

MILLENNIUM INNOVATION FORUM, 19 MAY 2021

Breakthrough technologies for a better life

FOREWORD

The **Millennium Technology Prize**, awarded biennially since 2004, highlights the impact of science and innovations on the well-being of mankind and society. The Prize is awarded for groundbreaking technological innovations that benefit millions of people worldwide, promote sustainable development and create new markets thereby contributing to economic growth. For information on the past Winners of the Prize, please visit <https://millenniumprize.org/winners/>. The one-million-euro Prize is donated by the Government of Finland and governed by TAF. The Patron of the Prize is the President of the Republic of Finland.

On 18 May 2021, President of the Republic of Finland, Mr. Sauli Niinistö presented the 2020 Millennium Technology Prize to Professor Shankar Balasubramanian and Professor David Klenerman, University of Cambridge, for developing the Next Generation DNA Sequencing technology. The technology has changed the basic understanding of life as such by enabling accurate, fast and low-cost DNA sequencing– the process of unravelling the genetic instructions for the building blocks and functional molecules of all living organisms. The innovation has a tremendous impact on the fields of biology and medicine worldwide. It enables improved healthcare and diagnostics, enhanced food production and better understanding of crop diseases. The innovation has played an instrumental role in helping the world to fight against the COVID-19 pandemic. The technology has had a crucial role in learning about the COVID-19 virus and its mutants, and thus laid the ground for creation of multiple vaccines being administered around the world. In addition the innovation is critical for the development of vaccines against other viruses to prevent future pandemics. The video of the Award Ceremony can be found [here](#).

The first edition of the Millennium Innovation Forum was organized on 19 May 2021 as a tribute to the Millennium Technology Prize. The focus of the Forum was on futuristic innovations and emerging breakthrough technologies as promoters of a sustainable future. This was addressed by exploring the role of technology and science in solving the grand challenges of the world, in supporting sustainable growth, in shaping the future of mankind, and in creating innovations for a better life. The Forum was moderated by Jason Palmer, host of "The Intelligence" podcast, The Economist, UK. **The Sessions** consisted of introductory talks by the panelists, followed by round-table discussions moderated by the Chair. **Below you will find the highlights each session, collected by our Rapporteurs.**

Originally, the 2020 Millennium Technology Prize Award Ceremony and the Millennium Innovation Forum were scheduled for May 2020. Due to the COVID-19 pandemic, the events were postponed by a year, and organized semi-virtually. This made it possible to engage with frontier innovators and researchers, business leaders and pioneers, R&D funding agencies and decision makers from all over the world.

The Call for 2022 Millennium Technology Prize nominations will be open from 2 August to 31 October 2021. The Award Ceremony will take place on 25 October 2022, and the Millennium Innovation Forum on 26 October 2022.

Please see Annex 1 for the full program of the Millennium Innovation Forum 2021, and Annex 2 for the members of the Organizing Committee, or visit <https://millenniuminnovationforum.fi/en/program> and <https://millenniuminnovationforum.fi/en/committee> respectively.

Yrjö Neuvo, Chair of the Organizing Committee of Millennium Innovation Forum
Marja Makarow, Chair of the Board of Technology Academy Finland TAF

SESSION 1: THE BIG PICTURE

Chair: **Marja Makarow**, Chair, Technology Academy Finland TAF

Bengt Holmström, Nobel Laureate (Economics), Professor, Massachusetts Institute of Technology, USA

Nina Kopola, Director General, Business Finland, Finland

Carl-Henric Svanberg, Chair, European Roundtable of Industrialists and Board of AB Volvo, Sweden

Rapporteur: **Samuli Hänninen**, Vice President, WEA Products & Systems, Vaisala Ltd, Finland

The session addressed the grand challenges of the world and explored research and technology as drivers of innovative and sustainable growth. The panel discussion focused on natural and digital ecosystems coming together. An ecosystem is a community of biological organisms and nonliving parts of their environment that interact as a system. Digital ecosystems mimic these natural ecosystems especially in terms of collaboration and competition, but there are many other characteristics that are in common, they are both scalable and sustainable and continue to grow by being self-organizing.

