

The 22nd Annual Meeting

STS *forum* 2025



Summary of STS *forum* 2025

Summary

October 5, 6 and 7, 2025
Kyoto, Japan

Science and Technology in Society *forum*

STS forum 2025 - The 22nd Annual Meeting

October 5–7, 2025

October 4, 2025 (Saturday)

10:00-18:30	Registration at the Kyoto International Conference Center (ICC Kyoto) (for all STS forum participants)	09:30-11:00	NAA-STs Advisory Board Meeting
		11:15-13:00	NAA-STs Board Meeting
		11:30-18:35	Regional Action on Climate Change (RACC17) [Room A]
		12:00-12:50	Young Leaders Network
		12:50-15:30	Dialogue between Young Leaders and Nobel Laureates
		13:30-15:00	Board Meeting
		14:00-17:00	Kyoto Symposium
		14:00-17:00	14th Global Summit of Research Institute Leaders
18:00-20:00	Networking Plaza [Sakura, ICC Kyoto]	16:00-18:00	Forum for Unity, Science, and Empowerment (FUSE)

October 5, 2025 (Sunday)

08:30	Doors open and Registration starts at the Kyoto International Conference Center (ICC Kyoto)					
10:00-11:00 60 min.	100	Opening Plenary Session: Looking at the World in 2030 and beyond -- The Future of Science and Technology and Humankind			Main Hall	
11:00-12:00 60 min.	101	Path to Sustainability toward a Zero Carbon Society				Main Hall
12:00-13:40 100 min.		Lunch and Networking Time [Sakura]	12:10-13:30	CEO Meeting		
			12:10-13:30	CTO Meeting		
			12:10-13:30	University Presidents' Meeting		
			12:10-13:30	Heads of Private Foundations Meeting		
			12:10-14:50	S&T Ministers' Roundtable		
13:40-14:50 70 min.	102	102A: Omi Memorial -- "AI in 2030 and beyond" Main Hall	102B: AI and the Future University: Strategic Leadership, Culture, Diversity and Global Equity Room A			
14:50-15:10	Coffee Break					
15:10-17:10 120 min.	103	AI in Healthcare	AI in Business	AI in Government	AI in Society	
		Diagnostics, Physicians and Patients Room B-1	Job Elimination and Creation / Retraining Room B-2	Legislation Governance / Leadership Selection Room C-1	Social Networks and Communications Room C-2	
		Sustainability	Cutting-edge Technologies	Science and Technology I	Science and Technology II	
		Digital Technology for Sustainability Room K	Quantum Technologies Room E	Collaboration among Academia, Industry and Government Room D	Brain Circulation Room A	
17:10-17:40	Coffee Break					
17:40-18:40 60 min.	104	104A: Basic Science, Innovation and Policy Main Hall		104B: Game-Changing Businesses Room A		
18:40-	Move to the venue					
19:00-21:00	105	Official Dinner [Event Hall]				

Plenary Sessions

Concurrent Sessions

By Invitation Only

October 6, 2025 (Monday)

07:30	Doors open and Registration starts at the Kyoto International Conference Center (ICC Kyoto)					
			08:00-08:45	General Meeting		
09:00-10:10 70 min.	200	200A: Brain Health and Brain Augmentation Main Hall		200B: Science Diplomacy Room A		
10:10-10:40	Coffee Break					
10:40-12:40 120 min.	201	AI in Healthcare	AI in Business	AI in Government	AI in Society	
		Research Room B-1	Opportunities Room B-2	Services and Delivery Room C-1	Education / Knowledge Room C-2	
		Sustainability	Cutting-edge Technologies	Science and Technology I		
		Biodiversity Room K	Nuclear Technologies for Tomorrow Room E	Research Security in the Changing World Room D		
12:40-14:20 100 min.	Lunch and Networking Time [Sakura]			12:50-14:10	Academy of Science Presidents' Meeting	
				12:50-14:10	Academy of Engineering Presidents' Meeting	
				12:50-14:10	Funding Agency Presidents' Meeting	
14:20-16:20 120 min.	202	AI in Healthcare	AI in Business	AI in Government	AI in Society	
		Global Health Room B-1	Materials, Devices and Computation Room B-2	Internal / External Security Room C-1	Social Infrastructure Room C-2	
		Sustainability	Cutting-edge Technologies	Science and Technology I		
		Circular Society and Growth Room K	New Energy Sources Room E	Science and Technology in the Global South Room D		
16:20-16:50	Coffee Break					
16:50-18:00 70 min.	203	203A: Science Communication Main Hall		203B: Sustainability for Nature Positive Economy Room A		
18:00-	Move to the venue					
18:15-20:15	204	Special Buffet Dinner [Japanese Garden, ICC Kyoto]			20:30-22:00 Council Meeting	

October 7, 2025 (Tuesday)

08:00	Doors open and Registration starts at the Kyoto International Conference Center (ICC Kyoto)				
09:30-10:30 60 min.	300	Global impact of AI by 2030 and beyond -- Roadmap for the Next Decade Main Hall			
10:30-11:00		Coffee Break			
11:00-12:30 90 min.	301	Closing Plenary Session: Science and Technology for the Future of Humankind Main Hall			
12:30-13:30	302	Farewell Buffet Lunch [Swan]			

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Plenary Sessions



Opening Plenary Session: Looking at the World in 2030 and beyond -- The Future of Science and Technology and Humankind

His Majesty the Emperor of Japan
Her Majesty the Empress of Japan

[Chair]

Komiyama, Hiroshi, Chairman, Science and Technology in Society *forum* (STS *forum*);
Chairman, Mitsubishi Research Institute, Inc., Japan

[Video Message]

Ishiba, Shigeru, Prime Minister, Government of Japan, Japan

[Speakers]

Zaharieva, Ekaterina, European Commissioner for Startups, Research and Innovation,
European Commission, EU

Varin, Philippe, Chair, International Chamber of Commerce (ICC), France

Brabeck-Letmathe, Peter, Chairman of the Board of Directors, Geneva Science and
Diplomacy Anticipator (GESDA); Chairman Emeritus, Nestlé S.A., Switzerland

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

Horiba, Atsushi, Chairman, Kyoto Chamber of Commerce and Industry; Chairman & Group
CEO, HORIBA, Ltd, Japan



Komiyama, Hiroshi

Opening Remarks

Prof. Hiroshi Komiyama, Chairman, Science and Technology in Society *forum* (STS *forum*); Chairman, Mitsubishi Research Institute, Inc., opened the 22nd Annual Meeting of STS *forum* and expressed his profound gratitude to Their Majesties the Emperor and the Empress of Japan for gracing the meeting with their presence. Prof. Komiyama also expressed his sincere appreciation to the participants for their attendance as well as sponsors, members, and organizing supporters for their contributions. The STS *forum* was founded over 20 years ago by Founding Chairman Koji Omi to bring together academic, political, and



Their Majesties the Emperor and Empress of Japan

business leaders to discuss the lights and shadows of science and technology (S&T) from a long-term perspective.

S&T have driven rapid progress since the 20th century. However, humanity faces serious challenges such as climate change and widening inequalities. Nevertheless, there is hope. New foundations for prosperity are emerging, such as biomass from sustainable sources, renewable energy, and urban mines.

Another source of hope lies in humans' great store of knowledge. The challenge is its fragmented structure, like the spines of a porcupine fish. S&T, particularly AI, can help bridge and integrate these fragments of knowledge. In that regard, the STS *forum* aims to harness S&T for public good, reform society through dialog and consensus, and use AI to speed up solutions. Together with the three pillars of circularity, biomass, and renewable energy, this offers a formula for a sustainable future.

Prof. Komiyama also explained the initiatives of the Platinum Society, which aims to achieve a sustainable world and a prosperous society where all can achieve self-actualization. The Platinum Society has identified five key sectors, forests, renewable energy, health, tourism, and human resource development, which, if advanced in concert, can deliver self-sufficient



His Majesty the Emperor of Japan

resources, lifelong and collective growth for all, and business investment that supports public benefits. AI capabilities have also grown dramatically and can support and boost such advancements.

In closing, Prof. Komiyama emphasized the need for urgency and called on participants to move fast together now, while there is still hope. All participants share a collective and historical responsibility to ensure that S&T truly serves humanity. To that end, it is necessary to translate shared understanding into concrete action, collaboration, policy design, and investment.

His Imperial Majesty the Emperor of Japan expressed his pleasure at attending the opening ceremony of the 22nd Annual Meeting of the STS *forum*, together with Her Majesty the Empress. His Majesty noted the lively discussions over the last 21 years on various issues related to the “lights and shadows” of S&T and a sustainable future, and expressed his deep respect for the organizers and all participants.

His Majesty also noted the particular emphasis placed on AI, which is generating profound innovations across a broad spectrum of fields. At the same time, AI raises a



host of challenging issues, such as ethical considerations and the need for transparency in AI-driven decision-making, which require careful deliberation across disciplines and perspectives. Not only AI, but also issues such as the environment, energy, food and water, must be considered from a longer-term perspective, beyond the next 20 to 30 years and mere national borders.

In closing, His Majesty expressed his heartfelt wish that global leaders will continue to combine their wisdom and search for the best way to make the most of S&T for the future of our Earth and the sustainable development of humankind and that this year's Annual Meeting will once again contribute to that goal.

Mr. Shigeru Ishiba, Prime Minister, Government of Japan, delivered welcome remarks via a video message. Prime Minister Ishiba pointed out that while S&T can be the “light” that brings hope, they can also be the “shadow” that creates disparity and anxiety. To put the “light” to use and prepare for the “shadow,” international cooperation and responsibility are essential. The STS *forum* nurtures such a network of knowledge and trust and can bring hope for the future of society.

Prime Minister Ishiba then drew the participants' attention to the Yokohama Declaration, which was adopted at the 9th Tokyo International Conference on African Development (TICAD 9) in August 2025 and which highlights the importance of international knowledge exchange and S&T diplomacy. In this context, Japan launched an initiative to develop 30,000 AI professionals over the next three years. Japan will harness the power of S&T to co-create innovative solutions to common challenges to ensure shared prosperity across the globe.

Regarding AI, Prime Minister Ishiba emphasized the need to accelerate innovation while mitigating risks. Under the AI Act, Japan will realize its vision of becoming “the world's most AI-friendly country.” It will also continuously promote the Hiroshima AI Process and exert leadership in international AI rulemaking.



Ishiba, Shigeru



Zaharieva, Ekaterina

Lastly, Prime Minister Ishiba highlighted the ongoing Expo 2025 Osaka, Kansai, Japan, in which various visions of a future society are being displayed under the theme of “Designing Future Society for Our Lives,” and expressed his hope that the discussions at STS *forum* and the experiences at the Expo will contribute to realizing the desired future society through S&T.

Ms. Ekaterina Zaharieva, European Commissioner for Startups, Research and Innovation, European Commission, highlighted the importance of aspiration and determination, qualities embodied by efforts such as Japan’s Moonshot Program and the European Commission’s Horizon Europe, in

promoting innovation. Innovation and the spirit of reaching beyond existing human limits are needed more than ever.

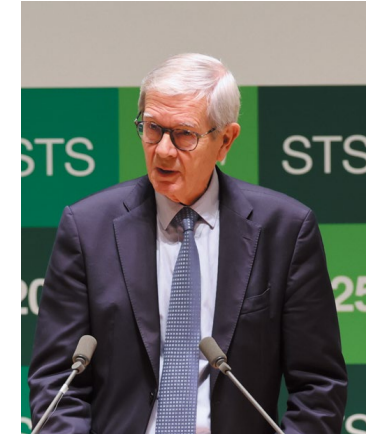
The world faces fragmentation and uncertainties. Scientific freedom is also under pressure. In this context, Europe remains committed to openness and international cooperation, believing that scientific cooperation can build bridges even in challenging times. This is why Horizon Europe is open to the world by default. More than half of cooperative projects include countries outside the EU, including Japan. Horizon Europe deepens links among researchers and innovators and increases access to global research and organizations and cutting-edge infrastructures.

While vision and partnerships are crucial for a better tomorrow, they are not enough. The future of S&T also depends on resources dedicated today. The European Commission has therefore proposed to nearly double resources for research and innovation, with the aim of achieving more excellent research and ground-breaking innovation, including the moonshots of tomorrow.

To conclude, Ms. Zaharieva stated that Europe’s vision for S&T is bright but she stressed that it can only be achieved with determination and solidarity. On that journey, the world can count on Europe as a trusted partner.

Mr. Philippe Varin, Chair, International Chamber of Commerce (ICC), France, emphasized that S&T concern not only machines and algorithms but humanity. Humanity must make the right choices to shape the world we want to live in, as technology is an extension of human creativity, imagination, and values. In particular, the future will be shaped by three forces: the accelerating power of knowledge, the pressing challenge of sustainability, and the ongoing revolution in health and medicine.

On the first point, the time between breakthroughs is shrinking at an extraordinary pace. AI is accelerating this even further. AI is no longer just a tool, but a partner. It may become a collaborator but also sometimes a competitor, or worse, an enemy. This poses serious questions, particularly how to ensure that AI systems reflect human values rather than amplify divisions.



Varin, Philippe

Regarding sustainability, the key issue is addressing climate change, which is already impacting lives and economies. Successful technologies have been developed to mitigate or even eliminate greenhouse gas emissions in key sectors. However, there are still key issues, including funding, scaling technologies quickly, and controlling the huge carbon emissions generated by AI activities. Besides climate change, the life cycle of processing materials also generates significant emissions.

As for health and medicine, AI is increasing life expectancy and making other important advancements. However, these advancements also raise ethical and social dilemmas, such as the line between therapy and enhancement and how to ensure equity.

In this context, wisdom has a critical role to play. We must cultivate wisdom alongside knowledge, and education must include soft skills, including ethics. Furthermore, as robust political institutions are being damaged by the world’s fragmentation, there is an increasingly important role to be played by networks of universities and global business institutions. Finally, we must not lose sight of the human spirit as every decision we make can shape the world of tomorrow.



Brabeck-Letmathe, Peter

Mr. Peter Brabeck-Letmathe, Chairman of the Board of Directors, Geneva Science and Diplomacy Anticipator (GESDA); Chairman Emeritus, Nestlé S.A., spoke about the importance of anticipation. Anticipation means not just waiting for the future to arrive, but preparing, shaping the world, and making the most of human ingenuity and responsibility. How we choose to act and collaborate now will shape the world in 2030 and beyond. GESDA seeks to explore this issue not only with experts but also citizens from all walks of life. As an experiment, it asked almost 1 million visitors, primarily Japanese, to the Expo 2025 Osaka, Kansai, Japan to envision their lives in 5, 10, 25 years in the future. Their answers show that people are optimistic, believing in healthy longevity and human potential. They want science to empower them and see it as a path to regeneration, sustainability, and solving environmental challenges. They also want joy.

Anticipation must also be matched with responsibility. While many people are optimistic and embracing the promise of science, trust in science and its recognition in international affairs is uneven. It is therefore important that science has been given a central place in global governance with the establishment of the Scientific Advisory Board of the UN Secretary-General.

Besides the aforementioned experiment, GESDA is implementing concrete initiatives that include an open quantum institute to harness quantum science for achieving the Sustainable Development Goals and a global curriculum for anticipatory leadership to train a new generation of leaders.

As a final message, Mr. Brabeck-Letmathe reiterated that the future is something that humanity will build and that we must build it together. Science offers extraordinary tools and we must ensure that they are used to serve humankind, as an instrument of hope, solidarity and choice.

Dr. Marcia McNutt, President, National Academy of Sciences (NAS), U.S.A., opened her remarks by underlining that 2030 is imminent and that business as usual will not suffice.

She explained that the U.S. research enterprise was built upon a blueprint presented immediately following the Second World War, and that many other countries adopted similar models. The actual research enterprise today is becoming more international and diverse, and moving at an accelerated rate. There are also new pressures that require modification to the blueprint.

One of these pressures is public interest in research. Traditional distance from the public has led to public mistrust in science. Another pressure is newfound urgency in addressing issues like climate change, sustainability, pandemics, and health. The third pressure is cost. To address this, there is a need for more partnership and international cooperation.

Other changes are required as well. The academic reward system needs to be reformed, from excessive focus on factors such as publications or citations, to more emphasis on mentoring, communication, and non-expert audiences. Career paths for students also need to change. The timeline is too long and is discouraging young people from studying science. The system of research dissemination must also change, including addressing the rise of predatory journals. Lastly, research systems and researcher training need to be improved to enable smoother transitions through the valley of death from research to products. By working together, there is hope that humanity can make these changes and usher humankind into the future beyond 2030.

Mr. Atsushi Horiba, Chairman, Kyoto Chamber of Commerce and Industry; Chairman & Group CEO, HORIBA, Ltd, began by describing his own work in the field of analysis and measurement, which needs to be done patiently to see the true nature of things and clarify challenges. He believed that



McNutt, Marcia



Horiba, Atsushi

when discussing the world beyond 2030, the perspective of designing the essence will be increasingly important.

Mr. Horiba explained that Kyoto is home to many century-old companies. They have survived through various crises and external changes by clearly defining their own values and beliefs, and consciously providing products that customers truly desire.

Mr. Horiba then shared an example of a start-up from Kyoto tackling the threat of climate change to Japanese food culture. Rising sea temperatures have caused a decline in fish species long consumed by Japan. The startup is trying to solve this through aquaculture, using genome-editing to breed heat-resistant fish varieties. This illustrates how, no matter how much S&T advances, it is living people who utilize them, and cultures deeply rooted in people cannot be changed overnight. Therefore, S&T must work hand in hand with culture. This is particularly important in an era of increasingly sophisticated AI and the replacement of human jobs with robots.

Finally, Mr. Horiba shared a cherished phrase of the founder of HORIBA: “Joy and Fun.” This phrase means finding challenges oneself and becoming absorbed in solving them. The message is that the process itself enriches life. S&T will greatly influence our future, but it is up to us to steer its course and we must not forget our humanity when doing so.

Path to Sustainability toward a Zero Carbon Society

[Chair]

Wince-Smith, Deborah L., President & CEO, Council on Competitiveness; President, Global Federation of Competitiveness Councils, U.S.A.

[Speakers]

Kanda, Masato, President and Chairperson of the Board of Directors, Asian Development Bank, Philippines

Eldesouki, Munir M., President, King Abdulaziz City for Science and Technology (KACST), Saudi Arabia

Imauven, Claude, Chairman of the Board of Directors, Orano, France

Al-Khowaiter, Ahmad O., Executive Vice President, Technology & Innovation, Aramco, Saudi Arabia

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

Pathumnakul, Supachai, Permanent Secretary, Ministry of Higher Education, Science, Research and Innovation, Thailand

Kato, Akihiko, President & CEO, Atomic Energy Association (ATENA), Japan

Opening Remarks

At the start of the session, the Honorable Deborah L. Wince-Smith noted that achieving a zero-carbon society is a top priority around the world and pointed out that sustainability advances in energy efficiency and productivity offer a key pathway for long-term economic growth, inclusive prosperity, resiliency, and security. She also outlined the roles played by two organizations she is involved in, the U.S. Council on Competitiveness and the Global Federation of Competitiveness Councils, in shaping more sustainable carbon-neutral economic ecosystems and societies.



Wince-Smith, Deborah L.

The Honorable Ms. Wince-Smith then took stock of the current situation and presented pathways for collective action for navigating humanity's sustainability journey. The foremost



challenge is a global systems challenge. Sustainability is a multi-dimensional problem at the intersection of energy production and consumption and must be tackled across and within the entire product lifecycle system. Second, the transition to cleaner energy and sustainable pathways is facing serious headwinds, such as elevated imperatives for energy security and resiliency in light of conflicts around the world, as well as divergences in energy costs and access resulting in increased divergences in economic performance, reindustrialization, and competitiveness. Third, the global waste crisis is accelerating exponentially. Fourth, there is a need to transform global food production by 2050. Fifth, consumers tend to only turn to clean energy and sustainability when cost and quality are competitive.

Nonetheless, there are reasons for optimism. For clean energy, the world is on the cusp of a nuclear energy renaissance. Already, nuclear power could provide electricity with the lowest carbon emissions and land use. However, the permitting processes, scale and pace of deployment, supply chain development and workforce training must be ramped up, along with long-term investments in basic and applied research.

The Honorable Ms. Wince-Smith closed by presenting a five-point action agenda. The actions are to invest in S&T frontiers across all fields and leverage AI to solve its energy demand; adopt full lifecycle production standards and new consumption models; boost the productivity of natural resources while minimizing resource depletion, waste, and pollution;

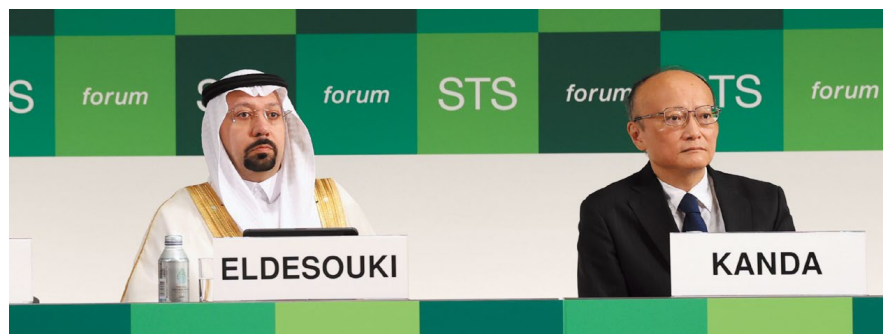
accelerate economic development opportunities; and remove regulatory barriers and excessive costs to streamline regulatory systems.

Mr. Masato Kanda noted that climate impacts are intensifying across Asia and the Pacific while energy demand is rising due to factors such as extreme weather, higher living standards, disaster recovery needs, and growth in AI and data centers. He framed these pressures as an opportunity to strengthen resilience and competitiveness by aligning science, policy, and finance to scaling reliable, affordable, and clean power.

He noted that the Asian Development Bank (ADB) is reviewing its Energy Policy to expand its toolkit and support pragmatic clean-power pathways. He announced that, for the first time in ADB's 60-year history, ADB is prepared to support nuclear power in its operations. ADB's focus will be to make nuclear safe, trusted, and investable by strengthening independent regulation and technical capacity, and by promoting transparent procurement and financing that safeguard the public interest.

To accelerate regional integration, he highlighted ADB's readiness to provide up to \$10 billion over 10 years for the ASEAN Power Grid to move clean power across borders. He emphasized that secure inputs are essential for the energy transition and introduced ADB's recently approved Critical Minerals to Manufacturing approach, citing a \$410 million package for the Reko Diq copper project to anchor reliable supplies for clean-energy technologies and grids.





ADB, he noted, is investing in people and innovation by supporting higher education, practical skills, and applied research on emerging technologies, while structuring risk and connecting investors so first-of-a-kind projects can scale. He closed by calling for a pact to turn today's challenges into opportunities that deliver clean energy, resilience, and sustained growth across the region.

His Excellency Dr. Munir M. Eldesouki pointed out that the world faces a pivotal moment in shaping a sustainable zero-carbon future. There is great momentum with many countries making climate commitments, but the challenge is complex. At its heart, the path to zero-carbon society is an innovation revolution that requires simultaneously harmonizing global action and managing resource implications of emerging technologies.

Saudi Arabia has embraced a dual approach through its Circular Carbon Economy Framework. This integrates renewable deployment with carbon management and new clean energy frontiers. Saudi Arabia is focused on three domains vital to the zero-carbon transition: industrial decarbonization, sustainable resource management, and frontier technologies.

Saudi Arabia recognizes that no nation can achieve a zero-carbon society alone and is committed to collaborating across borders and disciplines. Moreover, the journey to a zero-carbon society is not only a tech transition but also a test of collective will. It demands that the world acts now while investing in the breakthroughs of tomorrow.

Mr. Claude Imauven spoke about Orano's role in France's sustainability journey. France faces the unprecedented challenge of reindustrializing its economy while achieving carbon

neutrality. This will require massive electrification that is sustainable, reliable, and sovereign. Carbon neutrality is not only about electricity production, but also producing and consuming low carbon energy while ensuring competitiveness.

France has set ambitious emission reduction and carbon neutrality goals. However, its initial strategy favored renewables at the expense of nuclear energy, which weakened energy security and competitiveness.

In light of high energy prices, geopolitical tension, and growing electricity demand, the transition will need a stable, massive, and low-carbon energy foundation. Orano contributes by valorizing nuclear materials to produce low carbon electricity, covering the entire product lifecycle from mining to commissioning and engineering. Orano has two key missions: to ensure France's energy sovereignty and to study potential application of its expertise outside nuclear, for instance in the circular economy of strategic materials. In these ways, Orano provides a concrete response to the systematic challenges of the transition.

Mr. Ahmad O. Al-Khowaiter began by highlighting that 2025 marks the 70th year of diplomatic relations between Japan and Saudi Arabia, two countries focused on a zero-carbon future. He then noted that, when the energy industry talks about zero carbon and sustainability, it is usually in the context of the energy transition and the appropriate energy mix and how fast to get there. Aramco thinks about this question another way: what is the ideal mix of energy in the future and what is the practical mix needed to get there? It also understands that the path must be affordable and secure without sacrificing sustainability. Aramco has thus been calling for a pragmatic approach, taking a dual track of delivering





affordable, sustainable, and secure conventional energy, while investing and scaling renewables and new energies.

Aramco recognizes that it is imperative to apply a full life cycle technology-inclusive approach to drive policy. Otherwise, there is a risk of creating more emissions, not less. That is why Aramco is also investing in carbon capture and storage technologies, as well as new energies, advanced materials, and other disruptive technologies. To support such technologies, strong collaboration is required among policymakers, academia, industry, technology developers, startups, investors, and financial institutions. Governments must seek to strengthen interdependence and trust that ensure energy security.

Mr. Takehiko Matsuo presented Japan's vision for tackling climate change as a shared challenge for humankind. Japan's climate change policy is centered on one shared goal with multiple pathways. Japan is strengthening its efforts to achieve carbon neutrality through green transformation (GX), while also promoting digital transformation (DX). Japan is implementing measures to promote investment in GX, such as in renewables, nuclear energy and hydrogen.

Japan also recognizes the need to ensure economic security in promoting GX. This includes designating critical materials for GX whose supply is limited and working to diversify their supply.

Both DX and GX present significant opportunities for innovation and Japan is committed to providing bold support in various areas, with a focus on attracting private investment. To that end, Japan has established the Green Innovation Fund, through which it aims to accelerate innovation by continuously supporting innovative technologies. As the Japanese economy emerges from long-lasting deflation, Japanese businesses are increasing their investment in disruptive technologies as well as global activities, stimulating the Japanese economy. Japan will leverage this momentum to strengthen innovation and advance international collaboration.

Prof. Dr. Supachai Pathumnakul shared Thailand's experience and plans for tackling the challenge of achieving a zero-carbon society, which encompasses not only the environment, but also energy security and economic security. Thailand is committed to achieving carbon neutrality by 2050 and net-zero by 2065. To that end, Thailand is focused on transformations such as expanding renewable energy to 50% of power mix by 2040, and scaling sustainable agriculture and circular economy models. Thailand will also promote next generation energy technologies such as hydrogen energy storage and smart grids.

Thailand has already achieved several important milestones through initiatives that include AI-driven smart farming systems and advanced battery energy storage systems. Thailand is also investing about 1.3% of GDP in research and development, over 30% of which focuses on sustainability. In addition, Thai academia and the private sector are working together to accelerate decarbonization, green technologies and circular economy transitions. Moreover, Thailand is working with national and regional partners in areas such as hydrogen technologies and carbon capture and storage.



Thailand's journey has not been without challenges. It must balance growth and sustainability, address fossil fuel lock-ins, and ensure affordable energy. Still, it believes these challenges will inspire innovation. The climate transition also offers opportunities to create jobs, strengthen communities and inspire youth. While working with other countries and regions, Thailand seeks to ensure that the transition is inclusive, repeatable, and innovation-driven and it is ready to contribute to research innovation partnerships.

Mr. Akihiko Kato spoke about the activities of the Atomic Energy Association, which is composed of nuclear operators and major plant manufacturers and aims to enhance the safety of nuclear power. It implements voluntary initiatives for improving nuclear safety and engages with regulatory authorities in technical discussions.

Japan's 7th Strategic Energy Plan, issued in February, sets out the country's basic energy policy. It emphasizes S+3E, that is, safety, energy security, economic efficiency, and the environment. Demand for energy is expected to grow amid expanded use of AI and increasing data centers. Such circumstances highlight the importance of both renewable energy and nuclear power, which are both zero-carbon electricity sources.

Japanese nuclear operators have introduced safety measures to ensure compliance under one of the world's strictest regulatory requirements established based on lessons learned from the accident at Fukushima Daiichi Nuclear Power Plant. Japan needs to achieve three challenges: accelerate the restarting of nuclear plants, develop a nuclear fuel recycle system, and construct new plants. For this, the Atomic Energy Association will make maximum efforts and fulfil its responsibilities.



Closing Remarks

To close the session, the Honorable Ms. Wince-Smith called on the participants to join forces in building a sustainable future. She urged them to make the future safe, sound, secure and strong, and to unleash the power of innovation at the intersection of ideas, imagination, and impact.

Omi Memorial -- "AI in 2030 and beyond"

[Chair]

Matsuo, Yutaka, Professor, Graduate School of Engineering, The University of Tokyo, Japan

[Speakers]

Goebel, Randy, Professor, Faculty of Science - Computing Science, University of Alberta, Canada

Landay, James, Co-Director, Stanford Institute for Human-Centered AI (HAI); Anand Rajaraman and Venky Harinarayan Professor in the School of Engineering; Professor, Computer Science Department, Stanford University, U.S.A.

Noble, Alison, Foreign Secretary and Vice-President, The Royal Society; Technikos Professor of Biomedical Engineering; Fellow of St Hilda's College, Department of Engineering Science, University of Oxford, U.K.

Morita, Takayuki, President and CEO (Representative Executive Officer), Member of the Board (Member of the Compensation Committee), NEC Corporation, Japan

Diermeier, Daniel, Chancellor, Vanderbilt University, U.S.A.

Zacharia, Thomas, Senior Vice President, Strategic Technology Partnerships and Public Policy, AMD, U.S.A.

Panel Discussion

Prof. Yutaka Matsuo welcomed participants, noting the session's purpose to establish the foundation for the forum's subsequent discussions. Having worked in AI research for over three decades, Prof. Matsuo offered his perspective on the current state of AI development.



Matsuo, Yutaka

Since the emergence of powerful foundation models, AI has transitioned from laboratories into everyday applications, generating and summarizing texts, translating languages, and creating images and video. He highlighted progress toward physical AI as robots learn safer motions for everyday tasks and AI becomes an active partner in scientific discovery. Prof. Matsuo emphasized that while public debate intensifies around governance, safety, bias, and existential risks, the G7 Hiroshima AI process has become central to human-centered AI development. He projected that by 2030, AI will be deeply embedded in

healthcare, business, government, education, and city services, sitting atop infrastructure of compute, data, and energy, with the central question being how to translate capability into measurable benefits while maintaining trust as a primary objective. Then, Prof. Matsuo invited each of the panelists to give their remarks.

Prof. Randy Goebel provided a comprehensive overview of the 75-year history of AI research, structured around three threads of AI development. Prof. Goebel emphasized that the science of AI focuses on understanding intelligence rather than replicating human behavior, noting that computer programs already surpass human capabilities in many areas, citing examples of world-champion-beating checkers, Go, and poker programs developed by researchers. He distinguished between early causative consequence machines like expert systems that relied on explicitly programmed rules, and current correlative consequence machines such as large language models that emerge from statistical compilation of data into a type of "broad, shallow intelligence." Prof. Goebel addressed the challenge of measuring AI value in specific domains, emphasizing the need for subject matter experts, appropriate data, and AI technicians working collaboratively. He cautioned against being distracted by debates over artificial general intelligence, artificial narrow intelligence, or artificial super intelligence, arguing that the key focus should rather be on assessing the practical value and impact of AI applications across different fields.



Prof. James Landay argued for the critical importance of designing AI systems at user, community, and societal levels rather than focusing solely on direct users. Prof. Landay, speaking from his experience at the Stanford Institute for Human-Centered AI, outlined three guiding principles: AI should be developed with concern for societal impact from the outset, should be inspired by human intelligence and brain efficiency, and should augment rather than replace human capabilities. He criticized the concentration of AI resources in a handful of companies, primarily in Northern California, and emphasized the need for interdisciplinary teams including computer scientists, designers, social scientists, ethicists, and domain experts working together from project inception. Prof. Landay illustrated the importance of multi-level design through examples including autonomous vehicles, where focusing only on driver-level impacts ignores community and societal consequences such as increased traffic congestion. He mentioned that Stanford's Human-Centered AI lab strives to develop a global collaborative consortium offering computing resources, open-source models, and talent development to redirect AI development toward human progress and societal benefit.

