Pharmaceutical companies agree to fund only at the last steps to generate the most profit.

Prof. Monro commented that the COVID-19 pandemic provides an opportunity to rediscover how science is done and how it contributes to global issues. The old work paradigm involved being seen to be present for long hours. However, now we have people working from home, despite it not being something that they chose, work is now focused on outcomes and deliverables. This places more trust on people and clarity on the goals of work. More broadly, gradual modifications to workplaces might never amount to real change. COVID-19 has been so disrupting to workplaces that there is an opportunity to make these new working styles permanent. The barriers that one typically faces working with institutions are now gone. Prof. Monro hopes for even further changes in this regard, and that people are even more valued for their work.

Dr. Silver commented on how to affect structural change for inclusion and the best practices for it. It is clear that the future society wants is not possible with the structures that it has, so we must rethink the structures and systems. This work requires a multidisciplinary approach, as society might be able to identify what is lacking in the system in terms of inclusion. Dr. Silver questioned what the expectations are for gender and diversity, and what it means to be successful and not successful. Ideas of merit are recursive and therefore systems regenerate themselves. For real change, the scientific community should think about the systems



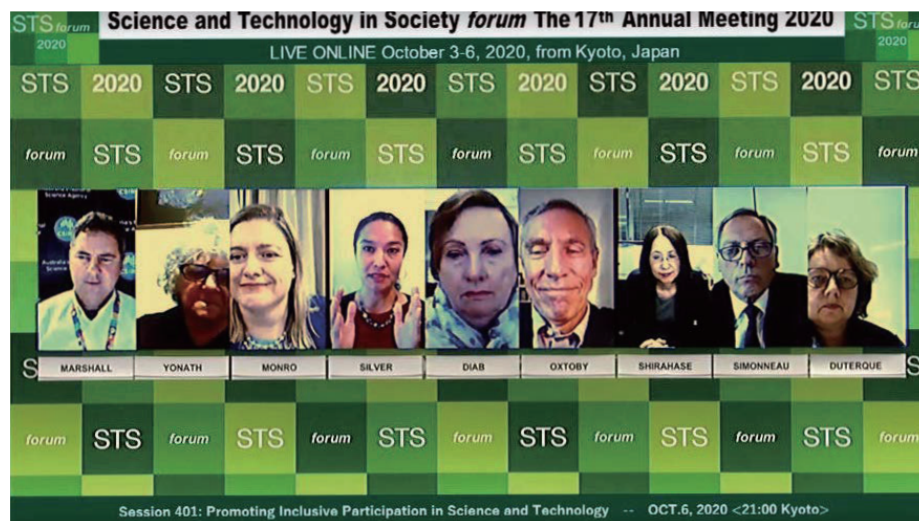
Simonneau, Denis



Shirahase, Sawako



Duterque, Adeline



that influence the possible outcomes for individuals, organizations, and institutions, and how they are nested together. Change should be focused even beyond individuals, and on the structures within institutions. Science and technology have insufficiently been asked to define what they value. COVID-19 is the great revealer, and all the layers need to be unpacked to understand the impediments to diversity. One specific example is Trinity Washington University in Washington D.C. The organization on their own efforts rethought the arc of the STEM curriculum with multiple entry points. This should be readdressed thoroughly.

Prof. Diab explained how the younger academies are achieving better gender parity and the lessons that can be learnt. Young academies, in contrast to senior academies, are very new organizations, and do not have legacy issues to overcome. They can also draw on a more transformed pool of scientists. The election process for young academies is generally reliant on an election committee, which is able to implement a policy directive from a governing body. Senior academies, on the other hand, elect new members through a voting process with all members having a vote. There is thus no control over the outcome and no way to ensure that policy directives are adhered to. The centuries old voting process is sacrosanct and unlikely to change, but if the science community wants to effect change for women in academies it needs to address this. Examples of best practices include measures such as a women's only election year, or for nominators to include at least one woman in their pool of nominees. Bold steps will indeed be needed.

Dr. Oxtoby commented on the new report by the American Academy of Arts and Sciences, called the *Perils of Complacency*. The report calls for efforts to increase U.S. competitiveness in science. Competitiveness in science in the U.S. will require significant public investment. However, competitiveness also comes from talent. To ensure the country has the correct talent pool, it needs to remain open in the long term for immigrants in order to attract new scientists. Another aspect to improve competitiveness in talent is to improve underdeveloped talent in the country itself, including focusing on girls and women in science, from school to graduate programs. Of course, this also involves including people of color who do not feel they have role models in science and who face barriers that others do not face. This is not only a U.S. issue, but an issue for many countries.

Prof. Shirahase expressed her thoughts on equal access to the internet being vital especially in connectivity at work and connectivity at home. Japan is very behind in gender equality compared to the rest of the world. One important factor in gender equality is having equal access to basic research. This relates to issues of opportunity. Opportunity itself is not equally distributed. In Japan, within science and technology, there is very severe gender inequality. The internet can provide any kind of information to anyone. But, at the same time, if there are discrepancies or limits by education background and the ability to handle the information, it would exacerbate the disparities. It is very difficult to change perceptions in the traditional atmosphere in Japan. The situation is seen as undesirable but perhaps rapid change is also undesirable. Being fair and having results in equality is the debate in Japan.

Mr. Simonneau stated that France is actually celebrating the week of the festival of science, and he commented on the importance of encouraging women in science in their early careers. L'Oréal Group decided to launch its program 20 years ago because of the difference between men and women in science. The situation in Asia and Asia Pacific is even more severe. This program is to develop women's visibility in science and STEM. The obstacles that women face start at school, middle school and high school but there are several obstacles to women at every level in a scientific career.

