Capgemini
RESEARCH INSTITUTE

breathe
in(novation)

UNCOVER INNOVATIONS THAT MATTER

Conversations
FOR TOMORROW

Con ver sa tions

FOR TOMORROW
Quarterly review

Innovation should come naturally to today's businesses – as naturally as breathing. Rather than a reactive impulse, stirred only by competition or changes in consumer behavior, innovation should be proactive, anticipating changes in the market. Responsible innovation needs to be at the core of the agile, sustainable mindset required to thrive in the future work environment. The content and design of this issue reflect the new prominence of innovation across all functions of every organization and its ecosystem.

Foreword
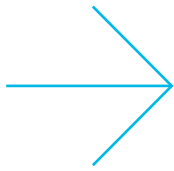
At Capgemini, we believe in helping organizations prepare for tomorrow. By distilling the unique insights and perspectives of leaders from global business, academia, the startup community, and wider society, we hope to do just that.

A 360-degree look at innovation

Through our quarterly journal, Conversations for Tomorrow, the Capgemini Research Institute enables leaders to identify the strategic imperatives for the future of business and the society in which it operates. In this edition, we look at how innovation leaders transform industries – from energy and utilities to life sciences, retail, financial services, and high-tech. We take a 360-degree look at innovation, from religious, scientific, business, and political perspectives, and from a multigenerational viewpoint.

Innovation takes the stage

Innovation has never been more exciting, with so many technologies blossoming to transform the social and business landscapes. Many technologies have moved from the realm of science fiction into the center of technological thinking, with very real implications for businesses. Synthetic biology has the potential to eradicate hunger through developing synthetic "food," and to combat diseases through engineered medicines and gene-editing. The metaverse and Web 3.0 are "reset moments," with the potential to transform industry in the same way that the internet did. Quantum technologies will disrupt the way we compute, communicate and sense, and therefore changes the game for cybersecurity, the discovery of new drugs, and addressing climate change.

The need for innovation has never been greater. Organizations that have hitherto succeeded in planting the seeds of innovation through innovation centers are now having to contend with the headwinds of scaling innovation. Across industries, organizations are now beginning to leverage innovation to address their sustainability, technological and business model challenges.

We would like to thank all the leaders and experts who have enriched this edition of the journal with their insights into innovation. By sharing insights from such a diverse range of accomplished individuals, we aim to help you breathe life into your organization's innovation process and accelerate your journey towards a more disruptive, inclusive, and sustainable future.

Key contributors include:

- **Nobel Prize laureate** in Chemistry 2020

- **Turing Award** winner 2012

- Senior executives from **ENEL, Corning, Deutsche Telekom, H&M, Medtronic, MUFG and Heng Hiap Industries**

- The **European Commissioner** for Innovation, Research, Culture, Education and Youth

- Academics from **Harvard Business School and the Pontifical Gregorian University**

- Venture capital firm **a16z**

- First ever **Time Kid of the Year 2020**

- **Capgemini's** own subject matter experts.

Pascal Brier
Group Chief Innovation Officer, Capgemini

Contents

P. 36

EXECUTIVE **CONVERSATIONS** WITH...

Contents

P.164
PERSPECTIVES FROM CAPGEMINI

P.198
INSIGHTS
FROM THE CAPGEMINI RESEARCH INSTITUTE

Executive Summary

> ❝
> ## People in innovative organizations need to develop a thick skin."
>
> Gary Pisano, Harvard Business School

Innovation used to be somebody's job. Usually, it was someone in the R&D department, who would be given a workspace near the back and would be expected to come up with a few new ideas a year. Over time, innovation has become a function in its own right and one that has a powerful influence on all aspects of business. However, it wasn't until the advent of startups driven by disruptive technology that companies started to accord innovation the status it deserves. Today, innovation is something in which everyone has a stake. It is a function that determines whether an organization survives the next big business-model shift; that allows organizations to meet their sustainability targets; and that prepares the organization to capitalize on a wave of new emerging technologies, such as synthetic biology, the metaverse, quantum tech, blockchain, and more.

Instilling an innovative culture

The first step to becoming an innovative organization is establishing the right culture. Easier said than done. Our research found that 82% of organizations cited culture and mindset change as significant obstacles in achieving agility.[1] Gary Pisano, Professor of Business Administration at Harvard Business School, emphasizes the basics: *"People in innovative organizations need to develop a thick skin. An innovative culture is expected to be fun. I think it can be fun – but it's not purely fun. People want to embrace just a part of it, not the whole thing."*

Marty Curran, Executive Vice-President & Innovation Officer at Corning, highlights a very important part of an organization's innovation culture when he says, *"It's critical to bring bad news to leaders faster than good news."* And it is not just about failure and success; organizations need to find their true north star – to know where they are trying to get to. Francesco Starace, CEO of Italian utilities giant ENEL, puts it this way: *"Innovation means nothing if it doesn't solve a problem, or [at least] offer a marked improvement."* Capgemini's CEO Aiman Ezzat adds an important caveat: *"Getting an innovative culture started is only half the task; maintaining it is the tricky part."*

Two transformative technologies: Synthetic biology and quantum tech

For Frank Chen, Partner, Andreessen Horowitz, [there are] *"two frontier technologies.One is synthetic biology. And the other is quantum computing."*

It's all ATCG and synthetic biology

Ten years ago, two scientists – Emmanuelle Charpentier and Jennifer Doudna – published the test results of an innovative experiment on bacterial genes. Today, the CRISPR gene-editing tool that arose from that experiment is regarded as one of the biggest biological breakthroughs in recent scientific memory. Jennifer Doudna and Emmanuelle Charpentier received the Nobel Prize in Chemistry in 2020 "for the development of a method for genome editing". Jennifer Doudna, Nobel Prize laureate and co-inventor, Professor at the University of California, Berkeley, USA, explains the importance of CRISPR: *"It is important to remember that what we're talking about here is effectively changing evolution."*

Amy Webb and Andrew Hessel, co-authors of The Genesis Machine (2022) make it succinctly clear that everyone should be paying attention to synthetic biology: *"We can now program biological systems like we program computers."* The possibilities arising from DNA editing are limitless. From eliminating diseases to mitigating the impact of climate change through next-generation seeds.

Mike Dunkley, Senior Vice President, Bioinnovation, and Karen Weisinger, Head of Cell Biology, US, at Cambridge Consultants, part of Capgemini Invent, add: *"Bio-based breakthroughs could rise to humanity's most pressing challenges, such as climate change, sustainability, and food and water security."* From a business standpoint, Capgemini's Ezzat emphasizes the importance of this exciting area: *"We are barely scratching the surface when it comes to synthetic biology. The possibilities … are limitless; and we are looking at a trillion-dollar market, ripe for disruption."*

The development of such potential requires strong oversight. Religious leaders are actively tracking the space. Father Paolo Benanti, Professor at Pontifical Gregorian University and technology advisor to the Pope, adds: *"We must develop a 'guardrail' to keep technological development on track … there are experiments using synthetic biology to augment humans. As well as the possibility that this could give rise to sinister inequalities, there is also the problem of poorer countries again becoming experimenting grounds for rich countries."*

> ## " I see two frontier technologies. One is synthetic biology. And the other is quantum computing."

Frank Chen, a16z

---

1.   Capgemini Research Institute, "Agile at scale – Four ways to gain enterprise-wide agility," November 2019.

The transformative nature of quantum technologies

Quantum technologies promise exponential speed-up vis-à-vis the best available supercomputers, tap-proof communications, and ultra-precise and fast measurements – a phenomenon commonly known as the 'quantum advantage' – over classical systems that are in use today. Such technologies can bring a huge shift in the way in which businesses solve problems around optimization, mechanical simulation, and machine learning. Quantum can bring greater efficiencies than current technologies in risk management, cybersecurity, logistics, scheduling operations, discovery of lightweight materials or new drugs, and addressing climate change, among other areas. Alan Boehme, CTO, H&M Group sums it up aptly: *"Generally, I see, quantum is going to change all kinds of things, from security to quantum for computers – just the ability to process things is mind-blowing."*

Innovation to help the planet

As consumer preferences shift, organizations are prioritizing sustainability-focused innovation. But more work needs to be done; according to our research, fewer than one in three manufacturing organizations have internal alignment on sustainability priorities.[2]

2. Capgemini Research Institute, Sustainable operations – A comprehensive guide for manufacturers, June 2021.

Claudia Nemat, Member of the Board of Management, Technology and Innovation at Deutsche Telekom, believes technology to be our only route to a sustainable planet: *"Without digital technologies, we would never be able to become a carbon-neutral society."* Mariya Gabriel, European Commissioner for Innovation, Research, Culture, Education, and Youth, agrees on the geosocial importance of technology: *"One of my main priorities is to focus on deep-tech innovations that target global challenges, from limitless energy production to sustainable construction, to efficient agriculture and food production."*

Silvio Micali, recipient of the Turing Award in Computer Science and founder of Algorand, emphasizes the need for sustainable digital technologies: *"We have a moral obligation to the planet, and that includes creating a blockchain that brings advantages without wasting energy. Global, borderless, open-source technologies must consider their impact on the environment."*

Sustainable innovation must be scalable innovation

Our research indicates that only 13% of organizations across sectors have successfully deployed AI use cases for multiple business teams.[3] While many large organizations have set up innovation hubs and are partnering with startups, few have looked ahead to the next step. The impact and value of innovation are only fully realized through scaling and adoption. Harvard's Gary Pisano drives the message further: *"Failure to scale is a symptom of the failure of the innovation system. Organizations don't think early enough about the scaling issues, the manufacturing, or the service issues."*

"

It is important to remember that [CRISPR/ gene editing] is effectively changing evolution."

Dr. Jennifer A. Doudna

---

3.   Capgemini Research Institute, The AI-powered enterprise: Unlocking the potential of AI at scale, June 2020.

Francesco Starace
Chief Executive Officer
and General Manager
Enel

enel

in discussion with

The CEO Corner

Aiman Ezzat
Chief Executive Officer
Capgemini

Capgemini

Francesco Starace
Chief Executive Officer and General Manager,
Enel

Francesco has been Chief Executive Officer and General Manager of Enel Group since May 2014. From September 2017 to December 2019, he was a Member of the European Commission's multi-stakeholder platform on Sustainable Development Goals. Since January 2020 he has been co-chair of the World Economic Forum's Net Zero Carbon Cities initiative and, since January 2021, he has been co-chair of the European Clean Hydrogen Alliance roundtable on renewable and low-carbon hydrogen production. Since September 2021 he has been a Member of the Climate and Environment Advisory Council of the European Investment Bank (EIB) Group.

Enel is a multinational power company present in 30 countries worldwide and the largest renewable private player, the foremost network operator by the number of end users, and the biggest retail operator by customer base. ENEL revenues in 2021 amounted to over 88 billion euros with over 66,000 employees.

Aiman Ezzat
Chief Executive Officer,
Capgemini

With more than 20 years' experience at Capgemini, Aiman Ezzat has a deep knowledge of the Group's main businesses. He has experience working in many countries, notably the UK and the US, where he lived for more than 15 years. Aiman was appointed CEO in May 2020. Before that, from 2018 to 2020, he served as the Group's COO and, from 2012 to 2018, as CFO. Aiman is also on the Board of Directors of Air Liquide and is a Member of the Business Council.

Capgemini is a global leader in partnering with companies to transform and manage their business by harnessing the power of technology. Capgemini is a diverse organization of over 340,000 team members in more than 50 countries. The Group reported in 2021 global revenues of €18 billion.

The Capgemini Research Institute spoke to Francesco and Aiman to understand their views on innovation, its role in building a sustainable future, and how organizations can build an innovation culture.

INNOVATING FOR A SUSTAINABLE FUTURE

Enel has brought forward its net-zero target to 2040. Why?

— **Francesco:** Typically, utilities have significant levels of scope 1 emissions. We have a clear trajectory, including a larger share for renewables and phasing out coal and gas. This is already underway. Progress on this front is relatively easy to track and we know that by 2040 – probably earlier – we will have addressed our scope 1 issue.

Then we have to address scope 2 emissions. For us, this is not a significant challenge and involves decarbonizing our offices, looking at the cars our executives drive, things like that.

Scope 3 emissions are mostly related to customers and our supply chain. The most difficult part of mitigating scope 3 emissions is the supply chain. We have around 20,000 suppliers and contractors working for us all over the world – most with no idea of the size of their carbon footprints. There is a lot of educating to be done in this respect. We're asking our suppliers, with our help of course, to implement a program of gradual decarbonization in their operations.

Our scope 3 levels go down when we decarbonize the mix of energy that we produce; we are also in the process of trying to convince about 6 million gas customers worldwide to switch to electricity. We are helping our customers by selling them decarbonized electricity.

The real challenge with the 2040 deadline is not related to our energy generation, nor to our customers, but to the supply chain. It is challenging, but not impossible.

"

The most difficult part of mitigating scope 3 emissions is the supply chain."

Francesco Starace

"

Achieving the necessary dramatic decreases in carbon emissions will require massive investment and a huge creative effort."

Aiman Ezzat

What do you see as being the role of innovation in the transition to sustainability?

— Aiman: Innovation is really one of the keys to a sustainable future. Achieving the necessary dramatic decreases in carbon emissions will require massive investment and a huge creative effort, notably in sectors such as energy, transportation, manufacturing, IT, and agriculture. Because sustainability will require rocket science. Just like vaccination needed rocket science to fight Covid. It will be hard to decarbonize some industries, and we do not have all the solutions today. But if we want to provide the same promise to consumers, we need to completely rethink and reengineer how things work, how businesses are run. Engines, powerplants, planes, cars… Our Fit for Net Zero report lists 55 high-impact technologies that can help Europe meet the 2050 net zero emissions target. Such as smart grids, battery recycling, or agriculture 4.0… It is these kinds of innovations, with both a strong technological content and a clear impact, that can really make a difference.

— Francesco: Regarding the role of innovation at company level, let me remind that our power-generation portfolio was built almost 40 years ago, with views of the world and decisions taken by the communities at that time. We had to overhaul the business model completely using an innovation mindset, putting everyone around this adventure: here the innovation is a key point. It took a while for us to grasp this, but now we are up to speed. The transition to a sustainable world demands this kind of innovation mindset of all traditional energy and utilities providers.

Can you highlight an innovation you are working on that could contribute to a more sustainable future?

— **Francesco:** One recent project aims at manufacturing advanced efficient solar cells, for which we won funding from the European Commission. This project uses a global approach to the eco-compatible design of photovoltaic systems, based on sustainability and circularity, with the goal of reusing a large quantity of materials across the entire value chain. This type of innovation will improve energy yield and costs, helping ensure a clean energy transition and a reduction in the EU's dependence on raw materials supplied from outside of Europe. Now we are innovating some basic concepts of the solar industry – for instance, can we use plastic instead of glass? The former is more resilient, performs better, and is easier to recycle. We are asking, how can it be made lighter and easier to transport? And how can we accelerate the transition to a productive model? Furthermore, we are very active in the energy storage area – either BESS or gravitational storage – which needs to be used for longer times.

— **Aiman:** We are collaborating with clients on several innovations. One example I am proud of is an intelligent data platform we developed to resolve the global food shortage. Global demand for food is anticipated to increase by 60% by 2050; the complex value chain and the lack of resources and connectivity result in agricultural inefficiency. Our platform uses artificial intelligence (AI) to detect farming patterns through big data, generating insights that can then be used as the basis for recommendations.