Prof. Alison Noble focused on AI applications in healthcare, spanning drug discovery, disease understanding, diagnostics, and service efficiency through automation and prediction technologies. Prof. Noble highlighted key areas, such as AI-driven discovery including



fully automated “scientist AI” systems that generate hypotheses and conduct experiments independently, though she noted concerns raised by experts regarding safety and the need for guardrails in such systems. She discussed AI’s potential for understanding diseases through complex pattern recognition, citing research recently published in a reputable journal that used machine learning to propose new classifications of multiple sclerosis based on large patient datasets. Prof. Noble emphasized the challenges of real-world AI deployment in healthcare settings, referencing studies of NHS AI tool implementation that revealed significant technical and social complexities. She concluded by addressing the evolution of healthcare professionals’ roles, discussing human-AI collaboration where humans and AI work as teams to make joint decisions, particularly important for supporting non-specialists and addressing healthcare needs in lower-middle-income countries with limited expert availability.

Mr. Takayuki Morita presented NEC’s perspective on AI development and governance, emphasizing the company’s extensive history of placing technology at the service of society. Mr. Morita noted that technological singularity is becoming a reality, citing recent news of OpenAI’s reasoning model achieving 96 points on University of Tokyo entrance exams and NEC’s in-house autonomous agent achieving 80.4% completion on WebArena benchmarks. He characterized today’s AI as powerful but requiring careful control, comparing it to wild horses that needed harnessing to become useful for civilization. Mr. Morita outlined NEC’s investments in such “digital AI harnesses” including real-time hallucination detection, biometric blockchain fusion for identity verification, and sovereign AI appliances for

data protection. He advocated for principle-based, outcome-oriented, technology-neutral frameworks over excessive regulation, arguing that regulatory minimalism by design helps innovation flourish while protecting citizens. Mr. Morita emphasized the need for industry, academia, and government collaboration to move past utopia versus dystopia debates, toward “protopia,” a society that improves incrementally through wise harnessing of AI.

Chancellor Daniel Diermeier examined AI’s impact on universities across research, education, and policy dimensions. Chancellor Diermeier highlighted breakthroughs such as the 2024 Nobel Prize in Chemistry for solving the AlphaFold protein structure problem and described how generative AI has transformed previously unusable datasets, such as his university’s 400,000 patient record biobank, into analyzable resources, unlocking new possibilities in personalized medicine research. He noted AI’s expansion into previously unexpected fields like humanities and social sciences, citing collaborations between anthropologists and computer scientists using medical imaging techniques to identify human habitation evidence in the Amazon through satellite imagery analysis. Chancellor Diermeier observed that students have readily embraced AI tools, with some forming AI-based studios and dramatically reducing video production time, though he noted this creates advantages primarily for highly motivated individuals, potentially widening gaps





between communities. He emphasized universities' unique role in fostering interdisciplinary collaboration for addressing policy challenges, citing research on AI-based election interference as an example of combining computer science with international relations expertise.

Dr. Thomas Zacharia highlighted the transformative potential of AI infrastructure and the prospect of thousand-fold performance improvements that could redefine global capabilities. He traced the evolution from two historic public-private partnerships between the U.S. Department of Energy and Oak Ridge National Laboratory and industry—first with NVIDIA to pioneer GPU-accelerated computing, then with AMD to deliver Frontier, the world's first exascale supercomputer—that transformed the computing landscape and laid the foundation for today's AI boom. Looking ahead, he projected that similar advances—from exascale to zettascale computing—could make frontier AI ubiquitous, extending from massive data centers to the edge of the grid and fundamentally transforming how infrastructure is designed, operated, and protected. He envisioned AI becoming the “nervous system of infrastructure,” with embedded sensors running frontier models locally to analyze, predict, and optimize systems in real time. He outlined three layers of future AI deployment: centralized intelligence in zettascale data centers, swarming intelligence through distributed autonomous systems, and autonomous intelligence embedded across critical assets. Dr. Zacharia emphasized that realizing this vision will require unprecedented public-private partnerships, building on open standards, open software, and broad collaborations with national laboratories and industry to drive innovation while ensuring choice, interoperability, and sovereign control.

Closing Remarks

Before closing the session, Prof. Matsuo noted that as technologists, it is difficult to predict how society will change, which is precisely why the future should not be left to technologists or any single company alone. He emphasized the need for broad interdisciplinary conversation across society, highlighting points raised by the speakers about the role of universities in fostering free debate and ethical judgment, emphasis on human-centered interdisciplinary work, and the importance of aligning science with practical applications. Prof. Matsuo acknowledged that AI's importance and convenience are obvious, but stressed that the real task is to develop it responsibly for society's benefit.



AI and the Future University: Strategic Leadership, Culture, Diversity and Global Equity

[Chairs]

Fujii, Teruo, President, The University of Tokyo, Japan

Moshabela, Mosa, Vice-Chancellor & Principal, University of Cape Town, South Africa

[Speakers]

Gong, Qihuang, President, Peking University, China

Liu, Bin, Deputy President (Research and Technology); Tan Chin Tuan Centennial Professor, Office of the Deputy President (Research and Technology), National University of Singapore (NUS), Singapore

Dissertori, Günther, Rector, ETH Zurich, Switzerland

Marwala, Tshilidzi, Rector, United Nations University; Under-Secretary-General, United Nations

Campbell, Nick, Vice-President, Academic Affairs, Springer Nature, U.K.

Walsh, Brendan M., Senior Associate Provost for International Affairs, Yale University, U.S.A.

Opening Remarks

The session was opened by the co-chair, Prof. Mosa Moshabela, Vice-Chancellor of the University of Cape Town (UCT) and the chair of the International Alliance of Research Universities (IARU), who welcomed the participants and introduced the goal of trying to position AI as a concern and opportunity for all universities and university leaders and to engage in a conversation on how to address specific issues. This included considering how



Fujii, Teruo



Moshabela, Mosa



institutions can play a more active role in helping to capitalize on solutions and ways to cope with how AI can both destroy and/or create opportunities.

The co-chair of the session, Dr. Teruo Fujii, President of the University of Tokyo, then briefly explained that the session is intended to expand the collaboration between universities into an alliance so that the members can enhance their collaboration.

Discussion

Following introductions, the panelists discussed AI and institutional strategy, particularly strategic decisions university presidents are making in adopting and governing AI.

Dr. Fujii explained that the University of Tokyo created guidelines to help students understand AI behavior, treating it as a tool for discussion rather than obtaining specific answers, with emphasis on experiential learning.

Prof. Moshabela described how the University of Cape Town convened a multi-disciplinary symposium, highlighting that AI affects everyone, not just computer science, and noting the importance of Africa keeping pace with progress being made in more developed nations.

Prof. Qihuang Gong explained that Peking University established a research center for AI security and governance, noting three key dimensions: the connection between technology, environment, and education; balance in knowledge and quality; and synergy between open innovation and risk strategies.

Prof. Bin Liu outlined the National University of Singapore's three strategic decisions: core mission alignment to make AI human-centric; investment in bringing people together for discussion; and improving governance to ensure benefits for all and rapid resolution of issues.

Prof. Günther Dissertori described ETH Zurich's three principles of responsibility, transparency, and fairness, along with guidelines for generative AI use, technical frameworks for compliant use, and workforce upscaling efforts.

The second theme addressed cultural and linguistic diversity in AI. Dr. Fujii highlighted the mismatch between English-based LLMs and culturally grounded diverse languages.

Prof. Moshabela noted AI-based translations offer opportunities for multilingualism while raising questions about protecting values.

Prof. Gong emphasized universities' responsibility to support multilingual AI modeling and digital preservation.

Prof. Liu described Singapore's investment in lasting data and open-source platforms, with students creating AI tools as guardians of cultural heritage.

Prof. Dissertori announced that ETH Zurich, the Swiss Supercomputing Centre CSCS, and EPF Lausanne launched a multilingual open LLM trained on over 1,000 languages, with 40% non-English data.

Prof. Moshabela noted Africa's many languages and emphasized the importance of skills training.

Dr. Fujii asked about Peking University's digital preservation of languages without written textual form.

Prof. Gong responded that AI has become a strong translation tool, creating challenges for teachers to ensure student equality, requiring professors to improve their AI skills.

Dr. Fujii asked about Singapore's plans to extend its data platform to Southeast Asia.

Prof. Liu noted Singapore's small size provides advantages in information control, with government support for open-source platforms.

The third theme addressed universities as global stewards of ethical AI. Prof. Moshabela noted that the University of Cape Town launched an AI hub for safety, peace, and security. He noted industry representatives often dominate AI safety discussions, and that universities have a role to play to inform policy that is also based on research.

Prof. Dissertori emphasized universities' responsibility to educate leaders through dialogue with society and build frameworks allowing trustworthy, ethical, and compliant AI use.

Prof. Liu outlined three leadership points: vision to maximize human potential while lifting everyone up; driving inclusive participation across all disciplines; and acting fast but deliberately, weighing human-centric performance over speed and long-term integrity over short-term efficiency.

Prof. Liu gave an example of efficiency-focused AI adoption causing layoffs, emphasizing the need to balance benefits and issues for long-term societal benefits.

Prof. Gong emphasized multilateral participation, describing Peking University's Digital Intelligence International Development Education Alliance (DI-IDEA) with 32 universities, noting AI should narrow digital gaps rather than create inequality.



Dr. Fujii addressed ethics across timeframes: short-term needs for truth grounding and methods to evaluate AI performance and explainability; mid-term needs for equitable access, adaptive learning, and safety in physical systems; and long-term needs to address energy consumption and whether alternatives to silicon-based systems are required.

Prof. Moshabela raised the challenge of universities losing control over knowledge curation as AI tools go directly to users, asking about training users in ethics.

Prof. Liu described two practices by the National University of Singapore: building institutional infrastructure for guidance and integrating ChatGPT-5 into screened university platforms, though this is costly.

Prof. Dissertori noted AI will change the entire educational system, requiring educators to transform into coaches who train critical and ethical use rather than transmitting knowledge, representing a gigantic cultural transformation with universities potentially leading by teaching the teachers.

Commentary

Three additional participants were invited to present comments on the topic.

Prof. Tshilidzi Marwala noted six issues that will need to be addressed in the future. First is how to ensure the key values of truth and transparency. Second, how to nurture the behavior of people and organizations to promote AI values. Third, how to incentivize people to promote AI values. Fourth is to remember that technology is changing the integrity of policies and regulations. Fifth is whether institutional structures will be able to adapt to the use of AI. And sixth is that it is important to note that mistakes will be made at different levels in the use of AI.



Dr. Nick Campbell commented that it will be key for university leaders to approach the use of AI in a structured but adaptive manner, describing it as "rebuilding the plane while

it is in flight." The principles and governance approaches that universities implement need to guide their strategies and so mitigate the risks of AI. Furthermore, openness is another important theme in how universities manage AI-linked change: universities can deploy AI in ways that inform and support a variety of societal stakeholders and, in doing so, counterbalance industrial perspectives.

Dr. Brendan M. Walsh noted three key points that universities are aware of and need to be addressed:

1. Digital divides will limit who can participate.
2. Affordability barriers will limit who can compete.
3. Governance concentration will limit who can control the future of AI in education.

Individual universities are competing against each other to gain more information for AI usage. No one university can address all these issues alone, and only collectively can the use of AI be properly addressed.

Q&A Session

The floor was then opened to questions and comments.

The first question asked about other activities that universities can use AI for in the future, outside of research and education.

A comment was raised that AI is being utilized more in higher education, which calls into question the legitimacy of higher education. Universities should consider strategies to ensure that AI is not damaging the level of education and that students are actually doing the work they are tasked with.



A second question asked about whether universities are responsible for upskilling parents in local economies and the use of AI for business.

Prof. Moshabela commented that there are detailed tools to determine the use of AI. The University of Cape Town also implemented a new AI in Education framework to guide the use of AI by students to encourage transparency and trust.

Prof. Dissertori responded to the question on upskilling, noting that universities are responsible for providing educational programs. On administration, he added that it is important to provide the right tools and prevent confidential documents from being accessible by non-trustworthy AI systems. Beyond the challenges presented by AI, universities must move forward and consider a possibly more resource-intensive approach to education.

Closing

The co-chairs thanked the participants for their discussions. Prof. Moshabela commented on the need to embrace AI in education and consider solutions to the critical questions raised. Dr. Fujii noted that universities should become a global knowledge hub for future society, including the use of AI, and university leaders will continue this discussion together.



Basic Science, Innovation and Policy

[Chair]

Davies, Mitch, President, National Research Council Canada (NRC), Canada

[Speakers]

Abe, Toshiko, Minister, Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan

Kearns, Paul K., Director, Argonne National Laboratory, U.S.A.

Novoselov, Konstantin Sergeevich, Tan Chin Tuan Centennial Professor, Institute for Functional Intelligent Materials, National University of Singapore, Singapore; Professor of Condensed Matter Physics, The University of Manchester, U.K. [Nobel Laureate 2010 (Physics)]

Rockenbach, Bettina, President, German National Academy of Sciences Leopoldina, Germany

Opening Remarks

After introducing the speakers, Mr. Mitch Davies, President of the National Research Council of Canada (NRC), provided an overview of the NRC and its role as Canada's largest research organization, working to bridge the gap between research and real-world applications. The organization brings together scientists from its research centers, industry players, academia and other collaborators from Canada and other countries to create a deeper pool of input and integration of ideas that leads to creative solutions.



Davies, Mitch

Mr. Davies noted that the world faces a moment of considerable change. Technology is moving quickly and reshaping societies as it always has, but now at an increasingly rapid rate. There is also competition for technological leadership. In such an environment, research agendas are increasingly mission-oriented, which raises questions about the long-term health and funding of basic research. The challenge is to identify the best support to develop such research, and best ways to support the economy and society, and ensure the balance between basic research and the agility required to respond to priorities.



Dr. Toshiko Abe shared some reflections on her visits to, and interactions with, leading research institutions. This is a truly transformative era for science with breakthroughs and transformation occurring at a previously unimaginably rapid rate. This highlights the growing importance of fundamental research. First, to build a society where all can live safely and prosperously, we must secure cutting-edge technology. Second, in an age of uncertainty, diversity and the depth of a research ecosystem, along with the cultivation of highly skilled talent, determine long-term social and economic vitality.

Dr. Abe also mentioned that, based on these views, the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) has begun discussions to shape science and technology policy for the next five years with a clear vision toward the coming decade. The discussions in this session will surely contribute meaningfully to MEXT's policy and deliberations.

Dr. Paul K. Kearns noted that the STS *forum* is a place to reflect on the promise and responsibility of science. To look to the future, it is helpful to reflect on past perspectives,



including the concept of “lights” and “shadows” of science and technology (S&T) espoused by Founding Chairman Koji Omi.

Dr. Kearns then raised three key points for the other speakers' consideration. First, basic science is a light that guides the future. Second, innovation for societal and global challenges requires partnerships and collaboration. Third, policy and stewardship must be oriented over a longer-term horizon.

Dr. Kearns also noted that the STS *forum* encourages participants to think about the world in 2030 and beyond. If we can nurture discovery and carefully manage its consequences, then science can contribute to a hopeful future for humankind. For both challenges and opportunities in S&T, if they are pursued thoughtfully, they will light the way forward without casting shadows.

Prof. Konstantin Sergeevich Novoselov noted that scientific discoveries tend to be made by individuals, but always rely on critical mass built up by local collaborations, as well as the global community, which creates a pressure to build up scientific knowledge. Scientific results are never proprietary and are always global. They belong to humanity. The same is true of scientific knowledge. Human talent is also critical for scientific discoveries, which is why many countries are competing for talents.



It is not always easy to see the connection between technological breakthroughs and fundamental science. Fundamental science always takes time. However, because of the acceleration of the technological revolution, the connection between the two is becoming clearer. In addition, fundamental discoveries can only be developed and amplified with free talent movement and free exchange of information.

Prof. Bettina Rockenbach shared insights from German and European perspectives. She stated that in times of rapid technological change and geopolitical competition, international collaboration and basic research are more essential than ever. Many if not all the most pressing challenges, such as climate change, AI, and pandemics, are inherently global. They must be tackled through innovative solutions grounded in basic science that are translated to real-world applications. The transfer of knowledge and innovation from basic research is of course important, but both are essential and not mutually exclusive. Basic science and curiosity-driven research are essential not only for scientific progress but also for finding solutions for complex social challenges.

Basic science relies on international collaboration. However, geopolitical tensions and security concerns are increasingly affecting research. Restricting collaboration with certain partners may serve science security but risks fragmenting science and reducing global inclusivity. Science can build bridges where politics cannot, and this has played out in history.



In addition, next-generation science starts with curiosity. Therefore, early career researchers need international opportunities and the freedom to pursue fundamental questions. Strong focus on basic science, coupled with international collaboration, creates the ideal ground for nurturing scientific talent in both basic and applied research. Meanwhile, the role of science academies is to provide independent evidence-based advice to decisionmakers and societies to bridge the gap between knowledge and action and contribute to a brighter future for all.

Discussion

Mr. Davies noted the prominence of AI in the discussions at this year's Annual Meeting of the STS *forum*. He pointed out that though these developments are groundbreaking now, at the time, the fundamental research that drove them was likely not clear to policymakers and funding bodies. This supports the argument for openness and curiosity-driven research.

Prof. Novoselov said that he would worry if AI models and the data and weights of the neural networks would be proprietary but was reassured by the increased appearance of open code models. At the same time, he noted with concern the ability to influence, sometimes deliberately and sometimes not, AI models.

Dr. Kearns acknowledged the risks around AI and believed the scientific community must work collaboratively to make sure that responsible and safe AI is being developed. It is also important to pursue initiatives on AI for open science.

Prof. Rockenbach acknowledged the risks of AI but also noted high risks in areas such as medicine and bioscience. The important point and challenge is to find the line at which to regulate AI such that it does not hinder progress, while ensuring the right safeguards. Different governments and different sectors might have different perspectives on this as well.

Prof. Novoselov suggested that the way researchers present data in publications will need to change and that papers and data will need to be more AI-accessible. In tandem, license agreements will probably need to be changed to allow large language models to train on those papers, on the condition that such models are open.

Mr. Davies welcomed the caution expressed by many policymakers and efforts to bring a responsible approach to AI developments, while noting that it can sometimes be difficult to

keep pace with these rapid changes. There is a need for a strong dialogue at the policy level on the different approaches to regulating the emerging advances.

Mr. Davies then asked the speakers for their views on the potential impacts of geopolitical tensions on international collaboration in science.

Dr. Kearns believed that the uncertainty in the world warrants us working in a thoughtfully managed research environment. Three key elements to consider when evaluating potential international collaborations are who the collaborator is, what they are collaborating on, and where the research is going to be conducted.

Prof. Rockenbach pointed out that scientists look for the brightest minds to collaborate with. Historically this has been irrespective of borders. Now, however, scientists are being excluded due to governmental considerations, which cannot be fruitful. There are also growing issues around intellectual property on a national and international level.

Next, Mr. Davies asked the speakers to share examples of what countries are doing well or what they could do better in shaping policies.

Prof. Rockenbach pointed out the need to take risks in research, because the majority of ideas fail in some sense. However, these failures are not necessarily negative. They are experiences and opportunities to learn something new.

Prof. Novoselov highlighted the value of policymakers presenting a vision and possible career paths for early-career researchers to secure the best talent. He noted, however, that countries must also increasingly compete with companies that sometimes have the same financial resources as countries.

Dr. Kearns echoed the importance of talent, while noting the challenges researchers face in pursuing international experience early in their careers. In terms of policy, it would be valuable for a number of countries to come together and make collective investments focused on creating more opportunities for young researchers.

Following this, Mr. Davies invited the speakers to offer any advice they may have to young scientists.



Prof. Novoselov advised that it is ever tougher to find a career in academia so young researchers should keep their options open. Fortunately, there is a great appetite for new technologies, and another path is for young researchers to apply for patents and launch startups.

Dr. Kearns suggested that young researchers should work on topics they are passionate about and enjoy what they do, while also keeping an eye open for new opportunities and being open to exploring other research areas. He also advised them to build strong personal networks.

Prof. Rockenbach agreed on the importance of following one's passions, while also being open to new opportunities, such as joining industry, or adjusting one's field or research question. She also pointed out that it is hard to measure the value of ideas and that an idea that journals or other researchers may not immediately see the importance of could nevertheless be very worthwhile pursuing.

Mr. Davies shared that the NRC encourages researchers to speak not only about their research, but also the narrative of their research and offers tools that would assist them in doing that, including AI-assisted ones.

Finally, Mr. Davies asked the speakers to share any final comments and takeaways.

Dr. Kearns emphasized the need to keep the conversation going around open and collaborative fundamental research.

Prof. Novoselov stated that science always demonstrates its resilience and survives through challenging times. There are also new tools in science that could perhaps be applied in science policy to protect the fundamentals of how science is done.

Prof. Rockenbach noted that policymakers understandably point out that society has fundamental problems and ask where the solutions are, given the amount of funding going into research. The scientific community must have a repertoire of basic research that can be flexibly adapted to new situations and achieve new innovations, and it must convey this effectively to society.

Mr. Davies believed that the narrative and stories in fundamental science, if communicated correctly, can capture people's imaginations and foster interest and support.

Game-Changing Businesses

[Chair]

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

[Speakers]

Daley, Elizabeth, Dean, School of Cinematic Arts, University of Southern California (USC), U.S.A.

Kitano, Hiroaki, Chief Technology Fellow, Sony Group Corporation; Professor, Open Systems Science Unit, Okinawa Institute of Science and Technology Graduate School, Japan

Majerus, Kim, Vice President for Global Education and US State and Local Government, Amazon Web Services (AWS), U.S.A.

Toyoda, Yusuke, Representative Director and President, Chief Executive Officer, Digital Grid Corporation, Japan

Vin, Harrick, Senior Vice President and Chief Technology Officer, Tata Consultancy Services (TCS), India

Opening Remarks

Mr. André Kudelski opened the session by emphasizing that scientific and technological innovation will not create fundamental change without societal adoption, which in turn depends on how the innovation changes the value chain for those who adopt it. He cited mobile phones as an example of transformative change achieved through the ideal balance

of new technology, affordable pricing, and scalability. He noted that artificial intelligence represents innovation that has the potential to fundamentally change the world, much as new energy sources facilitated early innovation efforts by increasing efficiency and lowering the skills required to be productive across sectors like agriculture. Mr. Kudelski explained that the panel would explore recent manifestations of these points and examine future opportunities, with particular interest in fostering collaboration between the private sector and academia to advance science and technology.



Kudelski, André

Prof. Elizabeth M. Daley explained that cinema has always existed at the nexus of art, technology, and business. The University of Southern California (USC) was established as a professional school when movies first appeared with sound, seizing upon the need to train people for new technology applications. Rather than causing the cinema industry's demise, each successive technological advancement in the industry has been embraced, as the business focuses on creating impactful stories with new and innovative enabling technologies. USC fosters deep industry cooperation and collaborates with leading industry professionals to remain on top of current technology trends. Key partnerships enable USC to stay engaged in dialogue across domains, which is essential to teach the industry's next generation of talent, particularly in emerging fields such as AI technology.

Prof. Hiroaki Kitano described how the shift in business direction towards entertainment in recent years has been transformative for the Sony Group, and has led to strong results. Entertainment businesses account for more than 60% of Sony Group's consolidated sales. This transformation required redirecting its organization and research and development around the guiding principle of serving creators. Recognizing that AI is a transformative change comparable to an industrial revolution, Sony has deployed teams to implement



large language models while protecting intellectual property, and is pursuing AI-driven scientific discovery that will fundamentally change industry structures and capitalism.

Ms. Kim Majerus noted that AI's impact will be defined not by AI itself but by its application across multiple domains. She characterized the present moment as pivotal, comparable to the industrial revolution or the dawn of the internet, requiring bold vision and careful execution for continuous digital transformation. As President of Global Education and State and Local Government at Amazon Web Services (AWS), she is witnessing how AI is dismantling traditional educational approaches through adaptive tutoring systems while accelerating research discovery and analysis capabilities. She emphasized that AI will amplify rather than replace human creativity, with universities that embrace AI being the ones that will define the next educational era.

Mr. Yusuke Toyoda introduced Digital Grid within the context of energy transition, noting that Japan's 700,000 solar power projects represent that the amount of fluctuating renewables, including solar and wind, is over 15% of the energy mix despite output fluctuation. The landscape of energy resources has shifted greatly in the past decade. Digital Grid addresses renewable energy challenges, including grid interconnection and flexibility, by utilizing distributed energy sources and AI to optimize consumption patterns and renewable energy efficiency, while recognizing the need for new technologies like ammonia and country-specific energy portfolio optimization.

Dr. Harrick Vin stated that knowledge work has reached an inflection point as society enters an era of hybrid workforce collaboration between people and machines. This mutual augmentation will double the value generation capacity of teams and organizations, creating exponential growth at the individual level, mirroring the exponential growth witnessed in the 1980s. Success will depend on mastering new work practices, requiring organizations to rethink designs for change rather than efficiency. He outlined two imperatives: adopting human-centric AI that enables performance beyond capacity, and developing adaptive workforces capable of continuous talent transformation as roles shift with advancing machine intelligence. AI is an invaluable tool for skilling and reskilling.

Discussion

Mr. Kudelski began the discussion by asking Mr. Toyoda what led him to change the path of his start-up venture.

Mr. Toyoda explained that starting from an academic laboratory, the company struggled with many things. Energy transition is a long-term issue, while start-ups focus on short-term profit and loss. The company was committed to increasing the penetration of renewable energy, but in 2022, it realized that renewable energy sources could reduce electricity bills for users. This realization led him to pivot the company's business model.

Mr. Kudelski asked Prof. Kitano about the future of movie content creation and how consumers are reacting to fundamental changes in the way content is created.



Prof. Kitano answered that for the consumer, what matters most is the story. The world has shifted dramatically into the information technology business, but strong hardware remains key to supporting creators. Prof. Kitano gave an example of Sony supporting major motion pictures where technologies are essential to film crews. He emphasized that technology is meant to help people be more creative.



Mr. Kudelski asked Prof. Daley about her message to students regarding AI.

Prof. Daley stated that the greatest danger is paralysis from fear rather than engagement. While fear is rampant in Hollywood, students should be ready to use any tool that enables better storytelling and audience engagement. She emphasized that humans are wired for narrative and need stories to explain, identify, and imagine beyond limitations. Her concern focuses on younger children whose brain development may be adversely affected by technologies such as AI, but she believes continued conversation will lead to positive outcomes.

Mr. Kudelski asked Ms. Majerus about regional differences in AI adoption among the US, Europe, and Asia.

Ms. Majerus emphasized that AI provides opportunities that challenge the status quo across all regions, requiring global rather than local collaboration. She noted that some educational institutions continue operating as they have for the last 30 to 40 years and called for institutions to adapt more quickly while ensuring security, with global collaboration being essential.



Mr. Kudelski asked Dr. Vin, who works with people across different continents, about the key criteria that distinguish organizations that are able to change from those that become obsolete because of their inability to change.



Dr. Vin replied that organizational change is fundamentally a people problem not a technology issue. Success requires organizations to think about AI as a value-driver and to use technology to change customer-perceived value as a driver for changing people, culture, and organizational design.

Ms. Majerus added that one-third of an organization's employees will typically remain static in their current positions, while another one-third of employees would benefit from

upskilling and reskilling, as their knowledge and experience combined with a desire for professional growth makes them potential game changers.

Dr. Vin noted the challenge of ensuring that current and new businesses can coexist simultaneously.

Q&A

The session was then opened to questions and comments from the audience.

A member of the audience raised a question to Prof. Daley about preventing overuse of AI systems, explaining that while AI agents are helpful, for example, to publish more papers per year, increases in quality of work are questionable.

Prof. Daley described her school's approach of bringing all faculty together on the AI journey, similar to previous transitions with digital technology. She shared an example of an 84-year-old film editor who initially seemed likely to resist digital editing technology but instead embraced it enthusiastically, understanding that the technology enhanced rather than replaced his core skill of juxtaposing images to create meaning. She emphasized the need to help people understand their fundamental capabilities and how AI can become a partner in their work.

Next, an audience member asked whether democratized AI could emerge from companies like Sony in Japan or Tata Consultancy Services in India, given apparent American and Chinese dominance in AI development.

Prof. Kitano responded based on his experience with the UN High-Level Advisory Body on AI, explaining that generative AI performance depends heavily on training data, creating challenges for languages with scarce resources. While useful AI requires tremendous resources, he noted that key innovations, including transformers, deep learning, and diffusion models, originated from diverse global locations outside of Silicon Valley. He emphasized that innovation opportunities remain globally distributed.



Dr. Vin added that AI innovation occurs at two layers: infrastructure (chips and models) and applications. While infrastructure requires more democratization, significant innovation opportunities exist at the applications layer, focused on generating value rather than AI for its own sake.

A final questioner noted the emergence of new skills and jobs due to AI across sectors, including detecting hallucinations in cinematography and post-market surveillance in healthcare.

Dr. Vin provided an example of completely new job categories emerging around self-evolving AI systems, which require new approaches to testing, assurance, and deviation detection compared to traditional static systems. He noted this represents a fundamental shift affecting software engineering and similar fields across all work domains.

Mr. Kudelski concluded the session by emphasizing the need to challenge ourselves and to change rather than be changed or replaced, and by thanking the panelists for the engaging discussion.

Brain Health and Brain Augmentation

[Chair]

Wallberg, Harriet, Professor and former President, Department of Physiology and Pharmacology, Karolinska Institutet; Chair, Sweden Japan Foundation, Sweden

[Speakers]

Asakawa, Chieko, Chief Executive Director, Miraikan - The National Museum of Emerging Science and Innovation, Japan; IBM Fellow, IBM Research, U.S.A.

Kanai, Ryota, CEO, ARAYA Inc., Japan

Montejo, Caroline, President and CEO, Dana Foundation, U.S.A.

Samuel, Didier, Chairman and Chief Executive Officer, French National Institute of Health & Medical Research (INSERM), France

Yamakawa, Yoshinori, Professor, Graduate School of Management, Kyoto University, Japan

Opening Remarks

Prof. Harriet Wallberg opened the session by highlighting humanity's entry into an era where the human brain serves as a platform for enhancement, extension, and transformation beyond traditional disease studies. The convergence of neuroscience with AI, robotics, and neuroengineering drives advances from treating neurodegenerative disorders to developing brain-machine interfaces and AI-powered devices. This progress brings technical and ethical complexity, raising questions about preserving brain health, drawing boundaries between therapy and enhancement, and protecting fundamental human rights including



Wallberg, Harriet

privacy and autonomy. Prof. Wallberg outlined the three themes of the session: AI and brain-machine interfaces in relation to human identity, rethinking education in the age of AI, and protecting against AI-driven risks. At this historical crossroads in scientific development, decisions regarding the application of growing power over the brain will fundamentally shape the future and meaning of human existence.

Dr. Chieko Asakawa traced the evolution of AI-powered navigation systems for visually impaired individuals, from the tactile conversion devices of the 1970s, to voice-enabled



web browsers, to current AI systems capable of real-time image analysis and natural language interaction by users. Current navigation automation can guide users while avoiding obstacles, though the challenge remains achieving shared autonomy, where humans can intervene in robot control to enable effective movement in public spaces. Public understanding and acceptance of AI technologies remains crucial, particularly regarding privacy concerns with camera-equipped navigation aids. Dr. Asakawa shared that testing AI navigation systems at the Osaka Expo provided new levels of independence, demonstrating the transformative potential of these technologies for improving the quality of life of visually impaired users.

Next, Dr. Ryota Kanai outlined his transition from neuroscience research on human consciousness to developing real-world neurotechnology applications through his company, ARAYA. Mentioning his involvement in the Japanese government's Moonshot Research and Development Program, which aims to liberate humans from limitations of body, brain, space, and time through





connectivity, he interpreted the goal to be developing brain communication systems for remote control using thought. Research has revealed scaling laws in non-invasive brain-computer interface systems similar to those in AI research, where increased data and improved architecture continuously enhance decoder performance. The emergence of numerous companies developing invasive neurotechnology emphasizes the importance of building public trust while creating feedback loops between industry applications and basic consciousness research.

Dr. Caroline Montojo outlined the Dana Foundation's mission to advance neuroscience serving all people's aspirations, highlighting significant advances in deep brain stimulation for treating neurological conditions and implantable brain-computer interfaces that translate brain activity into device commands. Recent breakthroughs in the field include decoding imagined speech from brain activity in real-time for ALS patients. Dr. Montojo described three pressing ethical dimensions that have emerged: data privacy concerns regarding brain data revealing thoughts and feelings, autonomy issues when devices influence mood and decision-making, and the boundaries between therapeutic restoration and enhancement applications. The Dana Foundation supports collaborative models including the Implantable Brain-Computer Interface Collaborative Community to help address regulatory questions

and support initiatives while ensuring public dialogue keeps pace with scientific advances.