L'Oréal Group decided to look at this issue through a social change model. Its conclusions are that identity and gender inequality in science has a promotion issue, and it is to generate visibility for women scientists, through awards, and also through training programs. The young talent program for scientists from 25 to 30 years old gives visibility and training to easily communicate, training for management, fundraising and social awareness. Mr. Simonneau mentioned that he was able to participate with a program in Senegal last year,

and he was impressed with how enthusiastic the participants were. This program recognized scientists, but ceremonies are suspended this year because of COVID-19. It is also important to have men involved in the program to commit themselves to joint action on the issues.

Mrs. Duterque mentioned that all the panelists agree that gender diversity sparks new discoveries by broadening the viewpoints and areas addressed by researchers. These are times that scientists must draw on all research skills and talents as the world faces two major global challenges for the first time, the COVID-19 pandemic and climate change. To address the challenges of diversity and inclusion in science and technology, there are four topics that should be considered. Education is paramount.

Women must be exposed to science and technology at a much younger age than is typical. Also, ambitious targets must be set. ENGIE as an organization has a goal called Fifty Fifty, whereby women managers need to rise from 25 percent of staff now to 50 percent by 2030. Furthermore, work networks need to be developed and promoted for women, to promote inspiring models for women. And lastly but not least, parenthood must be fully supported. This can be done by limiting meeting times, limiting emails on holidays, providing daycare centers to, as ENGIE does. The results speak for themselves. Two out of three of ENGIE's main research centers are led by women. Mrs. Duterque stated that her research center has almost 40 percent women researchers. Diversity is possible, but it takes time and drive.

Q&A Session

Dr. Marshall stated that the Commonwealth Scientific and Industrial Research Organisation ran an innovation program which was very successful and produced a disproportionately high number of women CEOs, without direct intervention, but only focusing on growth language, not leadership language. He questioned how people feel that inclusion differs in different countries, and if there is anything that can be done for faster change.

Mr. Simonneau mentioned that the L'Oréal Group's program was importantly placed in all five continents. This approach of science could be different. Also, L'Oréal Group knows that the cultural barriers that have been observed are at very different levels and need different actions. Therefore, it was necessary to start as soon as possible.

Dr. Yonath commented on gender diversity measures stating that the most important criteria should be excellence, for awards and funding, not equality in numbers. Society itself has



to be educated. The perception of women in science is not very good. Many girls go into science but want to stay in a level that is not competitive. Dr. Yonath stated that in her institute more than 70 percent of the scientists are women, but the view in society is still not seen well.

Dr. Marshall agreed with Dr. Yonath that society is continually putting us in boxes.

Dr. Oxtoby agreed with Dr. Silver and Prof. Monro stating that inclusion is much more challenging than diversity. Institutions must be more accepting and prepared to change.

Prof. Monro commented that interdisciplinarity, inclusion and diversity as concepts have a lot in common. It is problems that pull in diverse people, and scientists might be able to use problems to pull in a diverse group of problem solvers.

Dr. Silver stated that the scientific community tends to think about diversity as supplemental as a marginal improvement. But in fact it is core to rethinking the system. To elevate excellence, the scientific community has to think about whether the systems and institutions that

exist, are structured to identify to merit, and if there is a need to reshape and restructure ideas of merit, and include a broader range.

Dr. Marshall added that the Commonwealth Scientific and Industrial Research Organisation has made progress on shifting towards a diverse workforce, but has more work to do in this area, and must keep focused.

Dr. Silver added that the numbers of gender balance are also important and that they place decision makers in the room. The scientific community needs to go back and test its own assumptions in the social structures that surround science. The COVID-19 era shows very clearly that this cannot continue. These questions are difficult to answer, and are nonlinear in nature.

Prof. Shirahase commented that scientists can solve the problem of gender inequality, but there is a huge problem of extent of gender inequality. As the other panelist have said in order to make society innovative, diversity and inclusion is a key issue, but how to catch up is a remaining challenge.

Mrs. Genevieve Fioraso, Minister, Ministry of Higher Education and Research, France, raised the question of whether the panelists' organizations have taken steps to encourage women in science from slipping back.

Mrs. Duterque answered that the first step is to promote parenthood and those with children through daycare centers whether company-based or through other models. And then inspiring models need to be promoted. Just as men do, women need networks. ENGIE launches the Women In Networking in this regard. Furthermore, companies should set ambitious targets.

Dr. Marshall explained that Australia has adopted the UK program, Athena SWAN, which is aimed at addressing gender inequality.

AI and Society

[Chair]

Petit, Antoine, Chairman and CEO, National Center for Scientific Research (CNRS), France

[Speakers]

Bengio, Yoshua, Scientific Director, Mila - Quebec AI Institute; Full Professor, Computer Science and Operations Research, University of Montreal, Canada

Frey, Carl Benedikt, Director and Oxford Martin Citi Fellow, Oxford Martin Programme on Future of Work, Oxford Martin School, University of Oxford; Economics Associate, Nuffield College, U.K.

Nagel, Wolfgang E., Director, Centre for Information Services and High Performance Computing, Technische Universität Dresden - Centre for Information Services and High Performance Computing, Germany

Mojsilović, Saška, Head of AI Foundation, IBM Research, U.S.A.

Veloso, Manuela, Head of J.P. Morgan AI Research, J.P. Morgan; University Professor, School of Computer Science, Carnegie Mellon University, U.S.A.