From data to individual talent

Bengt Holmström highlighted the importance of data, the new critical asset. He called out data as a non-rival good that does not respect borders and that can be used multiple times and by many parties simultaneously without degrading the asset. Data ownership was another key topic of his. It is worth noting that the approach to data ownership and regulation differ between regions, and as digital transformation continues, there is a need for further clarity on this. A challenge for Europe is that US and China are leading in digitalization and usage of data, and the Top 10 companies by market cap originate from there.

Bengt Holmström also focused on the role of individual talent, pointing out that innovation often starts with the individual or within a small group, and creativity is naturally a key part of it. Turning creativity into a successful innovation is a journey, and same elements that influence creativity, can lead also to innovation.

Smart money and ecosystems

Nina Kopola pointed out that a good idea alone does not count, as an innovation must create value. The panel discussion highlighted the importance of smart money. Substance needs to come first to build a successful business, and it is not only the money that counts, but also the networks and expertise that can be offered both by private and governmental funding. Smart money works as an extrinsic motivator to enhance intrinsic motivation, the source of creativity and innovation.

She called out the need for heroes, the 3% of people who think big, who are willing to build their dreams true and can see solutions to real life problems. It is important for public money to support building of ecosystems around these individuals and help their ideas grow into innovations and successful businesses that fuel the economic growth.

Up-skilling for innovation

Carl-Henric Svanberg reminded us that we can learn from the past of industrial revolutions and understand that success in transformation requires investments into infrastructure and entrepreneurship. Expertise and continuous development of one's skills is instrumental. He pointed out that lifelong learning is a key prerequisite for innovation and companies and governments should continue to invest on upskilling to speed up the digital transformation.

Concerning sustainability, he assured the audience that the Green Deal is not lip service from the private sector. Industry sees huge competitive advantages in realizing its aims, while sharing the responsibility of contributing to a sustainable future for us all.

The panel agreed that both in nature and business the value of ecosystems is unparalleled. Competition and collaboration create an environment where value generation is enormous, as the entities drive towards a common goal, each benefitting from each other. The panel noted that the unprecedentedly fast development of corona vaccines was enabled not only by the Next Generation DNA Sequencing technology celebrated by the Millennium Technology Prize, but by open data sharing between the researchers. The shared goal of the ecosystem is in this case crystal clear, the desire to save millions of people and the future of our societies. The answer to the trillion-dollar question on how to harness the power of talented and diverse individuals to the benefit of everyone is now one step closer. Different organizations both private and public have started to endorse the ecosystem approach more widely and more openly.

Conclusions of Session 1

Digitalization has been a topic for decades, but as both the importance and the speed of transformation are accelerating, we can almost see a discontinuation point for something new to start.

Investment into R&D is the only way to sustain long-term economic growth, and the role of the public sector is to share the risk of the unknown.

We need heroes, who think big and are willing to build their dreams and have the ability to see the solution.

Europe is the best at training “many”, we have millions of people who need to be upskilled as part of digital transformation and it is a responsibility that belongs both to companies and governments.

The Green Deal and sustainability are for real, being driven both top-down by governments, companies and universities, and bottom-up by consumers requiring sustainable products and services.

SESSION 2: DON'T MISS THE FUTURE

Chair: **Jyrki Katainen**, President, Sitra, Finland

Anne Lise Kjaer, Futurist, Kjaer Global Ltd, UK: **Deep Future(s)**

Pasi Vainikka, CEO, Co-Founder, Solar Foods Ltd, Finland: **Surprisingly sustainable future**

Pupul Bisht, Founder, Decolonizing Futures Initiative project, India: **Inclusive futures**

René Rohrbeck, Professor, EDHEC Business School, France: **Corporate foresight and futures building**

Rapporteur: **Mikko Dufva**, Leading Specialist, Foresight, Sitra, Finland

The session “Don’t miss the future” focused on identifying the opportunities in the disruptions and changes taking place right now. The panellists discussed current megatrends and weak signals, the role of organisations and ways to “use futures” to challenge current assumptions, imagine alternative futures and create change.