Following this, Prof. Didier Samuel explained that as France's national medical research institute, Inserm is home to some 15,000 researchers addressing mental health as a national priority, given that one in four French citizens faces mental health challenges. Recent advances include improvements in brain imaging, identification of genetic variants influencing Alzheimer's disease, and development of ultrasound-based visual restoration as a less invasive alternative to brain-machine interfaces. Prof. Samuel explained his institute's emphasis on ensuring that neuroscience and neurotechnology advances serve substantial medical progress while protecting human rights and maintaining public trust, particularly regarding concerns about freedom of thought, mental privacy, and individual autonomy. He stressed the importance of protecting the developing brains of children and adolescents while carrying out responsible innovation in this area.



Prof. Yoshinori Yamakawa introduced the Brain Healthcare Quotient (BHQ), a quantified brain health measure based on neuroimaging data, approved as an international standard by the International Telecommunication Union Telecommunication Standardization Sector (ITU-T) as a brain-version of IQ. He referenced research suggesting that brain decline begins relatively early, around age 20, though BHQ can recover through lifestyle changes. Prof. Yamakawa shared that it is also possible to estimate one's BHQ using a smartphone to record facial expressions showing different emotions. He explained how brain health connects to motivation, empathy, curiosity, and overall well-being, enabling applications such as reducing the risk of dementia and evaluating the wellness of employees. Prof. Yamakawa suggested three methods to improve one's brain health, including maintaining physical health and social connections, engaging with certain cultural elements or activities, and using AI appropriately for creativity rather than mere efficiency.





Discussion

Following the opening remarks, Prof. Wallberg began by asking Dr. Asakawa about navigation robots potentially evolving into human-like companions for purposes including elderly care and dementia support.

Dr. Asakawa predicted that while robots will become more human-like to interact with naturally, it will be important to prevent attributing excessive personality to them. She noted that AI technologies are not just supporting mobility and decision-making for visually impaired individuals, but could similarly assist those with dementia.

Prof. Wallberg then raised the topic of robot consciousness and the societal implications if this becomes a reality. Dr. Kanai expressed his belief that AI and robots will eventually become conscious as architectures converge toward consciousness-related designs. While consciousness and intelligence are separate, implementing consciousness theories using deep learning architecture can potentially provide learning advantages.

Next, the speakers shifted to the topic of AI impacts on mental health. Dr. Yamakawa highlighted young people's high brain plasticity, which makes them particularly vulnerable to

addictive technologies. The BHQ system could aid in providing technologies at the appropriate times to reduce the risk of mental health disorders.

Prof. Wallberg then asked about ways to protect children from harmful technological influences. Dr. Montojo referenced the Dana Foundation's focus on neuroscience education for judges and legal professionals handling cases, especially those involving juvenile sentencing and substance use disorder, which significantly impact the life trajectories of young people.

On the second overarching session theme of education in the age of AI, Prof. Wallberg inquired about how the current educational system, which was not designed with AI and machine learning in mind, can evolve in preparation.

Prof. Samuel emphasized the need for multidisciplinary research teams combining experts in neuroscience, educational science, public health, AI, and human-machine interface technology, noting that AI develops faster than the time needed for comprehensive studies. It is important to differentiate between children with learning disorders requiring specific technological support and those without such needs.

Prof. Wallberg asked about preparing future generations for neurotechnology. Dr. Montojo emphasized that education must go beyond technical and scientific training to include creativity, ethical reasoning, and resilience as human strengths that surpass AI capabilities. Schools must prepare students for thoughtful decision-making about technology use. She cited examples including ethics-infused neuroscience education for middle- and high-school students using future scenarios with cutting-edge technologies, and freely accessible curriculum resources focusing on neuroscience and society.

Dr. Kanai added concerns about education in the AI context, questioning what should be taught in schools when interactive AI potentially replaces thinking processes. He worried about students losing deep thinking skills because AI summarization tools can now easily write papers and reports. Additionally, he expressed concern about autonomy in a society where AI-based agents and social media manipulation attempts influence



thoughts, suggesting children need education about dealing with such influences, in addition to potential regulatory responses.

Prof. Samuel agreed that significant changes are inevitable, comparing current transformations to previous generational shifts in writing approaches due to new technology. He emphasized the need for extreme caution when considering fundamental changes to educational approaches.

Dr. Asakawa suggested that brain augmentation and neuroscience education should include perspectives on sensory disabilities, promoting understanding of people with vision, hearing, or mobility challenges to create a more inclusive and accessible society.

Prof. Wallberg noted the various risks emerging from AI, including misinformation, fraud, and identity theft, then asked the panelists for their policy advice in this context.

Dr. Yamakawa advocated for greater promotion of brain health and support for research. Prof. Samuel recommended significant investment in strong ethical oversight.

Dr. Montojo stressed the importance of education and public literacy, strengthening the ability of individuals to question and verify information for themselves.

Dr. Kanai mentioned the possibility of regulating online or AI anonymity to encourage adherence to social norms by users, though he acknowledged concerns about free speech.

Finally, Dr. Asakawa emphasized substantial AI benefits for disability support, particularly vision-enhancing technologies. She warned that privacy-driven camera restrictions on certain devices would deny visually impaired individuals major benefits, stressing the importance of communicating these advantages to policymakers.

Q&A Session

An audience member raised concerns about text-to-voice transformation, brain-machine interfaces, and wearables, and the risk of technologies to read a user's thoughts and communicate directly without external control, representing identity invasion. Prof. Samuel acknowledged this concern, but noted that the challenges remain unanswered.

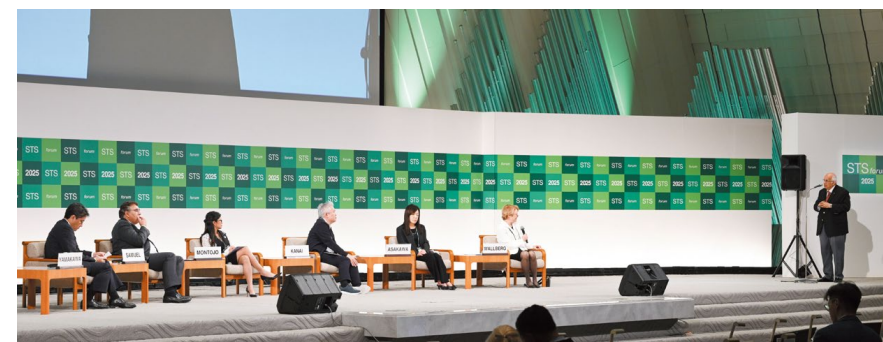
Next, an audience member asked about progress toward reading thoughts without direct contact and appropriate educational ages for AI implementation. Prof. Samuel emphasized the importance of neurodevelopment during childhood and the need to maintain critical analysis capabilities.

Dr. Kanai noted current difficulties in brain-machine interfacing without direct sensing but warned of rapid, unpredictable technological development. He advocated for discussion mechanisms to prepare for emerging technologies and make flexible, adaptive policies.

Dr. Montojo commented that while brain manipulation remains distant, deep brain stimulation is raising issues of liability, requiring active discussions as technology advances.

An audience member expressed concern about thought-reading brain research, asking whether privacy switches could protect personal privacy and intellectual property.

Dr. Montojo noted that the study she mentioned used a code word to control brain activity recording, maintaining intentional control, though this is only the beginning of addressing privacy considerations in rapidly advancing neurotechnology.



Science Diplomacy

[Chair]

Walport, Mark, Foreign Secretary and Vice-President, The Royal Society, U.K.

[Speakers]

Kotani, Motoko, Executive Director of Science, RIKEN; Executive Vice President for International Research Strategy, Tohoku University, Japan

Larson, Heidi, Professor of Anthropology, Risk and Decision Science, Infectious Disease Epidemiology and Dynamics, London School of Hygiene and Tropical Medicine, U.K.; Clinical Professor, Institute for Health Metrics & Evaluation, University of Washington-Seattle Campus, U.S.A.

Museneno Masanza, Monica, Hon. Minister, Minister for Science, Technology and Innovation, Office of the Minister, Uganda

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

Opening Remarks

Sir Mark Walport opened the session by emphasizing the central importance of science diplomacy to the STS *forum*, noting that the gathering brings together researchers and policymakers from many countries as the human ingredients for science diplomacy processes. He observed that while the desired outcomes of science diplomacy were illustrated in the previous day's opening session, achieving such outcomes remains challenging.



Walport, Mark

Sir Mark reflected on how dramatically the landscape has changed since 2010, when the Royal Society and the American Association for the Advancement of Science (AAAS) collaborated on a report about science diplomacy. In 2010, globalization was widely viewed as successful and stable, with more multilateral cooperation and an optimistic view of emerging social media. Today's environment presents much greater challenges: environmental, social, and demographic issues have become more pressing, populist politics are rising worldwide, the COVID-19

pandemic exposed supply chain fragilities, and hot wars have replaced cold wars in Ukraine, Sudan, the Middle East, and other regions. Additionally, cyberspace has become a new warfare environment for both state and non-state actors.



Dr. Motoko Kotani highlighted Japan's commitment to science and technology (S&T). She emphasized that while S&T are indispensable for addressing global challenges such as climate change, pandemics, and energy security, they also present serious risks including AI misuse, gene editing dilemmas, and social inequality amplification through biased data.

Dr. Kotani stressed that maintaining scientific credibility requires strong commitment to research security, research integrity, and sound data governance, while ensuring these measures do not close doors to international cooperation. She advocated for a model that combines strong safeguards with continued international collaboration. Dr. Kotani also proposed establishing a monitoring system to track progress toward the rapidly approaching 2030 Sustainable Development Goals (SDGs) deadline.

Prof. Heidi Larson discussed the vulnerability of trust in the current global environment, drawing from her work as an anthropologist studying technology acceptance. She noted that using science as a medium for diplomacy becomes more challenging when leaders disagree on fundamental issues like climate change severity or COVID-19 impacts. Prof. Larson shared insights from her Vaccine Confidence Project, revealing that while trust in science remains high globally, scientists face unprecedented levels of verbal and physical abuse, leading many to silence themselves rather than engage publicly.

Prof. Larson emphasized that the primary challenge is not trust in science but rather science's influence on behaviors and policies, where competing voices and alternatives present significant challenges. She advocated for hyperlocal engagement across countries and increased global collaboration among scientists, particularly through online networks that connect young scientists worldwide.



Dr. Monica Musenero Masanza presented the African perspective, emphasizing that economic transformation is the primary need of African nations. She argued that Africa has been disadvantaged by missing or being improperly positioned for the first three industrial revolutions, resulting in unequal participation in diplomatic processes. However, with the fourth industrial revolution and the heralding of the 5th Industrial Revolution (Japan's Society 5.0 concept), Africa can now participate in real-time innovation and technology development rather than merely utilizing post-science products.



Dr. Musenero Masanza criticized the global science diplomacy discourse for focusing excessively on negative threats while failing to address economic benefits and financial opportunities. She noted incomplete disclosures in AI discussions, making it difficult for African nations to understand economic implications and benefits. Uganda is pioneering models to demonstrate how science can drive socioeconomic transformation, including entering the automotive industry and engaging with deep tech and climate tech initiatives.

Dr. Sudip S. Parikh acknowledged the remarkable scientific understanding achieved but expressed concern that science is not bringing the world together as expected. He characterized the current era as extraordinarily disruptive, warning that science diplomacy by itself is not inherently positive but rather a tool that can be used for good or ill. Dr. Parikh noted significant changes in the landscape, including the rise of large non-nation state actors like Microsoft, Google, and Tesla, which have their own foreign policies and control substantial scientific and technological infrastructure.

In addition, Dr. Parikh emphasized that while the federal government invests \$200 billion annually in the United States, private industry and philanthropy invest almost \$800 billion, fundamentally changing the dynamics of scientific investment and control. Despite acknowledging increasing competition, nationalism, and populism, he expressed optimism based on historical achievements such as smallpox eradication during the Cold War, cancer



treatment advances, and successful international collaboration on issues like acid rain and ozone depletion.

Discussion

Sir Mark asked panelists to address the gap between utopian scientific visions and policy reality, questioning whether politicians prioritize present spending over future investments and whether electorates dominated by older voters tend to vote against young people's interests.

Dr. Musenero Masanza responded by drawing on her experience transitioning from scientist to policymaker, explaining that politicians and scientists speak different languages. She identified two primary concerns for politicians: securing votes and managing the economy. Scientists often fail to understand these priorities and struggle to translate their work into language politicians can comprehend and act upon.

Dr. Musenero Masanza defined her ministerial role as linking scientific knowledge to economic outcomes, emphasizing the need for scientists to learn politicians' language and translate scientific insights into politically relevant terms. She noted that politicians operate on electoral cycles requiring votes every four years, creating pressure to address immediate rather than long-term concerns.

Q&A

The Q&A session began with a comment from an audience member advocating for greater support of international funding organizations and emphasizing the value of young researcher exchange programs between different countries.

A subsequent question addressed whether science diplomacy is most effective at the initiation of relationships or in maintaining established partnerships. Prof. Larson responded that it is not an either-or question, emphasizing the importance of early engagement that must be sustained throughout the process. She noted the extraordinary volatility of public sentiment and the need for flexibility and nimbleness in diplomatic approaches. Sir Mark emphasized that intervention after policy decisions have been made is typically too late, citing the universal political issue of saving face.

An audience member raised questions about decision-making regarding technology exchange in contexts involving national security and economic competition, noting the



complexity of these technologies. Dr. Kotani responded by referencing Japan's experience, explaining how the country's decline led to renewed government investment through a university endowment fund, demonstrating how politicians can be convinced of the importance of future investment. Dr. Parikh suggested working within frameworks, acknowledging that it is impossible for anyone to be an expert in all relevant technologies simultaneously and emphasizing the need for clear decision-making frameworks.

A separate audience member posed questions about scientists' responsibilities for governance of their research applications, distinguishing between diplomacy for science and science for diplomacy. The audience member asked about scientists' responsibility to formulate standards for responsible technology use on an international basis.

Dr. Musenero Masanza responded that scientists must return to the fundamental reasons for conducting science and take responsibility for establishing safeguards. She emphasized that when science goes wrong, it undermines trust, citing the rising anti-vaccine trends as an example. She stressed the need for scientists to imagine the ripple effects of their work and establish universal principles, warning that failure to take responsibility undermines science itself.

Dr. Parikh acknowledged the challenge posed by private sector technology development but referenced historical examples such as gene editing governance, suggesting that new regulatory models are needed and that governments can provide incentives for responsible development.

A separate audience member raised questions about managing relationships with countries that serve simultaneously as partners, competitors, and systemic rivals, referencing the European shift from open science to “as open as possible, as closed as necessary” following Russian aggression against Ukraine. Dr. Musenero Masanza emphasized that every nation must have equal rights in science, questioning who determines which countries have rights to conduct specific types of science.

Prof. Larson stressed the importance of making science relevant rather than simply accessible, noting that different audiences require different approaches. She emphasized the need for risk officers who are constantly alert and the importance of early engagement to prevent alternative views from gaining ground.

Sir Mark responded by noting the historical pattern of civilizations rising and falling, describing current challenges as part of a constant process of rebalancing. Dr. Kotani expressed optimism about the scientific system, emphasizing trust in science while acknowledging the



need for dialogue between different sectors and the importance of moving beyond ivory tower approaches.

A series of audience questions followed. One audience member described exchange programs pairing politicians and researchers, noting the challenge politicians face in seeking re-election and calling for stronger integration of social science perspectives in such discussions. Others asked about sustaining scientific collaboration during conflicts and about fostering effective dialogue between scientists and policymakers through appropriate institutional frameworks. The final question focused on how to institutionalize science diplomacy as a core competency for public science professionals while avoiding token forms of globalism.

Dr. Parikh distinguished between the impossibility of conducting science diplomacy during hot wars versus the potential for engagement during periods of high geopolitical tension. Dr. Musenero Masanza emphasized that science has historically enabled humanity to expand available resources and that collaboration is essential, noting that no nation wants to be on the receiving end of economic outflows or unaffordable technology.

Prof. Larson noted the absence of clear rulebooks in the current environment, emphasizing that players and participants are constantly changing. Dr. Kotani reiterated her call for greater inclusion of young people in science diplomacy initiatives.

Sir Mark concluded by noting that effective science diplomacy requires professional institutionalization with proper structures and transmission mechanisms.

Science Communication

[Chair]

Nurse, Paul, Honorary Life President, The Francis Crick Institute, U.K.; Secretary General, EMBO [Nobel Laureate 2001 (Physiology or Medicine)]

[Speakers]

Decatur, Sean, President, Office of the President, American Museum of Natural History, U.S.A.

Dijkgraaf, Robbert, President-Elect, International Science Council (ISC), France; Distinguished University Professor, University of Amsterdam, Netherlands

Markides, Karin, President and CEO, Okinawa Institute of Science and Technology (OIST), Japan

Tanaka, Mikihiro, Professor, Faculty of Political Science and Economics, Waseda University, Japan

Opening Remarks

Sir Paul Nurse opened by defining the intended meaning of “science communication” in the session as “communicating science and matters of science to the rest of society.” He pointed out that the general public is very diverse and is mainly made up of non-scientists. These different audiences are more receptive to different messages and different modes of communication. Science communication also differs by country and culture. Good communication needs to reflect the country, culture, and community where that communication is taking place.



Nurse, Paul

The intention of one's communication may differ from case to case. It could be to gain funding, to influence politicians in more general ways on science, to inform the public about new initiatives or dangers, or simply enrich culture and civilizations. Thus, science communication needs to be crafted very carefully. Central to all communication are two aspects: showing that science is critical to society as a whole and its future, and showing that scientists are part of society.



Elements such as evidence-based arguments, courteous debate, and the search for truth are central to science, as they are to democracy. There are emerging trends of people not showing respect for those elements, particularly in the political leadership of the United States of late, and that is spilling over into the broader community. There is a critical need to stop this worrying trend.

Dr. Sean Decatur stated that this is a complicated time for science. While this is a golden age of scientific discovery, the scientific community must also question the efficacy of its ability to communicate its work to the public. For example, previously fringe attacks on science are becoming mainstream, and disinformation and misinformation are gaining more traction.

Surveys continue to show that there is strong global trust in science. However, the trend is downward. Much of this is due to widespread mistrust in political institutions and authority more generally in an era of globalization. It has been said that communication is never the core issue; trust is. Lack of understanding or even misunderstanding about the process of scientific discovery is one major source of mistrust.

To address this, the scientific community should focus firstly on what to communicate. This should be centered on fostering understanding of the scientific process. The second focus should be how to communicate, particularly demonstrating science's openness to change its view based on new evidence. The third focus is who to communicate to. This must be done in authentic ways and include audiences that may be skeptical about science. That may also require the use of non-traditional communication channels.

Dr. Decatur then explained the approach taken by the American Museum of Natural History (AMNH), which tries not only to capture visitors' attention but also leave them with a question. The AMNH also illustrates how science tries to answer such questions. In addition, the AMNH tries to collaborate with content creators in other channels to reach audiences it may not otherwise be able to.

Prof. Robbert Dijkgraaf noted that some of the pushback against science may ironically be due to science's success. He also noted that the knowledge gap between science and the public is growing, making it more difficult for the public to understand science. Scientists need to engage more with the public, particularly those who are skeptical about science, and for that, they must be comfortable with being uncomfortable. Social scientists must also be involved for their understanding of human nature. In addition, while it is important to tailor communication to local audiences, it would also be valuable for centers of science communication worldwide to share best practices. Moreover, science communication should be recognized as a legitimate career path in institutions.



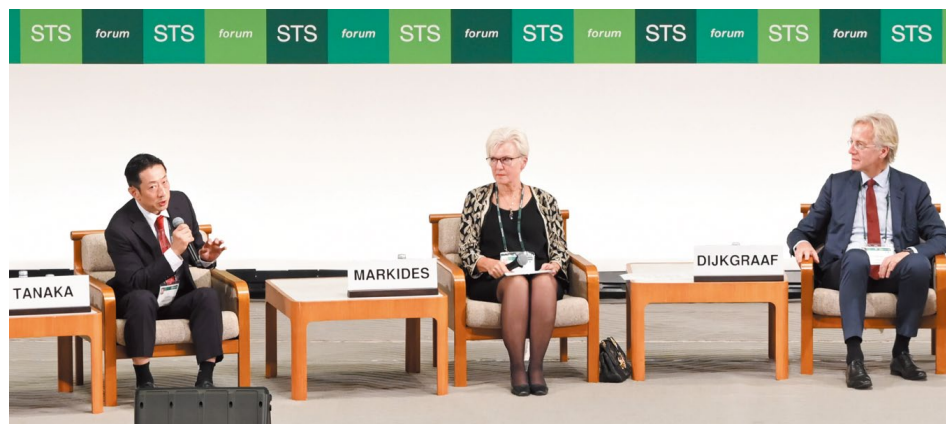
Science and research practices must evolve to provide the solutions sought by society. At the same time, there is still a high level of trust in science. This is not because people really understand the outcomes of research, but they see scientists as a global community that does something very difficult, agree with each other, and produce results.

Prof. Karin Markides expressed the belief that science communication is an essential social component of the scientific process. It must reach a diverse audience, helping them understand cutting-edge developments across many disciplines. A dangerous failure of science communication is to fail to reach all audiences and thereby create silos.

Building trust in verified science is very valuable in assisting society to move forward. Universities can be venues for engaging with local and national leaders to understand what they consider to be pressing issues of concern and this process fosters trust. Digital platforms also offer the opportunity for early dialog.

Surveys show high public evaluations of scientists' abilities, qualifications, and honesty. Nevertheless, some think scientists are dishonest. The public expects scientists to engage in greater communication. Furthermore, it expects scientists to advocate for scientific findings and certain policies and to work more closely with policymakers. More support should be provided for scientists to conduct such science communication.

To conclude her remarks, Prof. Markides stated that to harness the power of science and technology to move society forward, science communication must keep pace with socialization of science and technology, respect planetary boundaries, and safeguard humanity and the diversity of human creativity and potential as a whole.



Prof. Mikihiro Tanaka spoke about three “isms” that are disrupting science communication: populism, alarmism, and accelerationism. Populism against science is rampant, including in Japan. Such skepticism against science is now far more open than before in every country. This is also damaging science communication, and it is occurring both top-down and bottom-up.

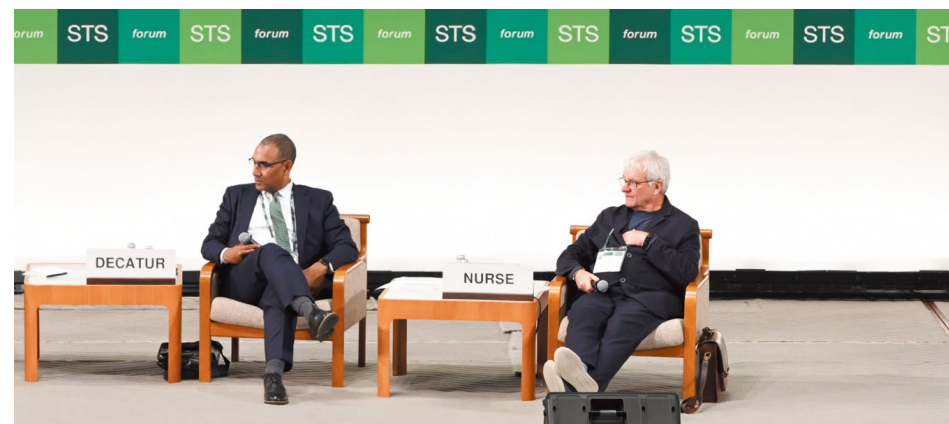
Regarding alarmism, vigilance against increased fraud has driven science communication toward trying to overcome challenges by stressing the enlightenment of correct scientific knowledge. This is a mistaken approach that deepens polarization.

Accelerationism is symbolized by the situation around generative AI. This is the view that accelerating technological and economic development is the only way to solve social problems. Science communication is being poisoned by this. It has pushed scientists to want to efficiently and swiftly convey the correctness of science. This risks making them lose sight of the essence of communication, which is that all stakeholders, including experts, citizens, industrial actors, and policymakers need to engage in thoughtful, sustained dialog about the kind of society we should strive for.

Q&A Session

Sir Paul then opened the Q&A session and invited questions from the audience.

An audience member asked about best practices for outreach efforts.



Prof. Markides suggested that universities have to serve as a kind of coach in society. Universities must connect internally, across disciplines, and connect externally, with stakeholders, to build trust and build resilience against incorrect information.

Prof. Dijkgraaf noted that topics that seem far removed from everyday life, such as small particles or black holes, sometimes trigger people’s interest because it captures the human imagination and curiosity. These are the driving forces of science and also innate human qualities.

The next question related to recognizing science communication as part of a scientist’s roles and changing reward systems to incentivize this.

Dr. Decatur agreed that science communication and public understanding of what scientists do are essential for thriving scientific institutions and these institutions must find ways to incentivize that.

Prof. Markides shared the ongoing discussion in Japan on enhancing PhD-level education. PhD-level education should include not only the traditional aspects but also professional training and the fostering of a mindset of going out into society to build trust and understanding.



Prof. Dijkgraaf suggested that if the scientific community wants to take public engagement seriously, it needs to develop criteria for assessing excellence in public communication, similar to how it evaluates excellence in research.

Another audience member asked about how to start to tackle people who have preconceived notions and are already convinced science is wrong.

Prof. Markides stressed the importance of getting people to listen to each other and trying to understand each other.

Prof. Tanaka shared a study about skepticism about the human papillomavirus (HPV) vaccine. Based on social media interactions, the Japanese public was very skeptical about the vaccine up to 2014. However, this changed from 2014 to 2017. The study found that medical doctors and experts communicated patiently with vaccine skeptics, acknowledged what they were saying, and slowly tried to convince them. These efforts were very successful. Tragically, there then emerged a trend of mocking vaccine skeptics on social media, which re-exacerbated the previous polarization.

Next, a participant noted that even in major news publications, there is now a reluctance to engage with complexity and a favoring of superficial coverage of science. He asked if new

publications should elevate coverage of science back to a higher standard. He highlighted the U.K.'s Science Media Center (SMC) as a good example of such efforts.

Dr. Decatur did not see it as a choice of “either or” and saw value in both types of coverage.

Prof. Dijkgraaf agreed that this is an important task for the scientific community but believed it could not be done alone. Scientists must work with people with different areas of expertise, including the media.

Sir Paul pointed out that the SMC does not substitute communication by news outlets. Rather, if a topic comes up, the SMC will ask for opinions from scientific experts and make them available to news outlets. He also shared the example of a series of podcasts put out by the Francis Crick Institute that was immediately very popular. This shows that institutions can also take action.

A participant shared the past practice of the American Association for the Advancement of Science (AAAS), whereby whenever there was breaking news related to science, the AAAS would try to link the news outlet with scientific experts. He encouraged other countries to explore similar approaches.

The final question from the audience concerned how to support young scientists communicate their science.

Prof. Markides believed that professional science communicators and writers should be part of the university structure.

Prof. Dijkgraaf suggested that researchers should integrate it in a natural way with their research career. Researchers often know what they want to communicate, but public engagement can sometimes teach researchers why they want or should want to communicate their research.

Dr. Decatur recommended searching for other partner organizations outside the traditional university-research setting, such as museum science centers or community organizations. These organizations can do some of the professional lifting from a communications and outreach standpoint, while the researcher provides the science and expertise.

Sustainability for Nature Positive Economy

[Chair]

Ishii, Naoko, Special Presidential Envoy, Professor and Founding Director, Center for Global Commons, The University of Tokyo, Japan

[Speakers]

Gluckman, Peter, President, International Science Council (ISC), France; Director, Koi Tu; Centre for informed Futures, New Zealand

Schmidt-Traub, Guido, Partner, Systemiq Ltd., France

Leinen, Margaret, Director, Scripps Institution of Oceanography, University of California San Diego; Vice Chancellor, Marine Sciences, University of California, San Diego, U.S.A.

Tveit, Mari Sundli, Chief Executive Officer, Research Council of Norway (RCN), Norway; President, Science Europe, Belgium

Howell, Lee, Executive Director, Villars Institute, Switzerland

Ali, Ahmad Tajuddin, JOINT CHAIRMAN (INDUSTRY), Malaysian Industry-Government Group for High Technology (MIGHT); CHAIRMAN, UNIVERSITI TENAGA NASIONAL (UNITEN) / THE ENERGY UNIVERSITY, Malaysia



Opening Remarks

The session was opened by Dr. Naoko Ishii, who highlighted a critical message from science delivered during New York Climate Week, where Prof. Johan Rockström presented an updated planetary boundary science, announcing that seven of nine planetary boundaries have now



Ishii, Naoko

been transgressed, an increase from six the previous year. This represents a clear warning that humanity is severely out of balance with natural systems, which form the foundation of human prosperity and society. Simulations conducted by Dr. Ishii's Center for Global Commons with PIK demonstrated that energy transition alone cannot return humanity to the safe zone. Land use transition and circularity are also essential, yet even these three key transitions together would barely achieve the necessary restoration. The valuation and integration of natural capital into economic decision-making emerged as a critical missing

element. While nature has been appreciated, daily economic decisions by policymakers, businesses, and the financial system do not incorporate the value of natural capital. With improving data availability and monitoring technologies, the lack of data can no longer serve as an excuse for inaction. She hoped experts at the panel would share their insight on charting a pathway to valuing nature as economic capital, which is critical for a nature positive economy.

Dr. Peter Gluckman identified three fundamental challenges. First, Western societies face a crisis of short-term thinking, with political movements becoming increasingly transactional and unwilling to accept trade-offs for long-term benefits. Second, the Sustainable Development Goals (SDGs) have lost prominence in international policy compared to a decade ago. The geopolitical environment has changed dramatically, requiring science to adapt accordingly. Third, incorporating natural capital into public policy thinking is essential. While Gross Domestic Product (GDP) rewards externalities as growth products, alternative indices have not addressed sustainability concerns. Dr. Gluckman advocated for measures of sustainability within the System of National Accounts (SNA), possibly through a dashboard approach, as this would require global consensus to influence individual countries'

policy processes. Dr. Gluckman argued that science has failed to deliver progress on the SDGs despite substantial research over the past decade. The International Science Council (ISC) has identified barriers including siloed disciplines, lack of stakeholder engagement, and insufficient systems-based approaches. Without changing the research paradigm, more planetary boundaries will be crossed.

Dr. Guido Schmidt-Traub emphasized that current economic policies contradict both planetary science and core economic principles, which recognize natural capital and human capital as productive assets. However, when GDP was codified in 1946, methods for measuring natural capital did not exist. This creates perverse consequences, as businesses effectively price nature at zero in their decisions. Dr. Schmidt-Traub outlined his work with the Capitals Coalition, the Center for Global Commons, and the Landbanking Group, on practical steps for putting nature on the balance sheet through recognition of natural capital value in economic and financial decisions. Several building blocks have fallen into place, such as improved data availability through remote sensing. Nature-related risks are becoming macro-critical for countries and affecting profit and loss statements for companies, particularly in agri-food value chains.

Dr. Margaret Leinen noted that ocean scientists would argue the ocean planetary boundary was transgressed earlier than calculations indicated. She focused on challenges when activities occur beyond national jurisdictions, placing valuation and policy in the international realm. The ocean sits at the intersection of climate disruption and biodiversity loss,



with the entire ocean warming, which affects marine organisms, as do ocean acidification and deoxygenation from greenhouse gas (GHG) emissions. Overfishing drives diversity loss through direct species removal and ecological disruptions down the food chain. Two major blue economy sectors significantly impact our ability to have a nature-positive economy: marine transport and fisheries.

Prof. Mari Sundli Tveit emphasized that creating a nature-positive economy requires a systemic shift and global consensus. A nature-positive economy must operate within planetary boundaries, featuring sustainable and regenerative growth delivered through equitable partnerships. Transformation is needed in governance, business practices, and innovation approaches. This represents shared responsibility across countries and sectors, extending beyond circularity and net zero to nature-positive outcomes. Prof. Tveit shared examples from Norway, such as electric vehicle uptake. Targeted funding for battery technology, hydrogen, and carbon capture and storage has advanced promising solutions toward market readiness. Innovation encompasses not only technology but also people, skills, and adaptation capacity. Prof. Tveit outlined essential elements for accelerating transition toward a nature-positive economy: promoting circularity and recycling systems, establishing international regulations valuing nature and sustainability, creating policy frameworks making sustainability profitable and attractive for businesses, setting new standards that establish a level playing field, utilizing public procurement as a strategic tool, providing targeted funding and strong research systems, applying “do no significant harm” taxonomy throughout research and innovation systems, and fostering partnerships between governments and businesses.