"

We are innovating some basic concepts of the solar industry – for instance, can we use plastic instead of glass? The former is more resilient, performs better, and is easier to recycle."

Francesco Starace

It collects data from various public and private sources, which it then hosts in a cloud environment, running analytical models there as well. The platform provides data relating to crops grown, potential and realized yields, field perimeters, credit, and repayments. This information is combined with data from the Copernicus satellite. The data and analysis are shown on a dashboard that provides useful insights. For example, farmers can access tailor-made advice to optimize crop production.

CREATING AN INNOVATIVE ORGANIZATION

How do you create a culture of innovation in large organizations?

— **Francesco:** Firstly, eliminate fear of mistakes. You cannot innovate without error. We had to battle against that. Secondly, let's only innovate once we have clearly identified the problem that we need to solve. Innovation means nothing if it doesn't solve a problem or offer a marked improvement.

— **Aiman:** Nurturing an innovation culture is one of the hardest parts of any organization's transformation. Organizations should encourage a culture where employees are empowered to experiment, test, and learn, scaling their ideas at pace. There are several broad actions organizations can take to strengthen an innovative culture. But getting an innovative culture started is only half the task; maintaining it is the tricky part. But it's strategic to attract and retain talent.

> "Innovation means nothing if it doesn't solve a problem or offer a marked improvement."
>
> Francesco Starace

MANAGING THE SKILLS SHORTAGE

How can organizations bridge the skills gap?

— **Francesco:** That's the most difficult problem we have today. The limiting factor for the energy transition is not money or opportunities or the technologies, it's a lack of the right people. You have to find them, train them, organize them, and then they go and work for somebody else. You have to instill your people with a unity of purpose.

There are two aspects to the skills gap. We have skill gaps in some business models, which companies have to fix internally; and then there is a worldwide, societal skills gap in digital capabilities, in particular at management level. In the next 5-10 years, there will be a lot of companies making very hard choices, affecting even good managers; those that fail to grasp the importance of digital going forward will be vulnerable.

— **Aiman:** There is a clear imbalance between the supply and demand of technology skills. Everybody is fishing in the same pool of resources. And I confirm: the lack of digital skills is the number one factor that slows down our economy.

"

Getting an innovative culture started is only half the task; maintaining it is the tricky part."

Aiman Ezzat

"

The limiting factor for the energy transition is not money or opportunities or the technologies, it's a lack of the right people. "

Francesco Starace

We need to invest significantly in upskilling; our eye is on the future, around 5G and edge, quantum computing, and more. Our research shows that less than half of organizations have an adequate supply of digital skills in areas such as AI and ML, or data analytics and data science. While organizations are accelerating their digital-transformation programs, they are not investing enough in upskilling. For example, we launched L'École, a skills-development program, together with leading academic institutions and our top technology partners. The good thing is that today, with digital platforms, we have a nearly unlimited training capacity.

In addition, I believe that we can only address the challenges of tomorrow with a more flexible, more hybrid, more transparent working model. There is no longer a rigid border between the company and the rest of the world. A company is now a platform involving a large variety of stakeholders: employees, freelancers, gigworkers, subcontractors… The workforce is becoming more fluid. Companies need to learn to live with talent ecosystems. You cannot fight what is happening in the market.

What is your top takeaway from the disruptions of the past 24 months?

— **Francesco:** In the past 20 years, global supply chains have not developed in a balanced way. We need more options built into supply chains. And these should not be designed for a perfect world but one that will see more disruptions like those of the past two years. It is important that we look not only at cost efficiency and convenience, but also security of supply and resilience. Going forward, there will be a lot of industrial investments in redesigning supply chains.

— **Aiman:** There are some very clear takeaways. Remote working is here to stay. We pursued the deployment of our "new normal" model, implementing our flex-work policy in most of our countries. Going digital has helped bring more freedom to the workplace and there is also more flexibility in hiring, training, and staffing in a hybrid-work world.

"

While organizations are accelerating their digital-transformation programs, they are not investing enough in upskilling."

Aiman Ezzat
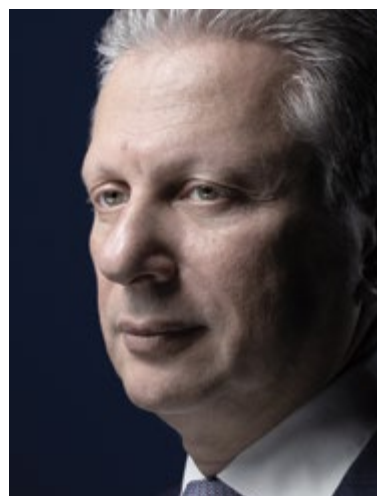
BIOTECH

Which new technology are you most excited about?

— **Francesco:** I think the advances in biotech stand out above everything else. It's due to miracles in biotechnology that we are emerging from the nightmare of the pandemic. Biotechnology can do a lot in the next few years to boost our wellbeing. You might be surprised that I don't talk about energy, but I think, for mankind, biotechnology is much more important.

— **Aiman:** We are barely scratching the surface when it comes to synthetic biology. By giving us the ability to create genomes, synthetic biology allows us to create organisms that can help us achieve carbon-negative status. It can reduce toxic substances in the environment. Today, there are startups looking to lessen our reliance on trees for furniture or turn genetically engineered yeast into environmentally friendly fuel. The possibilities with synthetic biology are limitless; and we are looking at a trillion-dollar market, ripe for disruption.

As CEO, which one piece of advice would you like to share with your peers?

— **Francesco:** Don't look at the energy transition as a future decision; it is happening already, and it is inevitable. Embrace it, because those who do so early on will reap the benefits. Understand the dynamics, the implications, the attributes, and the investments required. Leave denial and accept the future world.

— **Aiman:** To reimagine the future we want, we must act collectively and at scale. And innovation is our only way out. Net zero is a long road that will require deep changes and powerful innovations. But no one can achieve this challenge alone. Solutions can only be cross-industry.

> "A company is now
> a platform involving
> a large variety
> of stakeholders:
> employees, freelancers,
> gigworkers,
> subcontractors."
>
> Aiman Ezzat

Francesco Starace
Chief Executive Officer
and General Manager,
Enel

Aiman Ezzat
Chief Executive Officer,
Capgemini

"Going forward, there will be a lot of industrial investments in redesigning supply chains."

"The possibilities with synthetic biology are limitless; and we are looking at a trillion-dollar market, ripe for disruption."

Inside the mind of a Nobel Prize laureate...

DR. JENNIFER DOUDNA

Nobel Prize laureate and Professor of Biomedical Science, University of California, Berkeley

Conversations
FOR TOMORROW

EVOLUTION 2.0

Innovative
Genomics
Institute

Dr. Jennifer A. Doudna is the Li Ka Shing Chancellor's Chair and a Professor in the Departments of Chemistry and of Molecular and Cell Biology at the University of California, Berkeley. Her groundbreaking development of CRISPR-Cas9 as a genome-engineering technology, with collaborator Emmanuelle Charpentier, earned the two the 2020 Nobel Prize in Chemistry and forever changed the course of human and agricultural genomics research. Dr. Doudna is an investigator with the Howard Hughes Medical Institute, senior investigator at Gladstone Institutes, and the President of the Innovative Genomics Institute. She co-founded and serves on the advisory panel of several companies that use CRISPR technology in unique ways.

UNDERSTANDING CRISPR AND ITS APPLICATIONS

What is CRISPR-CAS9?

— The CRISPR-Cas system, sometimes referred to as "CRISPR" for short, is a technology for editing DNA. It is made of a guide RNA and a Cas protein. The guide RNA leads the Cas protein to a particular DNA sequence. The Cas protein then acts as molecular scissors, cutting the DNA. When DNA is cut, cells initiate a repair process that can change or "edit" the DNA sequence. CRISPR can remove, add, or change DNA "letters." In 2012, I published a research paper together with Dr. Emmanuelle Charpentier that laid out the inner workings of this technology. At that time, it did not attract much attention. Only in retrospect did it become clear to people who weren't specialists what an important moment that was.

> **"CRISPR is a technology for editing DNA."**

Figure 1: How Does CRISPR Genome Editing Work?

SEARCH
1 A CRISPR molecule finds a precise location in the target DNA.

CUT
2 The CRISPR enzyme cuts the target DNA at the point found by the guide.

EDIT
3 A new custom sequence can be added when the DNA is repaired.
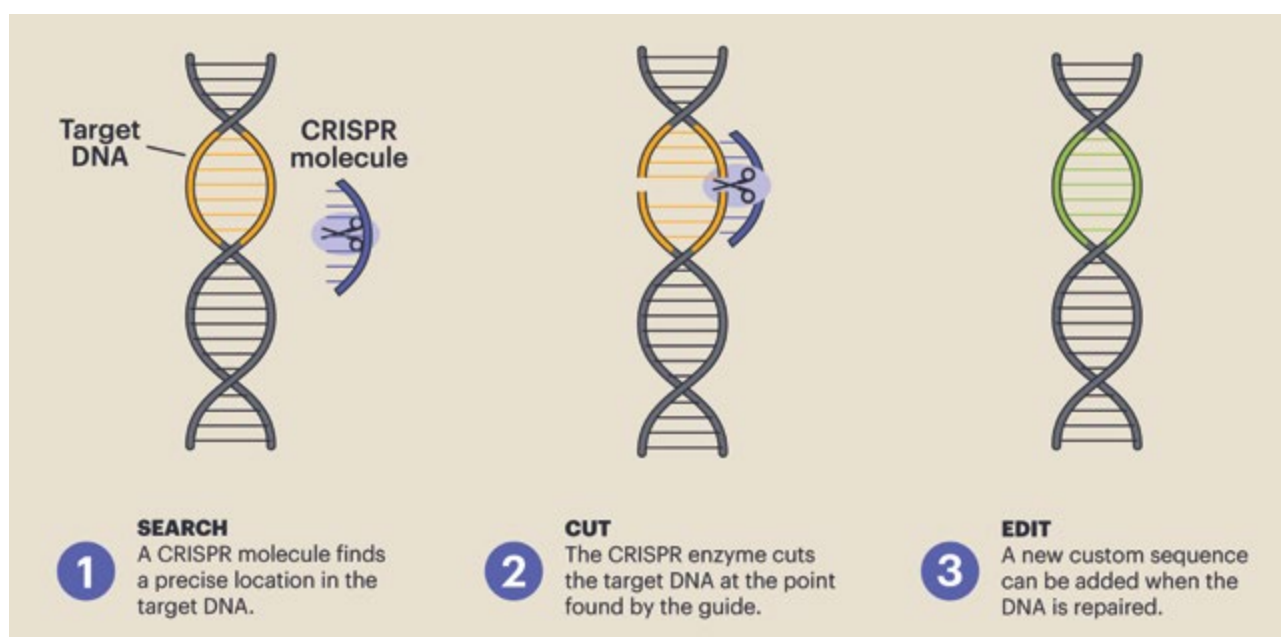
Source: Innovative Genomics Institute

GENE EDITING [CAN BE USED] TO OPTIMIZE PHOTOSYNTHESIS IN CROP PLANTS FOR INCREASED FOOD YIELD AND ENHANCED CARBON CAPTURE.

What real-world examples are we seeing of CRISPR-CAS9 having an impact?

— There are now half a dozen clinical trials of CRISPR therapies for sickle cell disease underway already. I recently spoke to Victoria Gray (the first sickle cell patient in the U.S. to be treated with CRISPR) to hear about her life before and after the therapy. I'll just never forget that moment. For a scientist to see the real-world impact of work they were involved in, there's just nothing like it . To see that real-world impact within 10 years of that original publication? That's just mind-blowing to me.

Can you help us understand how CRISPR-CAS9 helps fix sickle cell disease?

— It's referred to as sickle cell disease because when you look under a microscope, the cells have a classic sickled shape, and people with sickle cell disease make a form of the protein called hemoglobin that carries oxygen in the blood that is prone to aggregation, prone to sticking together and forming aggregates that lead to these sickled shape of the cells. To treat sickle cell disease at its source, what's done is to remove what are called

blood stem cells from an affected individual. These come out of the bone marrow. And they are cells that have the potential to develop into new red blood cells. And to ensure that they don't have the sickle cell trait, CRISPR can be used to either change the DNA of the affected gene, or they can actually suppress the effects of the sickle cell gene mutation. And that's what's done. So CRISPR is used to make those changes in blood stem cells, and then the edited cells are infused back into the patient where they can repopulate the bone marrow and effectively replace the red blood cells with corrected cells. And if this works well and is proven safe, then it is a great solution to genetic diseases that have hitherto been transferred from generation to generation.

CRISPR FOR A BETTER WORLD

How can CRISPR-CAS9 be used for helping cut down carbon emissions?

— At the Innovative Genomics Institute (IGI) that I founded, we are working on using genome engineering to help agriculture adapt to a changing climate . While we have viable solutions for reducing greenhouse gas emissions for many sectors, agriculture stands out as a glaring exception, and it accounts for nearly a quarter of all global emissions. Plants and microbes can be part of the solution, versus part of the problem, and genome engineering can help make this scale to meet the size of the challenge. We currently have a variety of ongoing projects in this area:

- Using CRISPR genetic screens and gene editing to optimize photosynthesis in crop plants for increased food yield and enhanced carbon capture.
- Gene stacking in rice to reduce pesticides and fertilizers. We are also using gene editing to develop drought-tolerant plants.
- Investigating the effect of rice root system architecture on microbes that could reduce methane emissions.
- Genomic and chemical analysis of the soil microbiome of rice paddies, with the ultimate aim of optimizing more long-term carbon storage in the soil and reducing greenhouse gas emissions.

Together, these projects aim to realize a vision of a net-zero farm that maintains food security with reduced input from farmers and greenhouse gas emissions, and use farming to capture and store more carbon from the atmosphere.

How can gene editing be used to help reduce poverty and malnutrition?

— One in four people globally, and rising, are unable to afford a healthy diet. COVID-19 has exacerbated this trend by disrupting food production and distribution, driving up by 20 percent the number of people threatened by hunger in 2020. The pandemic is unfolding amidst an environmental and climate crisis which is undermining food production and our ability to nourish the world. The IGI recently partnered with CGIAR, the world's largest publicly-funded agricultural research partnership, to harness the power of science to help millions of people overcome poverty, hunger, and malnutrition. The IGI is testing technologies with great potential to benefit people in the countries where CGIAR is active, such as a way of removing the cyanide found in cassava[1] and fighting diseases in economically important crops like wheat, rice, and bananas. We are using technologies such as gene editing to accelerate the development of more disease-resistant, water-efficient varieties that can improve food production and nutrition in areas that are especially vulnerable to climate change.

1   A staple upon which nearly a billion people depend.

"There are now half a dozen clinical trials of CRISPR therapies for sickle cell disease underway already."

THE ETHICS OF GENE EDITING

What do you think is the future of biology and CRISPR?

— There's a lot of evidence that we're entering an era in biology in which we have increasingly, at our fingertips, a collection of tools that allow manipulation of biological systems in controllable ways. Those capabilities will advance, the kind of things that have only been dreamt of in biological systems to a point where we can actually achieve them. Imagine that someone gets a diagnosis for a condition. They could have gone to a company like 23andMe or Color Genomics, and they have their DNA sequenced. And the result comes back that they have susceptibility to Alzheimer's disease in the future. Today, that kind of information is not directly actionable. Whereas imagine in the future, it's possible to use a technology like CRISPR to change those genetics so that that person no longer has that susceptibility. That would be extraordinary if we get to that point. Will we get there in 30 years? I don't know, but I think it's entirely possible that we will.