Four P’s and connecting the dots

Anne-Lise Kjaer talked about trends, sustainability and deep futures. She started by noting that there are always many futures, but “In times of turmoil our horizon shortens, and short-term thinking takes over –

especially in a life-altering crisis such as the current pandemic". However, it is exactly in times of crisis that a new vision for business and society is most needed.

To create new visions, one must have a long-term systemic perspective. This means seeing where we have come from, where have the trends started and why, how things are connected and what might happen in the next 100 years. The 4P model of people, planet, purpose, profit helps organisations to see the connections – to connect the dots. To achieve wellbeing, there is a need to balance the 4P's: "Once we balance People and Planet with a Purposeful ethos to match – we cultivate an inclusive culture and that leads to sustainable Performance."

Other panellists agreed on the need to broaden the view from profit and performance to people, planet and purpose. They also discussed the importance and challenge of deep time and slow time. How can we first find the time to think long-term and then challenge our current view to see new opportunities?

From Moore's law to Moo's law

Pasi Vainikka explained the process of making protein from air and used that as an example of how rapid technological development enables exponential change. Just like it would have been too far-fetched to talk about apps and social media in the early years of computers. Now we are struggling to see the impact of new technologies in for example agriculture and the food industry.

The future could be thought to be blocked by a wall, and new technologies create openings to that wall where we might peer through. Instead of Moore's law we now have "Moo's law" of exponential technological development in the food industry. This can lead to the disconnection of food production from agriculture, for example by using cheap wind and solar electricity to create protein out of air. In the future consumers will still have meat like today, but it will have nothing to do with agriculture as we know it now.

The panellists discussed how well organisations think about radical technologies and their impacts. It is often challenging to do the mental time travel needed to see the implications of new innovations. We often do not experience them before they become common. One way that would be helpful also in empowering stakeholders is to engage the whole value chain and the community at large to the discussion about possible futures.

Where are the images of futures coming from?

Pupul Bisht dived deeper into the topic of inclusion and empowerment. She raised the question of where are the images of futures coming from and why do we think the future is going to evolve in a certain way? Even though the plurality of futures is stressed in foresight, we are often subconsciously building quite singular images of the future.

The problem with these singular images is that they are heavily influenced by historic images and exclude anyone or anything that does not fit in. Quick internet search show quite similar images of futures usually tinted blue, or green in the case of sustainable futures – but often devoid of people. We need to change the story we tell ourselves about the future.

All stories have a "what if" question at their core. If we want to tell more plural stories about futures, we need to start from that what if question, challenge our assumptions and decolonise both our futures and our toolkit for thinking about futures. We need to ask who or what is rendered invisible in our narratives and how can we bring those back in the discussion. Positive stories that imagine ways out of our current situation are powerful changemaking tools.

The panellists agreed on the importance of challenging and creating new narratives about futures. Popularising foresight is ever more important for increasing societal resilience. Foresight should not be a privilege of few but should be inclusive and consider the next generations. Future power must lie with people who have to live in the future.

Being vigilant about futures

Rene Rohrbeck shifted the discussion towards corporate foresight in practice. Research has shown that vigilant companies – companies who are doing continuous, systematic foresight in a changing environment – clearly outcompete their peers in firm performance. They are like surfers, who can anticipate the waves of change and forces that drive these waves, as well as what will be the differentiating capabilities to catch the wave and ride it. They also set up automated trigger points that ensure they grab the window of opportunity while others are discussing if they should.

One of the key questions now is how much time is spent thinking about futures? Even though one would think a CEO thinks about future 90% of the time, studies have shown that it is about 3%, and might even be less. We are fighting for the time to do slow thinking amidst all the things that are asking for our immediate attention.

The panellists discussed about the time bubble we are all stuck in and the need to make room for slow work. We need changes on the level of culture and mindsets, and that takes time. Bringing awareness of how change happens is crucial.

Conclusions of Session 2

Have time to think slow and long-term. In crisis short-termism grows because it is hard to see the future. But those are the times we really need to pause and reflect on our assumptions about futures, our values, the ways forward - not to repeat the past, but to have inspiring futures to aspire to.