Gagné, Jean-François, Founder & CEO, Element AI; Co-Chair of the Innovation & Commercialization working group, Global Partnership on Artificial Intelligence (GPAI), Canada

[Commentator]

Haddadin, Sami, Director, Munich School of Robotics and Machine Intelligence at the Technical University of Munich (TUM), Germany

Shimada, Taro, Executive Officer and Corporate Senior Vice President, and Chief Digital Officer, Toshiba Corporation, Japan

Remarks



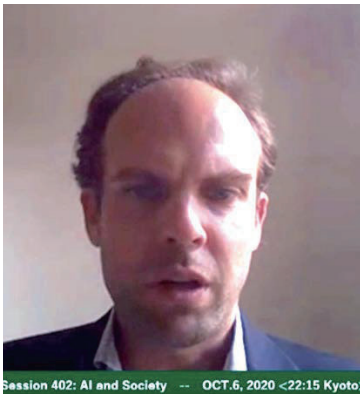
Petit, Antoine

Prof. Antoine Petit presented on the intriguing questions on artificial intelligence. Namely, is artificial intelligence still a maturing technology? Or is artificial intelligence a general purpose technology ready to be used in virtually all domains, even if improvements are possible and necessary? The COVID-19 pandemic has shown how dependent societies have become on digital technologies. Prof. Petit also posed the question of whether artificial intelligence should have played a more important role in the identification and analysis of COVID-19, and he questioned the concerns of the applications of artificial technology.



Bengio, Yoshua

Prof. Yoshua Bengio gave a presentation on artificial intelligence in the time of COVID-19 and beyond. As artificial intelligence has spread from academia to the wider world, it may be misused. In society, collective and individual wisdom has increased, but it does not outpace developments in concentrations of power. Artificial intelligence can be used for social good in healthcare, agriculture, education and environment. Notably, it has been used in the discovery of antivirals as well as infection risk estimates.



Frey, Carl Benedikt

Dr. Carl Benedikt Frey spoke on the enormous gains that artificial intelligence could bring to people, societies and economies in the long term, as well as significant disruption and transformation in the short term. Transformations in automation in the industrial revolution can serve as great insight to the possible developments in artificial intelligence. The technology will also have a significant impact on the labor market.

Prof. Dr. Wolfgang E. Nagel presented on ScaDSDresden/Leipzig and its role in artificial intelligence research. Its mission is to bring together knowledge from domain scientists, skills and expertise from artificial intelligence, to extend and improve the underlying methods, and to

make this available beyond the disciplines through its service center. It also engages in teaching and outreach programs in the region, and the group considers the effects on society through ideas such as privacy by design, legality, and explanation of artificial intelligence outcomes.

Dr. Saška Mojsilović spoke on her perspectives that she brings to the discussion as a scientist, business person, individual and mother. During COVID-19, society and the scientific community has come together to confront the pandemic, with many of these efforts based on artificial intelligence tools for detection, drug repurposing and analyzing scientific

research at scale. Dr. Mojsilović wondered how to keep this momentum and direct it toward solving other societal problems.

Dr. Manuela Veloso gave a presentation on artificial intelligence in society from the point of view of finance. She summarized artificial intelligence as a system of components, and has particular interest in how artificial intelligence and humans will interact together. AI Research at J.P. Morgan has identified several areas of artificial intelligence that it is investigating, namely, the understanding of financial markets, the sharing of data safely, and contribution to ethically good systems.

Mr. Jean-François Gagné gave a speech on the issues surrounding artificial intelligence that have come to the forefront as a result of the COVID-19 pandemic. Artificial intelligence is a new iteration of software that accomplishes a specific task based on large amounts of data. This technology does involve risks, but they remain manageable. Currently, very few businesses are effectively using artificial intelligence at scale which explains its limited role in the pandemic.

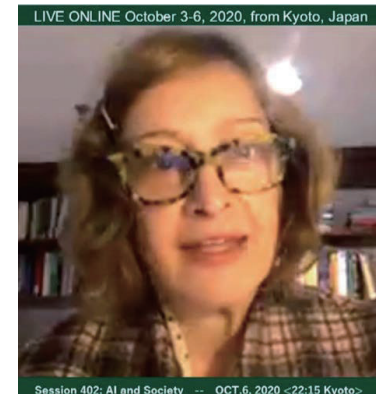
Discussion

Prof. Petit narrowed down the very broad subject of artificial intelligence in society, and focused the discussion mainly on the lessons society can learn from this crisis regarding artificial intelligence, and if the crisis is leading scientists to more international cooperation.

Prof. Bengio gave an example of one lesson that is important being the collaboration with experts in many disciplines. This includes social science, as many artificial intelligence techniques will be allied in social, political and economic areas. There is a resistance to things that most people do not understand. Therefore, artificial intelligence researchers need to



Nagel, Wolfgang E.



Mojsilović, Saška



Veloso, Manuela

improve education and make sure that scientists do more to prevent the misuse of artificial intelligence.

Dr. Frey commented that scientists cannot predict the impact of artificial intelligence but they can use different perspectives. Especially, when it comes to employment trends and automation that can be seen now, as it was in the industrial revolution. The luddites rioted because of mechanized factories. Wages were falling despite GDP increasing. Interestingly, workers are now also voters, so, society cannot take their acceptance of artificial intelligence for granted. Policy makers should think about how to make this transition towards automation smoother. The entire scientific community needs to think carefully about how to manage this process.



Gagné, Jean-François

Prof. Dr. Nagel added comments on the crisis regarding artificial intelligence and countries protecting sovereignty. In general, the crisis has led to a lot of collaboration. Society has learned how to deal with the crisis and with COVID-19. Basically, a couple of countries have issues regarding access to long term data, but this access should be granted so that it can be used and analyzed, with certain privacy protection methods in place. Prof. Dr. Nagel stated that he thinks it is very important that all have

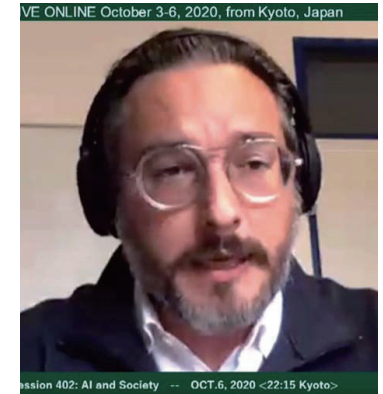
access to the technology that helps us in developing these methods. There are misleading efforts which will go in the wrong direction. Sovereignty is important but when we look at the data usage, the benefits are clear from the scientific community's unity in combatting COVID-19.