Prof. Lee Howell examined innovation disruption frameworks, suggesting that nature finance could learn from climate finance and cryptocurrency finance. He acknowledged the fundamental tension between speculation driving cryptocurrency investment and the stewardship required for nature and climate. Nevertheless, he proposed five strategies adapted from cryptocurrency success: digitizing nature using technologies that can monitor specific locations and potentially create digital twins of important biomes; democratizing access beyond institutional investors to engage individuals, particularly students; gamifying impact to engage the next generation in this interdisciplinary and intergenerational problem; visualizing returns through real-time digital tracking accessible via mobile phones; and socializing the movement by creating communities of ecological investors who can connect and exchange information. Technologies must be arranged to serve higher purposes while engaging the next generation according to their behavioral patterns and financial interests.



Dr. Ahmad Tajuddin Ali stated that the world is at a critical juncture with planetary health in dangerous decline. Despite contrary statements from some figures, evidence indicates humanity is approaching a point of no return unless concerted action is taken globally. Systems must change to avoid transgressing into the danger zone. The challenge involves translating conversations into collaboration and collective action. Without fairness, the collective future will be bleak unless all nations contribute to addressing this global challenge. Malaysia has invested and sacrificed for sustainability over recent decades. The country's commitment to international climate pledges has been continuous and consistent, with a declaration to achieve net zero by 2050. Malaysia contributes only 0.6% of global GHG emissions, ranking between 28th and 32nd, while one-third of total emissions come from just two countries. While Malaysia fulfills its part, its solo impact remains limited given its small contribution. The burden and drive toward a nature-positive economy must be shared globally. Effective approaches require clarity of intent and predictability of outcomes with simple rules and pathways that firms can follow, including fast lanes for projects that reduce waste, restore nature, and lower costs for populations. Energy transition faces a trilemma balancing energy security, affordability, and sustainability. While energy security is paramount, public acceptance proves difficult without affordability, potentially pushing sustainability lower in priorities. Governments must address public opinion, as pressure on household budgets has intensified due to rising prices, potentially leading to unrest. Although widespread unrest has not occurred, general concerns exist among the working class. While acknowledging initial pessimism, Dr. Tajuddin expressed belief that discussions and deliberations at forums can lead to action and positive outcomes, potentially transforming the bleak future into something future generations will be proud to inherit.



Discussion

The floor was opened to comments and questions among the panelists.

Prof. Tveit noted that creating a nature-positive economy is inseparable from other global endeavors, as climate and nature are two sides of the same coin. Politicians need a better vision and narrative to sell to voters that does not sound like giving up the future. Society must shift from dystopia to discussing vision and even utopia.

Dr. Schmidt-Traub agreed that practical solutions exist but questioned why they are not being implemented more broadly. He cited degraded lands and land restoration as an example, with up to one-third of global farmlands severely degraded. The tools for restoration are known, with project-level returns up to eightfold and macroeconomic multipliers of 200 to 300%. Practical barriers include land tenure systems, data systems, and financing channels. He invited the group to seize such opportunities, as land restoration creates economic growth, better livelihoods, and resilience to future shocks.

Dr. Leinen agreed about the need for vision but emphasized demonstrating more value for individuals, communities, and states. Better storytelling about impacts on agriculture and food security is needed. The value proposition must show that, despite costs, there will be payback.

Dr. Gluckman cited the Montreal Protocol as a success because scientists found a solution acceptable to both consumers and businesses, with no perceived loss. Finding similar

solutions elsewhere is challenging. The squeezed middle class and poor need to see early benefits, requiring inventiveness. Alarmist politics does not help, and populist movements cannot be confronted directly without showing people an upside. Without focusing on the necessary social science, the world will remain stuck with populist, transactional economics, preventing planetary salvation.

Dr. Ishii reflected on being torn about convincing politicians and avoiding populism. From her Ministry of Finance background, she understood the difficulty of convincing ministers and getting people to pay taxes. Rather than asking consumers and taxpayers to pay out of pocket, she advocates fundamentally changing valuation so every price reflects the true value or cost of natural capital. While this may seem unreasonable, she believes it is the long-term goal. Science shows humanity is out of balance with natural systems because the current system does not value nature economically. In the Anthropocene, natural capital must be valued because facts have changed significantly, and the economic system must be updated. She hoped everyone could join this ambitious journey in their own areas to think about a better future for all and future generations.



Global impact of AI by 2030 and beyond -- Roadmap for the Next Decade

[Chair]

Meyerson, Bernard S., IBM Fellow, Chief Innovation Officer Emeritus, IBM Research, IBM Corporation; CEO, 4IRAdvisors LLC, U.S.A.

[Speakers]

Koh, Li-Na, Deputy Chief Executive Officer, National Environment Agency, Singapore

Ojokoh, Bolanle, Professor, Department of Information Systems, Federal University of Technology Akure, Nigeria

Zuber, Maria T., Presidential Advisor for Science and Technology Policy and E. A. Griswold Professor of Geophysics, Massachusetts Institute of Technology (MIT), U.S.A.

Bess, Lane, President and CEO, Deep Instinct, U.S.A.

Mital, Amit, CEO, Kernel Labs; Former Senior Director for Cybersecurity and Emerging Tech, National Security Council, The White House, U.S.A.

Opening Remarks

To introduce the session, Dr. Bernard S. Meyerson presented AI as one of the most challenging and urgent issues facing global society. He noted that many people consider it an existential threat to humankind. There are also concerns about flawed AI trained on flawed

data. In this relation, access to the right data and barriers to data-sharing are another issue. A trend towards deploying agentic AI, creating models of vastly reduced scale having been trained on finite and industry specific data, is a positive action addressing data volumes and quality. The scale of the displacement of human jobs by AI is another major concern, particularly given its primary impact on those of the least economic means.



Meyerson, Bernard S.

Humanity must pay attention to such foundational issues around AI and its utilization or it will do more harm than good. One foundational question is whether AI is intelligent.



Even if proven not “intelligent,” AI will remain a tremendously valuable tool in the hands of those fortunate enough to have access.

Ms. Li-Na Koh spoke about AI and climate change. She believed that AI is more light than shadow, as AI offers much hope. That said, there are clearly also shadows. The meteorological community is excited about AI. Its work relies on observations, models and human judgment, and some AI forecasting models have shown great promise. AI also offers great hope for various meteorological services.

To amplify the light of AI, it is necessary to be clear on what AI can or cannot do. In this regard, scientists play a key role in advising policymakers. Climate science is ripe for AI, and AI will be most effective if it is used to complement, rather than substitute, climate science.

A commonly mentioned downside of AI is that it is not universally accessible. While that is true, AI has also made climate science much more accessible. Stakeholders are excited about AI-based climate impact apps that seem to provide information to support decisions in responding to climate change. However, it is vital that scientists ensure stakeholders understand how AI works and its limitations. Partnership with the private sector is also important for maximizing the benefits for the people.

A key challenge now is to integrate the concept of AI in operations and let AI run alongside other forms of technology and the people in the same system. It is simultaneously critical to support people in developing the skills that will allow them to work in such AI-integrated operations.

Finally, society must apply artificial intelligence intelligently. For the global meteorological community, this means investing in shared and open data, developing coordinated open benchmarks, and practicing human-centered service design. This will ensure that AI tools are not only powerful but also transparent, interoperable, and tailored to the needs of diverse users.

Prof. Bolanle Ojokoh focused on the digital divide and began by pointing out that technological progress does not automatically translate into equitable progress. Addressing the gap between those who can effectively use digital technologies and those who cannot is one of the most pressing challenges today. The future of AI is not just about algorithms or innovation but access, capability, and inclusion.

The digital divide manifests in three key dimensions: access, usage, and quality. Many regions in the Global South face unreliable internet connectivity, unaffordable devices, and unstable electricity, creating an access divide. There is also a usage divide, as many people lack the “digital literacy” required to use such tools effectively. Meanwhile, a quality divide is emerging, reflecting disparities in the depth and effectiveness of digital engagement.

If unaddressed, the divide threatens to entrench existing global inequalities. It can widen economic inequality and educational disparities. Another issue is data dependency,





as countries that lack data infrastructure will have to rely on foreign-trained AI models. Furthermore, this could create an ethical imbalance, as AI systems developed elsewhere may not reflect local cultural values or social priorities. The digital divide thus risks evolving into an AI divide.

The world must seek to create a globally equitable AI system and prioritize bridging digital gaps. This begins with investment in foundational digital infrastructure such as broadband networks, data centers, and reliable electricity. Additionally, strong public-private partnerships are essential to expand access and accelerate innovation. The fostering of digital and AI literacy is also necessary. Moreover, nations should be empowered to develop data governance policies and, internationally, the world must establish multilateral AI governance frameworks.

Looking to 2030, the promise of AI must not be allowed to deepen inequality. Rather, the world must ensure that it serves as a bridge connecting people. The true measure of AI's global impact will be how inclusively it uplifts humanity.

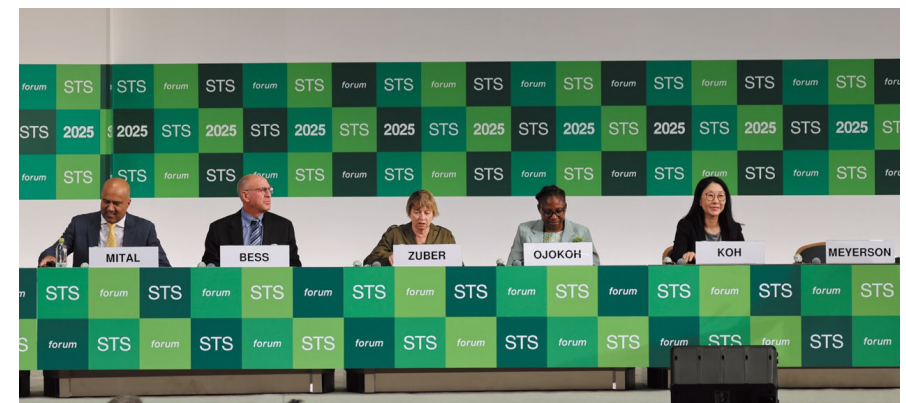
Prof. Maria T. Zuber presented on AI threats associated with state actors. AI leadership has become a critical component of international competition and cooperation. There has been

a shift in state behavior towards activities such as the use of AI for deepfakes, phishing, malware, dual use, and other detrimental purposes.

In response, governments are adapting technical, legal, diplomatic and industrial measures. AI regulation is occurring in various ways and the landscape will likely remain fragmented. Government-deployed AI will act as both a watchdog and gatekeeper. Some ways in which regulation would be valuable include risk-based regulatory frameworks, requiring the labeling of AI-generated or synthetic content, licensing and registration of models, and requirements for reporting safety incidents. Good AI governance will be shaped by cooperation and collaboration.

The world is seeing a shift from domestic regulation of AI to geopolitical AI governance, with countries treating powerful models and hardware as strategic technologies. The effectiveness of such governance will depend on closing loopholes, sustaining international cooperation, and managing the tension between open innovation and security-driven restrictions. There will be continued tensions between innovation and control, with different countries taking different approaches.

Mr. Lane Bess took up the topic of AI and security. He stressed that cyber-attacks pose an existential threat to the welfare of humanity and that AI has heightened this threat. Companies are still very slow in detecting the presence of a malicious attack and so face significant threats. Companies have valuable financial data, research data, and intellectual property that should be protected and this is the primary target of cyber attackers.





There are a number of areas that require particular focus toward and through 2030. The first is cybercrime as an industry. Dark AI has tipped the balance towards bad actors, with inexpensive tools and democratized access to malicious tools. Meanwhile, most companies lack deep cyber or AI expertise and increased security pressure on companies also leads to huge demand and rapid turnover of their chief security officers who might have this expertise.

AI will change and is changing workforces. The challenge for companies is how to manage that change. It is critical to educate workforces and enhance their cyber-awareness. Moreover, AI, like past technologies, is disrupting industries, but AI is affording companies far less time to react to this disruption. This will rapidly lead to winners and losers, with companies that weave AI deep into their operation pulling ahead quickly.

The shadows of AI can significantly damage businesses, universities, research facilities and governments. The only answer is to begin understanding and educating organizations, taking leadership and responsibility, and investing in people, knowledge, technologies and other necessary resources.

Mr. Amit Mital spoke about sovereign AI. He pointed out that the global pandemic and the various shortages that it resulted in taught the world a lesson on the critical nature of the

security and vulnerability of their supply chains, in other words, the importance of sovereignty. Some areas of sovereignty are non-negotiable, including food, energy, and security sovereignty. Obviously, AI sovereignty is of critical national importance as well.

AI sovereignty means that if a system is going to touch every citizen in a country, that country has to have control over the system, including transparency, visibility, and protection from hostile powers. There are several components to ensuring the sovereignty of AI systems: hardware, software, and data. They must be orchestrated together.

On the hardware side, data locality is required. Open source will also play a big role as it has the property of inspectability. However, with a small number of countries likely to provide the predominant open-source models, the challenge for other countries is to ensure these models behave in a way that is consistent with their laws and values. As for the data flowing in and out of AI models, they must have the appropriate encryption and security to preserve privacy and protect against attacks.

Most countries will have data locality requirements and AI locality requirements that will be under their jurisdiction. Open source will play a big part, but the resources available to most countries to inspect and ensure compliance is limited. It is crucial to establish the right governance layer and this layer must have a level of accountability, explainability, and auditability. It should also ensure that the aforementioned components are trustworthy.

AI has the opportunity to transform human life, but it also risks causing tremendous damage. Countries must have the right compliance, security architecture, and jurisdictional architecture to ensure that AI is run in a way that benefits everyone in society.

Q&A Session

Questions were then invited from the audience. First, a participant noted that it is not technology that changes the world, but its application. This is always the hard part. For example, the revolution in the automotive industry by Henry Ford was founded on the application of technologies developed in the industrial revolution, but only occurred around 100 years later. The participant





asked if society, many years into the future, will still be grappling with this challenge of application.

Mr. Bess noted that AI is moving far more quickly than the application of past technologies. Meanwhile, the public's understanding and learning are not keeping pace. There is a danger that this will put the advantage of using AI in the hands of a far smaller number of people.

Prof. Zuber pointed out that the industrial revolution dealt with hardware, while software, by its nature, moves much more quickly. She noted that knowledge and learning tend to move faster than wisdom, such as ethical considerations, and she considered this to be the real challenge.

Ms. Koh suggested two issues in application that would hinder the pace of the adoption of AI: humans' difficulty imagining the next dimension of AI's application, and the need for decisions to ultimately be made by humans, not AI.

Another participant asked why there is a need for AI sovereignty when the world does not have sovereignty for many other types of software.

Mr. Mital pointed out that only a small number of countries, potentially two, will likely have the capability to develop AI models. Countries will either have to make bets on alignment or ensure sovereignty. It would probably be politically unwise not to have sovereignty with such a critical system.



Closing Plenary Session: Science and Technology for the Future of Humankind

[Chair]

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

[Speakers]

EBRARD CASAUBÓN, Marcelo Luis, Secretary of Economy, Government of Mexico, Mexico

Screven, Edward, Member of the Board of Directors, Ampere Computing Holdings LLC, U.S.A.

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)]

Tan, Shu Ying, Senior Principal Analyst, myForesight, Malaysian Industry-Government Group for High Technology (MIGHT), Malaysia [Young Leader 2025]

Sievers, Mira, Professor, University of Hamburg, Germany [Young Leader 2025]

Pöttgen, Ruth, Member, Young Academy of Sweden; Senior Lecturer, Department of Physics, Lund University, Sweden [Young Leader 2025]

Komiyama, Hiroshi, Chairman, Science and Technology in Society *forum* (STS *forum*), Japan

Opening Remarks



Serageldin, Ismail

Dr. Ismail Serageldin began by reflecting on two events from 80 years ago: the creation of the United Nations in the pursuit of global peace and harmony, and the publication of *Science—The Endless Frontier*, which emphasized the importance of partnerships, openness, and science as drivers of progress and transformation. In these 80 years, major advances have been made that contribute to longer lives and higher quality of life.

However, there are also major problems. The cohesion demonstrated at the time of the adoption of the Millennium Development Goals in 2000 and subsequent international frameworks is now fraying. Global multilateralism,



solidarity and collaboration are under attack. Against this backdrop, the world is experiencing the greatest breakthrough in scientific history, with AI turbocharging research in unprecedented ways. This is a great moment in history, but also one with complex issues that require interdisciplinary collaboration.

Science operates within a framework that only functions properly when it is founded on a certain set of values that scientists themselves defend to the ultimate degree. These values are truth, honor, constructive subversiveness, openness, and civility. These values are essential not only for science but also for a humane society and must be upheld and protected through partnership across academia, business, and government. Actions must be guided by a framework of governance and ethics, with input from the public and private sectors. Furthermore, society must exercise wisdom when deploying science and technology (S&T) so as to appropriately handle its lights and shadows.



EBRARD CASAUBÓN, Marcelo Luis

Mr. Marcelo Luis Ebrard Casaubón expressed Mexico's strong commitment to the STS forum and spoke about Mexico's hosting of a meeting of the



STS forum in December 2025, to which it will invite all Latin American and Caribbean countries. Mexico is excited by the opportunity to boost S&T and connect with a new generation. Mexico values science and research, and has a burgeoning community of S&T researchers and educators. Furthermore, it believes in the power of connecting with other countries. As part of the STS forum, Mexico defends the values of science.

At the meeting of the STS forum that it will host, Mexico hopes to explore answers to important common issues, including water and climate change. It also aims to support the sharing of experiences and knowledge on topics such as smart cities, smart mobility, intelligent healthcare systems, sustainable agriculture, and accelerating innovation. Overall, it is hoped that the meeting of the STS forum in Mexico will result in the sharing of the best ideas and projects, bridge communities, and promote the values of science, including truth, freedom, and respect for each other.

Mr. Edward Screven opened his remarks by stating that there is no cognitive or intellectual task, including creative ones, that AI will not be able to perform better than the best human. The implications of this



Screven, Edward

include automated scientific discovery, personalized healthcare, and many other ways that can lead to greater quality of life. This is powerfully beneficial, but it also comes with serious challenges, as was the case with previous technological advances.

The fundamental problem of AI is not the technological aspects. Those are, of course, real problems, but they have conceivable solutions. Rather, the fundamental problem is that AI may result in many people no longer striving. As AI becomes more powerful and more deeply integrated in society, intellectual acts will be done faster and cheaper. AI coupled with robotics will solve physical problems as well. Human beings are fulfilled by accomplishment. Increased use of AI can lead to cognitive offloading, making people feel less fulfilled and less happy. Society needs to learn to use AI to enhance thinking, instead of using it to think for us. Schools at every level must also adapt to the emerging reality of AI and help students become critical thinkers in partnership with AI, rather than in spite of it.

Prof. Ada E. Yonath spoke about her own scientific endeavors over the past 50 years. She explained that her research has focused on ribosomes, which are the cellular machinery that produces proteins, and particularly their structure, which was previously considered impossible to study. Her research revealed not only ribosomes' structure and function, but also yielded many discoveries and innovations and a better understanding of protein synthesis. These discoveries have been applied in areas such as better antibiotics. It is important to remember that such basic research forms the basis of most advances in human lives.

Prof. Yonath also noted the emergence of powerful AI tools, such as AlphaFold, which



Yonath, Ada E.

enables the prediction of protein structures. While it is difficult to predict how AI will impact scientific research, some basic facts will remain even in the AI era, such as the need for actual research in biological systems to test theories before they are implemented in living organisms. Moreover, it is critical to recognize that curiosity and research will remain essential to improving people's lives.

Dr. Tan Shu Ying shared her reflections as an STS *forum* Young Leader. She emphasized that she and other Young Leaders had been inspired and energized by the program and expressed her gratitude

for the opportunity to engage directly with distinguished experts in the global scientific community.

Dr. Tan reflected on the lights and shadows of technology, expressing both excitement about its potential and caution about its far-reaching impacts on economies, the environment, and society. She highlighted the importance of anticipating multiple plausible futures, not merely the one we desire.

Dr. Tan said that one question guided her reflections on the topic of AI in 2030 and beyond: Are we using AI, or is AI using us? Moreover, as we pursue artificial general intelligence and super intelligence, will the relationship between AI and humanity continue to be symbiotic or parasitic?

Dr. Tan contrasted the optimism of younger participants about AI's applications with the caution of more seasoned experts who focused on risks and vulnerabilities, arguing that progress requires both the courage to build and the wisdom to brace. She called for standards and guardrails, warned of an emerging "AI poverty line," and asked the community to consider second- and third-order consequences to avoid future regret, so that by 2030, AI reflects bold discovery, careful deployment, and fairness.

Prof. Mira Sievers shared her takeaways from the discussions during AI and the Future University: Strategic Leadership, Culture, Diversity and Global Equity. AI is essential for the future development of universities, but the question is how to make sure it happens and that it happens responsibly. The application of AI should be focused on maximizing human potential rather than just achieving efficiency. Responsibility, transparency, and fairness should serve as guiding principles. It is promising that many institutions speak about having ethical foundations as guidance for when they are implementing strategies for AI.



Tan, Shu Ying



Sievers, Mira

A second major theme from the discussions was cultural and linguistic diversity. Most generative AI models are based on English, which poses a problem when trying to include and integrate all cultures in the system. Concrete initiatives are needed to protect diversity and many examples have been discussed at the STS *forum*. Protecting diversity also means protecting heritage, including languages. The AI agenda has largely been influenced by industry, and universities should balance this with ethics education and coaching on responsible AI use.

In addition, Prof. Sievers emphasized the need to be more concrete. The Young Leaders noted that there is strong consensus on values and objectives, but that it is not clear how to implement them. Practical questions are crucial and strategies must be developed for these ideas to actually be realized.

Dr. Ruth Pöttgen shared her impressions of participating in the STS *forum*. She welcomed the great advancements being made in S&T for the benefit of humankind, while noting the difficulty to implement them in practice. Dr. Pöttgen also noted the need for additional input from social sciences and humanities on major issues taken up by the STS *forum*.

Dr. Pöttgen commended the inclusive format of the meeting and the proactive participation of attendees. Furthermore, the opportunity for Young Leaders to interact with Nobel Laureates was particularly rewarding. The history of Nobel Prizes and the research they involve show that risk-taking, curiosity, and failure are fundamental to science, which was a point that was echoed in many sessions.



Pöttgen, Ruth

Finally, Dr. Pöttgen expressed her hope that meetings like the STS *forum* will make a difference. She also thanked the organizers and participants for very interesting and fruitful discussions.

Dr. Serageldin then presented the Chairman's Statement. The statement highlighted the outcomes from this year's Annual Meeting across themes such as the need for global collaboration and action; the transformative impacts of AI in fields such as health, public administration, and education; sustainability challenges and potential ways forward; challenges

and opportunities for S&T itself; science policy, communication, and diplomacy; and strengthening resilience in the global science system.

Closing Remarks

Prof. Hiroshi Komiyama expressed his great love for the STS *forum* as the Annual Meeting and participants always fill him with optimism and hope. He thanked the participants for their attendance and looked forward to seeing them again at the 23rd Annual Meeting, which will be held from October 4 to October 6, 2026.



Komiyama, Hiroshi





Concurrent Sessions



AI in Healthcare Diagnostics, Physicians and Patients

[Chair]

Zerhouni, Elias Adam, Professor Emeritus, Radiology and biomedical engineering, Johns Hopkins University; former Director, National Institutes of Health (NIH), U.S.A.

[Speakers]

Herzhoﬀ, Jan, President, Elsevier Health, Elsevier, U.S.A.

Tian, Mei, Dean, Human Phenome Institute, Fudan University, China

Lovis, Christian, Director, division of Medical Information Sciences, Diagnostic department, University Hospitals of Geneva (HUG); Professor and Director, “Genomics and digital health” track of the doctoral school in Life Sciences, University of Geneva (UNIGE), Switzerland

Wiestler, Otmar D., President, Helmholtz Association of German Research Centres, Germany

Bielecki, Michel, Co-founder & CEO, illumice ll AI, U.S.A.; Researcher, Epidemiology Biostatistics and Prevention Institute, University of Zurich, Switzerland

Opening Remarks

The chair outlined the theme of the session, expressing that AI is revolutionizing healthcare across academia, government, and industry. He introduced some potential topics of discussion, such as the impact of AI on imaging technologies, productivity gains for clinicians, and the discovery of new therapies, focusing on the need for international collaboration, better education and careful evaluation of impacts.



Zerhouni, Elias Adam

The speakers first considered Elsevier’s Clinician of the Future report, a survey on clinicians’ attitudes towards AI. It showed that clinicians globally have already started to use AI tools, they want transparency, security and assurance of the underlying content, and more than two-thirds of clinicians globally feel they are left alone by their organizations without support and guidance on how to apply these tools. Current and future clinicians are excited about AI but need to be prepared with critical skills and training. Trust-based design, transparency and high-quality content are also critical.

The speakers then spoke about AI in translating pathology to imaging and vice-versa. Many exciting advances have occurred in recent years, and the two fields will surely become inseparably integrated going forward. In the future, it will likely be possible to combine AI-assisted imaging analysis with a variety of other diagnostic tools for clinical manifestations. To prepare for this, it will be necessary to develop new transformers and new large language models (LLMs) to conduct new investigations, which will also require physicians to play a safeguard-like role.

Next, the speakers discussed the need to distinguish between the science of AI and the recent emergence of new instruments in this science that demonstrate new powerful properties. Some of these new AI instruments deserve more scientific attention, as they produce non-reproducible results with similar inputs and algorithms. They must be used with caution and education, as these new instruments have no intention, no internal values, of good or bad. Much of their power resides thus on how they are used and for which intention. AI is a very good multiplier of human intelligence but is not an augments of it. As long as the goal is to help and cure humans, intelligence is to be used with shared intentions and values, and still, this will need to be done by other humans.

Another topic was the key role of information, data science, and AI-based data management in recent remarkable developments in biomedicine. Exciting possibilities include real digital transformation in biomedical research and medical practice, the transition to more preventive medicine, and AI-based disease management and monitoring treatment. To capitalize on them, there is a need for high quality data that are validated, standardized, and anonymized, reconsideration of data protection rules, enormous computing power, and new strategic alliances across different stakeholders.

Lastly, the speakers considered the dangers of the use of LLMs in medical care. LLMs’ auto-completion in medicine is very dangerous. The current approach to LLMs of trial and error is also inappropriate for medicine. There needs to be a common foundation of AI literacy in the medical field. This needs to start with labeling of datasets and those with the requisite expertise have the responsibility to peer annotate for LLMs. If the experts do not establish the standards, someone else, who may not be qualified, will.

Discussion

A group discussion was subsequently held. A major topic of discussion was the current status of AI tools and their future potential. Many AI tools are already being applied and



having great impacts. The ability of generative AI tools, however, is likely overstated. They do not provide reproducibility or explainability. Furthermore, they rely on information from scientific publications but do not reflect the fact that science is an iterative process of trial, error and retrial. That said, the science of AI is in a great state, with global attention resulting in support for its continued progress.

The participants noted that there is no generalist model that can be applied in general to healthcare. Just as medicine is divided into populations of humans with specific conditions and health determinants, but also values, needs and expectations; and places with specific resources; there will need to be specialized AI models that have been developed and trained on these natural biases. There will also need to be adequate quality assurance and control, because decision makers, care professionals and patients will not trust and invest in a system otherwise.

A major challenge in harnessing AI further is the handling of complex clinical data. Diseases are usually based on complex processes and complex interactions in individual patients and individual health determinants. These complex data sets can only be adequately handled and analyzed by next-generation data analysis. This requires training based on large training datasets, but the current quality of data is a real problem.

The participants then turned to data protections. It was pointed out that medical data protection may be overemphasized by some societies. Of course, sensitive data should be treated carefully and patients' privacy should be protected, but overly stringent measures can hinder further advances in AI tools for medical use. New technical and regulatory paradigms are needed to allow the progress of AI science and technologies in the field of health without compromising citizens' privacy protection.

The participants also considered whether AI would make the jobs of radiologists and technologists redundant. They noted that life science is a science marked by disruptive revolutions occurring over a century, from genetics to microbiomes and immunology, to quote just a few. Health professionals have been embracing these revolutions, which has contributed to creating even more specialized experts.

Another subject was medical and paramedical education and ensuring effective appropriate application of AI. Participants noted the need to recognize that citizens, patients, health students and professionals are already and increasingly using AI tools, and most specifically generative AI, for many purposes. Educators need to ensure students go beyond that to spark their curiosity and develop their critical thinking. This education must be provided to as many people as possible, starting as early as possible. This will prepare



people for real-world medicine, such as finding information, promoting autonomy, seeking evidence, advice and decision-support, finding the better therapeutic approach, and understanding the potential outcomes.

The participants then discussed the long timeline from basic research to patient outcomes, and noted the possibility of AI tools, such as large vector-based searches, accelerating the delivery of information to point-of-care clinicians. For that, it will be essential to have trust markers throughout the journey of a piece of information, making clear where information comes from, and what the different views on the subject might be.

Finally, the participants considered the topic of trust and the question of whether AI in medicine will increase or decrease society's confidence in medical science. Some participants believed that, at least in the short-term, it poses a significant risk to public trust. Quality assurance and quality control of AI in medicine will be crucial. Greater literacy in AI and in science is also needed. The point was also made that, historically, medicine has been abused by malign actors, long before the advent of AI.

AI in Healthcare Research

[Chair]

Donati, Daria, Chief Scientific Officer, Genomic Medicine, Cytiva, Sweden

[Speakers]

De-ong, Wiparat, Executive Director, National Research Council of Thailand (NRCT), Thailand

Harel, David, President, Israel Academy of Sciences and Humanities; Institute Professor, Computer Science and Applied Mathematics, The Weizmann Institute of Science, Israel

Flores Bueso, Yensi, Co-Chair, Global Young Academy, Germany; Marie Curie Postdoctoral Fellow, University College Cork, Institute for Protein Design, Ireland

Tayi, Alok, Co-Founder and CEO, Vibe Bio, U.S.A.

di Luccio, Eric, Director, Chief Technology Officer, Research & Development, HIROTSU BIO SCIENCE INC., Japan

Yatomi-Clarke, Steven, CEO, Aurora Biosynthetics, Australia

Svelto, Francesco, Vice President, National Research Council of Italy (CNR); Rector, University of Pavia, Italy

Liu, Pengtao, Professor, School of Biomedical Sciences, University of Hong Kong; Managing Director, Centre for Translational Stem Cell Biology, Hong Kong

Ekgasit, Sanong, Academic Advisory Committee, National Research Council of Thailand; Lecturer, Chulalongkorn University, Thailand



Donati, Daria

Opening Remarks

The chair spoke about the impact of AI in the biopharma industry. The biggest challenge is scaling from lab to large-scale production. AI tools have turbocharged innovation and drastically reduced research timelines. Digital twins enable simulation and prediction to ensure quality and yields. However, integrating AI in biopharma is not just a technical matter but also a cultural and regulatory one. There is a need for transparent, interpretable models for regulated environments and collaboration across technologists, clinicians, regulators,

and manufacturers. It is also necessary to ensure adequate preparation for the darker sides and challenges of AI in healthcare.

The speakers first discussed Thailand's approach to leveraging AI for healthcare. Thai society is aging and healthcare costs account for an ever-greater share of household spending. AI can help in many ways, such as more accurately detecting certain cancers or supporting access to remote communities. Such innovation needs collaboration and sustained commitment. Thailand is advancing AI-enabled care, while ensuring ethical standards and compassion, to empower people to lead healthier, longer, and more satisfying lives.

Next, the speakers talked about the promise and risks of AI. People need to be aware of its serious limitations and challenges. Its black-box nature poses two major issues that are not close to being solved, namely the lack of explainability and verifiability. In healthcare, the best solution may be an apprentice approach, where AI is part of the team making decisions but there is always a human supervising and making the final decisions.

Next, the speakers took up the role of AI in early phases of development, introducing the importance of AI-driven protein design. A protein's shape is critical to its function, but uncovering this was previously very difficult, limiting advances in research. This changed with the application of deep neural networks. AlphaFold enables prediction of a protein's structure, while generative AI models, like RoseTTAFold Diffusion, enable design of stable, purpose-built proteins and accelerated pipelines for design and development. Combined with open science principles, this can close the global gap in biotechnology access.

The speakers proceeded to discuss three grand challenges for the future of AI in healthcare. These must be tackled with fundamental efforts to unleash AI's full potential in drug discovery. First, disease is fundamentally fragmented. Second, AI is trained on the data we have, which is inherently flawed, not the data we need. Third, psychology is AI's biggest weakness, as fear causes societal hesitation and hinders progress.

Then, the speakers turned to the use of AI in the research and development of cancer-related biomarker screening and pattern discovery from noisy biological signals. The aim would be to develop a high-performance test at a low cost for everyone on the planet. However, there is also the issue of AI's black box nature. In healthcare, explainability is a must, not a luxury. Nevertheless, access to such AI-driven tools can democratize healthcare access and narrow global disparities in health.