Pay attention to who and what is included in your futures. We tend to forget people in our images of futures, while people are what drives change. Foresight should not be a privilege of few, but something everyone does. Empower especially those who are now ignored - that is good for business, society and planet.

Connect the dots and challenge your assumptions. Do not just focus on one trend but see how they are connected and how they evolve. Find connections between surprising things. Think about what ifs and consequences of radical technologies.

SESSION 3: BUILDING A BETTER LIFE

Chair: **Jason Palmer**, Host of "The Intelligence" podcast, The Economist, UK

Peter Vanacker, CEO, Neste Corporation, Finland: **Circular economy**

Heli Skottman, Professor, Tampere University, Finland: **Human spare parts**

Pekka Lundmark, President and CEO, Nokia Corporation, Finland: **The connected world**

Jamie Paik, Professor, Swiss Federal Institute of Technology Lausanne EPFL, Switzerland: **Robotics**

Rapporteur: **Caj Södergård**, Research Professor, VTT Technical Research Centre of Finland Ltd, Finland

The session covered how “the rubber hits the road”, how futuristic innovations and emerging breakthroughs enable and impact the well-being of societies and their citizens, and how fast technological changes impact the future of mankind and are used by the public. The four panellists illuminated the theme from four

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complementing perspectives: **sustainability** by Peter Vanacker, **health** by Heli Skottman, **communication technology** by Pekka Lundmark and **robotics** by Jamie Park.

Circular bioeconomy

Peter Vanacker emphasized that a circular bioeconomy is not an option – it is a *must* to future-proof the industry. We must reduce the environmental impact of products to make a healthier planet for our children, but also to keep the business competitive in the long term. In 2018 in Europe, less than one third of 29 million tons of the collected plastic waste was recycled; the rest went into energy recovery and, even worse, into landfills. Plastics should be seen as a valuable material that remains in circulation. However, things are improving, companies and brand owners are under consumer pressure making sustainability commitments and legislators are pushing the development towards a more sustainable future.

Vanacker also stressed that *there are already available solutions* – and that these should be put *into action immediately*. In Europe, mechanical recycling of plastic waste has in a decade grown from zero to 15 %. In the following decade, 15 % more will be chemically recycled into new high-quality plastics, fuels and chemicals. The renewable feedstock of waste and residues will *replace fossils* in production of bio-based plastics and chemicals.

Finally Vanacker stated that circular bioeconomy is a *business opportunity* best grasped *together* with partners from the whole value chain - from the waste collector up to the big consumer brands. Forerunner companies can make a substantial impact, but no one can achieve a change alone. Successful innovations take years, even decades to materialize into products; therefore, we need forward thinking and long-term resilient cooperation including companies and research organisations. Consistent regulation is needed to get it started, e.g. the recent plastic EU taxes for non-recyclables, but we should not over-regulate.

Human spare parts

There is an intense demand for human transplants. Only in Europe, 150 000 people are waiting for transplants and 6000 are dying each year, because they cannot get a transplant in time. Globally the situation is much worse. Tissue engineering can provide a solution for producing these transplants in mass scale. *Heli Skottman* laid out the procedure for building human spare parts. We need cells, especially pluripotent stem cells, but also biomaterials supporting the cells. The blueprint of the spare part is in our bodies. A major enabling technology is *3D printing* of living components. Starting from a digital design and by using various cells, functional bio-inks and printing equipment, the tissue is printed layer by layer. Finally, the printed tissue is matured in bioreactors before transplantation into the human body.

Tissue engineering is already a reality. **Heli Skottman**'s research team at Tampere University is developing *cornea transplants* for correcting human vision. For this, they use 3D bio-printing. To make this happen, Skottman underlined the need for collaboration across the disciplines - biologists, material scientists, clinicians, 3D imaging and manufacturing experts as well as engineers must work together. Innovative business models are needed as well as regulation on a global level. Ideas and results must be shared widely with the public, colleagues and stakeholders. Finally, a long-term vision should inspire and guide the work.