Dr. Mojsilović explained that the crisis happened in parallel with the fires and floods. Society saw many innovations in how it works and solves problems. Humankind is moving away from the old models of innovation, to something that is more collaborative and decentralized. These collaborations are beginning to leverage artificial intelligence in many new ways. In

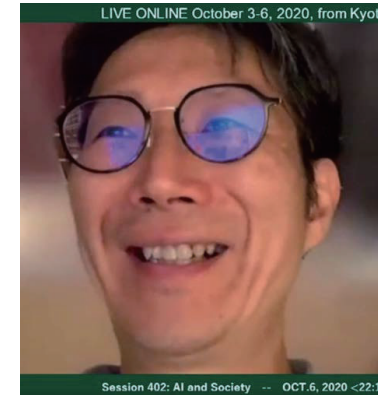
generating hypothesis and looking for new sources of knowledge, it can be seen that the demonstration of artificial intelligence is possible in new platforms that will expand beyond traditional computing, such as quantum computing. Dr. Mojsilović added that she thinks that this future is going to come soon.

Dr. Veloso stated that artificial intelligence at J.P. Morgan and in other places has several functions in analyzing data, making recommendations, and assisting people who need to make decisions. The other extreme of this is when artificial intelligence makes the decisions and they are carried ahead. Dr. Veloso gave the example of applying artificial intelligence to recommend a marketing message, compared to a loan assessment. Therefore, the range of risk is large in deployment of artificial intelligence. The developers of the artificial intelligence systems need to know what can be changed, and the reason why an artificial intelligence is giving a particular outcome. Researchers need to know what to change to change the outcome. They need to be able to do local explanations to customers. And specially, regulators need proof that the system overall complies with regulation. These are the three recipients for trust: the developers, local customers and regulators. The problem of explanation is not a one shot thing. J.P. Morgan is developing the approach of layered disclosure to try to understand what is going on at different levels of details. If the artificial intelligence system is asked the question three times, it cannot answer in exactly the same way each time.

Mr. Gagné commented on companies' abilities to apply and utilize artificial intelligence effectively. Elemental artificial intelligence is mostly focused on doing technology transfer in different industries and supply chain sectors. The pandemic provoked a questioning regarding the implementation models' fragility levels. These systems were initially ill equipped to reorganize themselves. Most organizations have been able to shift and react,



Haddadin, Sami



Shimada, Taro



and artificial intelligence is already contributing to getting them back on their feet. So, at first it was under manual control, but they are now getting a more mature grasp of the supporting systems and their value. It is imperative to have robust systems, to be able to contribute and manipulate data, and simulate new situations to train their models in new ways that do not exist yet in the world. The combination between sophisticated simulation and past data is vital. Society is getting better at using data, and this has been highlighted by the pandemic. Changes will occur increasingly faster in this field.

Prof. Dr.-Ing. Sami Haddadin commented that from the panelists, much has been said on collaboration and sharing being a major element, transitions being smooth as in industrial revolution, the demand for education to get many people in to the game, the limitations of technologies, and how to increase resilience. The takeaway from the last month that is very clear is that humanity is living in a digital world. But also the pandemic society saw how much it depends on physical presence. It is a great time to see how much collaboration can benefit society beyond the borders of our own societies. It is also interesting to see that more and more software-based artificial intelligence is trending into the physical word. In all the contributions by the panelists, it was clear that society would like to build a world where it shares its knowledge and skills, as well as a way to get to a more resilient society.

Mr. Taro Shimada added that people have too much expectation for artificial intelligence, and artificial intelligence engineers try to solve problems only with artificial intelligence. Mr. Shimada explained that he used to be an aircraft engineer, and that it is impossible to create a very safe airplane with a single system. At Toshiba, engineers are working side by side trying to solve the problems as a wider system, not just with artificial intelligence. Mr. Shimada questioned how to ensure quality assurance when artificial intelligence is used. It is important that artificial intelligence is getting mature now, but society should not just rely on artificial intelligence but solve problems as a system.

Q&A Session

Prof. Bengio further expanded that one of the lessons from the pandemic is to think more about collaboration and the need of it. There is the realization that in the pandemic, the whole planet is in the same boat. The rational thing is to think about this as a global problem. There are other global problems that humankind needs to face all together. On international collaboration and the sharing of knowledge, for artificial intelligence to work well, researchers need to share knowledge and data, but the rules and norms that exist in industry push companies towards secrecy. Society cannot afford to wait for information to seep slowly out. Everyone must push all their assets together to solve this.

Dr. Mojsilović commented that at IBM, the conventions that are put in place are monolithic. Even in research, there is no incentive in sharing data. Our papers are microscopic with minor inventions. As a society, we need to think about how to change incentives and how to direct the researchers in the field of artificial intelligence towards the beneficial sharing practices.

Mr. Gagné explained that with approaches like iterated learning, there are opportunities for new types of collaboration, sharing smaller pieces of intellectual property and putting them together. On the research front, there has been quite a bit of progress. Nevertheless, researchers are still missing many infrastructure pieces. A lot of the digital assets that are prerequisites are missing. There are some amazing international collaboration opportunities to create huge databases, such as in language. These can be put to free use. These are two big things that could move things forward.

Dr. Frey stated that the way to get to business is through the patent system, by innovating and then leaving information in the public realm. But patents have become strategic, so artificial intelligence researchers need new mechanisms to share knowledge. The pandemic

has shown that business underwrite their willingness to share a vaccine, and pool their financial resources, as seen in the Gates Foundation. There are many technologies that are a public good. The playing field is very uneven. The handful of major technology companies are in the U.S. which gives the U.S. less incentive to share with other economies.

Mr. Shimada added that maybe with some of the data the problem can be solved, but a lot of data is generated by a person. If the owner is not willing to give their data, they should not. He then questioned how researchers can incentivize the consumer to share data between different systems.