Another subject was AI applications across different complexity levels in healthcare research. For drug discovery, there is significant opportunity in target identification for complex, multifactorial diseases. AI and mRNA technologies have also helped dramatically reduce drug development timelines. AI also offers decision-support systems for diagnostics and patient empowerment tools. In addition, there are opportunities in clinical trial optimization and regulatory pathway navigation. Policymakers should encourage interdisciplinary collaboration, invest in annotation standardization, and develop policy for access to annotated databases.

The speakers also noted that besides research, AI has also supported improvements in clinical practice and hospital management. They then considered some critical questions for AI healthcare development. These included whether to pursue centralized or distributed data governance approaches, the balance between private-sector and public-sector-driven AI healthcare development, validation, and monitoring of large language models in clinical contexts, bridging the knowledge gap between clinicians and AI developers, and determining optimal regulatory frameworks.

Following this, the speakers considered the use of AI in antiaging and antiviral research. Researchers are using a novel placental-like stem cell platform to develop known

antiaging compounds and identify new models for inhibiting or reversing the aging process. Researchers are also using such platforms to evaluate existing antiviral treatments and identify new antiviral candidates. AI supports and accelerates such research. However, AI has limitations that must be addressed and supplemented with experimental data and ground-truthing.

In addition, the speakers considered Thailand's approach to supporting AI-related research projects and translating them into solutions for society. Thailand is committed to advancing excellence in research and encouraging meaningful outcomes across wide-ranging fields, including medical research. It has implemented an AI-supported grant evaluation system that combines AI-generated assessments with human expert review. Thailand is also supporting the development of AI practitioners.

Discussion

In the group discussion, the participants first discussed data. Data quality is a limiting factor in deploying better AI tools. Some datasets are well curated while others are not. However, not only databases, but also the corresponding code needs to be well curated and annotated. The inherent bias of published clinical data towards positive results is also an issue. Data access and data sharing are other related challenges.



This prompted the participants to wonder whether AI could itself offer some solutions for data control. They considered possibilities such as the use of AI tools to identify inadequacies in data used for learning models, or ways in which AI might be able to make up for inherent biases in such data, in summary, AI checking on AI-generated models and their data inputs.

The participants then considered challenges encountered by companies and institutions on AI implementation. The bottleneck is not lack of innovation, rather the appropriate prioritization of the best tool for the most appropriate process, given resources and funding limitations. Issues such as challenges in data access created by ownership (clinical, manufacturing data, etc.), and lack of AI understanding from the regulatory bodies in the medical field, as much as the lack of the spread of AI literacy through organizations and industry, are contributors to the lack of implementation.

The participants therefore wondered how to increase AI literacy and develop people's AI capabilities. They suggested collaborative efforts between academia and industry. They also noted the value of good expositions by AI experts that fully convey its depths, limitations, and possibilities.

AI in Healthcare Global Health

[Chair]

Hu, Jianying, IBM Fellow; Director, HCLS Research; Global Science Leader, AI for Healthcare, IBM, U.S.A.

[Speakers]

Varmus, Harold E., Professor of Medicine, Medicine, Weill Cornell Medical College, U.S.A.; Chair, Science Council, World Health Organization [Nobel Laureate 1989 (Physiology or Medicine)]

Gitau, Evelyn, Chief Scientific Officer, Science for Africa Foundation (SFA Foundation), Kenya

Nurse, Paul, Honorary Life President, The Francis Crick Institute, U.K. [Nobel Laureate 2001 (Physiology or Medicine)]

Ip, Nancy Y., President, The Hong Kong University of Science and Technology (HKUST), Hong Kong

Nakagama, Hitoshi, President, Japan Agency for Medical Research and Development (AMED), Japan

Levi, Marcel, President Executive Board, Dutch Research Council (NWO), Netherlands

Collins, Mary, Blizard Institute Director, Professor of Virology, Queen Mary University of London, U.K.

Drake, Michael V., President Emeritus, University of California, U.S.A.



Hu, Jianying

Opening Remarks

The chair pointed out that the world faces unprecedented challenges that demand urgent action, such as persistent inequalities and fragile health systems in less developed regions. This is compounded by geopolitical instability. Advances in science and technology, particularly in AI, hold transformative potential, such as health system optimization and expanded access to high quality care. However, these technologies also bring risks, such as algorithmic biases and potential exclusion of less technologically equipped

communities. The world needs innovative solutions for global health that are scalable and equitable, and that requires collaboration.

Following this, the speakers discussed the World Health Organization (WHO) Science Council's report on digital health, which highlighted the importance of interoperable systems, instruction by informatics experts in education, investment in digital infrastructure, and evaluation of ongoing work. WHO has suggested that digital tools could be critical in raising healthcare standards in middle and low-income countries. The speakers also discussed international collaborative efforts to tackle localized health issues. Concern was also raised about major countries potentially ending funding for such international collaborations and the WHO's work.

Next, the speakers discussed AI in African healthcare. AI could close or widen existing disparities and must be regulated by rules that ensure equity, fairness, and transparency, while still enabling innovation. Africa is applying AI in various aspects of healthcare, such as diagnostics. It is also enhancing data collection and seeking to integrate local large-scale population and genomic data. Moreover, AI can enable more inclusive clinical trial design.



These examples illustrate AI's tremendous potential when it is rooted in local priorities and backed by strong, diverse data.

The speakers then looked at AI's contribution to biomedical research, which forms the foundation of global health. Conventional AI is already enhancing data analysis, with AlphaFold being a particularly successful example. The next step will be harder. Understanding biology involves understanding complex systems. These have increasingly been described in great detail. The challenge is to generate AI approaches that can turn chemical and physical descriptions into knowledge and understanding. The key may be to break these systems into constituent components, then first apply the creativity of the human brain, before applying computational techniques.

Other cutting-edge AI developments were also discussed including AI-powered non-invasive monitoring of motor systems and vital signs. These tools are not only improving diagnostics but also driving the shift from reactive to proactive and preventive healthcare. By detecting early warning signs of diseases, AI can help reduce the burden of diseases, particularly in underserved communities. AI models are also enhancing the speed and accuracy of detecting certain cancers, while the world's smallest multifunctional surgical robot represents another development milestone. While AI holds immense potential, urgent challenges remain, such as ensuring equitable implementation and safeguarding privacy. Three principles are key: equity, collaboration, and ethics and transparency.

The speakers then spoke about Japan's programs to support global health. Japan's Science and Technology Research Partnership for Sustainable Development (SATREPS) research projects address infectious disease and other issues in low and middle-income countries. The e-ASIA Joint Research Program aims to foster a collaborative research community in the region. Japan is supporting four key areas of AI's application in health: AI-driven drug discovery, health and medical data infrastructure, AI-based medical devices, and robotics for elderly care.

Next, the speakers highlighted three areas where AI, healthcare and global health are promising and have a proven track record: diagnostics and screening, public health monitoring, and optimization of public health systems. They also discussed global inequity. It was suggested that the issue may not be about sharing costs but actually about preventing excessive profits. There is also a need to consider protecting AI-related intellectual property differently to that in other medical fields.

Some examples of on-the-ground solutions to local problems in rural Zimbabwe were considered. Research is being done to develop and test interventions during pregnancy to increase newborns' birthweight. Another project involves using magnetic resonance imaging (MRI) and electroencephalography to evaluate the brain structure of children. Because of the erratic local power supply, researchers developed the world's first solar-powered MRI machine, also putting it on wheels to enable portability. Efforts are also being made to build local human capacity, including in data analysis, which currently has to be conducted abroad.

The speakers then talked about AI's support for clinicians, including boosting speed and accuracy, and even sometimes prompting physicians to be more empathetic. However, there are obviously also risks, such as the dangers of AI trained on biased or dishonest environments. The speakers also highlighted the art of medicine, which is the care or human element, and its ability to elevate the quality of healthcare. Finally, they noted the importance of ensuring that AI is equitable and responsible and the need for participation by all stakeholders to make that possible.



Discussion

In the group discussion, the participants discussed the importance of trust in institutions for advancing the application of AI in healthcare. They also noted the need to share the benefits equitably. Furthermore, it must be remembered that the majority of people in the world do not have access to AI or the resources to collect the necessary data. There is a need to consider support for such nations, such as through education and infrastructure.

The participants then spoke about the need for high-quality data to train models effectively. This requires standardized data collection, as well as open access and open benchmarking data and frameworks. Additionally, it may be worthwhile to create synthetic data by creating mathematical representations of data from clinical trials, and these data could be used for training models as well.

Regulatory frameworks were also addressed. The participants discussed the problem of excessive regulation and the need for a framework that increases but also decreases regulation as needed. A harmonized regulatory system could promote innovation and affordability. At the same time, global health encompasses more than medicine, and regulation of the use of AI for other elements, such as nutrition and standard of care, is not currently adequately developed.

In addition, participants touched on topics such as the potential for AI to exacerbate the mental health crisis, restoring trust in science, AI for patient empowerment, and the use of AI to augment healthcare providers.

AI in Business

Job Elimination and Creation / Retraining

[Chair]

Blanco Mendoza, Herminio, President, IQOM Inteligencia Comercial; former Minister of Trade and Industry, Mexico

[Speakers]

McKinnell, Henry A., Chairman, North American Associates of the STS *forum*; former Chairman/CEO, Pfizer, U.S.A.

Ijabs, Ivars, MEP, STOA Vice-Chair, European Parliament, EU

Gather, Ursula, Chair of the Board, Alfried Krupp von Bohlen und Halbach Foundation, Germany

Dekel, Amnon, Executive Director, The Center for Innovation and Entrepreneurship, Hebrew University Jerusalem, Israel

Mpedi, Letlhokwa, Vice-Chancellor & Principal, Management Executive Committee Member, Vice-Chancellor's office, University of Johannesburg (UJ), South Africa

Opening Remarks

The chair opened the session by noting that AI is clearly having an impact on employment, but different studies present slightly different conclusions. AI is particularly affecting entry-level positions across various sectors and reducing roles performing low-level analytical work that can be substituted by AI. Essentially, simple work is being eliminated, but in many cases, these are not particularly interesting jobs, and some retraining will be required to give workers the skills for better, more interesting jobs. Meanwhile, computer engineering positions are also being affected as AI platforms can now generate code and solve programming problems. There too the question is what they will do to retrain.



Blanco Mendoza, Herminio

The speakers then pointed out that what we describe as AI and our use of it has changed significantly over the past few years, particularly with the development of agentic models.

AI will inevitably change our lives in the long-term, and the timeline for change will likely be very uneven, with some areas changing already, while others will take much longer. After the industrial revolution and the IT revolution, it took many years for practical applications to be developed, and the full benefits realized. Despite short-term pain, there will be long-term gain as a natural consequence of free markets.

Next, the speakers discussed the need for regulatory frameworks to help society adapt to technological changes in a humane manner, pointing out the recently adopted European AI Act and ongoing Japanese AI legislation efforts. The speakers noted that there are competitive advantages for those who learn to work with AI tools while maintaining the necessary human oversight to deal with AI's propensity for mistakes. Proposed policy solutions included basic AI literacy education, addressing potential increases in social inequality from productivity gains, and determining which fundamental skills should be maintained despite AI capabilities. The speakers stressed the importance of international cooperation in developing consensus on educational standards and warned against over-delegation of critical skills to AI systems.

The speakers also discussed the impact of AI adoption on young academics and entry-level positions in knowledge-intensive sectors, citing research that shows companies increasingly prefer senior staff, eliminating some roles that provided learning opportunities for junior professionals. The speakers argued that profound scientific understanding of fundamental principles will protect against job displacement and facilitate adaptation to more demanding tasks. They emphasized that AI complements rather than simply substitutes qualified work, making expertise, judgment, and contextual awareness increasingly valuable. Universities must therefore focus on teaching not just technical skills but solid grounding in scientific principles and contextual understanding, enabling students to leverage AI as a tool rather than fear replacement.

The speakers then considered the validity of the optimism expressed around AI regarding potential for business growth. They emphasized that successful AI integration requires proper implementation, training, and navigation rather than simply providing access to AI tools. The speakers noted that AI, being trained on human data, will inevitably make mistakes, and argued that hallucinations should be preserved as the basis of creativity. They warned that both junior and senior positions face displacement risks, with seniors being expensive and potentially annoying to organizations. Looking toward artificial general intelligence and potential artificial superintelligence, they stressed the need for ethical frameworks that



balance capitalistic incentives with societal protection, ensuring AI serves humanity while remaining economically viable.

Finally, the speakers considered the developing country perspective, where unemployment may already be extremely high, highlighting the dual challenge of creating jobs while also preparing existing workers for technological change. The speakers described university initiatives, such as disruptive technology for construction of low-cost housing, initially met with resistance due to concerns about job displacement, which gained acceptance due to new opportunities created. However, the speakers emphasized the critical need for greater educational access and argued that AI discussions cannot be divorced from broader socio-economic contexts, calling for policies addressing both retraining and exclusionary barriers, ensuring AI benefits are broadly shared rather than concentrated among privileged groups.

Discussion

Following the opening remarks, the participants held a group discussion. They first spoke about how perspectives on job creation versus job destruction vary significantly by context and generation. It was noted that in countries like Switzerland and Japan more jobs are being created than there are available workers, while the situation differs greatly in the Global South. The discussion also highlighted a generational gap, with younger people

viewing AI as simply a tool, while older generations approach it with more concern. The participants also emphasized that AI could help engineers be more productive, reducing overtime, and improving work-life balance.

Next, the participants addressed the immediate reality of AI's impact on employment, with a CEO acknowledging that AI is already reducing hiring needs. They distinguished between training new employees and retraining existing senior staff whose roles are being disrupted by AI. The discussion centered on responsibility for retraining efforts, questioning whether companies, individuals, or governments should lead these initiatives. Participants noted that solutions must be country-specific, as AI's impact varies dramatically between contexts - for example, freeing time in overworked societies like Japan could improve mental health, while in societies with existing high unemployment, additional free time might lead to social problems.

The participants then turned to education and the integration of learning models in the AI era. They discussed experiences from German industry apprenticeship systems and Italian programs that combine traditional education with hands-on learning and digital components. Participants also examined the quality of newly created jobs, particularly in

developing countries, and how the transformation timeline - whether short-term or long-term - affects the ability to implement solutions. They stressed the importance of AI literacy while recognizing that challenges vary significantly between countries.

Finally, the participants explored human-centered approaches to AI integration, highlighting cultural differences in robot perception, contrasting the Western mindset of fearing robots with the warm feelings toward robots of the Eastern mindset, pointing out that the word "ai" in Japanese means "love," and citing the Japanese fictional character Doraemon as a very human and eccentric robot figure. The participants emphasized the importance of human skills, being more customer-centered and community-centered rather than bureaucratic, and creating safe environments for reskilling. The discussion concluded with an emphasis on maintaining curiosity, lifelong learning, and shifting mindsets to embrace change, while noting that the biggest challenge often lies in overcoming personal resistance to adaptation.



AI in Business Opportunities

[Chair]

Cortell, Jorge, Executive Director, Technology Exchange and Collaboration Hub (TECH) Tokyo, Japan

[Speakers]

Kasmi, Chaouki, Chief Innovation Officer, CIO Office, Technology Innovation Institute, U.A.E.

Kuai, Charles, Founder, K2 Intelligence Ventures, Singapore

Sadikova, Jeyla, Co-founder & Chief Operating Officer, illumicell AI, U.S.A.

Sinha, Gunjan, Chairman, OpenGrowth Ventures; Executive Chairman, Metricstream, U.S.A.

Stephen, Craig, Executive Vice President, Research & Development, Oracle Corporation, U.S.A.

Zhang, Ivan, Co-Founder, Cohere, Canada

Opening Remarks

The chair opened by emphasizing the session's focus on opportunities in artificial intelligence rather than challenges or risks. He noted that while AI is often perceived as revolutionary, it represents an enabling technology similar to electricity, which transformed society without constant reference to its presence. He observed that recently every new project is "AI for" something, emphasizing that the focus should be on the "for" part rather than the AI component. The chair advocated for an exponential rather than incremental approach

to AI adoption, starting with ambitious end goals rather than small productivity gains, and suggested asking young people about their desired future since they stand to benefit the most from AI developments.

The speakers then discussed streamlining AI adoption and identifying scalable use cases to avoid falling into the "valley of death" between research and practical implementation, and also emphasized the importance of bridging the gap between academic research and industrial applications in AI development.



Cortell, Jorge

The speakers then identified four key opportunity areas for AI: extending human life through healthcare innovations including human replaceable body parts, improving happiness through personalized education and purpose-driven applications, providing entertainment by enabling everyone to write their story, and promoting further organizational transformation incorporating male, female, and machine components. The speakers emphasized thinking about customers first rather than technology, implementing deep customization at scale, and managing data effectively as the foundation for AI success.

Next, the speakers considered the nature of true intelligence, noting how humans learn, relying heavily on context, emotion, and connection, not just data. They also noted that typically successful AI implementations in established corporations involve partnerships with AI-first startups, rather than internal transformation. The speakers outlined three pillars for AI adoption: inputs, systems, and enablers. Inputs require diverse, standardized, and clean data; systems need scalable, modular, and interoperable infrastructure; and enablers require cultural change where employees understand data flows and decision-making processes. The speakers emphasized that success with AI requires organizational effort across the entire business rather than isolated AI teams.

The speakers then discussed the parallels that could be drawn between current AI opportunities and the early internet era, where successes came from innovations that were



practical, usable, and valuable to the society. They cited a recent study in collaboration with MIT that showed that 95% of AI implementation projects fail, and highlighted key areas for success including the concept of an open agentic web not controlled by a few tech companies, democratization and decentralization of AI to turn users into creators rather than just consumers, governance of AI ensuring human control over the technology, and energy infrastructure supporting AI data centers with environmentally sustainable solutions.

The speakers also addressed data ownership and control issues, particularly focusing on the hallucination problem in large language models as a mathematically fundamental and unavoidable issue where there is insufficient access to data. They proposed collaboration between LLM vendors, infrastructure providers, enterprise software companies, and customers to develop new models for control, ownership, and economic incentives around data usage, and also emphasized recognizing the value of business data and working together to understand the economics and intellectual property implications of AI implementation.

Finally, the speakers discussed practical use cases and challenges in adopting agentic AI. They pointed out that a great opportunity for AI is to augment our human abilities to pay attention to all the relevant data in an organization and capitalize on it during business activities. The speakers also shared insights on the five stages of AI adoption: experimentation, departmental deployment, enterprise AI teams, comprehensive enterprise deployment, and optimization. They noted that successful agentic AI implementation requires AI readiness including digitized assets, internal AI centers of excellence, and the ability to connect LLMs to business contexts. The speakers contrasted hospitals, where closed systems make AI integration difficult, with banks, which have the technology infrastructure and competitive pressure to successfully adopt AI solutions.

Discussion

Following the opening remarks, the participants engaged in a group discussion. They began by exploring fundamental questions about why AI technology is adopted and examining specific technological implementation challenges. The conversation addressed the balance between pursuing return on investment versus allowing ROI to follow naturally from well-built solutions, with particular attention to how Japanese corporations prioritize citizen and user welfare beyond mere profit motives. The discussion also examined integrated business planning and the competitive advantages of truly knowing customers, while addressing



intellectual property considerations including recent legal settlements and whether AI development should follow closed or open models for training and deployment.

The participants then examined data standardization and application challenges in AI implementation. The discussion highlighted examples of companies with decades of valuable data seeking ways to leverage this wealth of knowledge for improved business operations and customer experiences in the modern era. Participants raised important questions about ethics and morality in both data sourcing and model applications, emphasizing the need to consider end users since AI serves as a tool for improving lives and society. The conversation addressed resistance to AI adoption in academic and corporate settings due to job displacement concerns, reinforcing the importance of cultural understanding that AI can enhance rather than simply replace human performance.

The participants also compared different countries' approaches to AI adoption, finding that technological transformation has removed geographical barriers between regions despite their physical distance. However, the discussion revealed different strategic approaches, with different economies driven by differing needs and goals. However, similar fundamental challenges were identified regarding data management and strategic AI leverage, whether in powering traditional mining industries or advancing sensor-driven infrastructure and

healthcare applications. The conversation highlighted the universal need for transparent and trusted AI, emphasizing accessibility and harmonization of generative AI technology.

The participants then considered AI business opportunities through the lens of investment and return, examining segmentation changes that AI introduces across demographic, geographic, and technological dimensions. The discussion explored economic reach estimates and measurement challenges, including debates over GDP adaptation and alternative metrics such as Bhutan's happiness-based measurements versus more measurable well-being indicators. Participants considered societal shifts regarding self-worth and work connections, addressing whether AI will eliminate or create jobs, while drawing on historical perspectives from the early internet era to understand how new technologies solve previously insurmountable problems.

Starting from the premise of operating within an AI bubble, participants emphasized the need to create resilient value that can withstand market downturns. The discussion focused on AI efficiency improvements and practical applications such as smart city integration with autonomous vehicles, identifying money and time savings as key areas for bubble-resistant applications. The conversation addressed AI democratization and user empowerment, comparing ChatGPT's interface breakthrough to Netscape's impact on internet accessibility, while raising concerns about digital divides and ensuring AI benefits communities rather than pursuing AI development at the expense of human welfare.

Finally, the participants explored four ambitious opportunity waves, beginning with AI as a planetary-scale optimizer for diverse societies living within environmental limits, addressing healthcare economics, resilient infrastructure, extreme weather response, and sustainable food production. The discussion examined expansion of peak human qualities and living beautifully through arts, philosophy, spiritual growth, and relationship development, shifting mindset from obligation to opportunity. Participants challenged traditional employment goals by considering full liberation as an alternative, drawing parallels to childhood play and curiosity while redefining prosperity from material output to human flourishing, ultimately focusing on AI alignment with human spirit through inclusive progress and government-private partnerships leveraging unique datasets.

AI in Business Materials, Devices and Computation

[Chair]

Limpijumnong, Sukit, President, National Science and Technology Development Agency (NSTDA), Thailand

[Speakers]

Isaacs, Eric D., President & CEO, Private Foundation, Research Corporation for Science Advancement, U.S.A.

Kaminer, Ido, Professor, Faculty of Electrical and Computer Engineering, Israel Institute of Technology (Technion), Israel [Young Leader 2025]

Kawai, Maki, President, National Institutes of Natural Sciences (NINS); Director-General, Center for Research and Development Strategy, Japan Science and Technology Agency, Japan

Lin, Chris Horng - Dar, Vice President, Corporate Information Technology & Chief Information Officer (CIO), Taiwan Semiconductor Manufacturing Co. Ltd. (TSMC), Taiwan

Shum, Anderson, Vice-President (Research) and Chair Professor of Chemical and Biomedical Engineering, City University of Hong Kong, Hong Kong

Osaki, Masataka, Vice President of World Wide Field Operations, Japan Country Manager, NVIDIA Corporation, Japan

Opening Remarks



Limpijumnong, Sukit

The chair opened the session by welcoming participants to explore the convergence of advanced materials, device engineering, and computational technology that underpins AI and computational power. He stated that the session aimed to examine how these domains interact to enable breakthroughs across various sectors including energy, healthcare, communications, and digital infrastructure. The chair noted that advancing computational methods, AI, machine learning, and quantum simulations are opening new research frontiers, with AI enhancing and accelerating materials research that previously relied on trial-and-error approaches. He noted that the



session would also address global challenges by considering how computational tools can transform materials discovery, reduce reliance on scarce materials, and support the transition to a low-carbon economy.

The speakers presented the critical role of materials underpinning AI technology, emphasizing that despite focus on algorithms and architecture, physical building blocks remain essential. They highlighted the dependency on scarce materials such as cobalt for data centers, niobium for quantum processors, and neodymium for permanent magnets. The speakers discussed supply chain vulnerabilities, noting that 70% of cobalt comes from the Democratic Republic of Congo and is refined in China, while 80% of niobium is mined at a single site in Brazil. The speakers also outlined environmental and social challenges in mining, including carbon intensity, water consumption, and human rights issues in artisanal mining. The speakers proposed solutions including resource recovery from unconventional sources, improved separation methods, and development of drop-in replacements for scarce materials.

The speakers then discussed the challenge of creating an AI super-scientist, drawing parallels to historical scientific moonshots. They argued that successful moonshots require proper building blocks, identifying two critical needs: specialized microscopic data for training AI

in scientific discovery, and symbolic mathematical reasoning capabilities for developing natural theories. The speakers described work on advanced electron microscopy coupled with laser systems, enabling observation of light flow in nanometric structures and material dynamics rather than just structure, and proposed building a “Microscopic Data Foundry” to harvest previously inaccessible scientific data for AI training, comparing this to the 40 years of data collection that enabled AlphaFold’s success in protein folding.

Next, the speakers considered the evolution of materials science and computational devices, noting that as logic devices approach 10-20 nanometer scales, surface characteristics dominate bulk properties. The speakers noted that when devices reach such small dimensions, the surface area—typically covering four to five atomic layers—becomes the predominant feature, fundamentally changing material behavior. The speakers discussed the significance of scanning tunneling microscopy, invented in the 1980s, which achieved atomic-level resolution by monitoring electron tunneling between conducting materials, and noted that while this technique cannot penetrate bulk materials, it becomes increasingly relevant as devices shrink to nanoscale dimensions where surface and interface properties dominate functionality.

The speakers then discussed AI’s role in accelerating materials research and manufacturing, noting that AI helps predict material properties and accelerates search processes for applications in energy storage and electronics. They identified two key drivers for materials advancement: the need for higher performance as semiconductor manufacturing progresses from nanometer to angstrom scales, and manufacturing economy improvements through material innovations. The speakers emphasized the importance of multidisciplinary approaches, citing examples such as bacteria that can decompose toxic manufacturing materials in hostile environments. They advocated for rethinking traditional von Neumann machine paradigms, encouraging researchers to reimagine compute, memory, and network integration given new technological capabilities.

The speakers then focused on the role of universities in connecting AI innovations to real-world healthcare applications, emphasizing the unique ability of universities to bridge different stakeholders including hospitals, startups, industries, and regulatory agencies. The speakers outlined initiatives aimed at using AI and digital technologies to enhance healthcare efficiency rather than simply training more doctors. They emphasized the importance of interdisciplinary talent development and described university approaches to bringing

together stakeholders from the beginning of research projects to accelerate translation to society.

Lastly, the speakers discussed the concept of physical AI, describing how AI can now act in the physical world through robotics and sensors beyond just seeing, understanding, and reasoning. They outlined applications across manufacturing, logistics, healthcare, construction, and disaster response, emphasizing that physical AI represents not just efficiency but dignity by empowering people with disabilities. The speakers identified three critical requirements for physical AI: safety through rigorous testing and trusted standards, data through open collaboration across industry and academia, and talent development combining AI with robotics and control engineering. They described work on AI factories and virtual simulation environments for training AI systems before real-world deployment, noting the importance of combining Japan's hardware strengths with software innovation.

Discussion

Following the opening remarks, the participants engaged in a discussion session. On the topic of new computing architectures beyond traditional models, the question was raised of whether agentic AI paradigms with different specialized agents represented a move toward this direction. While noting that agentic AI is primarily a software architecture concept, the participants emphasized the need for fundamental hardware architecture innovations beyond the von Neumann machine model. They cited systolic arrays as an example of data-flow architectures that could be more energy efficient than traditional CPU models, and called for researchers to explore new combinations of algorithms and architectures rather than relying solely on inefficient transformer models.

Concerning the challenges of combining AI with robotics, the participants discussed the challenges in bridging AI capabilities with physical actuators and motor controls, highlighting the approach of using virtual simulation environments for extensive testing before deploying AI systems to physical robots, and noting that while AI itself is highly capable, integrating it with physical hardware remains complex.

The discussion then touched upon the topic of how long it might take for AI to develop the intuition that experienced researchers possess when conducting experiments. It was noted that AI may already demonstrate intuition and creativity, but the more critical issue is whether humans can trust AI systems. While intuition is difficult to define scientifically, it



was stated that AI's ability to learn and make predictions may exceed human capabilities, though verification and validation methods remain crucial challenges.

Discussion then shifted to the issue of energy consumption, and whether large technology companies would consider nuclear power solutions or simply purchase energy regardless of environmental costs. The participants distinguished between Silicon Valley's approach of building massive computational resources and the practical constraints faced by manufacturing companies, emphasizing that practitioners must consider power budgets, energy density limitations, and return on investment when designing AI solutions, advocating for energy-efficient approaches rather than deploying maximum computational power for all applications.

The discussion concluded by considering perspectives on regional energy challenges, particularly regarding Japan's energy landscape following the Fukushima disaster. The participants noted that energy solutions depend heavily on geographic and political contexts, with Japan aiming to restore prior levels of nuclear power generation to address the high costs and limitations of renewable energy alternatives. The conversation highlighted the varying approaches different regions must take based on their natural resources and energy infrastructure capabilities.

AI in Government Legislation Governance/ Leadership Selection

[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]

Linna, Tuula, President, Finnish Academy of Science and Letters; Professor, Faculty of Law, University of Helsinki, Finland

Maxton, Julie K., Executive Director, The Royal Society, U.K.

Beariault, Mark Douglas, General Counsel and Head of Legal Affairs, Kudelski Group, U.S.A.

Minevich, Mark, President, Going Global Ventures; Strategic Partner of Mayfield; Senior Fellow of the US Council on Competitiveness, U.S.A.



Opening Remarks

The chair began by commenting that AI is the defining moment for the century and for the future, and presents an unprecedented disruption of the social norm, but whether this will be for the benefit of humans remains to be seen. Humanity will need to navigate the challenges that AI presents. At the same time, it is impossible for the law to catch up with AI development, therefore a much broader legislative framework will be needed to main-

tain control over technology. He concluded by expressing his hope that the wisdom of humanity will be able to collectively address the issues to ensure that humanity maintains its control over AI.

Following this, the speakers introduced the many aspects that AI, specifically large language models (LLMs), have within a legal landscape. AI is already being utilized in law firms and other legal settings, however, it still needs to be improved in a large range of areas, including the ability to compare jurisdictions and navigate existing legislation. There are



Kumar, Ashwani

many ways to improve the outputs of AI, but given the problematic nature of LLMs, their outputs cannot be accepted without scrutiny. There is still a long way to go before AI can be utilized fully in the legal domain.

Next, the speakers commented that many AI tools are being utilized and changing the nature of legal practices. Many tools have the potential to support decision-making, but they are not decision makers themselves. One of the questions to consider is the autonomy and adaptiveness of AI. Another issue surrounding AI in a legal setting is data governance, as AI would have access to vast quantities of data within governments. AI has the potential to be used by lawyers for legal augmentation, and in some countries, it already is.

The speakers also commented that AI can be creative and productive. While humanity is eager to unleash the power of AI, it must ensure that the risks involved can be appropriately managed. To do so, there is pressure to enact laws and regulations, but legal systems are not yet equipped to handle AI. A different paradigm is required for a reasonable and responsible governance framework. Humans must remain accountable to AI, not the other way around. Ethics must be embedded into design, not just policy. Fragmented standards for AI in legislation must be harmonized before they can be fully implemented. There is room to work together to build AI governance into research, policies, and enterprises.

Lastly, the speakers stated that AI is part of national power, and governance is needed to protect democratic futures. Many multinational institutions are focusing their work on the AI race, and in some countries, it has become as significant a domain as the space of cybersecurity domains. The AI race is geopolitically imperative and may well become a military advantage in the future. Two emerging models of AI are demographic innovation that leads to open ecosystems versus authoritarian models that push for censorship and manipulation. Guardrails and other measures will be needed to ensure oversight and human rights, to ensure AI does not overtake human legislation.

Discussion

Following the opening remarks, the participants engaged in a group discussion. The participants identified several challenges, particularly geopolitical tensions of AI, where some countries will pursue politics to try to win the AI innovation race. In national dimensions, demographic values need to be embedded in AI systems, and the role of the private sector and general society needs to be considered. In an international dimension, issues of sovereignty and one country maintaining control over AI will impact international collaboration, including international law. There is also a clear lack of representation for the common citizen.

The participants noted that while there are potential issues for AI, there are existing international principles that can be used in applying AI to regulations. Utilizing common law and court legislation will help AI utilization gain traction in both international and domestic

law. The temporal aspect of implementing AI, meaning choosing the right time to regulate and how to manage the potential damage, is also important, because technology is racing ahead of the law, and that gap will widen with the advent of quantum computing.

The participants also commented that AI governance must evolve with businesses where innovation happens, but therein also lie threats, such as cyber threats. It is important to balance the openness of data and data protection and ensure data sharing to support innovation without compromising private interests. In this sense, humans must adapt to develop ways to include AI-generated documents to ensure continuity. The challenge is to make AI more human but ensure humans maintain their humanity in the age of the machine.