"

Imagine in the future, it's possible to use a technology like CRISPR to change those genetics so that that person no longer has that susceptibility [to Alzheimer] "

What worries you most about the transformative impact of CRISPR?

— It is important to remember that what we're talking about here is effectively changing evolution. It's changing us at our core and going back to the instruction manual that makes us who we are and making changes there. When we talk about it in the context of a disease like sickle cell disease that is so debilitating, it certainly seems like this might be something that some families might want to consider eventually, especially if the technology is vetted carefully and shown to be safe. But the broader issue really is equity, access to technologies. Who decides about something like that, something as profound as that? Who pays for it? Who has access to it? I think it gets complicated quickly. In a most extreme case, you could imagine that someday, couples, go to an in vitro fertilization clinic, and they receive a menu? And they can decide what types of traits they want for their children. This raises a number of ethical questions that we have to carefully consider. And this is why I and my colleagues have called for a global pause in any clinical application of the CRISPR technology in human embryos, to give us time to really consider all of the various implications of doing so.

So, is there any solution? How can we prevent this worst-case scenario?

> **"A global pause in any clinical application of the CRISPR technology in human embryos gives us time to really consider all of the various implications of doing so."**

— By 2016, the US Government had designated gene editing as a potential weapon of mass destruction . The same year, the Defense Advanced Research Project Agency (DARPA), set up a program called Safe Genes which had a goal of building tools to counter bioterrorism threats including weapons that employ CRISPR itself. That solution lies in what's called as anti-CRISPR molecules that nullify the effects of CRISPR. My team and I are investigating the development of novel, safe gene editing tools for use as antiviral agents in animal models, targeting the Zika and Ebola viruses. As part of the DARPA project, we are also aiming to identify anti-CRISPR proteins capable of inhibiting unwanted genome-editing activity, while developing novel strategies for delivery of genome editors and inhibitors.

THE BROADER ISSUE REALLY IS EQUITY, ACCESS TO TECHNOLOGIES [SUCH AS CRISPR]. WHO DECIDES ABOUT SOMETHING LIKE THAT, SOMETHING AS PROFOUND AS THAT? WHO PAYS FOR IT? WHO HAS ACCESS TO IT?

WOMEN IN SCIENCE

You and Emmanuelle Charpentier are among the very few women recipients of the Nobel Prize. What are your views on women in science?

— It's important for young girls and women to be able to see themselves as a scientist. When I was growing up, it was a woman scientist researching cancer who redefined my image of a scientist and inspired me to pursue my passion for chemistry, despite being discouraged from it by many others. We need to celebrate the contributions of women researchers, mathematicians, and engineers to encourage more women to pursue careers in science by underscoring the fact that science is a field where women can thrive and where we belong.

You work with supporting women in science. Can you elaborate on that?

— A recent Harvard Business Review study found that female founders in biotechnology only received 2.3% of venture capital funding in 2020 . I've found being an entrepreneur in the biotech world incredibly exciting and rewarding. But too few women have the opportunity to become entrepreneurs, even though a lot of the needed innovation today is coming from women researchers. If women have the dream of founding a company based on their research, the barriers that stand in their way need to be removed. At the IGI we recently announced the launch of the Women in Enterprising Science Program. The objective is to support aspiring entrepreneurs seeking to translate genomics research into impactful solutions to real-world challenges and advance the representation of women founders in biotechnology.

Is there anything that you wish the general public understood better about the science that you've developed?

— I think it's important to understand that technologies like CRISPR, more often than not, come out of fundamental curiosity-driven science. So, it really is important to support that kind of work, in concert with people that are taking those discoveries and applying them. Something like this doesn't just get created. It has to be uncovered by a more stochastic process of fundamental science.

"

Technologies like CRISPR [...] come out of fundamental curiosity-driven science."

Dr. Jennifer Doudna
Nobel Prize laureate and Professor of Biomedical Science, University of California, Berkeley

"Female founders in biotechnology only received 2.3% of venture capital funding in 2020."

Conversations
FOR TOMORROW
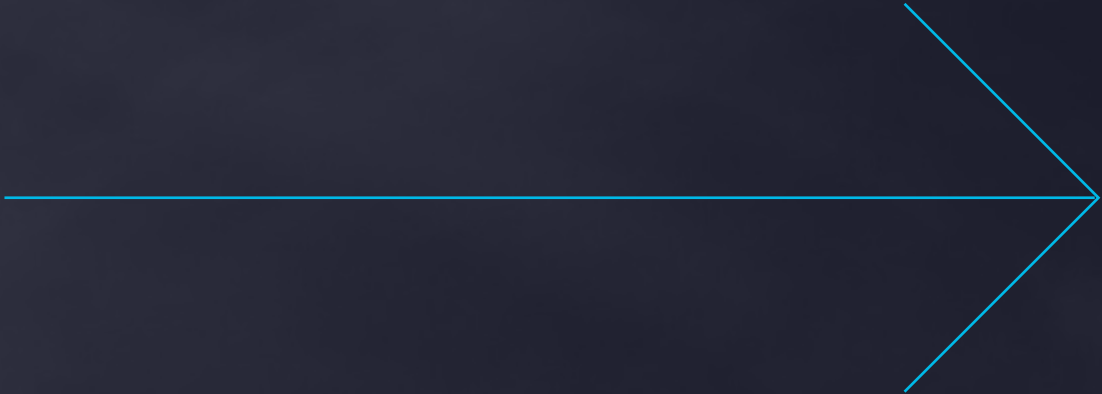
Executive conversations with...

DEUTSCHE TELEKOM AG
Claudia Nemat
**Member of the Board of
Management, Technology and Innovation**
→ **p.38**

H&M GROUP
Alan Boehme
CTO
→ **p.48**

EU
Mariya Gabriel
**European Commissioner for
Innovation, Research, Culture,
Education and Youth**
→ **p.58**

**PONTIFICAL GREGORIAN
UNIVERSITY**
Paolo Benanti
**Professor, Faculty of Theology,
Department of Moral Theology**
→ **p.70**

**HARVARD BUSINESS
SCHOOL**
Gary Pisano
**Harry E. Figgie Jr.,
Professor of Business
Administration**
→ **p.80**

MEDTRONIC
Mei Jiang
SVP, Global Digital Innovation
→ **p.90**

ANDREESSEN HOROWITZ
Frank Chen
Partner
→ **p.100**

CORNING
Martin Curran
**Executive Vice-President &
Innovation Officer**
→ **p.110**

**MITSUBISHI UFJ
FINANCIAL GROUP**
Masakazu Osawa
**Group Head, Digital Service
Business Group &
Group CDTO**
→ **p.120**

38

CLAUDIA NEMAT

Member of the Board of
Management, Technology and
Innovation

Deutsche Telekom AG

BUILDING THE INNOVATIVE TELCO OF THE FUTURE

Deutsche Telekom is one of the world's leading integrated telecommunications companies, with some 248 million mobile customers, 26 million fixed-network lines, and 22 million broadband lines. Deutsche Telekom is present in more than 50 countries with a staff of 216,500 employees. In 2021, Deutsche Telekom generated net revenue of EUR 108.8 billion.

Claudia Nemat has been a member of Deutsche Telekom's Management Board since 2011. Since January 2017 she has been responsible for the Board area "Technology and Innovation", which includes networks, IT, products, as well as information and cyber security. She focuses on digital transformation, the impact of new technologies like artificial intelligence on business models, our work and lives, technology and product innovation, as well as IT transformation, security and crisis management.

INNOVATION IS NOT A DEPARTMENT, BUT A CULTURE, AN ATTITUDE.

Could you elaborate on your current role and responsibilities at Deutsche Telekom?

— I'm the Executive Board Member for Technology and Innovation at Deutsche Telekom. I have accountability for the entire group IT function, central product development and innovation, group technology, supply chain, vendor management, and all international technology delivery functions, as well as cybersecurity and defense.

Claudia Nemat
Member of the Board of
Management, Technology
and Innovation
Deutsche Telekom AG

INNOVATION ARCHITECTURE AT DEUTSCHE TELEKOM

Can you explain how innovation is governed at Deutsche Telekom?

— First of all, innovation is not a department, but a culture, an attitude. The most important element is to have an environment in which people feel encouraged and supported in pursuing new paths. During the past few years, we have transformed the organization from being hierarchical towards being leaner and agile. Of course, this is an ongoing process, and we need to continue to work on it.

Second, in order to prioritize resources and react quickly to developments, we have established committees that assess funding requests as a priority, depending on achieved milestones and relevance of proposals.

Third, across Europe, in the US, and in Israel, we have set up partnering and venturing organizations to scout for new business and technology partners. We have also created our own incubator – hubraum – and we have our T-Labs research organization that collaborates with academics around the world. Finally, Deutsche Telekom Capital Partners (DTCP) manages around $1 billion for Deutsche Telekom and other institutional investors and has a portfolio of more than 60 businesses. DTCP pursues two investment strategies: growth equity in Europe, the US, and Asia, and investment in digital infrastructure in Europe. It acquires shares in companies that are in the growth phase and supports their development with a view to selling its stake for a profit later on. DTCP also plays an active role in establishing mutually beneficial business relations between the innovative portfolio companies and Deutsche Telekom and other partner corporations.

"

In order to prioritize resources and react quickly to developments, we have established committees that assess funding requests as a priority."

How has the pandemic affected innovation at Deutsche Telekom?

— The pandemic was a big challenge, but also a learning opportunity. One very positive effect was that it accelerated digitization. It also underlined for us that the future of work is hybrid; recognition of this is important for cultural coherence. However, it also made clear that complex problems can be solved only in face-to-face meetings, rather than online. But that does not mean that we need to be in the office five days a week. We all need to be more flexible and output oriented. The pandemic has shown us that we can change and adapt. Interestingly, it has also demonstrated the positive impact of these changes on decarbonization: in principle, if we are all more engaged in hybrid working and living, there will be less traffic and, consequently, fewer CO_2 emissions.

But let's be frank. The pandemic has also shown us what is missing from digitization in terms of tackling real-world challenges. For example, schools could not operate virtually during lockdown in the same way that businesses could. As in any crisis, resilience is paramount. And, in order to be resilient in the future, we have to invest in certain capabilities now.

Where does Deutsche Telekom stand on open innovation models?

— We believe in openness, interoperability, inspiration, collaboration, and sharing. We believe that the future of the telco industry will be built on open, disaggregated, and "softwarized" infrastructure.

How do you scale innovation from lab to market?

— In the past five years, we at Deutsche Telekom have switched priorities. Number one is: start small and get early feedback from customers. We had to get away from spending months and months on creating plans in PowerPoint, planning everything in detail, and then building up an organization that is dramatically oversized.

Then, it is very important to analyze the customer feedback; for instance, to look at the Net Promoter Score of a product. Do our customers really have a good experience? From the very beginning, together with our NatCo companies across Europe, we agree on priorities and joint objectives in terms of scaling. For instance, when we develop a router operating system, what is our target in terms of homes where that is implemented by year-end? Without the markets agreeing on scaling parameters, this would not work. It's not perfect yet but we have more and more success stories.

How do you promote a culture that motivates employees to innovate?

— As I said earlier, innovation is not a department. It's a mindset and a culture that runs through the company. You find innovation everywhere.

I also believe it is not about motivating people to innovate, it's about making them feel free to do so. We must create boundary conditions, which give space for outside-the-box thinking, giving people some money to play with. Conditions in which the focus is clear and where failure is accepted. We have created a fluid, modern setup called a Chapter Tribe organization. Under these conditions, all employees within the IT, product, and central technology units are allocated to capability chapters, and from there assigned to projects. If a given project doesn't fly, the individual can move on to a different one. This model creates a culture of psychological safety, which I believe is critical.

INNOVATION AND SUSTAINABILITY

What is the role of innovation in improving sustainability?

— It is key. Let me touch on green sustainability first. Without digital technologies, we would never be able to become a carbon-neutral society. Think about hybrid work. Think about technology like IoT that allows targeted application of fertilizers, for example. Think about the need to measure CO_2 in supply chains. We obviously need digital technologies, but technology alone will not solve all our problems.

Innovation is necessary, but is not sufficient. In Germany, we sometimes have this ideological fight about whether innovation is driving us towards sustainability or if it is about changing our usage patterns and agreeing to change certain practices. I guess the honest answer is: it's both. It's about innovation, but it's also about changing our habits. It's the combination that will enable us to save our planet.

> "Without digital technologies, we would never be able to become a carbon-neutral society. Think about technology like IoT that allows targeted application of fertilizers, for example. "

> "Sustainability is about innovation but also about changing our habits."

FUTURE OUTLOOK

What will the telco of the future look like?

— It will be software-defined, and it will put human beings into the center of what it does. It will be a telco that is guided by the commitment to do things that are good for human beings. It is very important to establish a governance system built around stakeholder value, rather than purely shareholder value. For the tech community, we need a strong commitment to humane, ethical technology development.

From a technology perspective, the future production model will follow a template of rigorous automation, supported by cloud-native principles. It will be data-enabled, based on algorithms. And it will be more disaggregated than today; it will be a more open ecosystem, with – I hope – more relevant innovation. But that is just the logic in the production model. If we think further into the future, I would expect networks of networks to develop, almost like organic mechanisms, like our human brain. The networks would need to function like our brains function: fully autonomous, but deeply reactive towards the application it serves. A sensing and self-healing network that can quickly adapt to different and new requirements.

"
[The future network]: A sensing and self-healing network that can quickly adapt to different and new requirements."

Which technology will have the most lasting impact on our society in the next five years?

> **In the next decade, I see mass democratization of services. "**

— Any technology that helps us to deal with the big issues: radical decarbonization, managing future pandemics, or combating cancer. In the next decade, I see mass democratization of services. Historically, only wealthy people had their own drivers, or kitchen help, or gardeners, etc. In the future, autonomous machines and robots and sensing networks will make those services available to everyone. We saw this in the last century with the invention of tools such as the washing machine, which freed our grandmothers from washing everything by hand.

Looking into the future, will these innovations necessarily lead to a better world? No. It is up to us to make the most of the opportunities and the extra time. My utopian vision is that we use it empathetically, to take care of each other. And to learn and get smarter. I believe the future can be bright, if we want it to be.

What would be your top three recommendations to help organizations become more innovative?

— First, advice for leaders: don't take yourself too seriously! Second, understand that the aim is not to invent everything yourself but to create an environment that fosters risk-taking and entrepreneurship. And, last but not least, I would say: be curious, look outside, get to know other companies, other countries, other people. Never stop being curious! And humor always helps.

NEVER STOP BEING CURIOUS!

Claudia Nemat
Member of the Board of
Management, Technology and
Innovation
Deutsche Telekom AG

"Historically, only wealthy people had their own drivers, or kitchen help, or gardeners, etc. In the future, autonomous machines and robots and sensing networks will make those services available to everyone."

ALAN BOEHME

CTO

H&M Group

THE METAVERSE BECKONS

H&M Group

Alan is the CTO for H&M Group and is responsible for the digital transformation and technology direction for the company on a global basis.

H&M Group is a family of brands and businesses present in 76 markets with net sales of over $19 billion in 2021. H&M Group's business idea is to offer fashion and quality at the best price in a sustainable way.