Dr. Veloso shared her agreement with Mr. Gagné. J.P. Morgan has generated synthetic data on payments and customer journeys. It is calibrated by real data, but it is not actually real. She thinks that society will get used to sharing synthetic data. The J.P. Morgan committee has allowed it to be shared because private data is not present but it provides more power to large enterprises.

Prof. Bengio agreed with the idea about the Gates Foundation funding from Dr. Frey. He mentioned that coming with strings attached to be globally beneficial for the planet is a way to play with the incentives that Dr. Mojsilović was talking about. The tools will not be sufficient unless scientists change their incentives. It is possible to start thinking about how to fund projects to come with constraints about transparency and sharing that will be globally beneficial.

Prof. Dr. Nagel added the comment that many people are willing to give data away because they get benefit from the tools. He does not recognize how it will be possible to share the interdisciplinary data. But, there is a huge potential to bring data together and analyze them from different viewpoints to create new knowledge that is not foreseeable. In the end, there will be more knowledge created, and it is free data. There is a huge potential for artificial intelligence to make in this regard.

Dr. Frey explained that data is highly domain specific. It is not clear that China with its disregard for privacy will lead to advancements, because the data will not travel well. It might prove to be China's natural resource curse. The data intensive applications of artificial intelligence are hindering. For artificial intelligence to become more efficient, more innovation will be needed, as seen in history with the development and innovation involved in the steam engine.



Prof. Bengio commented on quality and reliability of the data of organizations whether private or public generated and shared data or not. Organizations choose to share some things and not other things. What are the driving forces that make it so? The data that helped them come to their conclusions is not immediately clear. In the commercial world it is worse, with incentives misaligned. If the incentives are not changed, there will not be any progress.

Prof. Dr.-Ing. Haddadin queried that assuming researchers had the best data available, would artificial intelligence have had a better impact on the pandemic? Scientists need to look at it at a systems level. All the actions, right incentives and conclusions generated from the data, are also important. Artificial intelligence has to work in the system and humanity is part of that system.

Dr. Veloso commented further on data. She deems data to be a little overrated. She explained that even with large amounts of data on chess, it would not be possible to learn the rules. The same is true in finance. Decision making and complex processes on how

people are doing something now will not invent a new method. There is a need for artificial intelligence runs on abstract models to alert humans of better ways of doing things.

Dr. Mojsilović expressed her agreement with Dr. Veloso that data is important but it is not the only thing to consider. Drug discovery was done in the past in pharmaceutical labs optimized to create new drugs. In COVID-19, it was shown that scientists can generate new molecules and targets to analyze data, and that leads us new to drugs. This shift of how technologies are used will realign how we do things.

Prof. Dr. Nagel expressed his agreement with Dr. Mojsilović that this might lead to new approaches in new areas. There is more knowledge available in data if it is made accessible.

Mr. Shimada commented on the example of making exams more secure to illuminate the difficulty of applying regulations.

Prof. Petit added his thoughts that there is a need for more research in artificial intelligence in both industry and academia. International cooperation is also vital. Moreover, education will be paramount in having society accept artificial intelligence.

Closing Session

[Chair]

McNutt, Marcia, President, National Academy of Sciences, U.S.A.

[Speakers]

Fire, Andrew Zachary, Professor, Departments of Pathology and Genetics, Stanford University School of Medicine, U.S.A. [Nobel Laureate 2006 (Physiology or Medicine)]

Riza, Hammam, President, Agency for the Assessment and Application of Technology (BPPT), Indonesia

Komiyama, Hiroshi, Chairman, Mitsubishi Research Institute, Inc., Japan

Serageldin, Ismail, Founding Director Emeritus, The Library of Alexandria, Egypt

Remarks



McNutt, Marcia

Dr. Marcia McNutt offered gratitude and thanks to Chairman Omi who has bestowed her the honor of chairing this closing session which summarizes the main messages of the preceding days' discussions. In the quest to accommodate an online audience, Chairman Omi has delegated the role of chairing each session to whichever member of the international STS *forum* Board is most available given the hour of session. The STS *forum* had particular relevance for sustainability this year, as it was held amid COVID-19. The crisis has emphasized the need for a sustainable healthcare system, sustainable economies, sustainable educational institutions, and a sustainable society. The pandemic has also brought

about a radical increase in telework and video conferencing and drastically reduced the global carbon dioxide emissions rate. COVID-19 has also revealed disproportionate impacts on different segments of society, increasing the inequality gap. Such inequality is incompatible with a healthy, sustainable society. The forum is addressing the correct questions, and the experts here have informed our thinking on building a more enduring, resilient society.

Prof. Andrew Zachary Fire addressed the forum in the closing session and explained his particular expertise on the biology of cells working together in the same niche, and of how



Fire, Andrew Zachary

cells separated from each other can warn each other of challenges and threats. One threat signal is called RNAi, which has been subsequently developed into an effective treatment which sends a message to millions of cells. Research into this technology which laid the foundations for cures to disease that were otherwise incurable, has itself evolved from scientific communications with pen and paper, to telephones, to the nascent internet, to the present world of instant messages and data sharing. But many of the major advances have come when we were in the same place at the same time, allowing rich feedback on both verbal and non-verbal levels. Prof. Fire expressed his gratitude to the people who organized meetings past and those who organized the meetings of today with the STS *forum*.



Riza, Hammam

For the last six months, in addition to observing the horror of a pandemic not being addressed sufficiently by science and by some political leaders, Prof. Fire has been observing how communication continues to evolve. It is all the more critical at this time to ensure that all tools of communication (including an opportunity to meet and exchange ideas in one place) are available to scientists (many being very early in their careers) who will then lead us in new advances for society. Sometimes this is

just being together at a university or a company, but in many cases the right combination of expertise and ideas will involve cross-cutting forums such as the STS *forum*.