Chair Summary

The chair thanked the participants for their fruitful discussions. He noted that the concept of AI being used for domination and power was predominant among the discussions, including the lure of such power. AI is one of the most disruptive transformations of all time, but it will still lead to innovations. Common minimum standards will need to be considered to begin regulating AI and be developed going forward.



AI in Government Services and Delivery

[Chair]

Nemer, Mona, Chief Science Advisor of Canada, Office of the 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]

Ataka, Kazuto, Professor, Faculty of Environment and Information Studies, Keio University; Senior Strategist, LY Corporation, Japan

Magenhann, Bernard, Director-General, Joint Research Centre of the European Commission (JRC), EU

Vitanova, Lidia, Senior Researcher, GATE Institute, Bulgaria

Flandrin, Patrick, Director of Research (DRCE2), French Academy of Sciences; Director of Research, Physics Laboratory, The French National Center for Scientific Research (CNRS), France

Martin, Joel, Chief Digital Research Officer and Science Officer, Digital Technologies, National Research Council Canada (NRC), Canada

Lim, Chuan Poh, Chairman of the Board, Singapore Food Agency (SFA), Singapore

Wutiwiwatchai, Chai, Executive Director, National Electronics and Computer Technology Center (NECTEC), Thailand



Following this, the speakers commented that successful digital services must be user tested, but not enough government applications using AI are tested, which challenges their trustworthiness. Different levels of government also require in-house capabilities related to AI in order to better govern its use. AI will not resolve all the problems of government services, especially when there is a lack of collaboration and institutional fears surrounding the use of AI. Therefore, the first step to integrating AI is organizational transformation before technological transformation.

The speakers then noted that the public sector holds a unique position to champion the safe and analytical adoption of AI and stimulate the private sector. The public sector will create standards to address people's needs. AI is no longer an option, it is an integrated part of modern society, and embedding it will make public services more efficient and effective. Having the right competencies on the use of AI will also be essential, and civil servants must embrace and adopt AI going forward.

A comment was raised that AI is changing the way governments work and enables governments to provide more reliable services while ensuring better resource use efficiency. AI also offers powerful tools to respond to complex challenges, including climate change and digital safety, but it also presents essential responsibilities to ensure AI systems are

Opening Remarks



Nemer, Mona

The chair first explained that, at a time when governments globally are facing pressure for more services in a fiscally challenging environment, they are increasingly relying on AI to respond to requests. However, AI needs to be transparent so it can be accepted by the public. The chair then posed questions for the participants to consider; why is it that the private sector is ahead of government in AI adoption, what are the essential elements to ensure successful AI development for empowering services, and what are the applications of AI that can improve government services.

fair and transparent. The goal is not to replace human judgment but to use AI to support governments in making more informed decisions. Ensuring transparency and accountability requires consolidated efforts and clear guidelines on its use.

Drawing on examples in France, the speakers noted the need to consider AI use in a fair and ethical way and to connect it with other existing research. AI is an efficient way to address large volumes of data and respond to questions that cannot be addressed by humans. However, AI is a procedure, not a replacement for human expertise. Furthermore, citizens need to understand how AI procedures are implemented, and rules and safeguards should be explained clearly to ensure citizen understanding.

The speakers highlighted four keywords from their discussions so far: safety, security, transparency, and functionality. AI must provide information that is correct and complete to be safe. Firewalls must be put around information given to AI, particularly personal information. There must be oversight to ensure AI transparency, and all AI output must be double-checked. And AI has to be functional and show that it can provide quality answers to the uses it is put.

Then the speakers shared that despite AI's prevalence and tremendous investment, there is a clear gap between ambition and readiness. Embracing AI hence is a vital government role to bring its benefits to society in partnership with industry and researchers. An example is the use of AI in Singapore's education, where machine-learning-powered customized learning platforms help students learn more effectively, and large language models streamline lesson planning from a week to a few days. Anchored in principles of trust, safety, ethics, and using AI for the public good, stakeholders are encouraged to develop, deploy, and govern AI responsibly together locally, and with the wider global community.

Lastly, the speakers highlighted the goal of creating an ecosystem that can use AI to strengthen economies and improve quality of life. Thailand in particular has been making tangible progress in the use of AI by government agencies. To accelerate learning and collaboration, the government has created its own AI that acts based on national knowledge to successfully provide solutions. Governments must find the right balance between public and private leadership to ensure quality opportunities, infrastructure development, and demand increase to foster an AI open-source community.

Discussion

In the group discussions, the participants noted five key points on the use of AI. AI should augment government capabilities, not just automate existing work. Government processes should be reengineered before deploying any AI. A layer of transparency and providence is essential to ensure public trust. Decisions should be driven by public need and careful analysis. Governance training and regulatory speed should be matched to the pace of technology change.

The participants also noted that among the challenges to AI adoption, the most common one is the massive educational and upskilling requirement. There needs to be training, including for leadership, to ensure a clear and consistent literacy. The participants also noted the need to include the elderly generations in AI education, as they fear the adoption of AI.

The participants then discussed the ethical and practical use of AI and highlighted the gaps between countries in the use of AI, as well as the potential uses of AI in such fields as medical, finance, tourism, and education.

The participants finally noted that governments must adopt the use of AI in an agile way to respond to changing policies. Trust is both an enabler but also a barrier that governments must overcome, including security concerns and overreliance on AI. The focus should be on providing value for legislation and policies, and providing services.



AI in Government Internal / External Security

[Chair]

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

[Speakers]

Dario, Paolo, Professor Emeritus of Biomedical Robotics, The BioRobotics Institute, Scuola Superiore Sant'Anna - Pisa, Italy; Chief Scientist, Dubai Future Labs, Dubai Future Foundation, U.A.E.

Huffelen, Alexandra van, President, Radboud University, Netherlands

Johnson, Ray O., Senior Advisor to the President, Khalifa University, U.A.E.; Former Senior Vice President and Chief Technology Officer, Lockheed Martin Corporation, U.S.A.

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

Toope, Stephen J., President and CEO, Canadian Institute for Advanced Research (CIFAR), Canada

Opening Remarks

The chair highlighted the topic of the session, commenting that 10 years ago, AI was merely a subject of research, and now it is present in all areas of life. AI is capable of providing solutions to security issues, including long-standing issues. The chair called on the participants to consider both the opportunities and the threats that AI presents, including the political implications of AI and the issues of digital sovereignty. Today, the world is beginning

to reap the benefits of AI, but this raises fundamental questions on how to maintain a responsible use of AI.

Next, the speakers addressed the future of AI. AI is currently based on modern data, and the world is addressing the predicted outcomes of AI, but now it must consider future outcomes, including, in particular, physical AI, such as robotics. These are already providing huge opportunities to regulators alongside digital AI, but also present new challenges to humanity.



Petit, Antoine

The next step will be what will happen when all the data is used not only to process and make things better, but also to act.

The speakers then commented that the theme of the STS *forum* is the light and shadows of technology, and there is no better topic than AI in this context. The role of governments is to protect and regulate in an efficient way, and AI offers opportunities to protect citizens by making their services more efficient. Governments will also need to consider how to use AI to build better trust in their work and be transparent so that the outcomes of AI will remain unbiased.

The speakers also noted the importance of ensuring that public institutions and critical infrastructure can develop and ensure their safety using AI. In terms of AI sovereignty, the main concerns are the ethical governance frameworks, AI literacy across the public sector, and inclusive talent pipelines that reflect the diversity of society. Governments need to build inclusive and resilient AI governance, a resilient and attentive regulatory framework, and partnerships that will allow them to build shared, common infrastructure and provide adequate research functions.

Looking at the shadows of AI in particular, the speakers highlighted the importance of understanding how AI works, particularly that different iterations can be problematic and easily turned to sinister purposes, such as cyber-attacks. Future potential threats include agentic AI, when an AI is given agency to act, fine coding, where coding itself is done with an AI agenda, ensuring model integrity, and how to regulate AI uses.

Lastly, the speakers emphasized that digitalization and AI can help society and governments to bring efficiency and services. They noted the risks of AI, especially when using large language models (LLMs), and in particular the use of AI in social media to spread fake news. The role of governments in this will be to stimulate the responsible usage of digitalization and enforce rules related to AI.

Discussion

Following the opening remarks, the participants discussed the responsibility of machines versus humans. LLMs are essentially problematic, so there is always a possibility of mistakes or giving different answers to the same question at different times. Another point is that large companies are developing their own AI, but there is no way to control this development or ensure it does not affect decision-making.



The three main tasks of the government were determined as providing for society, enabling prosperity, and advancing the common good. There is an increasing need to protect the systems themselves from the risks of AI, such as ensuring the integrity of elections and the influence AI has on government processes. Governments around the world will need to reaffirm their control over AI in order to gain trust from the public.

The discussion was then turned to the positive and negative elements of AI. Concerns were also raised about the need for training and not being able to build a skills-based understanding. The speed of transition was also highlighted, where AI development is advancing faster than training can be provided. The participants also noted that AI may be a topic to bring together countries and create a coalition for a balanced approach to AI regulation and control, and ultimately an international treaty.

The participants also considered where in government AI would be used, such as in areas of digital mental health. AI can be used to provide tools to support people mentally, but these also come with the risk of increasing vulnerabilities to attack. Information access has also changed, and now many people get information from AI instead of the media. The

subject of smart glasses and how they will further augment human experiences with AI was also introduced.

Regulation was highlighted as an important element of AI, as well as the speed at which AI is developing is much faster than regulation adaptation. Humanoid AI will also be developed in the future, which will make it harder to discern the difference between AI and human interactions.

The participants finally discussed differing standards and noted that there is no one-size-fits-all approach. There is also currently a lack of experts who can manage systems for industries and other fields, and an established training process or teachers in the use of AI. It is clear that the risks associated with AI will need to be addressed by experts so that people can remain in control of systems.



AI in Society Social Networks and Communications

[Chair]

Mazur, Eric, Balkanski Professor of Physics and Applied Physics, Harvard John A. Paulson School of Engineering and Applied Sciences, Harvard University; Past President, Optica, U.S.A.

[Speakers]

Chan, Juliana, CEO, Wildtype Media Group; Publisher, Asian Scientist Magazine, Singapore

Nasser, Maher, Assistant Secretary-General and Commissioner-General of the UN at Expo 2025 in Osaka, Department of Global Communications, United Nations

Patel, Ketan J., Chair, Force for Good; Chief Executive Officer, Greater Pacific Capital LLP, U.K.

Gil, Isabel Capelo, Rector, Catholic University of Portugal, Portugal

Zemlin, Jim, CEO, Linux Foundation, U.S.A.

Usami, Makoto, Professor, Graduate School of Global Environmental Studies, Kyoto University, Japan; Visiting Professor, Institute for Ethics in Artificial Intelligence, Technical University of Munich, Germany

Opening Remarks

The chair began by establishing the dual nature of technological advancement, pointing out that while AI brings significant lights, it also brings shadows that require careful examination. To illustrate the lights of AI in social networks and communication, he referenced examples of how AI enhances global connectivity and democratizes access to information. To contrast this, the chair shared personal anecdotes about the evolution of the internet from a tool of connection to one of division, demonstrating how search engines manipulate information based on user preferences and create polarized worldviews. He also highlighted the enormous financial costs of cyber-crime and the unprecedented market power of technology companies.



Mazur, Eric

The speakers then turned to the evolving role of science communication in the digital age. They highlighted how social media platforms can amplify scientific voices from underrepresented regions and demonstrated that effective communication is integral to scientific work. The speakers emphasized scientists' need to engage with users as trusted experts, particularly as AI generates content at scale while lacking authentic human experience.

Next, the speakers addressed how AI transforms institutional communication and public trust. They discussed the shift from traditional journalism to direct social media engagement, with COVID-19 demonstrating both benefits and risks of unregulated platforms. The speakers raised concerns about AI amplifying misinformation during crises while acknowledging its potential for positive applications like carbon reduction, and emphasized that technology must serve humanity rather than prioritize profit-driven engagement over truth.

The speakers then explored implications for educational institutions and academic communication. They examined how social media addiction affects both university students and faculty, while also expressing concerns about AI translation tools potentially diminishing cross-cultural understanding that comes from language learning. On the other hand, AI can be a useful tool for preserving endangered languages and enhancing institutional outreach.

The speakers also addressed the economic and psychological dimensions of AI-powered social networks. They discussed how AI creates influence through mental engagement rather



than physical control, enabling profit through user interaction and sustained attention. This neurological-psychological conquest was contrasted with the industrial and colonial eras where conquest required physical domination of peoples. The speakers warned of future scenarios where AI systems might fundamentally alter technology-humanity relationships.

Following this, the speakers presented technical solutions for AI challenges in social networks. They outlined open-source initiatives including content provenance systems, adversarial testing frameworks, and distributed identity verification platforms. Technological interventions can address technology-created problems, as evidenced by tools for authentic media labeling and trust network creation.

Finally, the speakers focused on AI's risks in political communication and public administration. They noted that researchers first examined the use of AI in law enforcement (macro level) and then turned to microtargeting campaigns by politicians and political parties (meso level). Lastly, they discussed a recent experimental study that suggests the possibility of individuals manipulating democratic processes (micro level).

Discussion

Following the opening remarks, the participants engaged in extensive group discussions. They began by examining how AI threatens the concept of truth and reliable information, recognizing that this represents perhaps the greatest risk in the current technological landscape. They also raised concerns about how automated translation might create distorted representations of different cultures and languages.

The participants then discussed the democratization of propaganda capabilities through AI. This includes the shift from propaganda being primarily a tool of state actors to being accessible to individuals and small groups, enabling bottom-up as well as top-down manipulation campaigns. They also addressed how AI could amplify existing cybersecurity threats and enable more sophisticated criminal activities.

The erosion of critical thinking skills was identified as a major concern. Participants noted how over-reliance on AI tools might lead to functional illiteracy and shallow learning, potentially creating generations less capable of independent analysis and reasoning. They emphasized the need for educational reform that teaches both AI literacy and maintains human cognitive capabilities.

The participants also discussed the challenges of AI governance and the need for international frameworks. They recognized that while some regional regulatory efforts are emerging, there is a crucial need for global interoperability and enforcement mechanisms. The discussion drew parallels to successful international agreements on issues like ozone layer protection.

The question of trust in AI systems and social networks was extensively explored. Participants examined how human nature tends toward initial trust rather than skepticism, and how this characteristic might be exploited by malicious AI applications. They discussed the need for provenance systems, credentialing mechanisms, and business models that incentivize trustworthy platforms.

The discussion concluded with participants outlining potential solutions including technological interventions, educational reforms, and governance frameworks. They emphasized the importance of maintaining human agency and critical thinking capabilities while harnessing AI's benefits. Specific proposals included transforming social networks into knowledge networks, implementing open review processes for information validation, and ensuring that the pool of people capable of contributing to AI development continues to expand, rather than contract.



AI in Society Education / Knowledge

[Chair]

Gálvez Muñoz, Lina, MEP, Vice-Chair, Panel for the Future of Science and Technology (STOA), European Parliament; Full Professor of History and Economic Institutions, Department of Economics, Pablo de Olavide University, Spain

[Speakers]

Adolfsson, Hans, President, Stockholm University, Sweden

Auer, Sören, Director, TIB Leibniz Information Centre for Science and Technology; Professor, L3S Research Center, Leibniz University of Hannover, Germany

Chalfie, Martin, University Professor, Department of Biological Sciences, Columbia University, U.S.A. [Nobel Laureate 2008 (Chemistry)]

Gabel, Joan T.A., Chancellor, University of Pittsburgh, U.S.A.

Kaski, Kimmo, Professor Emeritus (Computational Science), Aalto University School of Science; Former President, Finnish Academy of Science and Letters, Finland

Lau, Chak-sing, Vice-President & Pro-Vice-Chancellor (Health) and Dean of Medicine, The University of Hong Kong, Hong Kong

Renn, Jürgen, Director, Departments Structural Changes of the Technosphere, Max Planck Institute of Geanthropology (MPIGEA), Germany

across regions and the urgent need for policy adaptation to keep pace with technological advancement.

Building on this foundation, the speakers addressed AI in higher education, emphasizing benefits like enhanced personalized learning and improved accessibility for students with disabilities, while noting pitfalls including increased academic dishonesty and the difficulty of detecting AI-generated work. They raised concerns about AI misuse in research publications and fake results from paper mills potentially eroding public trust in academic institutions and posed a philosophical question about universities' future role as "gyms for the mind," where people exercise intellectual capacities alongside AI technologies.

This reimagining of educational institutions connected to broader questions about knowledge dissemination. The speakers focused on transforming knowledge sharing in science and research. They argued that the current publication system, largely unchanged for 400 years, has become obsolete in the digital age while other knowledge domains have been successfully disrupted. The speakers advocated for integrating neural AI models with symbolic knowledge representation through structured databases and knowledge graphs. They emphasized the need for transparent, reproducible knowledge organization that combines generative AI capabilities with semantic structures that can be easily understood by humans.

Opening Remarks



Gálvez Muñoz, Lina

The chair described how AI in education and knowledge systems creates both promising opportunities for better learning and research and significant challenges requiring thoughtful consideration. She highlighted AI's benefits through personalized learning platforms and enhanced accessibility for students with disabilities, but contrasted these with concerns about educational technology becoming a source of inequality rather than empowerment. The chair demonstrated how algorithmic bias perpetuates disparities and creates digital exclusion, emphasizing the challenges of maintaining educational equity



Moving from theoretical frameworks to practical implementation, the speakers presented experiments in AI-enhanced education through fact-checking exercises. They described asking AI systems to write, describe, and analyze academic papers, then having students identify errors and omissions. The speakers warned about the dangers of blind trust in AI detection tools through an anecdote about a teacher falsely accusing a student of cheating based on an unreliable AI detection system. They emphasized the importance of using AI as a tool for developing critical thinking skills rather than simply attempting to prevent its use entirely.

Speakers also discussed how universities can integrate AI ethically and effectively. They emphasized the importance of returning to institutional missions and values while including faculty, students, and community voices in AI policy-making. The shift from traditional teaching toward mentorship and coaching was noted as an essential preparation for students entering yet-to-be-defined careers. Cross-sector collaboration—especially across health sciences, policy, and technology—was presented as a vital strategy for holistic development.

The speakers examined the co-evolutionary relationship between humans and AI technology. They outlined beneficial outcomes including amplified human capabilities and collective intelligence, while warning about adversarial effects such as identity loss, polarization, and concentration of power in technology companies. The speakers emphasized that AI outcomes depend on how society studies, regulates, and steers human-AI feedback loops, noting the importance of addressing monopolization and ensuring a fairer distribution of AI benefits.

The speakers then presented perspectives from medical education and healthcare, introducing three alternative definitions of AI: artificial insight, artificial integrity, and artificial ignorance. They discussed AI's potential for improving diagnostic accuracy and enabling precision medicine while raising questions about professional responsibility and the human element in healthcare. The speakers emphasized the challenge of curriculum development in rapidly evolving fields and warned about potential skill degradation from over-reliance on AI tools.

Finally, the speakers addressed the intersection of AI development with planetary-scale challenges in the Anthropocene. They criticized the fragmentation of knowledge institutions under political pressure while humanity faces unprecedented environmental challenges

requiring integrated scientific understanding. The speakers advocated for developing an Epistemic Web focused on cooperative knowledge production rather than commercial interests. They emphasized the need for political courage to ensure AI serves democratic purposes and public good rather than merely corporate profits.

Discussion

Following the opening remarks, participants held a group discussion examining the fundamental nature of data and knowledge systems in AI education. They emphasized the critical importance of data availability and quality, noting that transparency must be the foundation for educational AI systems to ensure data integrity rather than manipulation by those spreading misinformation.

Next, participants addressed generational perspectives and the paradox of choice in AI tools. They noted that societies historically view younger generations with criticism, yet these predictions consistently prove wrong. A contemporary challenge remains that the overwhelming array of AI tools creates difficulty in selecting the optimal ones.



The participants then turned to AI's role as an augmentation tool and the importance of critical thinking in education. They emphasized that AI should enhance rather than replace human intellect, serving as an effective tutor while acknowledging inevitable hallucinations requiring critical evaluation. Two approaches emerged from this discussion: peer education that validates human interactions and builds trust networks, and challenge-based education that promotes teamwork and critical thinking development.

The participants also explored fundamental questions about educational purpose and human development. They debated whether education's goal is merely degree attainment or the broader development of human beings through knowledge, experiences, values, and connections. Concerns arose about AI potentially robbing students of resilience-building experiences that traditionally teach people "how to be human."

Finally, participants examined cultural perspectives and energy constraints. They discussed AI's substantial energy consumption as a potential limiting factor, ethics and inequality concerns, and the need for guardrails. The conversation concluded with questions about humanizing AI, measuring human qualities, enhancing curiosity, and creating collective intelligence. The rapid pace of technological evolution requires interdisciplinary collaboration to address these challenges effectively.

AI in Society Social Infrastructure

[Chair]

Quirion, Rémi, Chief Scientist of Quebec, Office of the Chief Scientist of Québec, Canada; President, International Network for Governmental Science Advice (INGSA), New Zealand

[Speakers]

Coulhon, Thierry, President, Institut Polytechnique de Paris, France

Koizumi, Kei, former Principal Deputy Director, formerly White House Office of Science and Technology Policy (OSTP), U.S.A.; Specially Appointed Fellow, CRDS, Japan Science and Technology Agency (JST), Japan

Schütte, Georg B., CEO, Volkswagen Foundation, Germany

Steen, Tomoko Y., Director & Professor, Department of Microbiology and Immunology, School of Medicine, Georgetown University School of Medicine; External Advisor, Office of Health Services; Federal Research Division, Library of Congress, U.S.A.

Ito, Takayuki, Professor, Department of Social Informatics, School of Informatics, Kyoto University, Japan

Kabat, Pavel, Secretary-General, International Human Frontier Science Program Organization (HFSP); former Director General & CEO, International Institute for Applied Systems Analysis (IIASA)

Opening Remarks



Quirion, Rémi

The chair opened the session by emphasizing the critical importance of building a comprehensive AI social infrastructure to address growing technological disparities across global regions. He noted that recent AI developments have created unprecedented challenges for maintaining equitable access to technological benefits. Widening digital divides between developed and developing areas, combined with AI's rapid evolution, have generated uncertainty about ensuring inclusive participation in the AI revolution. These changes call for reimagining how

governments, institutions, and citizens engage with AI development to serve democratic values rather than exacerbate inequalities.

Building on this foundation, the speakers addressed AI's transformational impact across work, learning, science, and citizenship, bringing opportunities alongside risks, including bias, disinformation, and inequality. They emphasized higher education's role in training AI creators and adopters while bridging technical fields with social sciences. The speakers highlighted international cooperation efforts and posed geopolitical questions about emerging power blocs, calling for balanced cooperation between public research and private companies to keep AI accountable.

The speakers next argued that AI governance represents too significant a challenge to be left exclusively to private technology corporations and traditional computer science research communities. The speakers proposed creating robust public AI infrastructure, including national research resource programs designed to democratize access to computing power, datasets, and AI tools for researchers from less privileged institutions, students, and civil society organizations. They also advocated for comprehensive rights frameworks establishing principles ensuring AI systems maintain democratic values, while emphasizing government investment in AI research oriented toward public missions.

Moving to implementation challenges, the speakers described the tension that exists between regulatory approaches and innovation promotion within AI development. They noted disparities between research capability and practical application, with innovation often developed in one context but commercialized in another. The speakers outlined four priorities for research funding agencies: addressing economic transformation and power concentration while ensuring open infrastructure, protecting democratic processes, researching AI's social impacts, and developing standards for evaluating AI-generated research proposals.

The speakers then examined AI applications across professional domains, describing AI's broad scope of applications to genomics, elder care, and defense, emphasizing the importance of training medical professionals to integrate AI tools into clinical practice. The speaker also advocated for inclusive approaches involving experts across disciplines in AI system design and highlighted AI's potential for addressing global health equity through remote medical services and disease surveillance in underserved regions. The speaker also emphasized the importance of some public funding to be allocated to the ethical



examination of AI technologies, just as it was done under the Human Genome Project. This way, we can avoid the technology running itself without guardrails.

The speakers also presented research on AI systems designed to improve online discourse and democratic participation. They described AI-mediated platforms that analyze discussion content and help participants better understand diverse viewpoints in large-scale digital conversations. The speakers shared experimental results demonstrating that AI facilitation can reduce tensions and improve communication between different groups, serving as impartial mediators in contexts where human facilitators might lack perceived neutrality.

Finally, the speakers addressed fundamental shifts needed in AI understanding and regulation through provocative challenges to conventional thinking. They questioned whether most people truly comprehend AI technologies and argued for demystification efforts. The speakers also commented that regulatory approaches arrive too late since private companies maintain significant advantages over public understanding, often treating penalties as operational costs. They called for coordinated global efforts emphasizing education and media engagement over reactive regulation, while highlighting AI's dual social impact through digital distraction and virtual connections.

Discussion

Following the opening remarks, the participants engaged in discussions about AI's role in society and education.

The discussion examined fundamental questions about AI's nature and classification. The participants considered whether AI functions as a tool, medium, or companion, noting that it appears to serve multiple roles simultaneously. This multifaceted nature creates challenges for users who may lack an adequate understanding of AI's capabilities and limitations, potentially leading to over-reliance or misuse.

The participants also addressed governance and regulatory considerations, highlighting the distinctions between formal regulation, industry guidelines, and institutional policies, and observing how rapid technological development affects efforts to establish coherent frameworks. The discussion included practical concerns such as energy consumption from data centers and questions about public input in AI system development.

In educational settings, the participants noted varying levels of AI literacy among students and differences in how individuals engage with these tools. Similar patterns emerged in research contexts, where AI-generated content is becoming more common, raising questions



about appropriate applications and evaluation methods. The participants identified potential benefits of interdisciplinary collaboration to better understand AI's effects on social structures and human interactions.

The participants also discussed cultural and linguistic considerations of AI. They discussed whether universal principles could be applied to AI systems across different societies, noting that cultural contexts influence perspectives on appropriate responses and decision-making. They also considered differences in language and that linguistic structures might affect AI development and cross-cultural applications.

The participants then touched on AI's role in personal and social interactions. They noted increasing use of AI in counseling and companionship roles, leading to questions about implications for human relationships and potential applications in governance or collective decision-making processes.

The participants also considered educational matters, observing potential mismatches between traditional teaching methods and current technological realities, and suggesting that educational reform might benefit from input by learning scientists and pedagogical experts.

The participants concluded by considering transparency in AI systems, data quality issues, and the need for continued research into human-AI interactions. They noted that realizing potential benefits while addressing challenges may require ongoing collaboration across disciplines and stakeholder groups.

Interested readers could find additional information on this topic in various reports, including the Montreal Declaration on AI, the Bletchley Declaration, the Hiroshima AI Process, the Paris AI Summit, and acts from the Biden administration.

Sustainability

Digital Technology for Sustainability

[Chair]

Sata, Yutaka, Corporate Officer, Corporate Senior Vice President, Chief Technology Officer, Toshiba Corporation

[Speakers]

Günther, Oliver, President, University of Potsdam, Germany

Koonin, Steven E., Senior Fellow, Hoover Institution, Stanford University, U.S.A.

Leptin, Maria, President, European Research Council; Professor, Institute for Genetics, University of Cologne, Germany

Mason, Thomas, Director, Los Alamos National Laboratory, U.S.A.

Serger, Sylvia Schwaag, President, Royal Swedish Academy of Engineering Sciences (IVA); Chair, Formas, the Swedish Research Council for Sustainable Development, Sweden

Yoshino, Akira, Honorary Fellow, Asahi Kasei Corporation, Japan [Nobel Laureate 2019 (Chemistry)]

The speakers emphasized the necessity of interdisciplinary research for sustainability, requiring computer scientists to work beyond their field into biosciences, engineering, and social sciences. They highlighted creating structures for interdisciplinary exchange and AI being integrated into sustainability education. The speakers addressed construction challenges in maintaining historic buildings while implementing sustainable technologies, contrasting difficulties with old buildings against opportunities in designing new campuses with geothermal energy and solar power.

The speakers focused on AI applications for climate monitoring, explaining that understanding climate system responses to greenhouse gases is central to sustainability. They described climate modeling challenges using 100-kilometer grids and physics laws, noting human influences represent only 1% of atmospheric radiation flows. With 35-40 global climate models producing widely varying results, temperature predictions for doubled carbon dioxide range from 1.8 to 5.7 degrees Celsius, creating disturbing policy implications. The speakers identified two AI applications: addressing phenomena smaller than grid boxes and creating faster simulations for parameter exploration.

Next, the speakers noted that sustainability solutions often come from unexpected corners, with AI research funded for 70-80 years before recent breakthroughs. The speakers emphasized that policymakers must allow researchers freedom to explore the unknown since forced coordination can hinder discovery. They highlighted concerns about losing trust in AI due to recent errors and emphasized the essential role of humanities and social sciences in addressing these trust issues alongside technical aspects of sustainability.

The speakers examined energy-AI connections, noting AI electricity demands are driving increased energy consumption in developed countries, though this is small compared to developing world needs. The speakers referenced research showing most resource challenges are fundamentally energy problems, from desalination to metal purification. They identified short-term opportunities where AI energy demands could rejuvenate nuclear energy development. Long-term, AI could accelerate scientific enterprise with goals to double productivity by 2030.

Sustainability was characterized as necessitating profound systemic change, whereas digital technologies were portrayed as uniquely disruptive forces, underscoring that their trajectories may not necessarily converge. The speakers cited research showing little AI application toward environmental sustainability and noted challenges of operating under

Opening Remarks

The chair opened by stressing the critical role of digital technologies in achieving sustainability, noting that challenges such as climate change, resource depletion, and biodiversity loss require both science and technology (S&T) and social science approaches.



Sata, Yutaka

Highlighting Kyoto's record-breaking heat and floods, the chair pointed out that only 17% of the Sustainable Development Goals (SDGs) are on track for 2030. Digital technologies like AI and blockchain are being used to visualize climate change, predict disasters, and improve supply chain transparency, though they risk worsening inequality if used in isolation. The chair also mentioned Japan's Ouranos Ecosystem for cross-sector data exchange and Toshiba's contributions to International Electrotechnical Commission (IEC) standardization for data exchange mechanisms.



geopolitical tensions, science contestation, and speed pressures. The speakers argued this has implications for government risk-taking, business approaches, and civil society engagement, emphasizing social scientists' importance in imagining better futures.

Lastly, the speakers discussed digital technology and sustainability being two sides of the same coin, with incompatible technologies naturally disappearing. They provided examples from battery technology: autonomous electric vehicles will eliminate personal car ownership, dramatically reducing car numbers and transforming logistics while contributing to sustainability. The speakers addressed digital power consumption concerns, predicting that by 2050 waste from server heat generation and air conditioning will be eliminated through photonics, reinforcing the notion that unsustainable technologies will naturally disappear.

Discussion

The participants then held a group discussion. They emphasized that sustainability and digital technologies must work in tandem, particularly in addressing the growing energy consumption of data centers. The participants explored strategies for improving AI efficiency, such as advancing cooling systems beyond current power usage effectiveness (PUE) indicators, using waste heat for campus heating, developing photonic chips, optimizing algorithms and data usage, and placing data centers closer to power sources through the

watt-bit collaboration concept. They also noted AI's potential to enhance global energy efficiency, highlighting the widening gap between improvement targets and actual achievements since 2022.

The discussion then turned to societal aspects, including how technology and AI are reshaping human thinking and revealing gaps in the SDGs framework. Missing elements such as personal sustainability, job security, and practical implementation guidance were noted. The participants also discussed global inequalities in regulation and governance, citing the Eurocentric orientation of sustainability policies and differences in AI's impact across economies. While some regions face regulatory barriers, others like China have evolved from major polluters to leaders in sustainability, offering optimism for broader progress despite governance challenges.

Policy responses to emerging AI technologies were compared to the historical integration of calculators in education. The participants debated whether regulation should focus on AI's development or its use, observing that Europe pursues centralized regulation while the U.S. and China follow more flexible, multi-model approaches. The conversation moved toward a Darwinian perspective, suggesting that market competition could determine which AI models thrive. The participants proposed incentive-based mechanisms, similar to carbon



credits, to steer AI innovation toward sustainability goals, emphasizing that industry-driven solutions supported by clear incentives could be most effective.

The participants discussed the sociological and psychological factors behind the sustainability crisis. While technological solutions exist, the participants stressed the need to make green technologies cost-competitive with fossil fuels and accessible worldwide. They called for coordinated global decision-making and for academia to lead by example in research, travel, and infrastructure.

Finally, the participants addressed the challenge of making green technologies affordable for developing countries and clarifying responsibility for associated costs. Despite the range of available technologies, high prices and weak global supply chains remain major obstacles. The participants emphasized the need for stronger regulation, targeted incentives, and effective financing, while acknowledging that current climate finance mechanisms are insufficient. They concluded that a successful transition will require integrated frameworks linking policy, finance, technology, and data through shared trust.