"

H&M also opened its first-ever virtual showroom […]. Inside the virtual showroom people can walk around, talk to other guests, and view the virtual collection."

What are the most significant innovations that you have seen in the fashion industry recently?

— There have been some great enhancements to the customer experience. We are piloting tech-enabled in-store shopping solutions to provide visitors with seamless payment options and personalised styling recommendations in our COS stores in the US. For example, at our COS store in Beverly Hills, California, fitting rooms are equipped with smart mirrors that recognise products brought into the room (e.g., item, size, and colour) with the possibility to offer personalised product and styling recommendations. When the customer requests an item through the mirror, the sales advisor locates the item and brings it to the customer's fitting room.[1]

H&M also opened its first-ever virtual showroom with the launch of the Cherish Waste Collection. Most of this is still a sandbox, I'd call it an extension of traditional advertising. Inside the virtual showroom, people can walk around, talk to other guests, and view the virtual collection. You can try clothing on your avatar. You can explore some things for fun, but it's almost got that video-game vibe. It will be interesting to see when this becomes part of day-to-day commerce.

Alan Boehme
CTO, H&M Group

1.H&M Group,"H&M Group explores tech-enabled shopping experiences in US stores", May 2022

There are also interesting innovations in the provenance and traceability of goods. The whole concept of smart contracts, guaranteeing traceability, is very important. If you want to deal with organics or recycled products, you need to be able to prove the lifecycle. Technology can help us keep up with the huge volume of information about consumers and supply chains and make real-time automated decisions on everything from product allocation to store merchandising.

How do you think the advent of the metaverse could change the fashion industry?

— The groundwork for the metaverse was laid during COVID-19. It spread from gaming into the fashion industry. All brands should take into consideration that our younger generation of consumers, the children, have already incorporated a lot of technical capabilities into their lives. The metaverse is already part of their day-to-day. So, we too will need to meet our customers where they are.

The metaverse will really take off when we understand what that means and how this influences what we buy. How easily people accept the metaverse will also depend on the interactive devices of the future; for example, the goggles are still a little clunky. But, as various interactive methods become available, there'll be greater adoption, and virtual will be an increasingly important complement to the omni experience.

"How easily people accept the Metaverse will depend a lot on the interactive devices of the future."
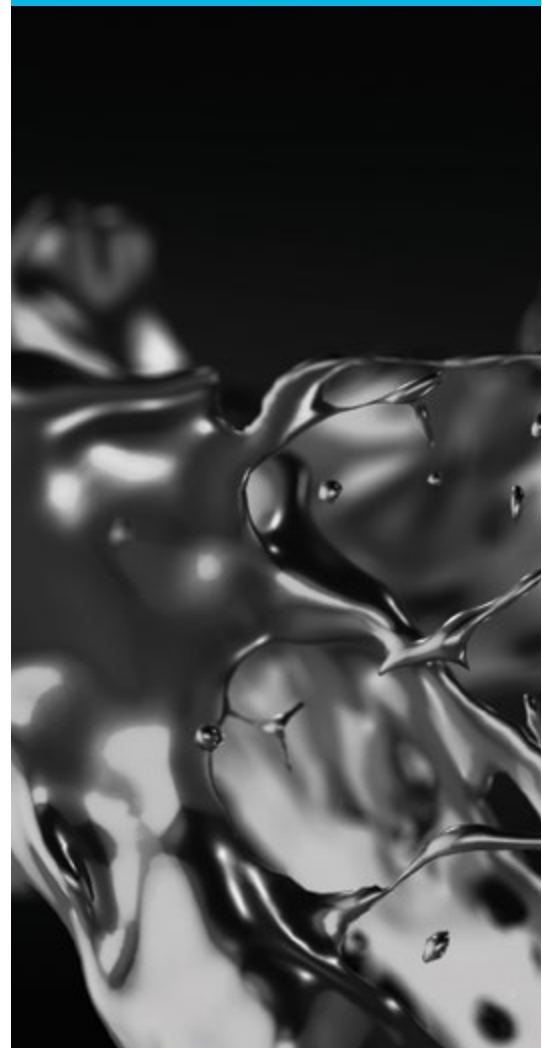
How would you visualise the industry five years from now?

— Web 3.0 is a reset moment for businesses and consumers alike and has the potential to change the way people express their lifestyles, interact with each other and shop. It will evolve much faster because everything can be done in virtual, simulated and physical worlds wherever the customer wants to be. Web 3.0 is the evolution towards a decentralised internet that is built on distributed technologies.

For example, Web 3.0 brings immersive experience in the form of the metaverse where you can aspire to assume the persona of anyone you want, in any virtual world. In addition, people will be able to reimagine and visualise themselves and share it with their friends to understand their friends' thoughts regarding their new look and try it out before buying.

"Web3 is a reset moment and has the potential to change the way people express their lifestyles."

The acceptance and use of the new technologies and creative content by the consumers will create new business and consumer interaction opportunities for organisations. This means companies will evolve into a mindset of operating anywhere, anytime and in any place and any space.

What is the innovation governance setup at H&M Group?

— You want to channel innovation, not govern it. I don't know any successful startup that governed what they were doing. They just had an idea that they were able to get people excited about.

At H&M Group, we look at different opportunities. We test, learn, and iterate to grow. We celebrate failure as much as we celebrate success, and we celebrate speed above everything else. This is channeling.

How do you scale innovation across the entire organisation?

— Labs are good to test and try, but the real innovation comes when you put it in the field, run real customers through it and potentially earn revenue. You get real feedback, understand the use case, and then scale it. Once you see it working, and have the support from your teams when they see, feel, and touch it, it'll scale naturally.

When you start seeing a repeatable pattern, you make your business case. Then, you just go. Successful innovation can't be imposed on people; it happens when people pull it towards themselves.

How is H&M Group approaching collaboration and open innovation?

— For us, collaboration and open innovation are crucial to build the most impactful ecosystem and to achieve our 2030 goals for people, the planet and growth, which are to double sales while at the same time halving our carbon footprint and exceeding profitability 10 percent over time.

To support our company goals, we place a lot of emphasis on collaboration with universities, startups and between our teams internally. We're constantly looking for new approaches to sustainable innovation. We bring creative minds together through competitions, hackathons, round tables etc. This helps us have diverse perspectives and do a lot of listening.

This isn't just about competitive advantage, we are here to grow in meaningful ways. The more we grow, the bigger the difference we can make for the industry.

> **"Successful innovation can't be imposed on people; it happens when people pull it towards themselves."**

How are innovative circular business models like resale platforms, rental services and subscription services transforming H&M Group?

— The reality we continue to face is that we are living on a planet with limited resources, threatened by a climate crisis and increasing waste. The industry can't continue in the same way – to us it is clear that the way we produce and consume has to change. Currently, less than one percent of the material used to make clothing is recycled into new garments.

H&M Group has a big role to play as a global fashion retailer, and we have taken several steps in transforming our business to become circular and to reach our net-zero ambitions (Climate - H&M Group (hmgroup.com)). Technological innovations are crucial to enable circular business models.

For example, we are using existing clothing and textiles more, recirculating them through repair, reuse and remaking before increasing the recycling rate of used textiles.

Rental Services: We are offering customers the opportunity to rent occasional wear. Customers book an appointment in the store to view available garments. This is currently available in selected H&M stores in the Netherlands, Sweden and Germany.

Resell Services: We have also invested in Sellpy – a platform helping consumers buy and sell pre-owned items, thus giving these items a new life. We are offering this service to our customers in 24 markets at present.

Recycle Services: H&M's Looop machine is another good example of how tech, creativity and innovation help us engage with our customers in different ways. Bringing them closer to a textile recycling process that usually happens behind closed doors. H&M in Stockholm offers customers the possibility to transform their old clothing into new fashion favourites. The Looop visualises for customers how old textiles hold value.

Which technology of the next five years do you think will have a lasting impact on our society?

Generally, I see, Quantum is going to change all kinds of things, from security to quantum for computers – just the ability to process things is mind-blowing. Miniaturisation fascinates me; I've seen a lot that will help the medical profession. The third thing is the speed at which communication technology is progressing. It's not even 5G anymore. We're now going beyond that, just the speed at which we can process things.

I'd say it will not be one but many different technologies that will impact our society. A lot of technological discoveries will be made in the areas of sustainability that will have far-reaching impacts across industries, especially the fashion retail industry, people and the planet as a whole.

Alan Boehme
CTO, H&M Group

"Generally, I see, quantum is going to change all kinds of things, from security to quantum for computers – just the ability to process things is mind-blowing."

58

MARIYA GABRIEL

European Commissioner for
Innovation, Research, Culture,
Education and Youth

TURNING THE EUROPEAN UNION INTO AN INNOVATION POWERHOUSE

European Commission

The European Commission is the EU's politically independent executive arm. It is alone responsible for drawing up proposals for new European legislation, and it implements the decisions of the European Parliament and the Council of the EU.

Mariya Gabriel is the European Commissioner for Innovation, Research, Culture, Education and Youth. Under her leadership, the new Horizon Europe, Erasmus+, and the cultural strand of Creative Europe programmes are being implemented. Between 2017 and 2019, she was European Commissioner for Digital Economy and Society. She has been elected as Member of the European Parliament in 2009, 2014 and 2019.

Could you elaborate on your key priorities as European Commissioner for Innovation, Research, Culture, Education, and Youth?

— The areas and programmes under my responsibility embody both the talent and heart of Europe. Taken together, they can have a real positive impact on the businesses, as well as on the daily lives of citizens in all regions across Europe. Since the beginning of the mandate, with my team, we are working for a true European Education Area, a renewed European Research Area, an innovative and modern digital education that leaves no one behind, and a stimulating innovation ecosystem in which creativity, innovation and businesses can thrive.

One of my main priorities is to focus on deep-tech innovations that target global challenges, from limitless energy production to sustainable construction, to efficient agriculture and food production.

We ensured that the EU has the largest programmes, in terms of budget and time duration, like Horizon Europe (95.5 bn EUR) and Erasmus+ (28 bn EUR), which can turn our ambitions into joint actions and deliver with impact.

The new European Innovation Agenda adopted in July 2022 will create a true pan-European innovation ecosystem to ensure Europe becomes a global powerhouse for innovation, startups and talents. We focus on crowding in private investors and on creating networks of networks to build a true pan-European innovation ecosystem.

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

Finally, with my team, we place excellence at the centre of our knowledge, with our aspiration to ensure access for all regions and citizens. This is crucial for making the EU more competitive and a leader in science and innovation.

What are the objectives of the EU Commission when it comes to innovation?

— Our goal is to help researchers and innovators in the most efficient way possible, to ensure they reap the greatest possible benefits. Compared to Horizon 2020, the number of Horizon Europe Partnerships has been reduced, from 135 to only 49. The intention is to be more strategic in selecting our investments and to have greater impact on technological challenges, such as developing a clean hydrogen supply or innovative medicines.

The European Commission is also looking for an innovative way to approach policymaking. Our Horizon Europe Missions embody the concept that research and innovation continuously shape our everyday lives and our future – and that we, as stakeholders and citizens, can have a say in the process.

One of my main priorities is to focus on deep-tech innovations that target global challenges, from limitless energy production to sustainable construction, to efficient agriculture and food production."

Innovation as a topic is associated more with private firms, startups, and academia. How is government policy pushing the innovation agenda?

— Government policy is essential in creating a favorable ecosystem for innovation stakeholders in terms of regulations, incentives, and funding. Government policy is also important in guiding innovation towards policy objectives and desired societal goals. We need to remind new innovators that, above and beyond the profit motive, there is a broader societal landscape to consider.

At EU level, we are working on one hand to provide a favorable regulatory framework for startups and scaleups, and on the other hand to ensure that innovation ecosystems provide sufficient support to innovators.

Why is innovation important for the EU Commission specifically?

— Europe is a recognized global scientific powerhouse, but we need to strengthen further our innovation potential to transform research outputs to marketable products. The green and digital transitions are key priorities that drive innovation to the forefront of political discourse. The Commission sees innovation as the key to a sustainable future.

"We need to remind new innovators that, above and beyond the profit motive, there is a broader societal landscape to consider."

Con
ver
sa
tions
FOR TOMORROW

63

Is Europe investing enough in innovation?

— Three factors must be considered: investments in innovative startups; investments in the underlying education system; and investments in science.

In terms of startup investment, 2021 was a remarkable year in Europe. Private funding has tripled from last year, and unicorns [startups valued at €1 billion or more] have proliferated.

In terms of education, the New Universities Strategy encourages continuous investment in European education systems, mobilizing €80 billion for higher education in the EU. In response to the COVID-19 pandemic, the EU is channeling more funds than ever into education and training, with around €50 billion of the EU's NextGenerationEU recovery fund dedicated to the sector.

"In terms of startup investment, 2021 was a remarkable year in Europe. Private funding has tripled from last year, and unicorns [startups valued at €1 billion or more] have proliferated. "

And, finally, in the area of science, in 2020, the EU Member States spent around €311 billion on research and development (R&D). The R&D intensity – R&D expenditure as a percentage of GDP – stood at 2.3 percent in 2020, up from 2.2 percent in 2019, with the goal of increasing to 3 percent of GDP.

"In the area of science, in 2020, the EU Member States spent around €311 billion on research and development (R&D)."

Although Europe is investing significantly in innovation, we can do more. Most importantly, we need to connect the programs dedicated to education, science, and innovative startups.

How is the European Innovation Council (EIC) supporting the growth and commercialization of high-impact technologies in the EU?

— As Europe's flagship innovation program for identifying, developing, and scaling game-changing technologies and innovations, the EIC was created to overcome the major barriers to Europe fulfilling its innovation potential.

The first of these is the 'European Innovation Paradox,' which states that, while Europe is a world leader in science, other regions lead in innovation. In 2022, €350 million will be made available to EIC Pathfinder projects to develop cutting-edge technologies, as well as more than €130 million for EIC transition funding to turn research findings into well-designed innovation opportunities. Startups originating in the EIT have priority access to EIC assistance.

The 'valley of death' is a second barrier for deep tech startups looking to scale up high-risk innovations.[1] The EIC will provide close to €1.7 billion for an accelerator in 2022, with around half of that amount invested in equity via the EIC Fund. The EIC Fund is already one of Europe's leading early-stage

"While Europe is a world leader in science, other regions lead in innovation."

technology investors.

Five EIC-supported startups have already become unicorns, but we want to get more out of the EIC. For this reason, in 2022 the new ScaleUP 100 program will select the 100 most promising scaleups, supporting them in reaching unicorn status by ensuring they have the right connections with investors, customers, industry, and public procurement opportunities.

What are the major focus areas for innovation in Europe?

— Deep-tech innovation will be one of Europe's primary focus areas. We are focusing on deep-tech startups that are trying to solve our most pressing problems in areas such as energy, food security, and the circular economy.

In the New European Innovation Agenda, we have identified five areas: attracting more institutional investment; providing an innovation-friendly regulatory framework; connecting local innovation ecosystems across Europe; enhancing policymaking on innovation at both European and member state level; and strengthening Europe's attractiveness to entrepreneurial talent.

How will the NEIA be working to create a single, borderless market for innovation and technology across the EU?

— The NEIA will work to improve cross-border access to finance for innovative businesses; connect local innovation hubs across national borders, and promote talent mobility across the continent. It will also focus on the Listing Act, which aims to simplify both initial and ongoing listing requirements for companies. This action should facilitate cross-border capital flows, give companies more options for their IPOs, and reduce investor home bias.