Prof. Fire posed a number of questions. Will we be able to assemble next year to discuss the deliverables to full put COVID-10 to rest? Will we be able to assemble next year to adapt the knowledge we have gained to address the next pandemic? Will we be able to assemble next year to share to tools from COVID-19 to tackle chronic infectious diseases like tuberculosis and malaria? Will we be able to assemble next year to use the energy from the COVID-19 fight to addresses larger questions of systemic inequity. Will we be

able to assemble next year to transfer the unity from the COVID-19 fight to arrest and mitigate climate change? Will we be able to assemble next year through tailoring new communications platforms from a year of COVID-19 that will make online meetings uniquely rich? Will we be able to assemble next year in Kyoto and allow the appreciation of the magical aspects of an in person human interaction to solve human problems?

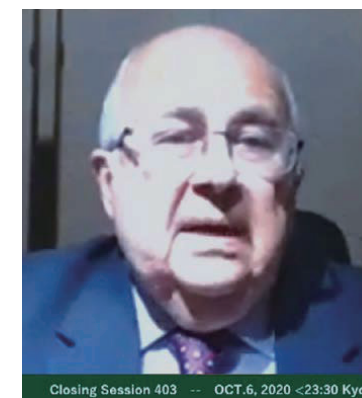
Dr. Hammam Riza expressed his great honor to be in the closing session, and shared his appreciation to Chairman Omi for inviting him to have this great opportunity. He mentioned that he had learned from the issues discussed by many speakers in many of the sessions.

He added his thoughts on the three topics in relation to Indonesia. On energy and environment, although Indonesia has a situation of increasing consumption due to the pandemic, it has a plan to reach renewable energy emissions of 23 percent in 2025. Dr. Riza expressed his agreement with Prof. Fire's comments on the sustainable development goals and ensuring the sustainability of our way of living.

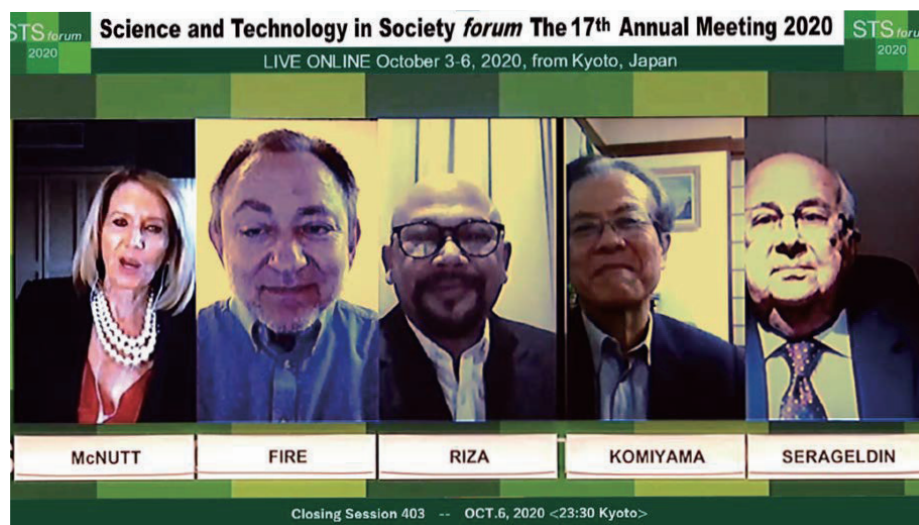
Indonesia is targeting to biofuel development in 2020. In electricity, the government intends to accelerate biomass development with a plan for rooftop solar energy and firing biomass plants which will increase renewable energy contributions. It is targeting a 6.5 gigawatt solar plan in 2025. Indonesia has also developed science and technology in collaboration with the involvement of many universities from business to industry communities which formed a quad helix, or a penta helix if including the media, in how health protocols are run to fight the pandemic. This taskforce was able to produce local products such as a rapid test kit, ventilators, mobile laboratories and others as a result of the strong collaboration in science and technology in Indonesia.



Komiya, Hiroshi



Serageldin, Ismail



Indonesia is also transitioning from teaching universities to research universities. In artificial intelligence and society, Indonesia has just released its national strategy on artificial intelligence. It is clear that artificial intelligence plays a role in advancing digitalization, smart farming for optimal use of fertilizer, predicting natural disasters as Indonesia is prone to earthquakes, floods and tsunamis. Artificial intelligence has also been developing the analysis of scans for COVID-19, and for Industry 4.0 in five sectors, healthcare, bureaucratic reform, education and research, food security, and mobility and scarcity. The STS *forum* has been extremely fruitful and Dr. Riza shared his hopes to see everyone next year for a better, greater forum.

Prof. Hiroshi Komiyama expressed his sincere wish to share his notions that post COVID-19 society will be a platinum society which he has been struggling to realize. Japan is an advanced society with advanced issues such as those related to super ageing and energy. Prof. Komiyama questioned the vision of the future world that Japan and humankind should aim for.

Prof. Komiyama proposed a society where the Earth is beautifully sustainable, abundance for all, and self-realization is attainable for all people. He defined this world as a platinum society and has been working for its realization for more than ten years. COVID-19 seems to be a signal to accelerate the realization of a platinum society. Well governed regions such as Luxembourg, Iceland, Singapore, Qatar, UAE, Oman responded well and rapidly to avoid

havoc. Such countries suffered from many cases of infection but have been successful in limiting the death toll. In some regional areas in Japan controlled the first wave without any strong measures. Small scale areas were able to respond to COVID-19 appropriately by adjusting to the infection situation and the capacity of the local healthcare system. This shows that democracy and COVID-19 response are compatible if an autonomous decentralized cooperative system is realized. The platinum society is a prerequisite for an autonomous decentralized and cooperative society.

During COVID-19 responses, great progress was made in remote working, online meetings, and online medical care. Traffic rush hour was a terrible phenomenon. Human interaction is an inevitable condition of society. However, freedom in ways of living and working styles has increased significantly. Humankind will be able to make its societies better with a hybrid system of real and virtual.