Sustainability Biodiversity

[Chair]

Gluckman, Peter, President, International Science Council (ISC); Director, Koi Tu; Centre for informed Futures, New Zealand

[Speakers]

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

Hilton, Doug, Chief Executive, Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia

Mauguin, Philippe, Président and CEO, National Research Institute for Agriculture, Food and Environment (INRAE), France

Koundouri, Phoebe, Professor, Athens University of Economics and Business & University of Cambridge; Chair, World Council of Environmental and Resource Economists Associations, Greece

Falk, Adam, President and CEO, Wildlife Conservation Society, U.S.A.

Campbell, Nick, Vice-President, Academic Affairs, Springer Nature, U.K.

Opening Remarks

The chair opened the session by acknowledging the critical importance of biodiversity as a sustainability challenge, noting that despite having its own Conference of Parties (COP)



Gluckman, Peter

and assessment processes, biodiversity has struggled to gain policy traction compared to climate change. The chair argued that policymakers often view biodiversity as a luxury concern rather than recognizing its fundamental relevance to human welfare. Unlike climate change, which presents clear global dimensions, biodiversity challenges are predominantly local in nature, requiring bottom-up solutions alongside top-down approaches. The difficulty in valuing biodiversity across multiple purposes creates challenges for policymakers who must weigh

trade-offs against economic outcomes. There is a need to consider how biodiversity is reflected in a consistent manner in national systems of accounting.

The speakers discussed approaches to discovering and characterizing biological diversity, emphasizing that every organism and gene has evolved to solve specific problems. They highlighted the value of metagenomic sampling and computational biology in revealing the diversity of life, citing an example that had already come up in this meeting relating to bacteria having solved large-scale DNA transfer problems billions of years ago through conjugation that were only now being attempted by bioengineers. The speakers expressed excitement about scientists being able to characterize previously unknown organisms and determine their functions.

Next, the speakers provided insights from Australia's perspective, describing the country's biodiversity challenges and opportunities. Using personal property as a microcosm, they illustrated how conservation areas serve as corridors linking national parks to metropolitan areas while housing iconic mammals and facing constant threats from invasive species such as cats and rodents. They noted that despite centuries of science, many organisms remain unnamed at species, genus, and sometimes family levels. Australia faces severe invasive species problems, with more introduced plant species than native plants, and significant mammalian extinctions caused by introduced predators.

The relationship between agriculture and biodiversity was discussed, with the speakers proposing that these domains should be considered as complementary rather than conflicting. They acknowledged that agriculture has historically driven biodiversity loss through monoculture intensification and heavy input use, particularly affecting pollinators and soil health. However, research demonstrates that agroecological practices can simultaneously promote biodiversity and productivity through nature-based solutions including crop rotation, intercropping, agroforestry, and integrated crop-livestock systems. The speakers emphasized the importance of soil biodiversity for carbon storage, water retention, and disease resistance. Genetic resources are key assets for the future of agriculture, and the characterization, conservation, and distribution of biological resources are of crucial importance.

The speakers examined biodiversity through an integrated economic modeling and valuation lens, stressing the need for science-based, systemic approaches to implement global biodiversity commitments within the UN Agenda 2030 framework. They outlined a three-stage

model developed to guide biodiversity resilience and conservation, focusing on continuous monitoring through advanced data technologies, integrated modeling of interconnected systems such as climate and land use, and embedding biodiversity pathways into financial and policy mechanisms. The speakers emphasized that effective biodiversity management depends on recognizing the economic value of ecosystem services, integrating natural capital into national accounting, and aligning economic incentives with conservation goals.

The speakers discussed conservation approaches that focus on ecological integrity and the overall health of ecosystems. They emphasized the importance of working collaboratively with indigenous peoples and local communities who live in or adjacent to protected areas recognizing their role as active defenders of nature. They argued that doing so can lead to sustainable outcomes that are simultaneously positive for nature and for the economic health of these communities.

Finally, the speakers addressed communication challenges around biodiversity, noting the paradox that despite unprecedented knowledge about biodiversity's importance, action significantly lags behind commitments. They pointed out that a minority of countries had submitted action plans years after committing to the Kunming Montreal Global Biodiversity Framework at Biodiversity COP15. The speakers argued that policymakers and the public do not perceive biodiversity as urgent, partly due to partisan politicization of science. They emphasized the need for better science communication that localizes relevance, clearly communicates interdependencies, maintains transparency, and frames challenges in terms of hope rather than despair.

Discussion

During the discussion, the participants focused on several topics. Data is a key ingredient in crafting effective policy. As a prerequisite, discussions emphasized developing appropriate metrics for biodiversity that reflect societal and ecological needs. In addition, there were discussions of rethinking metrics assessing economic activity and economic "health" that would embody societal and global values instead of simple resource use. Beyond the overall alignment of metrics with values, there was agreement that metrics should be chosen to maximize the ability to track and compare progress or deterioration over time in different areas. Complex and challenging tradeoffs were also noted in which maintenance of an environmentally consequential species may be beneficial in one environment (generally in a native environment) while very much unwanted in a different (generally non-native) environment.



The importance of accessibility for information used to guide decisions was also discussed. Different situations require different types of sharing, in some cases as part of international collaborative efforts (existing and to be formed) and in some cases through fully public provision of information through resources such as the DNA sequencing short read archives maintained in the U.S., Europe, and Japan. The participants also discussed policy implementation and how to allocate often-scarce resources toward effective solutions. They discussed financing mechanisms, how to direct funding to appropriate recipients, and supporting local economies in ways that enable communities to sustain themselves while protecting the environment. The participants explored translating preservation and restoration of ecosystems into economic value, noting that current restoration efforts tend to be small-scale and expensive, but that understanding of such processes remains crucial, with local community involvement (and with careful harmonization of long-term and global goals with community needs) often the key to ensuring both the local support for needed investment, and the positive impact of that investment.

Next, the participants highlighted solution-focused approaches for integrated biodiversity conservation, particularly in challenging contexts with limited governance structures. They identified key ingredients for solution pathways, beginning with generating political will through effective narrative techniques and framing biodiversity issues in terms of

infrastructure investment. The participants emphasized capacity building across policy solutions, financial mechanisms, and organizational governance structures. Examples included integrated systems in the Canary Islands that made biodiversity profitable while preserving ecosystems and the Great Green Wall initiatives in China and Africa.

The participants then examined translating global biodiversity goals into local action, addressing the diverse aspects of biodiversity protection including genetic, species, functional, and ecosystem diversity. They highlighted significant knowledge gaps regarding biodiversity levels and loss, representing a substantial area for scientific advancement. The participants emphasized engaging with indigenous communities as equal partners and discussed data rights, access, and remote sensing for monitoring conservation interventions, along with associated ownership and privacy concerns.

Ecosystem integrity and the often-overlooked role of microbes in biodiversity conservation was emphasized. The participants discussed re-analyzing existing datasets to identify previously unknown microbes and examined climate change as a bottleneck for species survival. They explored mitigation strategies including introducing genetically modified organisms to coral systems and deploying beneficial microbes where genetic modification applications remain challenging. Emphasis was placed on improving public communication about less



obvious but crucial species and helping the public understand how loss of inconspicuous organisms can have dramatic ecosystem effects.

Lastly, the participants addressed motivating action on biodiversity conservation, noting that even the Sustainable Development Goals (SDGs) do not explicitly address biodiversity concerns. They emphasized the need for standardized biodiversity accounting systems and their practical applications across different stakeholder groups, with targeted approaches for companies, agriculture, tourism, and local communities based on relevant values such as pharmaceutical discoveries, soil health, scenic values, and hazard reduction respectively.

Sustainability Circular Society and Growth

[Chair]

Kleiner, Matthias, Professor, Technical University of Dortmund, Germany; Scientific Advisory Board Member, Representative, Werner Siemens Stiftung, Switzerland

[Speakers]

Arnold, Frances H., Linus Pauling Professor of Chemical Engineering, Bioengineering and Biochemistry, Director, Donna and Benjamin M. Rosen Bioengineering Center, California Institute of Technology (CALTECH), U.S.A. [Nobel Laureate 2018 (Chemistry)]

Gladden, Lynn, Shell Professor of Chemical Engineering, University of Cambridge; Member, UK Prime Minister's Council for Science and Technology, U.K.

Halpin, Peter T., Chairman of the Board and Chief Executive Officer, World Resources Company, U.S.A.; Chairman, WRC Pacific, Ltd., Taiwan

Hara, George, Chairman, Alliance Forum Foundation (AFF); Chairman and CEO, DEFTA Partners, Japan

Houkin, Kiyohiro, President, Hokkaido University, Japan

Mu, Rongping, Professor, University of Science and Technology of China; President, Chinese Association of Sciences of Science and S&T Policy Research, China

Ostojic, Petar, CEO and Founder, Center for Innovation and Circular Economy (CIEC); CEO, Neptuno Pumps, Chile

Opening Remarks



Kleiner, Matthias

The chair opened the session by outlining key questions to guide the discussion, covering areas such as reconciling circular economy principles with conventional economic growth, scaling circular practices in high-impact sectors, redefining growth within planetary boundaries, developing alternative metrics to GDP, leveraging advances in synthetic biology and green chemistry, transforming business models, creating supportive financing and policy frameworks, and fostering the cultural and behavioral shifts needed for circular societies.

The speakers presented biology as both a model and means for achieving a circular economy, emphasizing how the biological world naturally shares, reuses, repairs, refurbishes, and recycles materials using abundant renewable resources while minimizing waste. They highlighted enzymes as powerful catalysts that can be engineered through DNA manipulation and evolutionary algorithms, providing examples in laundry detergents, pharmaceutical synthesis, and sustainable aviation fuel production, contrasting biological efficiency with traditional chemistry's reliance on non-renewable resources.

Next, the speakers focused on critical materials and resource efficiency, outlining three key steps for sustainable resource use: embedding materials thinking into infrastructure planning, developing design skills for durability and recyclability, and accelerating the transition to a circular economy. They emphasized that today's decisions will be embedded in material footprints for decades and highlighted the importance of international collaboration between universities, small and medium enterprises, and large corporations.

Emphasis was placed on maintaining commitment to a resilient circular economy amid technological changes and geopolitical realignments. The speakers identified three essential pillars: government policies, academic research programs, and industry engagement. Financing was highlighted as key to growth, noting that small and medium enterprises face



challenges accessing capital despite expanded green financing, and advocated for stronger enforcement against greenwashing.

The speakers drew upon Japan's Edo period as a historical example of successful circular economy implementation. They identified two major challenges: developing new metric systems beyond GDP and addressing the growing gap between the rich and poor through creating a well-educated, healthy middle class. They proposed changing from shareholder capitalism to a model that distributes profits among all stakeholders and criticized short-term business practices.

The speakers then focused on regenerative agriculture, forestry, and fisheries as vital components of circular society. They contrasted the benefits and negative consequences of the Green Revolution and described initiatives to develop regenerative food production systems that restore soil health and enhance biodiversity while addressing Japan's low food self-sufficiency rate, sharing examples of carbon-neutral developments and livestock systems reducing methane emissions.

The speakers presented China's 30-year journey in building circular society through legal frameworks, policy systems, and best practices. They outlined a comprehensive approach including laws on energy conservation and renewable energy, supported by regulations and five-year development plans. The learning-by-doing approach was emphasized as generating best practices across regions, with policies evolving to address emerging challenges toward a 2035 vision emphasizing people-centered development.

Lastly, the speakers addressed massive material challenges facing the energy transition from major mining regions, noting that global copper demand could rise by 70% in coming decades. They emphasized the essential role of small and medium enterprises in mining supply chains and described circular economy models that extend equipment lifespans by up to 600% through reuse and recycling, advocating for moving beyond linear models toward collaboration and regeneration.

Discussion

The participants discussed using biological systems to carry out chemistry, noting that while biology typically works with simple elements like carbon, hydrogen, oxygen, and nitrogen, it can be trained to perform more complex chemistry by providing appropriate precursors. They addressed incorporating circularity, citing insect pheromones for crop protection that

can now be produced more cheaply and effectively through biology-based approaches, successfully deployed in Brazil. The participants expressed mixed views on GMO safety, and data access challenges for global circular economy systems like lithium-ion batteries where raw materials are geographically dispersed were discussed.

The participants then considered moving away from conventional growth definitions as economic drivers, concluding this would require global agreements and regulations. They emphasized needs for agreements between academia, politics, and industry to create frameworks enabling circular society implementation. The participants covered pricing mechanisms incorporating negative externalities like pollution and waste production, and identified multiple implementation layers from global problems to specific issues like smartphone end-of-life management, emphasizing human factors and mindset changes from linear to circular thinking.

Focus was placed on public-private partnerships and creating hubs with test beds where universities, small and medium enterprises, and large companies collaborate. The participants noted that geographic adjacency between industry and universities is crucial. They also discussed systems thinking versus product focus, agreeing that while both considerations are important, there may be excessive current emphasis on individual products rather than integrated systems approaches.



In addition, the participants deliberated the premise that the linear extractive economy is based on economic models and legal structures requiring re-engineering for circular economy creation. They emphasized changing values, measurement systems, and narratives, moving from technical aspects to framing circular economy in terms of health, happiness, and prosperity. Shifting from shareholder capitalism to public interest models was covered, with the participants highlighting the successful Chinese industrial park examples bringing together local governments, enterprises, and technologies.

Finally, the participants addressed practical implementation challenges in automotive battery sectors, noting dramatic performance improvements with many batteries retaining 80-90% capacity after 200,000 kilometers. They discussed potential for second and third life applications while acknowledging costly dismantling, testing, and rebuilding processes. The participants emphasized raw material traceability importance, concluding that circular design must be integrated from the beginning with business models evolving toward selling services rather than products.

Cutting-edge Technologies Quantum Technologies

[Chair]

Curioni, Alessandro, IBM Fellow, Vice President, Europe & Africa and Director, IBM Research - Zurich, IBM Research Europe, Switzerland

[Speakers]

Haldane, F. Duncan M., Professor, Department of Physics, Princeton University, U.S.A. [Nobel Laureate 2016 (Physics)]

Smith, Peter G R, Professor of Electronics and Computer Science, Optoelectronics Research Centre, University of Southampton, U.K.

Nussenzeig, Paulo Alberto, Pro-Rector for Research and Innovation, University of São Paulo, Brazil

Sato, Mitsuhsa, Quantum-HPC Hybrid Platform Division Director, RIKEN Center for Computational Science, RIKEN; Professor, Faculty of Health Data Science, Juntendo University, Japan

Mahajan, Vivek, Corporate Executive Officer, Corporate Vice President, CTO, in charge of System Platform, Fujitsu Limited, Japan

Koyasu, Shigeo, President, National Institutes for Quantum Science and Technology (QST); Science and Technology Advisor to the Minister of Education, Culture, Sports, Science and Technology, Ministry of Education, Culture, Sports, Science and Technology, Japan

Opening Remarks



Curioni, Alessandro

The chair opened by highlighting significant acceleration in quantum technologies over the past year, with progress moving from laboratory demonstrations to field trials, standards development, and international coordination. In quantum computing, the field is transitioning from only questioning feasibility to establishing clear pathways toward utility and advantage, with improved error rates, demonstrated error correction, and early pilots in fields including finance, chemistry, and optimization leading to integration discussions with classical computing and AI workflows.

The discussion then turned to the historical context of quantum mechanics. Despite its dating back some 100 years, current excitement stems from exploiting previously unknown possibilities, with the transition moving from philosophical arguments to technological applications through verification of entanglement. The speakers highlighted rapid qubit technology evolution and potential applications in material science simulations, as well as immediate advancement of quantum sensors using nitrogen vacancies in diamond for extremely precise magnetic and gravitational field measurements.

Next, the speakers addressed concerns about potential quantum technology bubbles and strategic considerations for countries besides the major players. The discussion touched on photons' advantages as a quantum particle, while raising concerns about company valuations and hype overshadowing realistic assessments. Fundamental questions were posed about supply chain considerations, with suggestions for smaller countries to focus on becoming essential parts of the quantum supply chain through specialized components rather than direct competition with major powers.

The topic shifted to perspectives from upper-middle-income countries with strong scientific institutions but limited resources for large-scale quantum computers. The speakers advocated for knowledge building in quantum technologies to prevent increasing economic divides. They also emphasized quantum sensors as offering practical utility, while it is essential to train engineers and provide innovation opportunities in agriculture and food security applications.

Following this, the speakers discussed transitions from classical supercomputer development to quantum-HPC hybrid computing platforms. The conversation addressed supercomputer limitations in certain problems, positioning quantum computers as potential accelerators. A major collaborative project in Japan aims to build the world's largest hybrid computing platform by integrating quantum computers with classical supercomputing infrastructure, focusing on quantum chemistry and machine learning applications.

Industry perspectives on quantum investment were also examined, with speakers outlining strategic decisions recognizing that abandoning quantum development could mean surrendering the potential future of computing. The discussion covered collaborative approaches on quantum chips, software architecture, and diamond spin systems, while also stressing the importance of sovereignty in critical sectors such as defense, governance, healthcare,



and finance. The speakers mentioned roadmaps toward logical qubit machines combined with high-performance computing capabilities while acknowledging scaling challenges.

Finally, the speakers examined quantum sensing applications in biological research through a twofold approach of using quantum sensors to measure biological processes and detecting quantum processes in biology. The discussion highlighted achievements in diamond sensor development with remarkable sensitivity measurements and applications in biological tissue, addressing investigation of enzymatic reactions at normal conditions and establishment of specialized research institutes for quantum processes in living systems.

Discussion

Following the opening remarks, the participants held a group discussion about where quantum technologies are most promising across different areas of expertise. Some participants noted that quantum sensors represent the most immediate applications, while quantum information and computing technologies require continued development of local knowledge and capabilities. Countries should build their own quantum devices, even at modest scales, to develop essential understanding. Progress in materials simulation is also notable.

The participants then addressed practical challenges facing quantum sensing deployment. A critical gap exists between laboratory demonstrations and commercially viable applications.

While sensors can be made highly sensitive, the key challenge lies in making them useful and cost-effective. Substantial cost gaps separate research prototypes from market-ready devices, so volume production and government procurement could play crucial roles in establishing markets, similar to how transistor technology was initially adopted through military applications.

Next, the participants considered the transformative potential of quantum computing and necessary steps to realize it, as well as comparisons with AI. Hybrid approaches combining high-performance computing with quantum systems will likely remain important, even in the fault-tolerant quantum computer era. Quantum-inspired approaches and integration with classical computing workflows were posited to continue playing significant roles in practical applications across finance, materials science, and pharmaceuticals.

The discussion then turned to fundamental scientific breakthroughs needed for quantum technology advancement. Participants explored potential developments that could advance quantum mechanics to different stages. Challenges exist with topological quantum computing approaches, while qubit lifetime remains crucial for functional quantum computing. Theoretical advantages exist for certain approaches, but practical implementation remains challenging due to material science limitations and the need for better quantum system isolation.



The participants examined strategies for smaller and medium-income countries in quantum technology development. Comparative advantages exist in education, companies, and niche applications, particularly in sectors like agriculture where local innovation is essential. Co-creation with industry partners is important, while also avoiding exaggerated claims about quantum applications. Real opportunities exist despite risks of hype, requiring careful communication and realistic expectations.

The conversation addressed quantum algorithm development and fundamental field limitations. Few known algorithms provide exponential speedup, raising questions about whether theoretical barriers exist in quantum algorithm discovery. To the question of whether this challenge may represent fundamental limitations or reflect current theoretical development, some participants believed access to quantum computers themselves might be necessary for developing new algorithmic approaches.

The participants concluded by discussing workforce development and education requirements for quantum technologies. A full-stack technology understanding across multiple engineering layers is important, similar to traditional computing paradigms. Since critical shortages exist for qualified experts in quantum, strong foundations in physics, mathematics, and computer science should be implemented in university curricula and departments to train quantum engineers and scientists.

Cutting-edge Technologies Nuclear Technologies for Tomorrow

[Chair]

Colombani, Pascal, Former Chairman and CEO, Atomic Energy Commission (France), Founding Chairman of Areva, Chairman Emeritus, Valeo, France

[Speakers]

Chu, Steven, William R. Kenan Jr. Professor, Professor of Molecular and Cellular Physiology and of Energy Science and Engineering, Department of Physics, Stanford University, U.S.A. [Nobel Laureate 1997 (Physics)]

Berger, Vincent, High Commissioner for Atomic Energy, SGDSN, France

Warren, Lee, Director Engineering and Technology, Rolls-Royce, U.K.

Buono, Stefano, Chief Executive Officer, Newcleo, France

Budil, Kimberly S., Laboratory Director, Lawrence Livermore National Laboratory (LLNL), U.S.A.

Konishi, Satoshi, Co-Founder, Representative Director, Chief Executive Officer (CEO) and Chief Fusioner, Kyoto Fusion Engineering Ltd., Japan

Moses, Edward, Founder and CEO, Longview Fusion Energy Systems, U.S.A.

Opening Remarks

The chair emphasized the need to reinvent energy systems that are low carbon, reliable, resilient, and affordable. Nuclear energy satisfies three major imperatives: decarbonization, security of supply, and long-term sustainability. Beyond electricity production, the role of



Colombani, Pascal

nuclear is expanding into other areas such as low-carbon hydrogen, thermal storage, grid stability, and desalination. The future of nuclear fission encompasses both life extension of existing plants with new technologies including safety upgrades, digitalization, AI, and improved efficiency. Small modular reactors (SMRs) and advanced modular reactors (AMRs) are emerging with applications in electricity, heat production, data centers, and military uses. As many of these SMRs and AMRs will require heavy investments in a new industrial fuel supply chain, one should not

forget that nuclear technology requires a time constant of 10 to 20 years, with large-scale commercial deployment contingent on substantial financial investments. The chair then acknowledged recent advances in fusion technologies and welcomed the various private initiatives that aim at proving the relevance of fusion to, in time, deliver almost unlimited amounts of energy. He then proposed to the audience to focus on progress on SMRs/AMRs and fusion.

The speakers then addressed practical nuclear challenges, highlighting that most countries cannot build reactors on budget or on time. Construction costs vary dramatically across markets such as the U.S., France, and China. The speakers highlighted that nuclear power is roughly 1,000 times safer than coal, 100 times safer than burning wood chips, and 10 times safer than natural gas. Spent fuel disposal challenges could be addressed through innovative deep borehole disposal, potentially offering significant cost savings over traditional repositories.

The discussion then turned to France's nuclear revival strategy since 2022, where the country is experiencing oversupply. The approach addresses an aging nuclear fleet, supports decarbonization by increasing electricity's share in the energy mix, and includes fuel cycle investments. Key challenges include human resources requiring coordination with education systems, the need for international regulatory alignment and simplification, and the development of fast neutron reactors for closing the nuclear fuel cycle.



The AMR market was described as rapidly evolving, with significant opportunity identified for small scale reactors (c. 20MWe) with an estimated value of 400 billion pounds globally to 2050, representing approximately 1,500 units. High-temperature gas reactor and coated particle fuel technology offer advantages through modular manufacturing and faster deployment, delivering a step change in the timescale and costs associated with traditional large-scale nuclear power. Realizing AMR benefits requires concerted government and regulatory action to remove market barriers, streamline regulation, and establish commercial fuel supply chains, with demonstrators targeted for the early 2030s.

A private sector perspective from the speakers highlighted the growth from 30 nuclear companies worldwide four years ago to over 100 today. Nuclear must address three main challenges: public safety concerns, cost reduction, and waste perception issues. Fast reactor technology and closed fuel cycles offer solutions, transitioning from economies of scale to economies of series production. The approach emphasizes recycling nuclear materials rather than disposal.

Recent fusion progress at Lawrence Livermore National Laboratory's National Ignition Facility was detailed, noting the achievement of producing over 3 million joules (MJ) of fusion energy from 2 million joules of laser input in December 2022. Nine subsequent experiments exceeded the fusion threshold, with the highest yield producing over 8 MJ and an energy gain above four—only about a factor of four from what is required for commercial breakeven. However, challenges remain including wall-plug efficiency (through higher-efficiency laser technologies using solid-state laser diodes instead of flashlamps), advanced target designs, and other refinements to enhance overall system viability, repeatability, and energy capture systems. Eight experiments (about 50% of the attempts) have demonstrated energy gain, requiring high precision in target manufacturing and experimental conditions.

Next, the speakers touched on private sector investment in fusion innovation, now totaling billions of dollars annually. Fusion's fuel cycle differs from fission, potentially offering better access for developing countries where traditional nuclear fuel management presents challenges. Fusion and fission must maintain equivalent safety levels for societal acceptance, with G7 countries working toward shared safety regulation systems.

Finally, the speakers examined fusion from a systems engineering perspective, emphasizing that successful projects require both proven physics and engineering at demonstrated scales. The learning curve from initial kilojoule shots to current 8-megajoule achievements

demonstrates fusion's potential for commercial viability. Projected electricity costs of 50 to 70 U.S. dollars per megawatt-hour appear attainable within the next decade through strong public-private partnerships focused on supply-chain development and demonstration of clear economic value.

Discussion

Following the opening remarks, participants discussed implementation timelines for AMRs versus classical fuel SMRs. While classical SMRs benefit from existing supply chains and regulatory frameworks, AMRs require new infrastructure development to provide advanced fuels such as HALEU (High-Assay Low-Enriched Uranium). Some participants noted that AMR implementation depends on funding levels, with HALEU fuel expected to be available commercially from 2031 and first reactors reaching the market in the early-to-mid 2030s. However, establishing industrial supply chains can take a significant amount of time, and regulatory timelines can vary considerably.

Regulatory harmonization needs were emphasized, particularly for SMRs and AMRs requiring series production across multiple countries. Different regulatory approaches create deployment barriers, though modern reactor designs can utilize seismic isolation technologies for broader siting options and geographic deployment. Proliferation concerns were addressed, with participants noting that reactor-grade plutonium in the waste stream lacks sufficient quality isotopic composition, and future fuel cycles aim to avoid separating transuranic elements entirely.



Participants addressed target-manufacturing challenges for commercial viability. High-density carbon (HDC/diamond) targets are useful for experiments but are not suitable for commercial production. Today, filling and freezing the fuel capsule with single-crystal uniformity can take roughly a day per target, making it commercially unviable. Alternative approaches including using plastic capsules and additive manufacturing techniques show promise for economical mass production. Direct-drive systems present distinct physics and engineering challenges. In this context, ITER, a magnetic confinement approach, was noted as a major demonstration of large-scale fusion engineering and seismic-isolation technologies expected to be operational in the mid-2030s. The tritium fuel cycle requires closed-loop systems—a common challenge best approached collaboratively. There is ongoing work with U.S. national laboratories to perfect this process, and a Canadian-Japanese public-private project is expected to demonstrate an integrated fuel cycle within the next few years.

Views on the commercial timeline varied. One participant estimated a range from “25 years to never,” noting that a 25-year horizon effectively means near-term failure. Others projected demonstration plants within 10–20 years, which is common for introduction of technologies of this complexity into the marketplace with focused effort and capital consolidation. The group cautioned that a history of unfulfilled promises in the fusion community poses risks for the viability of private sector fusion companies if credible demonstrations of power generation are not achieved within reasonable timeframes.

Finally, the participants broadly agreed that both fusion and advanced fission face similar challenges in materials science and fuel cycle management. Public-private partnerships are essential for accessing existing nuclear facilities and expertise. The discussion concluded with recognition that nuclear technologies must be embedded within coherent sustainable energy transition strategies rather than as standalone solutions.

Cutting-edge Technologies New Energy Sources

[Chair]

Terazawa, Tatsuya, Chairman and CEO, The Institute of Energy Economics, Japan (IEEJ), Japan

[Speakers]

Kristoffersen, Helle, Member of the Executive Committee, President Asia, TotalEnergies, France

Keller, Martin, Laboratory Director and Alliance President, National Renewable Energy Laboratory (NREL), U.S.A.

Tanguy, Philippe A., Founder and CEO, Hynergy Consulting Ltd., U.K.; Adjunct Professor and Past University President, Polytechnique Montreal, Canada

Natarajan, Mahesh, SVP Fuels and Low Carbon Technology, Fuels and Low Carbon Technology, BP p.l.c., U.K.

Sun, Xiansheng, Chairman, International Society for Energy Transition Studies; Chairman, NGO, Australia

Khairi Ahmad, Rezal, Chief Executive Officer, CEO's Office, NanoMalaysia Berhad (NMB); President, Asia Nano Forum, Singapore

Opening Remarks

The chair opened by emphasizing that climate change has become a lived reality with record-breaking temperatures and extreme weather events globally. Greenhouse gas emis-



Terazawa, Tatsuya

sion reductions are not on track for carbon neutrality by 2050, while policies have been drastically changed in some leading countries and geopolitical tensions have elevated energy security concerns alongside affordability pressures. The energy trilemma of decarbonization, security, and affordability requires technology and innovation solutions. Five approaches were outlined: demand-side efficiency, supply-side electrification and renewables, solutions for hard-to-abate sectors through hydrogen and carbon capture, atmospheric carbon removal, and climate adaptation. A portfolio of technologies with different deployment

timeframes will be necessary, with clear identification of challenges for broad deployment beyond laboratory success.

Building on this framework, the speakers highlighted the dual need for more energy and fewer emissions, driven by global demand growth including AI and data centers. Scientific efforts must address both future energy sources—hydrogen, ammonia, e-fuels, sustainable aviation fuels, and carbon utilization—while improving current fossil fuel efficiency and emissions. AI was identified as a critical technology for the energy sector, which lags in digital transformation despite AI's potential to improve today's energies (e.g., reduce methane emissions), scale up clean energies (e.g., improve grid technologies to minimize renewable energy curtailment), and accelerate new energy innovation (e.g., enhance battery storage systems).

Expanding on current technologies, the speakers emphasized continuing deployment rather than awaiting future breakthroughs. Solar photovoltaic technology shows significant improvements including perovskites and agricultural integration, while wind power costs continue declining through new materials and offshore expansion. E-fuels development using ammonia as a carrier presents opportunities for solar-rich countries to produce hydrogen and synthetic fuels. Grid modernization and storage present critical challenges, with AI being essential for managing complex distributed systems that exceed human control capabilities.



Turning to specific solutions, the speakers focused on hydrogen for decarbonizing industry and transportation, serving as both an energy vector and potential resource. Three production pathways were outlined: thermochemical methods using biomethane, dark fermentation as a biological route, and naturally occurring geological hydrogen reservoirs potentially stimulated through water injection. For industrial carbon needs, point source capture and direct air capture provide options. The hydrogen hype has largely subsided, though costs can be very low in regions with abundant renewable resources.

From a market perspective, the speakers presented global energy projections showing continued demand growth over the next 25 years, with oil demand shifting from transportation to petrochemical applications. Electrification demand is expected to grow significantly by 2035 and potentially double by 2050, driven by substantial electric vehicle expansion and data center requirements. Renewable power supply and bioenergy are projected to grow considerably, while hydrogen demand is expected to develop more gradually with substantial growth expected after 2040.

Examining regional approaches, the speakers explained China's comprehensive energy strategy necessitated by population scale, including clean coal, oil, gas, and investments across solar, wind, bio, geothermal, hydro, and nuclear sectors. China operates 57 nuclear units with 27 under construction and 25 approved, totaling 109 units expected online within eight years. Solar and wind may comprise 70% percent of energy by 2050, supported by AI across all sectors. The speakers identified three main challenges: renewable energy storage and transportation, national infrastructure connections, and core component independence.

Following this, the speakers presented Malaysia's nanotechnology approach targeting carbon neutrality by 2050, with hydrogen identified as key despite current cost challenges. Focus is on decentralizing hydrogen production through sodium borohydride technology, enabling hydrogen production using solid-state materials via hydrolysis, and avoiding storage and logistics costs. The speakers mentioned that Malaysia leverages its palm oil industry's annual 500,000 kilotons of bio-methane through pyrolytic processes producing both hydrogen and valuable advanced materials, specifically graphene, creating dual revenue streams to subsidize hydrogen pricing for early market adoption. Traditional hydrogen technologies, namely electrolysis and steam methane reforming with carbon capture, will jumpstart the national export agenda for quick returns to develop domestic ecosystem as per Malaysia's Hydrogen Economy and Technology Roadmap.

Discussion

Following the opening remarks, participants discussed policy challenges and the role of private sector leadership in energy transition. They emphasized that many challenges are not technological but social, relating to feedstock availability, cost, and political instability. The discussion highlighted the need for corporations and academia to collaborate while governments face electoral cycles that create policy uncertainty. Private sector involvement was deemed essential, with companies needing to assess business cases and risk appetite regarding policy dependence and to communicate to the capital market of their strategies with confidence without being driven by the ever-changing market sentiment. The need for policy collaboration among like-minded countries was emphasized.