---

1 Period in the life of a startup in which it has begun operations but has not yet generated revenue.

The NEIA will also propose actions to increase the inclusion and interconnection of less well represented regions and actors into a more tightly knit European ecosystem, capitalizing on the experience, needs, vision, and perceptions of an increasingly diverse range of people, businesses, and places.

What are the main challenges you face to drive the innovation agenda at EU level? How can we accelerate the pace of innovation in the EU?

— We face several challenges to innovation in Europe. First, there are innovation divides between and within member states that impede a balanced and inclusive social and economic recovery in Europe. Second, European innovation requires the accelerated transfer of new technologies from research to market. Third, there is a lack of risk finance for companies to scale quickly. Finally, internal-market fragmentation and the regulatory burden are another challenge.

One of our most important tasks now is to reverse these trends, boosting Europe's innovation performance, and addressing these long-standing issues. The NEIA aims to position Europe as a leading player on the global innovation scene. It includes five flagship initiatives that will:

- improve access to finance for European startups and scale-ups, for example, by mobilising untapped sources of private capital and simplifying listing rules;

- improve the rules to allow innovators to experiment with new ideas; for example, we are considering the creation of regulatory sandboxes to aid us in our green and digital transitions in areas such as wind, hydrogen, and geothermal energy;

- help create "regional innovation valleys" that will strengthen and better connect our innovation players through Europe, including in regions that need to improve their innovation potential;

- attract and retain talent in Europe, for example by training 1 million deep tech talents, increasing support for women innovators and innovating with start-up employees' stock options;

- improve innovation policy-making through clearer terminology, indicators and data sets, as well as policy support to Member States.

Only by focusing on these five dimensions will Europe become an innovation leader.

What are your thoughts on innovation as a driver of the sustainability agenda?

— Our objective is to deliver an innovation policy that can drive sustainable, resilient recovery and accelerate the green transition. Research and innovation are enablers for key sectors of the European Green Deal – from new energy sources to efficient heating of buildings and creating circular industrial processes, to implementing sustainable transport and mobility and food systems, and defending the biodiversity of our ecosystems. European research and innovation will drive the transformative Green Deal agenda, with 35% of Horizon Europe's budget devoted to climate-related activities.

Horizon Europe EU Missions are set to deliver concrete results by 2030, four of which will address key Green Deal areas: adaptation to climate change; restoring our oceans and waters; the transition towards healthy soils; and the highly ambitious Cities Mission, aiming to transform 100 cities into climate-neutral smart cities by 2030.

Another key tool to delivering the green and digital transitions is the new
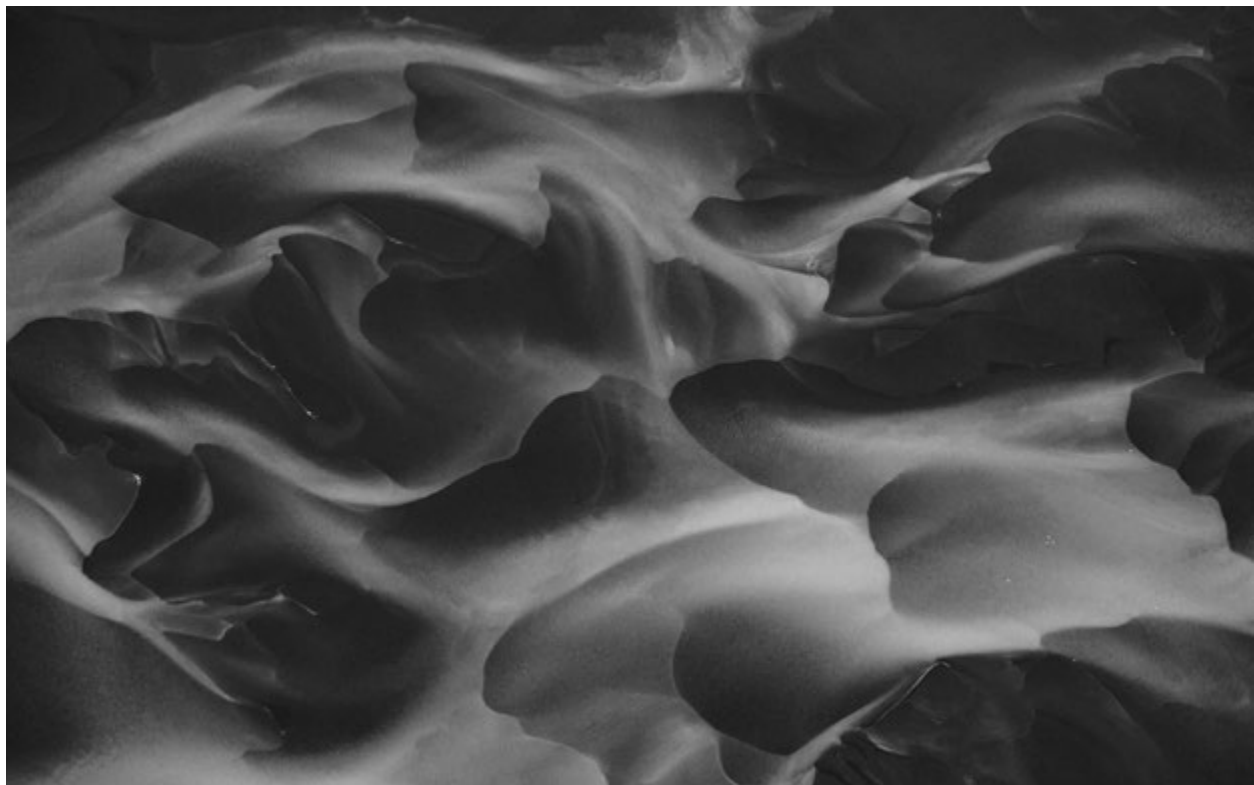
wave of European 'research and innovation partnerships' with industry and/or EU Member States. Under the Horizon Europe Cluster 5: Climate, Energy and Mobility, the Commission is investing €7.1 billion into these partnerships. Our partners, the private sector and Members States, have committed an additional €11.6 billion.

Finally, the recently created EU-Catalyst partnership brings together the Commission, the European Investment Bank (EIB) and Breakthrough Energy Catalyst to mobilize up to €820 million in 2022–26 to accelerate the deployment and commercialization of innovative technologies that will help deliver on European Green Deal ambitions and the EU's 2030 climate targets. Investments will be directed towards a portfolio of EU-based projects with high potential in four areas: clean hydrogen, sustainable aviation fuels, direct air capture, and long-duration energy storage.

€7.1 BILLION

Under the Horizon Europe Cluster 5: Climate, Energy and Mobility, the Commission is investing €7.1 billion into these partnerships.

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

"European research and innovation will drive the transformative Green Deal agenda, with 35% of Horizon Europe's budget devoted to climate-related activities."

FATHER PAOLO BENANTI

Professor, Faculty of Theology, Department of Moral Theology

Pontifical Gregorian University, Rome, Italy

Con
ver
sa
tions
FOR TOMORROW

IN TECH
WE TRUST.
OR DO WE?

Father Paolo Benanti is a full-time professor at Pontifical Gregorian University, Rome, in the fields of Ethics of Technology, Digital Technology, and AI. He is also an advisor to the Pope and works with entities of the Holy See such as the Pontifical Academy for Life and the Pontifical Council for Culture.

PONTIFICIA
UNIVERSITÀ
GREGORIANA

HARNESSING TECHNOLOGY TO HELP THE WEAKEST

"

We can harness technology to help the weakest in society, children and the elderly, to bring them back into the community and give them a sense of belonging."

What is the position of the Church on new technologies?

— The Church and technology can be strong allies in retaining a sense of community in today's changing social environment. We can harness technology to help the weakest in society, children and the elderly, to bring them back into the community and give them a sense of belonging.

However, we can't ignore that digital tools could equally be used to alienate vulnerable people in an insidious way by pushing them towards purely online interactions as a substitute for "real" social relationships. The mission of the Church in this context is to be an active voice to reinforce the importance of the timeless values of caring and togetherness.

Father Paolo Benanti
Professor, Faculty of Theology, Department of Moral Theology, Pontifical Gregorian University, Rome, Italy

DEVELOPING GUARDRAILS TO KEEP TECHNOLOGICAL DEVELOPMENT ON TRACK

Are there any new technologies that particularly worry you?

— It is not about specific technologies but the ethos according to which they are implemented. Machine learning and artificial intelligence, for example, have the ability to predict but not to explain. Can we accept the risk that artificial bias could be propagated at incredible speed by an indefatigable algorithm, if left to run without human oversight?

We must develop a "guardrail" to keep technological development on track. The same challenge applies to genetics, where you risk losing control over the nature and purpose of genetic modifications if they are removed from a social context and simply calculated by algorithms as being viable or otherwise. Biotechnology could allow us to eradicate hunger from the face of the Earth, or it could allow a new form of cartel control, with the production of synthetic meat eradicating the market for real meat, and wiping out livestock farmers. It could also be employed by richer countries to control poorer ones by creating a dependence on means of production held only by the few.

> **"Biotechnology could allow us to eradicate hunger from the face of the Earth, or it could allow a new form of cartel control, with the production of synthetic meat eradicating the market for real meat, and wiping out livestock farmers."**

Over the past 100 years, the position of the Church has become clear: technology should be used to support communities in developing as they want to, rather than used to dictate the direction of that development. The problem lies not in the technology itself but in the lack of a guardrail; that is what we must keep top of mind. And to design that guardrail, we need an alliance between civil society, business, political power – and the goodwill of the people.

Is there any new technology that you are particularly excited about?

— Actually, I have a couple of examples. I have access to GPT-3.[1] This is exciting because I have a machine that is the perfect interface between myself and the computer. The machine can transform a high-level task into a series of elementary tasks that an unskilled human being can follow, step by step, and accomplish something. So, GPT-3 as a fluid interface between man and machine for me is exciting. The other exciting technology is AlphaFold.[2] The ability to predict a protein's 3D structure from its amino acid sequence is a wonderful innovation for drug discovery. These two technologies constitute a giant leap forward.

"An exciting technology is AlphaFold. The ability to predict a protein's 3D structure from its amino acid sequence is a wonderful innovation for drug discovery."

1. GPT-3 is the third-generation language prediction model in the GPT-n series created by OpenAI, a San Francisco-based artificial intelligence research laboratory.
2. AlphaFold is an artificial intelligence program developed by Alphabet's/Google's DeepMind, that performs predictions of protein structures.

SYNTHETIC BIOLOGY: BOON OR BANE?

"

In many countries in which genetically modified crops are used, one effect is a displacement of power of production, which means that conventional farmers are impoverished. This is an issue of social injustice."

What are the guiding principles for the Church in respect to advancements in synthetic biology?

— There are two ethical principles that underlie the Church's position, especially since the installation of Pope Francis. The first is the precautionary principle that essentially means: "Think twice, cut once." The second is to consider the social impact of technology. For instance, in many countries in which genetically modified crops are used, one effect is a displacement of power of production, which means that conventional farmers are impoverished. This is an issue of social injustice.

How does the Church view advancement in synthetic biology, human enhancement, and genetic engineering?

— In terms of crops, we have to recognize that seeds are selected by a natural process over centuries as they are exposed to a variety of weather conditions. If we lose this kind of biodiversity by concentrating on the production of GMO seeds, we may lose protection against future unforeseen conditions, as all remaining strains may be vulnerable, rather than just a selection. Applying the precautionary principle, we should seek to preserve biodiversity because we cannot know all the possible consequences of not doing so.

We also need to recognize that animals have the right to a certain dignity of life, without unnecessary suffering. Due to the scarcity of human organs for transplant, organs from genetically engineered pigs can be vital in saving lives. At the same time, in some countries, experimentation is being undertaken to augment pigs, so that they develop more muscle than they would naturally. This latter kind of technology is an ethical gray area and needs to be kept in check.

Even more worryingly, there are experiments using synthetic biology to augment humans. As well as the possibility that this could give rise to sinister inequalities, there is also the problem again of poorer countries becoming experimenting grounds for rich countries. The Church continues to oppose this kind of unjust, unethical experimentation.

THE ROME CALL FOR AI ETHICS

You helped draft an ethical commitment for AI, entitled The Rome Call for AI Ethics, which was endorsed by Microsoft and IBM. Could you elaborate more on this commitment?

— The idea is to keep humans in the loop with AI. AI should be used not simply to optimize cost efficiency but to enhance human cognition and, ultimately, make better choices. This kind of ethical design, with human sensibilities at the center, is where we want to find common ground with Big Tech. Tech giants have a lot of power in society and they require guidance in keeping that within humane bounds.

The idea is to foster a culture of ethical conversation, with multiple voices from a range of companies. We cannot set international regulations, but we can encourage the right kind of ethical culture. We can anticipate, we can give some direction, and we can help people find areas of agreement, of consensus, where we can then move forward together. We want the children of today to grow up in a world where ethics is a strong governing force in technological development.
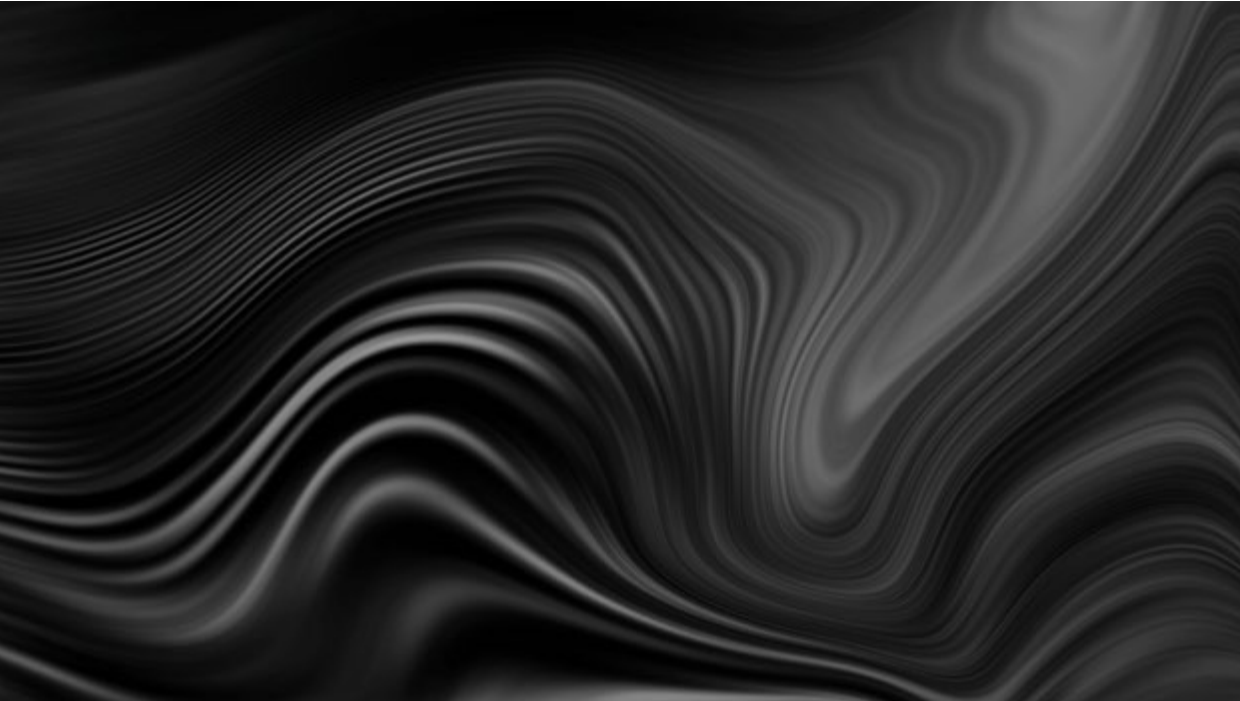
The Church is also reaching out to other religious leaders to draft a multi-religious ethical charter to protect society from the harmful impacts of AI. Could you elaborate on this?