Helping the world act together

Pekka Lundmark pointed out that communication technology – especially 5G – brings together world's people, machines and devices into a *collective intelligence* that helps to solve the big global problems - the foremost being climate change - by leveraging the cumulative power of millions of small acts. One such pressing challenge is how to feed a growing global population with more than 820 million people going hungry. Smart precision agriculture is one solution and Lundmark mentioned how Nokia's IoT network has

helped 50,000 Indian farmers improve resource efficiency (pesticide, fertilizer, water usage), achieve higher yields and grow high-quality soy and cotton crops.

Lundmark's second big challenge is the transition from fossil fuels to *renewable energy*. To ensure the lights stay on when the sun does not shine, or the wind does not blow, smart power grids are needed for managing that supply meets demand. That will require greater digitalization and automation. The third challenge is how to build a *safer world*. Pekka Lundmark noted, that in critical industries there are still many jobs that come with risks. Mining is one example, where communication technologies, like Nokia's wireless industry-grade networks, help to run fleets of automated vehicles with remote monitoring. In road transport, a new age is beginning with cars connected to each other, and their surroundings, through 5G and edge computing – all this in real-time. These advances could eventually deliver accident-free driving. Currently over 1,3 million people die on the roads globally each year.

Pekka Lundmark did not see that robots and automation necessarily will replace humans, but instead they will assist us and augment our skills so we can achieve more. Nokia expects that 70 percent of all jobs will be reliant on a blend of human and machine skills by 2030.

Robotics

Jamie Paik started by stating that we need softer human-machine interactions. Getting her inspiration from paper *origamis* - the ancient art of paper folding - she and her team have created highly configurable robots – *robogamis*. They are thin, intelligent multi-layered sheets that can fold themselves into many shapes and thereby can crawl, roll and even do gymnastics! Because robogamis can adapt and perform multiple specific tasks and environments, they form a *platform*. Upon this platform, robogamis can be straightforwardly customized, but at the same time efficiently mass-produced. Mass-manufacturing 2D sheets on conveyer belts is much easier and cheaper than mass-producing 3D objects.

Paik stressed that for a robot, interaction with humans is by far the most demanding environment. We humans are highly unpredictable and consist of a variety of biomaterials! This requires that the robots - like a facial prosthesis helping stroke patients - must be highly adaptable. Robogamis can be configured to form sensitive haptic interfaces. When the user has these robogamis on the fingertips, the touch, texture and shape of virtual objects can be felt very realistically. Combined with visual screens, the haptic interface delivers an impressive virtual reality experience to be used e.g. in e-commerce, education and health-care.

Altogether, the customizable robogami platform enables robots to be manufactured in mass-scale; yet filling the personal needs of the individual.

Conclusions of Session 3

Regulation, affordability and inclusivity were seen by both the audience and panellists as the biggest hurdles for adopting new technology. These factors were seen as intertwined; successful regulation enables efficient scaling and affordable products. In the concluding panel discussion, there was a wide agreement on the rules for regulation. They should be simple without too many details, long-term, persistent, predictable and sufficiently open to leave space for researchers and companies to find the right technologies. Over-regulation should be avoided to retain competitiveness and the will to invest. Worrying signs of over-regulation can be seen e.g. within AI.

The panellists were positive regarding the **public acceptance of new technologies** – in some cases the general public is even more ready to go for new technologies than the experts. Bringing in a new innovation culture into companies and organisations is complex, especially in large corporations. Collecting ideas from the

employees, careful hiring of new personnel and clear communication of the purpose of working for a better world were seen as crucial.

CONCLUDING COMMENT EXPRESSED THROUGH ART

The Millennium Technology Prize Award Ceremony the night before ended with Leonard Cohen's song Hallelujah performed by students of Sibelius Academy of the University of Arts Helsinki. In the lyrics there is a sentence "your faith was strong, but you needed proof". The Millennium Innovation Forum was a great endorsement to prove that the humankind can act as one, it can form ecosystems enhanced by digital, and through collaboration and competition continue to innovate, harnessing the power of individual talent to the benefit of everyone.