However serious consideration should be paid to those vulnerable in society, as they have suffered more severely than the rich. Disparity has been the biggest issue facing modern society even before COVID-19. The mechanism by which disparities occur differ from country to country. In any case, it goes without saying that businesses that facilitate disparity will be eliminated. There will be a growing movement to evaluate businesses by how seriously they take into account disparities. Prof. Komiyama expressed his worry that the problems of the Earth are getting worse, and that the sustainability of the Earth is more important. In conclusion, he shared his conviction that the platinum society is the society that should be aimed for in the post COVID-19 era.

Dr. Ismail Serageldin saluted with respect, affection and appreciation, the vision of Chairman Koji Omi, who created this Forum for the discussion of the lights and shadows of Science and Technology in Society (STS), and noted that despite the unique circumstances of the pandemic of 2020, we welcomed, in person or on-line, 1,500 global leaders from nearly 120 countries.

The COVID-19 pandemic has infected more than 35 million persons and claimed over a million lives. It has struck countries unevenly, and success in coping with COVID-19 has varied enormously. It has impacted physical and mental health as well as social relations between people. All must collaborate, for a global problem requires a global solution. We need better tests, therapeutics, and vaccines, which when developed must be shared with all who need it, not just those who can afford it.

But lockdowns and other measures have impacted economies and tens of millions have lost their jobs. However, these enormous challenges can also be an opportunity. We can rebuild differently to make our economies more efficient, equitable and resilient, as we pursue a sustainable growth path in the face of the longer-term challenges of climate change, and redouble our efforts at limiting emissions and promoting adaptation and resilience.

The move to this energy efficient society should be guided by a proper investment framework. IT management systems must be employed to protect biodiversity and move towards precision agriculture, with robotics, artificial intelligence, the internet of things, big data, cloud computing. The digital revolution has taken a huge leap forward in the last few months. Already, distance learning supplements if not replaces educational formats, and opens the possibilities of lifelong education. And the biological revolution also opens new doors.

But the trust of people in this science and technology revolution needs to be built on the public understanding of both benefits and risks. The distrust that is stemming from disinformation and fake news needs to be addressed. It is important to build a frame of reference to ensure the future will depend on science, and learn to trust science. This in turn requires more transparency and the discussions at the STS *forum* on the lights and shadows of science and technology has provided great benefits to humankind in this regard.

Dr. Marcia McNutt offered her final closing remarks. She shared her belief that many of the participants who have convened online have felt that the benefits have outweighed the disadvantages. The STS *forum* has been able to attract a high caliber of speakers and has been able to attract a more diverse audience, and there has been a much smaller carbon dioxide footprint for the meetings. The STS *forum* is a truly international meeting and its issues of time zones are somewhat unique because of this. There is no way the Earth can stop from being round, thus it is nearly impossible to schedule an international meeting so that sessions are not disadvantaging some participant. The personal fellowship at STS *forum* has been sorely missed and Dr. McNutt shared her hope that in future years, all of the participants will be able to meet in person again in Kyoto. She also added that the positive benefits of the digital format should be retained, so that those who are unable to travel will be able to benefit from the great speakers and great discussions. Dr. McNutt brought the meeting to a close by thanking everyone that made the meeting a success, Chairman Omi, the STS *forum* staff, all the speaker and sessions chairs, her fellow panelists today. She expressed her wishes to see everyone again next year in Kyoto, and declared the 17th Annual Meeting of the STS *forum* closed.



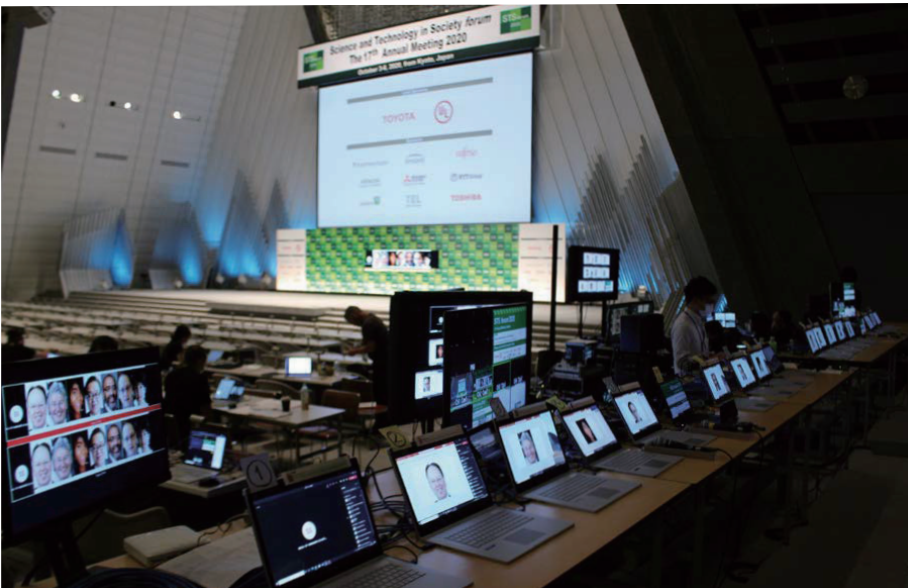
Science and Technology in Society *forum* (STS *forum*)
17th Annual Meeting
Kyoto, Japan, October 6, 2020

Statement

1. The 17th Annual Meeting of the Science and Technology in Society *forum* took place from October 3 to 6 live online from a base studio in Kyoto, with online participation of about 1,500 global leaders in science and technology, policymaking, business, and media from nearly 120 countries, regions, and international organizations. This meeting is taking place in one of the most challenging periods in history, when a pandemic is devastating the world, and the impacts of climate change require redoubling our efforts at limiting emissions and promoting adaptation and resilience if we are to adhere to a sustainable development path.