— We are hoping to sign an ethical charter with Muslim and Jewish leaders. Next year, we will go to Japan to discuss this with leaders of Buddhism and other religions. This cultural network to facilitate discussion is the greatest soft power that religion has today. We have to provide the platform for discussion of these issues.

What does a positive future impact of technology look like to you?

— The best that technology can do is make our lifestyle sustainable. I admire everyone who is using technology to make the circular economy a reality. On that basis, we can continue to build towards a future where technology is our friend, rather than something to be feared.

Father Paolo Benanti
Professor, Faculty of Theology,
Department of Moral
Theology, Pontifical Gregorian
University, Rome, Italy

"The best that technology can do is make our lifestyle sustainable."

GARY P. PISANO

Harry E. Figgie Jr.,
Professor of Business
Administration

Harvard Business School

BUILDING INNOVATIVE CULTURES

HARVARD BUSINESS SCHOOL

Gary Pisano is the Harry E. Figgie Jr., Professor of Business Administration at the Harvard Business School where he currently serves as Senior Associate Dean for Faculty Development. Over the course of his career, Pisano has explored fundamental questions about how organizations innovate, learn, compete, and grow. Pisano has written six books, including his latest, Creative Construction: The DNA of Sustained Innovation. He is a two-time winner of the McKinsey Award (2009, 2019) for the best article published in Harvard Business Review, and the inaugural winner of the Clayton M. Christensen Prize (2020) for his work on innovative cultures. In addition to his academic research and teaching, Pisano serves as an advisor to senior leaders at leading companies around the world and has been a director of both public and private company boards. Professor Pisano currently serves on the board of directors of Axcella Health and Generate Biomedicines.

What are the challenges in building an innovation culture?

— It is all about behaviors. There are behaviors around innovation cultures that everyone seems to embrace: tolerance of failure, collaboration, willingness to experiment, feeling safe to speak up, and individual empowerment to take decisions. The other side of the coin is a set of more demanding behaviors: chiefly, intolerance of incompetence and insistence on high performance standards. These create an environment that's intimidating to some people. Everybody talks about how much they love psychological safety; however, if you are free to speak up to others, people should be free to speak up to you. People in innovative organizations need to develop a thick skin. An innovative culture is expected to be fun. I think it can be fun – but it's not purely fun. People want to embrace just a part of it, not the whole thing. I don't think that works.

What should be the role of a chief innovation officer?

— Every Chief Innovation Officer (CINO) I have met is an incredibly competent, experienced person working against tough odds: the organization hasn't set them up to succeed. I think the problem with the role is limited empowerment. CINOs in most companies can't fire people. For instance, if the head of a business unit refuses to change the culture and strategy, I don't think any CINO I have ever encountered could go in and say, "That's not how we are going to work here. You have got to find another place to work." CEOs can do that. Building an innovative work culture requires an incredible transformation. You need a lot of clout to do that, and it can be painful. CINOs need authority to drive that change.

Gary P. Pisano
Harry E. Figgie Jr.,
Professor of Business
Administration,
Harvard Business School

"
The problem with the role [of Chief Innovation Officer] is limited empowerment. CINOs in most companies can't fire people."

Con
ver
sa
tions
FOR TOMORROW

"

Organizations don't think early enough about the scaling issues, the manufacturing, or the service issues."

Why do a lot of organizations struggle to scale their innovations?

— Failure to scale is a symptom of the failure of the innovation system. Organizations don't think early enough about the scaling issues, the manufacturing, or the service issues. This often stems from a lack of experience. They are not asking questions early on, such as what kind of equipment or process to use. Innovation requires a high degree of discipline. New organizations are keen not to constrain creativity but, if you don't have the right manufacturing, delivery, and service processes, the new idea won't be scalable. You must think about what these will look like when you are producing a million units, not just the first 100. You must start asking questions about processes and systems very early. Scalability is something larger companies typically do well, even if they have not transformed their cultures.
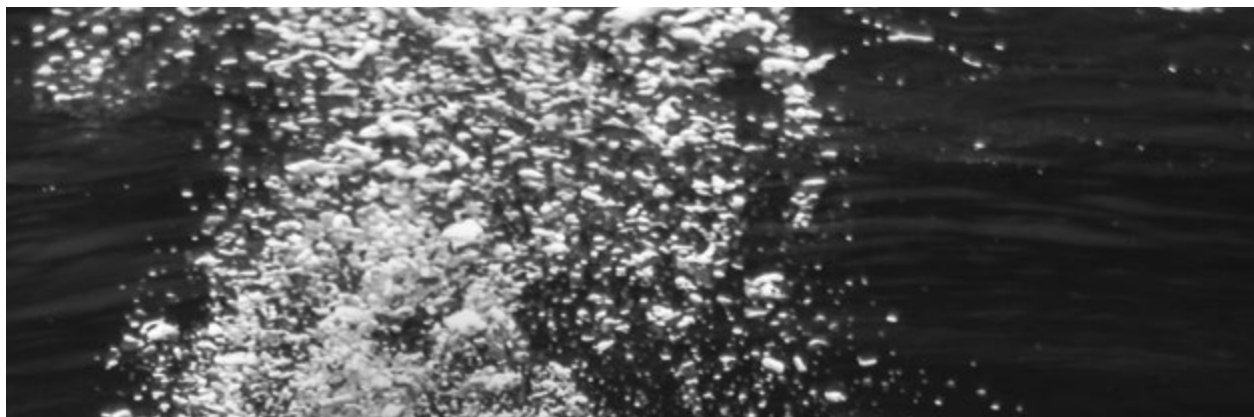
BUILDING AN INNOVATION TEAM

How do you think an innovation team should be structured?

— I love the idea of cross-functional teams bringing different perspectives, but they should collaborate well and have some authority to drive things.

"

I love the idea of cross-functional teams bringing different perspectives, but they should collaborate well and have some authority to drive things."

Often, such groups are not teams, they are just committees or representatives of functions and lack the necessary unity and authority. Power resides in the separate functions. To innovate requires unity, purpose, and focus. It doesn't mean your innovation team needs to be insulated from the rest of the business. The team must be very functional culturally; it has to have a tolerance of failure; it has to be comfortable with ambiguity; and people must take accountability for their decisions. All the characteristics of innovative cultures at organizational level also play out at team level.

What are the characteristics of innovative people?

— First, you must make sure people are technically or functionally competent in their roles. Innovation often presents technical or functional difficulties. Creativity requires a degree of intellectual horsepower. You also need people to exhibit specific behaviors: they should be comfortable with risk, ambiguity, and stress. Are they ambitious? Are they curious? When hiring, you must ask people about their experience and track records. Have they taken on big challenges? How do they deal with failure? A high degree of self-confidence – although not arrogance – goes a long way in building an innovative culture. Confident people can give and receive candid feedback without being problematic about it. Insecure people are the worst people in an innovative organization because they don't like to be challenged.

"

Culture can be measured. There are indicators of behavior."

LESSONS FROM THE WORLD OF TECHNOLOGY

What lessons can organizations learn from innovative tech companies?

— Tech companies have been very innovative but so have lots of other companies. Every company uses technology. This distinction between tech and non-tech is a little blurred. Technology firms have always been forced to innovate rapidly or fail. In other sectors, things used to change more slowly. Now, everybody is experiencing dramatic change. The generally applicable lessons are: have the right strategy for innovation; think about what you want to achieve; and build the right systems and culture. Innovation is not just random, it's quite systematic and repeatable.

"Innovation is not just random, it's quite systematic and repeatable."

"This idea that large companies can't innovate is one of those business myths that has been perpetrated."

Can large organizations innovate like tech companies?

— This idea that large companies can't innovate is one of those business myths that has been perpetrated. IBM was incredibly innovative in the 1960s, for instance. Bell Labs was a massive organization that was innovative. Today, Google, Apple, and Amazon are massive innovators. A lot of what is going on in the automobile industry today is innovative. Everybody talks about Tesla, but other auto companies are moving into autonomous vehicles and electrification alternatives. They have been doing a lot of innovation while running huge businesses in very harsh conditions. The auto industry is a tough one to compete in. Any company with over $1 billion in annual revenue can be considered a large company. There are nearly 5,000 companies in this category, worldwide. So, in fact, most innovation is done by quite large companies.

Can culture be quantified?

— Culture can be measured. There are indicators of behavior. People get in trouble when they try to measure values that are hard to observe but behaviors are not hard to observe. It's not perfect but the suggestion that other measures that companies use are perfect is false. Let's consider depreciation. If we buy a piece of equipment, it depreciates over five years. Does that mean that, every year, 20% of the piece of equipment falls apart? No. We just set up general rules to account for that, to structure our profit and loss statements. The metrics we think are precise are really generalized and complicated. A set of rules that, while not precise, is reasonable is sometimes the best we can do. The same applies to measuring culture.

INSECURE PEOPLE ARE THE WORST PEOPLE IN AN INNOVATIVE ORGANIZATION BECAUSE THEY DON'T LIKE TO BE CHALLENGED.

MANAGING INNOVATION

At what point in the innovation cycle should a product or idea be scaled back or killed?

— It varies, depending on the nature of the product and how deeply you understand it. In pharmaceuticals, there are certain disease states that are easier to model and predict. So, what you observe, even in animals, is highly predictive of what will happen in people. Similarly, what you observe in a small sample of people can be predictive of what you are going to observe in a large sample. If you are getting bad signals early, you can stop the process. There are some poorly understood diseases, where early observations are very noisy. Animal models are extremely noisy, so good and bad news cannot be taken at face value. It really depends on the level of knowledge around the product. Sometimes, predictive modelling can be trusted and sometimes it can't.

How can you predict the success rate of innovation?

— A good model is an accumulation of deep, empirical knowledge over time. Industrial chemistry has been around more than 150 years, and now has a deep reserve of accumulated knowledge. So, you can design a chemical process on a small scale and predict the complexity of what's going to happen on a large scale. Both the aircraft and auto industries use computational methods to predict air flows and drag coefficients, without ever building a physical prototype. They can test lots of designs virtually; those tests are not perfect but are predictive of what you will see when you build a vehicle or an airplane. In the newer fields, the knowledge base and theory have yet to be built up. The data hasn't accumulated to be able to create the models that allow you to do the prediction, so it's much more empirical.

THE FUTURE OF INNOVATION

Is there a specific innovation that you think will have a lasting impact on wider society?

— People are calling this the century of biology – I agree. We are finally able to engineer medicines, instead of discovering them. This could improve our health, giving us better quality of life. The internet transformed our lives and the way we learn and shop now. I hope, in the next 15-20 years, we will come to look at medicine in the same way.

What are your top tips for organizations to become more innovative?

— First, hire confident, open-minded, curious people. Second, really think through what innovation means and how it is going to help you, specifically, to compete. It's not just innovation for innovation's sake. Three, don't just go with the latest innovative trend; think it through systematically. You are building a bespoke system for your organization; don't just copy the market leaders, because what's best for Apple is not necessarily best for you. Fourth – in order but not in importance – work on the culture.

Con
ver
sa
tions
FOR TOMORROW

Gary P. Pisano
Harry E. Figgie Jr.,
Professor of Business
Administration,
Harvard Business School

"People are calling this the century of biology – I agree. We are finally able to engineer medicines, instead of discovering them. "

MEI JIANG
SVP,
Global Digital Innovation

Medtronic

INNOVATION-LED HEALTHCARE:
ENGINEERING THE EXTRAORDINARY

Medtronic

Medtronic is a global healthcare technology leader, with more than 90,000 people across 150 countries and revenues of $31.686 billion in fiscal year 2022.

Mei Jiang, SVP, Global Digital Innovation at Medtronic, is a serial entrepreneur with a blend of experience at both startups and corporations. Since early 2000 she has worked on and led three startups in Silicon Valley into accelerated growth and exit. Currently she is driving intrapreneurship at large enterprises and has helped many large corporations drive fundamental technology and business transformations. She started her career in product, and has led and contributed to multiple digital products' design and incubation, including China's early target drones (unmanned aerial target or UAT), the world's first low-cost, high-capacity tape drives in the 1990s, the industry's first large-scale, open, and secure big data platform, IoT, smart wearables and AI/ML, and telepresence robots in the 2010s.

Could you elaborate on your current role and responsibilities as Head of Global Digital Innovation at Medtronic?

— I lead Medtronic's digital transformation journey. My job is twofold: First, exploit what we have today by continuously expanding and optimizing our medical devices and healthcare solutions to stay relevant and competitive; and second, explore the possible to create a radically new, future-fit, and innovative global healthcare technology leader for the foreseeable future.

Our mission – to alleviate pain, restore health, and extend life — unites a global team of 90,000+ passionate people across 150 countries. Our technologies and therapies treat 70 health conditions and include cardiac devices, surgical robotics, insulin pumps, surgical tools, patient-monitoring systems, and more. And we take great pride in knowing that we impact the lives of two patients every second. That adds up to roughly 80 million patients per year. That sounds like a lot … but 80 million is just a small fraction of the world's population.

We can do a lot more than doctors and devices. With advances in data and technology, including 5G, edge computing, IoT, AI/ML, immersive AR/VR, miniaturization, and robotics, among other areas, Medtronic can extend its range to a much wider demographic, not only late-stage hospitalized patients.

With a shift from Wellness Debt (patient) to Wellness Wealth (consumer), Medtronic can go from 80 million patients a year to 1 billion. To make the shift, we must be more digitally minded, creating the medical equivalent of the Apples and Amazons of the world.

Mei Jiang
SVP,
Global Digital Innovation
Medtronic

80 MILLION
PATIENTS PER YEAR

"We impact the lives of two patients every second. That adds up to roughly 80 million patients per year."

Con ver sa tions FOR TOMORROW

BREAKTHROUGH INNOVATIONS IN MEDICAL DEVICES

Micra™, the world's smallest pacemaker

"Imagine a miniaturized, leadless pacemaker about the size of a large vitamin capsule, which listens "digitally" to blood flowing across a human heart."

Can you give some examples of the latest innovations in medical devices?

— Some of the greatest advances in medical technology are unfolding right now.

Imagine a miniaturized, leadless pacemaker about the size of a large vitamin capsule, which listens "digitally" to blood flowing across a human heart. In the event of an irregular rhythm, this tiny wireless device sends an electronic signal to keep the heart pumping as it should.

For decades, patients with diabetes relied solely on blood-sugar measurement to adjust the application of insulin therapy. By using AI, we are modelling patient behavior and diet to predict the impact on their blood-sugar level at a later date to help them plan their treatment proactively.

This kind of predictive technology can also help patients living with neurodegenerative disorders. A first-of-its-kind Medtronic deep brain stimulation (DBS) device can sense and record brain signals while delivering therapy to patients with Parkinson's disease. Now, imagine that in the future we could automatically adjust the stimulation levels and optimize them for each individual patient, based on their own brains and the patten of their brain activities – that is true personalization.

How is Medtronic innovating through data and AI to enhance its range of products and therapies?