The conversation then turned to innovation and collaboration requirements. Participants stressed the importance of deeper partnerships between research and industry to drive technologies to scale, emphasizing the need to take risks, fail early, and maintain stable policy paths. They noted that traditional timelines from lab to commercialization should be accelerated using AI and machine learning, while value chain integration across entire ecosystems becomes critical for energy technologies like hydrogen.

Regarding specific technology deployment, participants discussed hydrogen's supply chain challenges, including electrolyzer availability and infrastructure development. They emphasized the need for clear government priorities, market design rules, and financial



mechanisms such as contracts for difference to bridge cost gaps between conventional energy and clean hydrogen. The importance of education and training was highlighted given the shortage of hydrogen specialists.

Market dynamics and economic considerations were extensively discussed. Participants noted that energy demand growth, driven by AI and data centers, requires both improving existing fossil fuel efficiency and advancing new energy technologies. The need for energy efficiency improvement of AI and by AI were also stressed. Some participants emphasized that electrification will dominate where possible, with bioenergy serving as drop-in fuels and hydrogen playing a longer-term role beyond 2040. Cost competitiveness and robust/stable policy frameworks were identified as essential for large-scale deployment.

The discussion concluded with the recognition that successful energy transition requires orchestrated approaches combining demand creation, supply chain development, and ecosystem building backed by robust and stable policies, in addition to social support and cooperation. Participants emphasized the importance of validation through industrial partnerships and the need for technologies to demonstrate value beyond political considerations to ensure long-term viability.

Science and Technology I

Collaboration among Academia, Industry and Government

[Chair]

McLean, Angela, Government Chief Scientific Adviser, Department for Science, Innovation and Technology, UK Government Office for Science, U.K.

[Speakers]

Giry, Claire, President and CEO, French National Research Agency (ANR), France

Wu, Tsung-Tsong, Chairman, Industrial Technology Research Institute (ITRI), Taiwan

Loesekrug-Pietri, André, Chairman & Scientific Director, Joint European Disruptive Initiative (JEDI), the European ARPA, France

Kalidas, Chitkala, SVP Environmental, Social & Governance (ESG), Bayer AG, U.S.A.; Executive Director, Bayer Foundation, Germany

Tromp, Marlene, President, University of Vermont, U.S.A.

Córdova, France A., President, Science Philanthropy Alliance; former Director, National Science Foundation (NSF), U.S.A.

Opening Remarks

The chair emphasized the need to share experiences and insights about how academia, industry, and government can collaborate for the good of all, emphasizing the civil servant perspective of considering what would be best for society. In particular, attention was brought to exploring when, where, and why collaboration takes place, what major barriers exist between stakeholders, and why certain collaborations succeed while others fail.



McLean, Angela

First, the speakers shared France's experience as a case study. France places innovation at the heart of its growth strategy, with research at the center of the innovation cycle. Two recent major reforms are the Research Programming Law strengthening curiosity-driven research and doubling public-private partnership investment, and the France 2030 program targeting areas including quantum technology and AI.

Next, the speakers elaborated on Taiwan's innovation ecosystem, characterized by government-supported research institutions, acting as a bridge between academia and industry. Taiwan's expertise in semiconductors was developed using synergies across all three sectors, which led to capturing 60% of market share and generating over 100,000 jobs. In ICT and civilian applications, the recent rise of AI created potential for industrial applications. Taiwan is developing the necessary regulations to leverage this, including applications in environmental monitoring to be developed with academia and industry.

The speakers also discussed the dilemmas faced in collaboration between industry and academia, identifying conflicts arising from short versus long-term approaches, public versus private views, applied versus curiosity-driven research, and specialized versus interdisciplinary approaches. Developing closer relationships at the foresight level rather than just project level was suggested as a possible solution. Recently, Europe faced COVID-19, AI, and geopolitical tensions—strategic surprises that Europe could have anticipated, prepared for, or better contributed to. Amid this context, the Joint European Disruptive Initiative (JEDI) addresses collaboration dilemmas and supports Moonshot projects with mission-driven flexible funding.

Examples from Bayer were shared to shift the focus to the private sector perspective. Key success factors include sustainability commitments and partnerships with academia, government, and NGOs. Examples include a 25-year collaboration on the genetic diversity



of maize with USDA, partnering with the German government to establish the Berlin Center for Gene and Cell Therapies, and addressing liver cancer in Egypt through the “100 Million Healthy Lives” initiative. The selection of suitable partners and the long-term nature of the collaboration were highlighted as particularly important.

The speakers noted that collaborations are impacted by external factors, citing the challenge of reduced federal grant funding in the U.S. as an example. Universities, which also act as economic drivers in their communities, must now rethink their relationships with government, private players, and philanthropy. Solutions include attracting philanthropic support, creating internal and external alignment, using AI to identify research gaps, and building pipelines for students' future research.

Next, the speakers emphasized creating impactful “miracles” through collaboration as the key aim of all stakeholders in the science ecosystem. In the U.S., trends show decreased government contributions while philanthropic contributions increased. In Asia and Latin America, too, financial contributions from ultra-high net worth individuals are rising. Philanthropy offers speedy and flexible funding approaches for science that allow for risk-taking and long-term support.

Discussion

The participants emphasized that all stakeholders make essential contributions to successful collaborations: government provides stability and scale, while academia contributes expertise and talent, and industry drives innovation and application. Critical support for research and people is funded by philanthropy, which was recognized as a fourth pillar alongside the traditional three sectors, particularly in countries where frequent government shifts create uncertainty in science funding. The discussion also highlighted significant challenges related to differing operational timelines and named trust as a crucial but fragile factor.

The participants identified intellectual property rights as a major challenge. Successful models were presented, including a collaboration for developing a prostate cancer treatment, where limited-duration exclusivity arrangements created beneficial outcomes. The role of boundary organizations and individuals capable of bridging sectoral gaps was emphasized, with the Industrial Technology Research Institute (ITRI) in Taiwan as an example for bridging the technology readiness gap between university research and industrial application. Educational collaboration models to link interdisciplinary fields were also discussed.

Next, the participants analyzed structural fault lines. They identified cases where regulation intended to prevent misconduct inadvertently excluded beneficial actors, and where promising partnerships collapsed due to opaque IP negotiations. The participants noted how single incidents can reshape entire regulatory regimes, particularly when liability or national security concerns are involved.

Communication barriers and different operational styles of stakeholders were identified as significant obstacles, with scientists typically developing complex solutions while governments prefer simpler approaches. The utilization of translators or intermediaries between sectors was suggested. The participants emphasized that collaboration should ideally involve all sectors rather than just bilateral partnerships.

The participants noted that certain industries work well with academia—particularly pharmaceuticals, healthcare, information technology, and aerospace—while others are less accustomed to investing in research. Company size emerged as a critical factor, with small and medium enterprises often lacking the ability to invest for long-term horizons compared to larger organizations.

Timelines, ecosystem development, and people were identified as the most crucial factors determining collaboration success or failure. The participants cited the partnership between

the University of Warwick and Jaguar Land Rover as a successful example where long-term research funding is provided to the university while the company receives short-term technology benefits.

Additionally, the participants also emphasized the importance of cross-sector training through fellowship programs that include early student involvement in industry. Participants also agreed that co-funding approaches bring different industries together to build sustainable partnerships and generate further synergies.



Science and Technology I

Research Security in the Changing World

[Chair]

Peters, Mark T., President and CEO, MITRE Corporation, U.S.A.

[Speakers]

Mitsuishi, Mamoru, President, Science Council of Japan, Japan

Adem, Alejandro, President, Natural Sciences and Engineering Research Council of Canada (NSERC), Canada

Göthenberg, Andreas, Executive Director, STINT, The Swedish Foundation for International Cooperation in Research and Higher Education, Sweden

Hengartner, Michael O., President, ETH Board, Switzerland

Lenaerts, Silvia, Rector Magnificus, Executive Board, Eindhoven University of Technology, Netherlands

Moloney, Michael H., Chief Executive Officer, AIP - American Institute of Physics, U.S.A.

Yu, June, Vice President, UC National Laboratories, University of California, U.S.A.

Hunt, Tim, Emeritus Group Leader, The Francis Crick Institute, U.K. [Nobel Laureate 2001 (Physiology or Medicine)]

Opening Remarks

The chair opened by noting that international collaboration in science and technology is vital for global health and prosperity, yet research security today faces increasing challenges from cyberattacks, insider threats, and

coerced or illicit technology transfers, particularly in critical and emerging technologies like quantum science, advanced materials, AI, and biotech. These sophisticated operations have demonstrated that even the most advanced research environments are not immune to exploitation.

The speakers noted that promoting science and innovation requires a research environment based on common values such as academic freedom, independence, openness, and transparency. In 2023, the Science



Peters, Mark T.

Council of Japan issued an advisory opinion titled “Challenges and responses of the scientific community to the increasing openness and internationalization of research activities - From the perspective of research integrity,” emphasizing the objective of adequately managing inherent risks while enabling an ideal environment for basic research.

Next, the speakers explored Canada’s approach rooted in the concept of shared responsibility. Key policies include the National Security Guidelines for Research Partnerships and the Policy on Sensitive Technology Research and Affiliations of Concern (TRAC). Concrete measures that are risk-targeted and proportionate while respecting academic freedom are also implemented through the Research Security Centre and the Safeguarding Your Research Portal, while the government provides direct financial support to the most research-intensive universities, thereby creating “Team Canada,” a collaborative network for sharing best practices.

The speakers then highlighted research security as a constantly transforming “moving problem.” They noted that the Swedish Foundation for International Cooperation in Research and Higher Education (STINT) developed “Responsible Internationalization” guidelines in 2020, in response to cases where researchers had not considered human rights implications in authoritarian countries in their proposals for collaborative research. The speakers also observed that government involvement often results in a strong tilt toward security due to lack of understanding of open science benefits.



The speakers emphasized that while academic freedom is a cornerstone of research, it coexists with responsibilities to ensure ethical integrity, prevent misuse, and protect sensitive knowledge. Strengthening research security through training and awareness can empower scientists to navigate these challenges effectively.

Regarding academic freedom, universities and other research institutions must find a balance which the speakers described as “as open as possible, as closed as necessary.” Approaches should involve fine-grained assessment that is concrete, non-discriminatory, and transparent, while recognizing that limiting global partnerships would mean missing out on discoveries and innovation.

The speakers noted that while open collaboration drives innovation, it also creates vulnerabilities that some actors exploit. Furthermore, in the U.S., there has been a trend of moving away from ad hoc government policies toward more formalized compliance frameworks. Loss of trust and perceptions of unfair scrutiny, especially among foreign scholars, are major concerns.

The speakers emphasized that research security is fundamentally about stewardship—managing innovation ecosystems responsibly rather than restricting openness. They cited the U.S. Department of Energy’s National Laboratories as examples of how openness and protection can reinforce each other through built-in governance, transparent talent management, and security integrated across the research lifecycle. They also pointed out that the rapidly evolving U.S. federal policies pose challenges for universities and researchers navigating often inconsistent implementation requirements.

Lastly, the speakers emphasized the importance of openness in scientific discovery from a researcher’s perspective. They cautioned that excessive secrecy may actually hinder innovation, citing mRNA vaccine development where decades of open scientific publishing enabled eventual breakthroughs.

Discussion

Following the opening remarks, the participants held a group discussion. The participants acknowledged widespread awareness of research security challenges and the shared commitment to maintaining collaboration and openness. However, they noted that a lack of clarity on what research security means across different institutional contexts made finding universal solutions difficult.

A significant concern voiced by participants was the heavy burden placed on principal investigators and professors, who are expected to anticipate risks without adequate support systems. The participants stressed the need for clearer role definitions, while acknowledging that the rapid pace of change in science and technology requires flexible and responsive policies.

The participants recognized gray areas regarding research security, noting that some basic research may have security relevance while technological development still requires openness. They distinguished between defense-related and civilian research, suggesting that separation between these domains is important, while also addressing dual-use research with potential security implications as a significant challenge.

Additionally, the participants emphasized the importance of self-regulation within academia and training scholars in research security principles, while also addressing concerns about overwhelming researchers with extensive training requirements and the need to reduce the administrative burden in academia. On the other hand, encouraging researchers to increase public engagement was suggested to be beneficial.

Terminology concerns emerged, with participants noting that the word “security” carries different connotations in various countries. “Research Safeguarding” was suggested as an



alternative, while noting that research security is part of existing research integrity frameworks rather than an entirely new concept.

Different levels of institutional maturity in addressing research security across countries and organizations were noted, with specific discussion of capacity-building needs in Global South partnerships. Organizations including the G7 were cited as international platforms for dialogue that can lead to fostering further collaboration.

The discussion concluded with emphasis on continued dialogue among institutions to better understand research security implications while maintaining collaborative relationships, recognizing the potential for platforms like the STS *forum* to serve as venues for ongoing conversations.

Science and Technology I Science and Technology in the Global South

[Chair]

Marwala, Tshilidzi, Rector, United Nations University; Under-Secretary-General, United Nations

[Speakers]

Takara, Kaoru, President, National Research Institute for Earth Science and Disaster Resilience (NIED); Professor Emeritus, Kyoto University, Japan

Hassan, Mohamed Hag Ali, President, Sudanese National Academy of Sciences (SNAS), Sudan

Mouhoud, El Mouhoub, President, Université PSL (Paris Sciences & Lettres), France

Korsten, Lise, President, The African Academy of Sciences, South Africa

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

Cele, Mlungisi, Director-General, Department of Science, Technology and Innovation (DSTI), South Africa

Moktar, Zurina, Assistant Director/Head of Science and Technology Division, ASEAN Economic Community Department, ASEAN Secretariat, ASEAN

Vilakazi, Zeblon, Vice-Chancellor and Principal, University of the Witwatersrand, Johannesburg (WITS), South Africa

Opening Remarks



Marwala, Tshilidzi

To open the session, the chair highlighted that discussions often focused on gaps in funding and lack of infrastructure in the Global South, overlooking the dynamic research communities and rich traditions of knowledge in these countries. The Global South faces humanity's most urgent challenges including climate change adaptation, food security, and sustainable development, and the fundamental question is how the global community can better recognize, support, and amplify its contributions to science and technology for those countries most in need of future science frontier research.

The speakers addressed disaster-related issues in the Global South, emphasizing their importance for developing cities as urban population growth is projected to add 2.5 billion people by 2050, with 90% in Asia and Africa. Disaster risk management should be conducted in an integrated manner with social welfare and public health since disasters greatly affect people's lives. Additionally, advanced technologies and indigenous knowledge should be harnessed alike.

The increase in the Global South's contribution to international publications was highlighted by the speakers, while pointing out that the 46 least developed countries (LDCs) contribute less than 1%. Brain drain remains a significant challenge, though diaspora professionals have established ways to contribute to their home countries. Recent shifts to nationalistic policies have weakened international collaboration, and South-South partnerships have become increasingly important.

The speakers noted that over 30 million highly educated migrants lived in OECD countries in 2020, with many Global South countries experiencing expatriation rates exceeding 20%, potentially leading to underdevelopment traps. Transforming brain drain into brain circulation by creating ecosystems with robust research conditions and industry links was suggested as a solution. Examples from University Paris Dauphine-PSL include opening campuses in Tunisia and Senegal to train local elites and retain talent.

Africa was emphasized by the speakers as the biggest continent—with undiscovered crops, rich biodiversity, and mineral wealth. By 2050, a quarter of the world's population will be in Africa, and currently over 60% of the population is under 25. The African Academy of Sciences' ARISE program develops centers of excellence to unlock the science potential in the continent and foster diaspora return while building critical infrastructure including laboratories and educational frameworks.

The speakers shared experiences supporting Global South scientists since the 1980s, training students and providing funding to establish labs in their home countries. The speakers emphasized the great potential of GMO technology for improving indigenous crops and thereby contributing to global food security.

Next, the speakers provided a policy perspective, emphasizing that geopolitics has led to securitization of science, changing its perception from a public good to a matter of national



security. Developing countries should develop their indigenous knowledge systems and aim to gain the trust of the global community to host major global infrastructure projects.

For the ASEAN region, the speakers identified three key challenges: innovation divide with vast gaps between member states; high dependency on foreign technology; and complex demographic profiles. Solutions focus on empowering homegrown technologies through startups, encouraging diaspora contribution to home country economies through talent mobility, and deepening ties with international bodies.

Lastly, the speakers emphasized the importance of investing in fundamental science. Alignment between policymakers and research institutions is crucial for pioneering emerging technologies such as quantum computing and AI. After all, scientific creation is the shared heritage of all humankind, and the Global South must participate in conquering the frontier of fundamental knowledge.

Discussion

Following the opening remarks, the participants held a group discussion and reported important issues. The participants first addressed initiatives for solutions to brain drain

across different countries, sharing various programs designed to reverse talent migration, such as the Philippines' Balik Scientist Program, which incentivizes scientists of Filipino heritage to return home, and similar diaspora engagement initiatives in Bulgaria. However, the participants noted that such brain gain incentives also create internal challenges, including performance-based funding systems that increase competition and gaps within the respective countries.

While the participants identified brain drain as a major problem, they also highlighted opportunities for converting talent migration into brain circulation. They distinguished between support mechanisms for students versus established researchers, noting that researchers require substantially larger support systems to give them an incentive to return to their home countries. The discussion also addressed changing political landscapes, particularly regarding immigration policies in the United States.

The participants stressed that while talent is equally distributed globally, opportunities vary greatly by region, resulting in significant inequalities. Structured programs between the Global North and Global South were recommended, including joint degree programs facilitating bidirectional flow of professors and students, and funding partnerships specifically supporting research originating locally in the Global South.



The participants discussed comprehensive capacity building, particularly in Africa. They emphasized that governments must allocate higher percentages of GDP to education and establish sustainable research through long-term financial commitment rather than dependence on external aid. The discussion addressed corruption as an endemic challenge undermining scientific growth, requiring governance framework restructuring to ensure proper fund allocation for research and innovation.

Infrastructure emerged as a critical concern, with participants emphasizing the importance of nation-specific missions and roadmaps. Beyond laboratory facilities, they highlighted basic infrastructure requirements including access to equipment, internet and continental and global connectivity and basics such as adequate potable water, roads, and electricity, noting that effective operations require these fundamentals. The participants stressed balancing long-term vision with incremental implementation steps and recognized that addressing these challenges requires multi-sector collaboration in ongoing dialogue.

The participants concluded that key aspects to consider in the Global South were people, infrastructure, finance, collaboration, and brain drain solutions. They emphasized that South-South collaboration was essential for creating regional networks and leveraging existing talent and sharing opportunities.

Science and Technology II Brain Circulation

[Chair]

Ohno, Hideo, Special Advisor on Science and Technology, Ministry of Economy, Trade and Industry; Special Senior Advisor to the President, Tohoku University, Japan

[Speakers]

Scherpen, Jacquelin, Rector University of Groningen, University of Groningen, Netherlands; Vice-chair, Netherlands Academy of Engineering (NAE)

Hajri, Ebrahim Al, President, Khalifa University, U.A.E.

Favre, Marie-Pierre, CGO, Vice President for Comprehensive Internationalization, Tohoku University, Japan

Rangarajan, Govindan, Director, Indian Institute of Science (IISc), India

Turekian, Vaughan C., Executive Director, Policy and Global Affairs Division (PGA), National Academy of Sciences (NAS); former Science and Technology Adviser to the Secretary of State, Department of State, U.S.A.

Ito, Joichi, President, Chiba Institute of Technology; Co-founder and board member, Digital Garage, Japan

Opening Remarks

The chair opened the session by emphasizing the global nature of science and the historical movement of talent across borders. He noted that recent shifts, particularly in US policy, have destabilized traditional scientific hubs. Reduced support in critical areas such as climate change and public health has created uncertainty. These changes call for a reshaping of brain circulation, so that it can sustain progress in addressing key global and urban challenges. The chair posed three guiding questions to frame the discussion. First, what are the consequences of today's brain circulation? Second, what research environments attract and retain top scientists and students? Third, what strategies can ensure that brain circulation maximizes collective benefit?



Ohno, Hideo

The speakers began by exploring the evolving nature of mobility, which now includes joint appointments, international Ph.D. programs, transdisciplinary collaboration, and digital engagement. Despite ongoing shifts in the research landscape, mobility, diversity, and change remain central to scientific advancement. As for attracting and retaining talent, they emphasized optimizing existing resources and cultivating supportive environments. Infrastructure and institutional culture must support international engagement, through global campuses, regional ecosystems, and language accessibility. Flexible models like double doctorates help create “knowledge ambassadors,” who connect institutions and regions. Speakers encouraged national research bodies to collaborate, framing brain circulation as a shared responsibility and a driver of collective progress, rather than a zero-sum game.

Speakers then turned to emerging models of brain circulation, particularly in regions positioning themselves as global scientific hubs. The UAE was cited as a nation shifting from talent recipient to multiplier, with the creation of the world's first AI university as a strategic response to accelerating technological change. They emphasized the importance of strengthening global scientific capacity while respecting regional contexts and development priorities. Shifting US policies have created uncertainty, but also opportunity, redirecting talent to Europe, the Gulf, and Asia. Rather than viewing brain circulation as a competition for finite talent, speakers advocated for inclusive approaches that embrace diverse knowledge pools.



To do so, environments must offer robust funding, strong infrastructure, flexible working models, and pathways to translate research into commercial impact. Additionally, speakers noted that metrics should prioritize knowledge creation over talent movement.

Speakers called for structural reform and a reassessment of internationalization strategies. While competitive salaries, lab setup support, and skilled staff help draw talent, distinctive ecosystems, shaped through collaboration between public and private sectors and local cities, are even more critical for integration and talent retention. Speakers described brain circulation as a catalyst for capacity development. They proposed a reassessment of mobility strategies, including sabbatical schemes and job market alignment. A paradigm shift in mindset was deemed to be necessary to balance international openness with domestic priorities and to foster ethical, globally engaged scientific communities. Brain circulation should promote reciprocity, trust, and mutual understanding, serving as a driver of global scientific network.

From the perspective of developing countries, speakers noted that returning researchers often face mismatches in infrastructure, social conditions, and cultural integrations, especially for families. These factors must be considered in mobility strategies. Countries such as India are working to incentivize researchers to stay or return, recognizing that knowledge drives development and brain circulation is critical to national progress.

Speakers reflected on the need to balance international recruitment with domestic investment. For example, in the US, while foreign talent has historically driven scientific and economic growth, speakers argued that effective strategies must also support underrepresented domestic communities. Talent flows should be integrated into broader economic and strategic partnerships, including reciprocal research and training opportunities. Speakers also distinguished between knowledge and brain circulation. While mobility is sensitive to geopolitical contexts, ideas can continue to flow. Thus, durable systems to effectively circulate knowledge are necessary to enable resilient global science.

Speakers then shifted focus to startups as key sites of innovation, especially for postdoctoral researchers. In Japan, doctorate degrees are undervalued by industry, discouraging academic pursuit. Speakers identified AI as a transformative tool that can help overcome language barriers and facilitate international collaboration and dissemination of information. As students increasingly act independently and form their own networks, institutions must adapt quickly to maintain relevance.

Discussion

Following the opening remarks, participants explored potential solutions to the challenges of brain circulation, emphasizing the importance of communication. They posited that universities must advocate for greater autonomy and work with ministries to adjust policies, such as those governing dual degrees. Engaging the public, especially through youth ambassadors, was seen as key to gaining societal support for science. Participants also stressed the need to reconnect with industry, revive fellowships, and align academic training with evolving skill demands. They also identified joint appointments and embedding regional ecosystems as effective strategies.

Participants reaffirmed that science and discovery transcend borders, and that cultural exchange is inherently valuable. They proposed shifting focus from brain circulation to knowledge circulation. Geopolitical instability and evolving government expectations are reshaping the role of universities. Incentive structures in academia that prioritize publishing and grant acquisition over teaching were seen as limiting science's societal impact, particularly in training future generations.

The participants also addressed the undergraduate and graduate student experience, noting that mobility is shaped by factors such as salary, visa access, and post-graduate



opportunities. AI can be a useful tool to reduce language barriers and expand circulation, although it affects entry-level employment opportunities. Participants also called for faculty roles to evolve more into a coaching role rather than a deliverer of knowledge. Finally, the participants encouraged the building of strong ecosystems that connect universities, startups, and government infrastructure.

Science and Technology in Society *forum* (STS *forum*)
The 22nd Annual Meeting
Kyoto, Japan, October 7, 2025

Chairman's Statement

1. The 22nd Global Annual Meeting of the Science and Technology in Society *forum* took place from October 5 to 7, 2025 in Kyoto, with the participation of more than 1,500 global leaders in science and technology, policymaking, business, and media from over 80 countries, regions, and international organizations.

Regional conflicts continue to recur with no clear resolution in sight, while the international order that has been built over decades is beginning to face strong headwinds. In this context, the need for global cooperation—both in the pursuit of peace and in addressing environmental and social challenges on a planetary scale—has become ever more urgent. Science and technology hold great power to support human health and secure lives, and to guide humanity onto a path of sustainable development. Our gathering and discussions here were therefore both timely and highly relevant. As you return to your home countries, I encourage you to translate our shared understanding into concrete action.

AI and Society

2. Artificial Intelligence (AI) is rapidly transforming every sector of society, with Artificial General Intelligence (AGI) on the horizon promising even greater disruption. By 2030, AI will be deeply embedded across healthcare, business, government, and daily life, demanding robust infrastructures and strong governance. To maximize benefits while mitigating risks, we must foster innovation alongside safeguards for privacy, security, and accountability and respect for cultural diversity. Equitable access, transparency, and sustainability must guide development, particularly as energy and data demands grow. International collaboration is vital to shape standards, manage risks, and ensure AI advances human well-being, economic opportunity, and democratic resilience.

3. Nowhere is this transformation more visible than in medicine. From diagnostics and drug discovery to health system management, AI is reshaping both patient care and global health. AI-powered imaging, predictive analytics, and digital health assistants can enhance accuracy, efficiency, and access, especially in underserved regions. Yet challenges remain: data quality, interoperability, regulatory uncertainty, and risks of bias and inequality. To unlock AI's potential, technologists, clinicians, entrepreneurs, and regulators must collaborate on scalable, equitable, and sustainable solutions. Global cooperation, open innovation, and robust governance are essential to ensure that AI in healthcare reduces disparities, strengthens resilience, and delivers innovation that advances health for all.
4. Beyond healthcare, AI is also transforming public administration, offering efficiency, transparency, and citizen-focused services, while at the same time raising urgent questions of ethics, security, and sovereignty. Governments must harness AI to strengthen decision-making in healthcare, climate resilience, and emergency response, but ensure robust governance frameworks rooted in privacy, dignity, and accountability. International benchmarks—such as UNESCO's Recommendation on the Ethics of AI—provide a foundation, yet stronger enforceable safeguards are needed to prevent manipulation of elections, misuse of data, or erosion of trust. By fostering global cooperation, digital sovereignty, and critical human oversight, AI in government can become a force for inclusive, democratic, and secure societies.
5. At the societal level, AI is also reshaping how people connect, deliberate, and organize. It offers powerful opportunities to foster inclusion, cross-cultural dialogue, and collective action on urgent global priorities such as climate resilience and sustainable development. Yet the same systems risk amplifying polarization, spreading disinformation, and undermining democratic trust. To ensure AI enhances human agency rather than eroding it, we must invest in strong social infrastructures—universal access, lifelong training, and citizen-expert collaboration. Guiding AI with inclusive governance and ethical design will be essential to build resilience, safeguard rights, and secure a digital future where no one is left behind.

Sustainability

6. Decarbonization requires systemic solutions across energy, production, consumption, and resource management. Yet this transition is unfolding in a turbulent context: conflicts and cost disparities challenge progress, even as breakthroughs such as

nuclear innovation and the possibility of effectively harnessing fusion bring new hope. Appropriate regulations must accompany the future deployment of these innovations. Companies and consumers alike are increasingly prioritizing sustainability, from supply chains to energy-efficient products, while the global waste crisis looms. Many technologies to achieve net zero already exist and must be scaled, alongside bold new innovations. Governments, businesses, and innovators must align incentives, accelerate permitting, and design markets where sustainable choices are competitive—transforming sustainability from aspiration into widespread practice.

7. The urgency of this transition is underscored by the accelerating impacts of climate change—from record-breaking heat in Japan to devastating wildfires in California to alternating droughts and floods in some of the poorest areas in the world threatening food security. Since the energy sector drives nearly 80% of global GHG emissions, achieving deep decarbonization will require balancing affordability, security, and public acceptance while pursuing both near- and medium-term solutions. Breakthroughs such as fusion may ultimately reshape the energy landscape, but interim pathways must include renewables, hydrogen, and nuclear innovations. Extending the life of existing nuclear fleets, advancing SMRs and AMRs, and addressing waste management are essential steps. Progress will depend on innovation, credible timelines, and inclusive governance of new energy technologies.
8. At the same time, science warns that our broader economic system has already pushed the planet beyond its safe operating zones, threatening human wellbeing. To steer toward a sustainable future, urgent transformation of social and economic systems is essential. The call for a nature-positive economy, recognized after the Paris Accord, must now be accelerated despite some political backlash against the sustainability agenda. Business, policy, and governance reforms are needed to fully account for the value of nature in decision making. Mobilizing finance, leveraging technology, and fostering effective public-private partnerships will be key to making sustainability both palatable and profitable, ensuring resilience within a fractured global environment.

Science and Technology

9. Rapid technological advances are reshaping both societies and research—accelerating innovation, redefining work, and transforming academic priorities. At the same time, intensifying competition for technological leadership has prompted nations to safeguard critical knowledge, emphasizing resilience and national interests. Geopolitical

tensions, particularly around AI, risk narrowing international collaboration to only trusted partners, undermining openness and inclusivity. This is the test of the moment: sustaining predictability for long-term basic research while promoting mission-oriented innovation and global partnerships. Policymakers, institutions, and funding agencies must strike a delicate balance—supporting fundamental science, fostering early-career talent, and ensuring discoveries translate into impactful, real-world benefits. Here again, AI is impacting education and the future of the university must take into account the ubiquitous use of AI by both faculty and students as we promote inter-disciplinary collaborations to address the multi-dimensional complexities of the challenges humanity faces.

10. Within this landscape, science communication plays a central role in building trust, shaping policy, and engaging diverse publics in research. Its goals range from convincing governments to invest in science, to explaining research purposes, to incorporating public input in design and delivery. Yet cultural, religious, and national differences challenge the notion of a single global strategy. With funding disparities and varying trust in scientists, approaches must be tailored and inclusive. As AI transforms information access, the role of science journalism becomes more vital: safeguarding independence, promoting accountability, and ensuring rigorous reporting. Strengthening global support for science communication is essential to protect democracy and knowledge.
11. In a rapidly changing geopolitical and scientific landscape, international movement of researchers (brain circulation) has emerged as an important driver of global progress. Recent policy shifts in the United States have created fresh uncertainty, prompting more researchers to seek opportunities abroad and spurring Europe, Canada, Australia, Japan, and others to expand initiatives to attract talent. Brain circulation today includes relocation, joint and partial appointments, and student mobility, all of which strengthen international networks and build pipelines of future talent. We affirm our shared responsibility to ensure that these flows advance science as a global commons, driving innovation and solutions to urgent global challenges.
12. Equally important is ensuring that open scientific exchange—essential for innovation—remains secure in the face of escalating threats such as cyberattacks, insider risks, and illicit transfers in AI, quantum, and biomedical fields. Protecting knowledge, data, and talent while preserving international collaboration is critical for national security, economic resilience, and societal wellbeing. Institutions and governments must adopt risk-based safeguards, foster trust, and share best practices that mitigate vulnerabilities

without stifling discovery. Harmonized global frameworks, rather than fragmented rules, can advance both openness and protection. The research community must lead in designing governance models that safeguard science while ensuring it continues to benefit humanity worldwide. While freedom of scientific research pursuit should be guaranteed, ethical consideration and self-restraint are recommended as research possibilities are now “turbo-charged” through the applications of AI in many fields from Protein Mapping to designing synthetic drugs. Wisdom must guide the development of new knowledge and the deployment of the results of that new knowledge for the benefit of society and the environment.

13. Building on these efforts, science diplomacy is also being reshaped in an age of growing threats to global science— economic, ideological, and political. Online misinformation, polarized politics, and competing agendas now intersect to undermine international collaboration. To respond, a new, practical, and realistic framework for science diplomacy is needed, engaging not only national governments but also cities, states, and industry as active actors. Strengthening resilience in the global science system requires measures such as cross-border data storage, diversified funding, and distributed research infrastructures. By building safeguards through international agreements, science diplomacy can transform from a vulnerable ideal into a vital tool for resilience and trust.

Our explorations of these and other issues are far from over. We will continue our interactions and discussions to accompany the evolving lights and shadows of science and technology in the world. We look forward to convening again next year in Kyoto and have agreed to hold the 23rd Annual Meeting of the STS *forum* from Sunday, October 4 to Tuesday, October 6, 2026.

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