COVID-19 Pandemic

2. The COVID-19 pandemic that has forced this change in our format has already infected more than 35 million persons and claimed over a million lives. It has demonstrated the vulnerability of human societies, and underlined the global, regional, and local inequalities among our citizens. The pandemic is not just a public health crisis, an economic crisis, and a social crisis, but also more seriously, a crisis of confidence.
3. The public health crisis has unleashed an economic crisis of unprecedented magnitude, as measures to combat the spread of the disease have impacted economic transactions within and between countries and affected economic growth and jobs. In many countries economic contraction and massive unemployment are the new reality. Entire sectors like travel and hospitality are devastated. Supply chains have been disrupted. Patterns of work have been transformed, with many of those who can do so working from home. Education is facing radical challenges as distance learning supplements, if not replaces, face-to-face instruction. The social and economic impact is enormous



and we are facing an uncertain future. The future will depend on science. Young people must not only take up the torch of science, technology, and innovation, but society must also have greater confidence in science. Trust must be rebuilt. This in turn requires more transparency in science and greater, inclusive, multi-faceted public dialogue that rejects disinformation and efforts to politically pressure scientists and censor scientific reports.

4. The pandemic has struck countries around the globe unevenly, and success in coping with COVID-19 has varied enormously, with countries in East Asia doing better than most other countries. We are still trying to develop better tests, therapeutics, and vaccines, which when developed must be shared with all who need them, not just those who can afford them. Developed countries must work with the WHO at sharing information, tracking the spread of the virus, and mapping the measures for its containment as well as ensuring that the best of science and technology, shared throughout the world. A global problem requires a global solution.
5. The pandemic-generated lockdowns and other measures have devastated the economies of many countries. In 2020 the global economy is contracting significantly, with the US and Europe contracting even more. Firms rush to cope with the challenge, by redesigning their supply chains, accelerating digitization, and reducing employment. This has led to tens of millions of unemployed, and the rich countries' governments have adopted enormous stimulus packages in the trillions of dollars to try to avoid or reduce bankruptcies of firms and provide sustenance for those who have lost their employment as a result of the pandemic.
6. Meanwhile, these enormous stimulus packages are also an opportunity to promote a "Green Recovery" where government funding is used to transform the economy, not simply seek to recreate the past. Thus, this crisis presents a window of opportunity, a historic chance to universally transform all sectors in order to achieve the Sustainable Development Goals and the Paris Agreement. We can rebuild in new ways to make our economies and our societies more resilient to environmental challenges and future health crises such as the current pandemic.

Education

7. Education is being transformed, with the introduction of digital technologies and distance learning, which challenge the conventional models of education systems inherited from the past. Rapid changes in both science and technology mean that lifelong continuous training is needed to avoid the constant social dislocation of older workers. Science and technology are essential for driving innovation but are not enough to solve major and complex challenges like the rise in non-communicable diseases, issues of social inequality, or climate change. To develop solutions that take into account culture, tradition, and geopolitical reality, science and technology must be better integrated with human and social sciences.

Energy and Environment

8. In the wake of this pandemic, society has the opportunity to sustain a significant part of the savings in fossil fuel consumption achieved during the period when travel was restricted in order to accelerate toward a low-carbon future, aiming for a more energy-efficient society. In this context, nuclear energy, including small modular reactors (SMRs), remains a potentially important source for baseload electricity generation, under strict conditions of safety, security, and non-proliferation. Investment is needed in advanced technologies for low-emission energy sources, including hydrogen, reliable energy storage, massive electrification, and negative carbon emissions such as carbon capture and utilization. A proper framework of market-based policies and incentives will be needed to reduce greenhouse gas emissions, and IT-based energy management systems will be essential for efficiently balancing sustainable energy supply and demand with minimum damage to the environment, including protection of biodiversity and movement towards precision agriculture to ensure food and nutrition security for a growing global population undergoing the stresses of climate change.

The ICT Revolution, AI, and Society

9. The ICT revolution continues apace with robotics, AI, the Internet of Things (IoT), and cloud computing all evolving rapidly. AI builds on the availability of large sets of digital data and profits from the recent conceptual and practical advances in the domain of machine learning. However, AI should neither be reduced to only its technical aspects nor delegated solely to computer scientists and engineers. It is important to

address AI from multiple perspectives. All sciences, including the humanities and the social sciences, can contribute to better understanding the possible applications and consequences of AI and ultimately improve the design of tools built from AI. Scientific organizations should contribute to helping decision-makers and the general public understand the implications, benefits, and potential risks of AI.

Global Governance of Information

10. Data is not only a source of corporate and national competitiveness as well as of scientific and medical progress; it is also a force driving economic development. However, problems including growing economic disparity due to huge enterprises' data oligopoly, severe violations of privacy, and promotion of discrimination or biases through intended/unintended misuse of personal information have emerged. Rising anxiety and distrust toward information caused by fake news expanding through media, including social networking services, and so-called "infodemics," which has become evident especially during the COVID-19 pandemic, pose major challenges to fundamental values like stability, mutual trust, and respect for human dignity. It is important to build a frame of reference enabling ethical, trustworthy, and proportionate use of personal data to address these issues.

Inclusive Participation

11. Inclusive participation in decision-making can be a key enabler to success. But around the world, systemic inequality is prevalent. From an economic standpoint, companies with more diverse leadership have been shown to be more successful. Various barriers, which may include structural challenges, access to services like childcare, access to education, cultural expectations or bias, stand in the way of achieving diversity with inclusivity. Governments and societies should actively work to overcome such barriers. Our discussions at STS on the lights and shadows of science and technology in society help move us in that direction.
12. We look forward to convening again next year in Kyoto and have agreed to hold the 18th Annual Meeting of the STS *forum* from Sunday, October 3 to Tuesday, October 5, 2021.



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STS *forum* 2020 – 17th Annual Meeting Summary

Issued by Koji Omi

Edited by Science and Technology in Society *forum* (STS *forum*)

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