— Let's start with life-changing devices. Besides the world's smallest pacemaker, we have developed a swallowable camera. For colon cancer, routine colonoscopies may not be the answer. While they're the standard of care in the US, too many patients put them off and the guidelines for screening keep changing. Not to mention, they haven't even become

"

A capsule you can swallow that includes an integrated camera that will take thousands of images as it works its way through your digestive tract. The images will then be downloaded by a clinician for detailed analysis."

PillCam™, Capsule Endoscopy
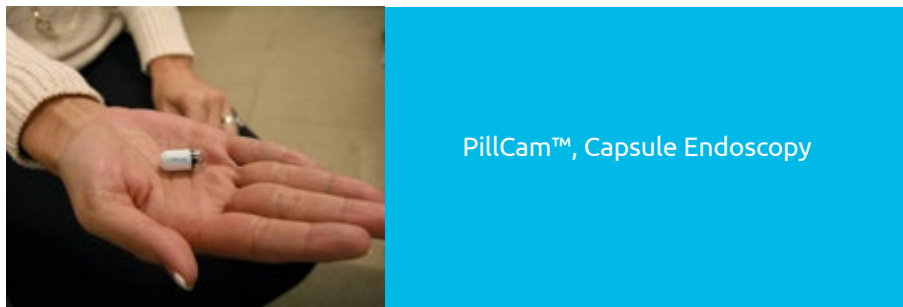
the standard of care yet in many countries outside the US. What if there was an alternative to a traditional colonoscopy? A more efficient way to screen moderate-to-low-risk individuals in everyday life, anywhere? And it was as easy to use as swallowing a multivitamin-sized pill?

Well, here comes Medtronic PillCam™. A capsule you can swallow that includes an integrated camera that will take thousands of images as it works its way through your digestive tract. The images will then be downloaded by a clinician for detailed analysis.

Now, can you also imagine a clinician having AI assistance during routine colonoscopies to scan for polyps that can be difficult to detect by the naked eye. The technology flags areas of concern independently and automatically as the clinician performs the procedure in real-time. This would be our GI Genius™ device, which is the first of its kind to be approved by the FDA in the US.

Besides life-changing devices, we're building new digital data and AI capability to enhance intelligent therapies, insight-driven med-tech solutions, and bigger, broader digital-health ecosystems to help lower cost, improving quality and outcomes.

The following new concepts could improve the quality of life for people around the world:

- **Intelligent therapies:** In the future, sensing and closed-loop algorithms that collect patient data and personalize therapy could be used to improve outcomes (e.g., BrainSense™ neurostimulator capturing brain signals while delivering therapeutic simulations)

- **Insight-driven med-tech suites:** Interconnected devices, products, and intelligent therapies across a care continuum that exchange data and information (e.g., NextGen Spine Surgery Ecosystem combines spinal implants, biologics, navigation, robotics, and AI-powered data to surgeons and patients)

- **Digital-health ecosystems:** Product suites that integrate and exchange insights with a broader community of partners and stakeholders

THE INNOVATION PROCESS

How do you assess innovation and decide how to allocate resources?

— Based on statistics from early-stage venture capital investments in the past decade or so, only one out of 250 VC investments will return 50x ROI, and nearly 70% of investments lose money. The hard truth is, we can't pick the winner. Good and bad ideas look exactly the same at the beginning. It will take several missteps before we can distinguish between them.

To avoid a 'HiPPO' —the highest paid person's opinion determining how we make our bets – we must take an evidence-based approach by building a robust funnel for systematic decision-making.

Here is an example of how to make better investment decision in three key dimensions, adapted from The Invincible Company by Alex Osterwalder (2020):

a. **"Strategic Fit":** Assess the problem space and proposed solution against your strategic direction, culture, brand, etc. In essence, you are asking, "Is this consistent with our DNA? Does this jive with our end-game and our corporate identity in 5–10 years from now?" Before we move forward with any opportunity, our strategic direction must be clear, agreed upon, and known to all involved – this is the first filter.

b. **"Risk Readiness":** Aim to reduce investment risk by building evidence for success or failure; in other words, our role is to prove or disprove whether the idea will work in the real world. Evidence come from research, interviews, concept testing, and experiments. We can't stay in the theoretical world, and we must try to fail with quick and dirt-cheap tests.

c. **"Size of Opportunity":** Quantify the opportunity. As with step 2, this is based on evidence. We expand our experiments beyond what is technically possible to what is financially possible. It is literally, "Is anyone willing to pay for this? And if so, how much?"

"Good and bad ideas look exactly the same at the beginning. It will take several missteps before we can distinguish between them. "

What are your tips for scaling innovations from lab to mass market?

— Avoid overengineering version 1.0. The key is rapid product iterations, delivering value in increments over months or even weeks, rather than years.

We begin by designing customer value, not specification of features and functions, into our product right from our very first prototype. We focus on technologies and products that can be matched to true, compelling market needs with adequate business cases.

What are the key capabilities/qualities of a Chief Innovation Officer (CINO)? How has this role evolved over the past few years?

— A successful CINO is a customer champion, a trailblazer, a commercial officer, a broker, and a storyteller. The customer champion puts the customer first. The trailblazer assumes there's always a different, better way to do things, and takes on the high-impact problems, the seemingly impossible. The commercial officer focuses on profit, building entirely new digital lines of business. The broker links disparate silos, uniting the organization in collaboration. The storyteller creates strong, potentially emotional experiences for customers using new technologies.

Which book or personality inspires you the most to drive innovation in your organization?

— One book that inspires me is *The Fearless Organization: Creating Psychological Safety in the Workplace for Learning, Innovation, and Growth* by Amy C. Edmondson (2018).

She uses the expression, "Innovation is culture." To truly innovate, a shift in culture is key to achieving ambitious strategic goals. Create a safe environment where people trust one another, do crazy things, and where risk-taking is encouraged and rewarded. Failures are readily accepted as an integral part of learning. However, we must learn how to fail small and cheap, recover fast, and pivot like a "lean startup."

Con
ver
sa
tions
FOR TOMORROW

Mei Jiang
SVP, Global Digital Innovation
Medtronic

"A successful CINO is a customer champion, a trailblazer, a commercial officer, a broker, and a storyteller."

FRANK CHEN

Partner

Andreessen Horowitz

SOFTWARE IS (STILL) EATING THE WORLD

Andreessen Horowitz (known as "a16z") is a venture capital firm that backs bold entrepreneurs building the future through technology. a16z has $33.3B in assets under management across multiple funds.

Frank Chen is an Operating Partner at US venture capital firm Andreessen Horowitz, where he works at a16z Seed Fund helping founders build, launch, and scale their companies. In addition to his work on the Seed Fund, Frank trains a16z's deal and research team, which finds and backs bold entrepreneurs building the future through technology. Frank has also worked for HP, Opsware, Oracle, and Netscape Communications.

How do you think the innovation process has evolved?

— A decade ago, Marc Andreessen wrote an op-ed in which he declared that "software is eating the world." Today, that's still true. Organizations are still undertaking digital transformations and making software an increasingly core part of how they find, win, and keep customers.

A plethora of "digital native" companies has also sprung up in the interim. Take Tesla: Tesla is the most important car company on the planet right now because they thought the car through from first principles. You can spec and buy your car online. When you get into a Tesla, you know you are in the most sophisticated self-driving vehicle in the world, with self-updating software. Tesla shows you what software makes possible when you think it through from first principles. This is equally true for Netflix, Amazon, and Apple. Digital native companies are leading the way in today's economy.

The other big driver of change has been the pandemic: it pulled forward the digital initiatives of mainstream companies, from the big box retailers down to the corner restaurants which now offer curbside pickup, online ordering, and online payments. Software is eating the world much more rapidly now.

Frank Chen
Partner
Andreessen Horowitz

"THE SPEED OF STARTUP CREATION IS NOW HIGHER THAN AT ANY POINT IT'S BEEN IN HISTORY. "

How do you see startup evolution in this period?

— The speed of startup creation is now higher than at any point it's been in history. Ten years ago, there might have been 3,000 seed stage companies that raised $1 million each. Now, that number is around 25,000, with an average investment size over $4 million. So, startup creation has grown in terms of both number of companies and average size of investment. It's easier than ever to get a product to market, but it's still a challenge to build a product that reaches a lot of people and build a company that can take advantage of it.

What separates startups from large companies when it comes to innovation?

— A startup is willing to fail. If you are a big company executive and you have 10 projects, and you fail on five of them, you get fired. VCs and startups have a much higher tolerance of failure – and that freedom from fear supports innovation. Innovation is ultimately about creating something from nothing. You need a failure-tolerant environment to allow people to experiment and create.

Why do you think more companies should start paying attention to the crypto economy?

— We pay a lot of attention to what top talent is doing, from the best new graduates to seasoned engineers. Around 7-10 years ago, we saw them heading toward Bitcoin and other cryptocurrencies and, since then, we've probably had four waves of price inflation and crashes, but each one of those cycles has pulled the median activity up. So, we take crypto very seriously. There are many reasons why companies should pay attention. Let me illustrate them with a couple of examples. Take Helium. Helium is the first major decentralized challenger to building a wireless network. It operates the Decentralized Machine Network, a community owned and operated computer network for IoT devices, and just launched its second network, Helium 5G. It's about building a network on the back of peer-to-peer cooperation, and crypto enables this through a token-based model.

Another good example is in understanding how Web2 works. We know that tech giants are extracting a high price for all content creators who participate in the network. So, if I'm doing a Google search, I'm the product: Google gets to monetize me. But it's my identity, my digital trail, and my search history that generate economic value. How much do I make from that? Nothing. Spruce is a great example of a service that is enabling individuals to own their own identities, rather than giving all that power to Google and Meta, who then generate the profits. Spruce allows individuals to connect to Web2 and Web3 applications and control their digital identities directly using their wallet keys, instead of through an intermediary.

How do you define the objectives of Web3?

— Web1 set out the core Internet protocols. It was mostly read-only and very democratic. Once all that infrastructure got laid, then the killer apps came in Web2. It was the era of gatekeepers such as Facebook/Google/YouTube, and they made the Internet read-write for a lot of people. In concrete terms, it meant, you could not only consume YouTube content, but also upload; not only could you do a Google search, but you could contribute by publishing a Google Doc. These killer apps dominated the landscape.

Governments are now worried that big tech has gotten too powerful, because the gatekeepers capture a disproportionate share of the value. Web3 is about taking the read-write nature of Web2 and the exciting democracy of Web1. The hypothesis is that if we give users ownership rights and they participate, then we are going to have a better place. And we'll make everybody sort of part-owners, and it will not be owned by anybody and we'll all just agree to use it. That's Web3.

"Web3 is about taking the read-write nature of Web2 and the exciting democracy of Web1."

Is the metaverse the next phase of the Internet?

— To us, the metaverse is a way of saying we're going to keep on pushing the Internet along a couple of dimensions: social and immersive. Twitter/Facebook made the Internet more social and TikTok made it more immersive. It is going to feel more and more like reality, whether you're working on a digital twin or playing in a fanciful virtual world. And the technologies that will make this real are getting there. It will continue to be decentralized and open. We will go through multiple metaverses – some owned by the gatekeepers and some built on Web3.

What are your thoughts on synthetic biology?

— Synthetic biology might be the most interesting and fundamental melding of biology and computer science. My top advice to college-age kids: do something at the intersection of biology and computer science. You could say that synthetic biology saved the world: we went straight from the DNA sequence of COVID to having vaccines. Moderna created the vaccine with a digital version of the virus, not the biological sample. We can reprogram biology to imitate existing substances, and improve on them. You can make all sorts of engineered foods, such as meat without animals. And we've also got spider-silk proteins that can make shirts stronger than Kevlar and lighter than cotton.

"We will go through multiple metaverses – some owned by the gatekeepers and some built on Web3."

To give you a real-world example, we invested in a company called Nobell Foods. The company uses synthetic biology to make a protein that's found in milk and will convince E. Coli to manufacture it at scale. It is chemically identical to protein in cow's milk. Another very interesting startup is Asimov. What if we could program biology in the same way that we program computers? Asimov is applying software concepts and many aspects of the electronic design automation (EDA) toolchain to engineer living cells. They're making the engineering of biology follow the same workflow of engineering as a computer chip.

Which new technology excites you the most?
— I see two frontier technologies. One is synthetic biology. And the other is quantum computing. It is a take on the same idea: if we can harness what nature is doing, we could benefit from it.

In this case, quantum computation is using the fundamental properties of subatomic particles to solve problems that are unsolvable by classical computers – at least in our lifetimes. If we can hitch a ride on it, who knows where it might take us.

"MY TOP ADVICE TO COLLEGE-AGE KIDS: DO SOMETHING AT THE INTERSECTION OF BIOLOGY AND COMPUTER SCIENCE."

What are your recommendations to large organizations that want to keep up with these tech developments?

— If you're at a large organization and you're trying to figure out how to be innovative, you have the traditional choice: build or buy. If you go down the build path, then you need to reward risk-taking and accept failure, which, as we have discussed, is very tough for an operating company. If you want to buy, then you must figure out what to buy and how to integrate it to enhance innovation, while hanging on to your existing talent.

There's a lot of ways to do this unsuccessfully. If you're committed to this path, then my advice is – please don't love your acquisitions to death. You have to understand what you are actually getting. Are you getting a product? Or a technology? Or a route to market? You have to recognize which stage you are at and nurture the acquisition accordingly.

Frank Chen
Partner
Andreessen Horowitz

"I see two frontier technologies. One is synthetic biology. And the other is quantum computing."

MARTY CURRAN

Executive Vice-President &
Innovation Officer

Corning

INNOVATION BY PRIORITIZATION

CORNING

Corning Incorporated is one of the world's leading innovators in materials science. Their innovations include the encasement for Thomas Edison's electric light bulb, and Corning® Gorilla® Glass for mobile devices. Corning has 61,000 employees and sales of approximately $14.1 billion in 2021.

Marty Curran was appointed Corning's first innovation officer in August 2012. In this role, Curran manages a portfolio of programs to increase the probability of success for new business opportunities. The innovation office was created to build an entrepreneurial-focused organization that could operate across all business segments to identify and develop near-term revenue opportunities.

Could you elaborate on your current role and responsibilities as Chief Innovation Officer at Corning?

— In 2012, I was appointed Corning's first Innovation Officer. Since I took up this role, we have created the Emerging Innovations Group (EIG), which has a portfolio of programs in nascent stages that provide a bridge between new ideas and our mature business programs. We source new ideas from four areas: Corning's research organization, Corning businesses, "knocks on the door" from potential partners, and as a result of exploratory scouting. EIG was created to identify, prioritize, and develop profitable opportunities by tapping our incredibly relevant expertise and proprietary platforms to develop category-defining products in markets that transform industries and enhance lives. An invention only becomes an innovation when profitable sales occur.

Marty Curran
Executive Vice-President &
Innovation Officer
Corning

How should organizations identify the key innovation areas / ideas to focus on?

— The key is understanding your organization's capabilities. What do you know, or what can you do that is truly unique? Then, seek customer problems that you feel you can solve. We differentiate the small "i" innovations that a business manages in the normal course of events from large "I", or New Growth Innovations, where the offering is completely new and unique.

"

We differentiate the small "i" innovations that a business manages in the normal course of events from large "I", or New Growth Innovations, where the offering is completely new and unique."

Corning is the best in the world in three core technologies (glass science, ceramic science, and optical physics); four manufacturing and engineering platforms (vapor deposition, fusion, precision forming, and extrusion); and five market-access platforms (MAPs; optical communications, mobile consumer electronics, display, automotive, and life sciences vessels). We refer to these sets as "3-4-5." We direct 80% or more of our resources to opportunities that draw from at least two of these capabilities sets. Twenty percent of the time, we'll work on something new but, as this will be in an area where we lack deep expertise, we'll be more circumspect and take our time.

Corning Incorporated World Headquarters

"

For our organization to keep up with the rapid pace of technological change, we want business leaders to take responsibility for innovation – it is a key part of our company's Values."

How does the pace of technology change impact how organizations innovate?

— Corning is one of the original S&P 500 companies, and we have watched the cycle of technology adoption accelerate drastically over the last century. For our organization to keep up with the rapid pace of technological change, we want business leaders to take responsibility for innovation – it is a key part of our company's Values (Innovation is one of Corning's 7 Values). This heightened sense of urgency also means that it is important for teams to use tools such as AI, modeling, and simulation, as well as process and prioritization tools. You can never let up!

How difficult is it to manage an innovation portfolio and still meet quarterly and annual financial targets?

— Given the twists and turns of running an innovative business, it's an ongoing challenge to manage a portfolio of startups while adhering to your financial plan. To help manage the volatility inherent in innovation, the Innovation Office "protects" these projects by having EIG as a distinct organization within Corning, separate from business segments. We're also experimenting with Program Offices in our MAPs – run separately – for New Growth Innovations.

Program managers must validate the market opportunity and test the business model by "making one that works" with a "crystallizing customer" before receiving additional budgetary leeway. A "crystallizing customer" is a leading customer in a particular industry that helps refine and establish a new solution and business model and acts as a leading influencer for the rest of that industry segment. This can speed the time to adoption, limit volatility, and minimizes financial risk.

How should innovation be governed in large organizations?

— Large organizations are (correctly) focused on generating steady profit growth, whereas innovative businesses have inherent volatility. Innovations rarely turn out as expected. Corning's approach is to protect New Growth Innovations by utilizing innovation framework tools, prioritizing resources, and encouraging program managers to find and expose "the Big Lie" – that is, to uncover why the innovation may not be adopted – at which point we need to either solve the problem or stop the program. In addition, it's critical to bring bad news to leaders faster than good news, as well as build the correct team and access critical knowledge on demand and in real time. It's amazing how many times a subject-matter expert with deep knowledge will save a project team.

"It's critical to bring bad news to leaders faster than good news."

At what point in the innovation cycle are innovation initiatives scaled back or killed?

— One of the most important disciplines for an Innovation Project Manager is use of our innovation framework tools, which we view as a "toolkit" for managers to regularly utilize. This toolkit lays out methodology, approaches, frameworks, examples, and training for assessing a new opportunity. First, they must develop the foundational assumptions upon which an idea is based. I think of this work as understanding the technical and commercial "lift" required – for you and your customer.

If a key assumption is deemed incorrect, the manager has a chance at this stage to fix it or stop. Even when we stop, we still capture our learnings. Innovations are often based on years of work on multiple projects. If we stop, teams are transitioned to other areas. One thing we do is recognize stopped projects through an annual "Day of Dead Projects" celebration, where lessons learned are shared and teams' work is recognized by the broader technology organization.

How diverse is the innovation portfolio mix at Corning to address incremental and disruptive innovations?

— Corning's portfolio of innovations is quite diverse. Our global capabilities are applicable and valuable to a great number of market segments. After a decade in the role, I'm still pleasantly surprised by the constant flow of ideas. The problem is not finding opportunities – it's prioritizing how we use our time, talent, and treasure.

What do you think is the role of open innovation?

— Crowdsourcing solutions are difficult to adopt because Corning's capabilities are deeply rooted in our 3-4-5 technical specialisms. Working with suppliers and our value chains give our inventions a multiplier impact. We also sign agreements with many universities each year. Open-innovation models can be beneficial in solving problems quickly and getting to market faster.
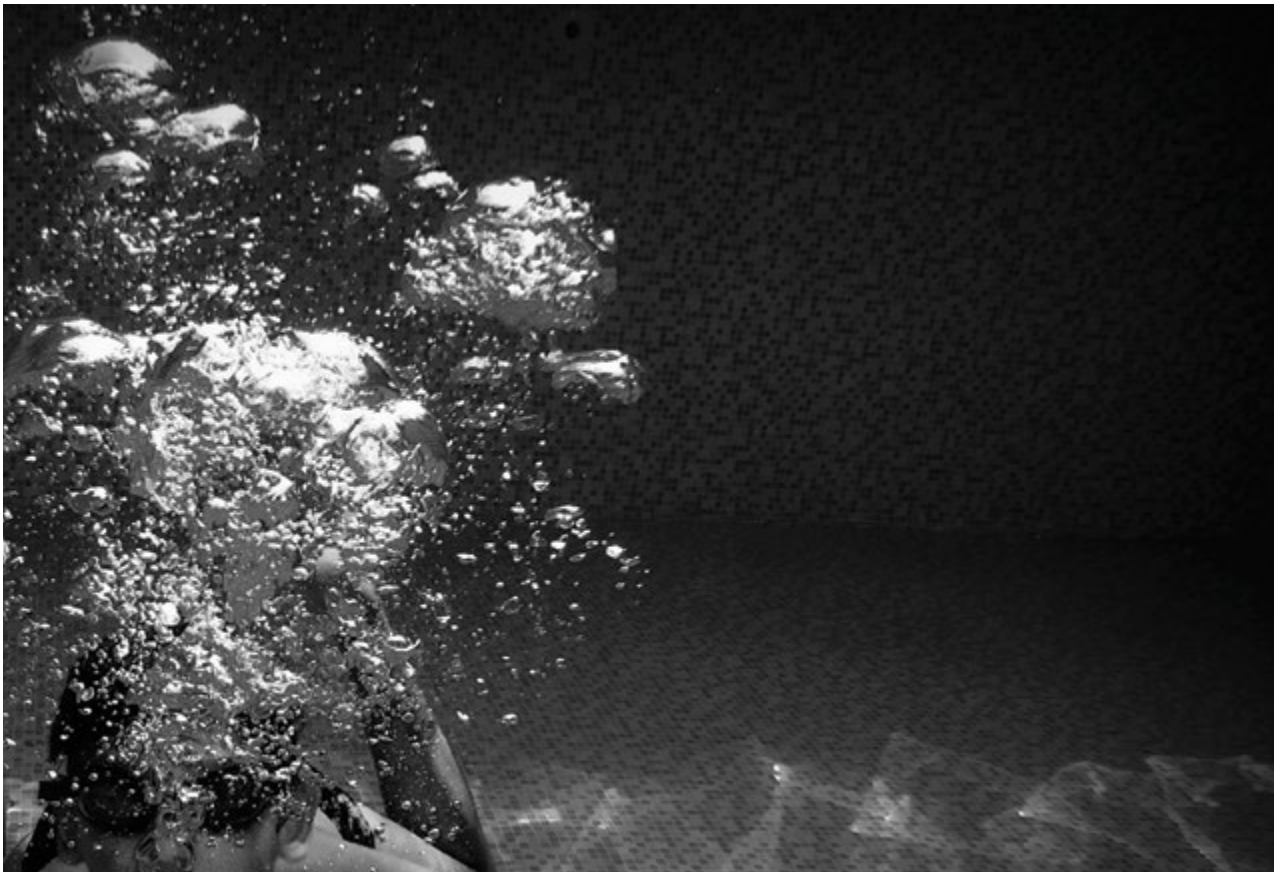
Which book, personality, or mantra/saying inspires you most to drive innovation in your organization?

— You've got to stay curious. There are many good books, by authors including Clayton Christensen, Alex Osterwalder, Jay Levinson, Tim Laseter, and Cliff Farrah. Learning the lessons of history can be empowering; innovation occurs in many ways, so interacting with lots of different potential partners is crucial. Michael Lewis, Malcolm Gladwell, Chernow and Isaacson's profiles [of leading businesspeople], Kearns-Goodwin's Team of Rivals [Abraham Lincoln biography], Loonshots [Bahcall], Bold [Diamandis/ Kotler], and The Idea Factory [Gertner] are some other works worth exploring.

What is the technology that will have the most lasting impact on society in the next 5 years?

— Artificial intelligence (AI) and modeling/simulation tools are key areas that will unlock critical information, and will ultimately make us more productive.

What would be your top 3 recommendations to help organizations become more innovative?

— First, hire the right people; if you take care of that, the bottom line takes care of itself. Second, seek out customer problems that match your organization's capabilities – this puts you in the best place to win. And, finally, take risks – they can be measured risks, but nothing gets done without taking some chances!

Marty Curran
Executive Vice-President &
Innovation Officer
Corning

"Hire the right people; seek out customer problems that match your organization's capabilities and, finally, take risks."

MASAKAZU OSAWA

Group Head, Digital Service
Business Group &
Group Chief Digital
Transformation Officer

Mitsubishi UFJ Financial Group

Con
ver
sa
tions
FOR TOMORROW

A FUTURE ON THE BLOCKCHAIN

MUFG

MUFG (Mitsubishi UFJ Financial Group) is one of the world's leading financial groups headquartered in Tokyo and with a global network with over 2,500 locations and over 170,000 employees. MUFG reported gross profits of 3,964 billion yen in the fiscal year 2021.

Masakazu Osawa has held key roles in Corporate Banking, M&A, and Retail Banking since joining the company in 1991. He was appointed Head of Digital Transformation Division in 2017, where he has been responsible for leading MUFG's digital transformation strategy. In 2020, he was promoted to Group Chief Digital Transformation Officer (CDTO).

Which innovations have had the biggest impact on the financial services sector in recent years?

— One major innovation is the use of AI and machine learning to analyze non-financial data traditionally not owned by financial institutions. For instance, Mitsubishi UFJ Financial Group (MUFG) has been working with the strategic partner, Grab, the leading "superapp" of Southeast Asia, which provides delivery, mobility, and financial services. Grab analyzes daily transaction data that accumulates on their platform such as the number of orders and daily income of drivers and food merchants as well as spending propensity of those who use the Grab app, thereby developing sophisticated credit decision-making tools. In our collaboration with Grab aimed at providing next-generation financial services, we can now provide credit to customers who had not been well served with financial services, such as Grab drivers and food merchants, by taking advantage of the increased visibility on potential borrowers on the back of those data and analyses. We combine those non-financial and behavioral data with our own expertise in a traditional way of credit assessment, making a stronger credit assessment to meet financial needs. In Japan, we also utilize non-financial data to deliver new solutions to small and medium-sized enterprises (SMEs) through an online factoring business working with Money Forward.

Masakazu Osawa
Group Head,
Digital Service
Business Group &
Group Chief Digital
Transformation Officer
Mitsubishi UFJ
Financial Group

"Tokenization of non-financial assets will also accelerate. NFTs (non-fungible tokens), for instance, have enormous potential"

How could bitcoin and blockchain transform the financial services sector?

— There are many use cases for which blockchain offers significant advantages. For instance, going forward, blockchain will continue to offer remittances and settlements at a lower cost than that offered by existing mechanisms.

We have several blockchain initiatives currently under way. For instance, Progmat is a security-token issuance and management platform that utilizes distributed ledger technology promoted by Mitsubishi UFJ Trust and Banking Corporation. Progmat started its business by issuing and circulating tokenized trust beneficiary interests of residences in Shibuya [one of the major wards in Tokyo, the Japanese capital] in the form of public offering financial instruments. I have no doubt that many more diverse assets can be tokenized in the future.

Tokenization of non-financial assets will also accelerate. NFTs (non-fungible tokens), for instance, have enormous potential and we shall monitor their development closely. For Bitcoin, however, scarcity is the root of the price, and its value is not stable. Therefore, we feel that it might not become a payment tool that everyone can use.

"Blockchain will continue to offer remittances and settlements at a lower cost than that offered by existing mechanisms."

Con
ver
sa
tions
FOR TOMORROW

What are the biggest challenges that financial services firms face in scaling innovation initiatives?

"

Regulation poses the most significant challenge to innovation.

— Regulation poses the most significant challenge to innovation. Owing to deregulation in Japan, financial institutions are able to participate in operations beyond the original remit of the financial sector. However, financial institutions have traditionally established structures and business models. Integrating new payment models using digital currencies is challenging.

In addition, regulations typically tend to be applied in the new world, and for innovative new service, it becomes necessary for the major players in the finance sector to communicate and lead to a change in such regulations. Organizations need to develop what I call "ambidexterity," where they intensify the focus on core business, while continuing to challenge themselves to innovate. It is necessary to achieve both of these goals in a well-balanced manner, while, never losing sight of the end-goal: serving our customers.

"Organizations need to develop what I call "ambidexterity," where they intensify the focus on core business, while continuing to challenge themselves to innovate."

INNOVATION @ MUFG

MUFG is investing in and collaborating with startups. How successful is the open innovation model when working with startups?

— MUFG's open innovation aims to break away from self-reliance, bringing in new ideas and technologies from external sources and, through that, delivering new value to customers. We are constantly looking out for potential startup partners, for collaboration and strategic investment.

MUFG set up Global Innovation Teams in Silicon Valley in 2014 and Singapore in 2016, looking for opportunities to collaborate on new technologies and create new business models.

In 2015, we launched the MUFG Digital Accelerator, the first accelerator program within Japanese banks. The Accelerator symbolizes our open-innovation mindset, and is now one of the leading accelerator programs in the Japanese financial sector. Until today, five batches were held with the participation of 31 startups from Japan and overseas, and the 6th batch is

coming soon in this Autumn. The program has successfully commercialized multiple cases. In 2019, we launched Biz LENDING, our online lending service for SMEs. Biz LENDING was the fruit of collaboration with Credit Engine, a startup that participated in the 3rd batch of the program. Also, multiple startups from previous batches collaborated with us on our new asset-management platform Money Canvas, which we launched in 2021.

In 2016, we began investing strategically in startups. Through MUFG Innovation Partners (MUIP), the corporate venture capital of MUFG established in 2019, we have invested in over 30 startups in Japan and overseas.

As a good example, in 2020 we have launched Mars Growth Capital, a Singapore-based joint venture with Israel's Fintech company Liquidity Capital, which MUIP invested in. The company has already increased the total fund size to USD 500MM, and by leveraging the advanced AI credit model they provide its financing to overseas startups that traditional banks have difficulties in extending credit to.

Could you elaborate on MUFG's plans for a stablecoin platform?

— Our stablecoin[1] platform Progmat Coin (PC)will launch in 2023 following adjustments to meet regulatory changes. Conceptually, it is similar to the Japanese security-token scheme utilizing trust funds to fix and guarantee the valuation at PC1:JPY1. The initial use case is for the deliver versus payment [DvP; the guaranteed transfer of securities only after payment] settlement of secondary trade for the security tokens, and subsequently for any digital assets as the next step. We are in a position to drive the digital-asset markets in reducing its trading cost compared with any Fiat currency and lowering counter-party risks due to the implementation of T+0 trade.

How do you promote a culture of innovation across the organization?

— I believe that innovation should come from "trained" corporate culture of clarifying customer persona, digging deep into the customer's needs and issues, and to providing value and services to the customers as a solution.

1. A stablecoin is a cryptocurrency that is pegged to a fiat currency such as the US Dollar. Details to depend on the legal grounds in each country. MUFG's platform is based on the rules and regulations in Japan.
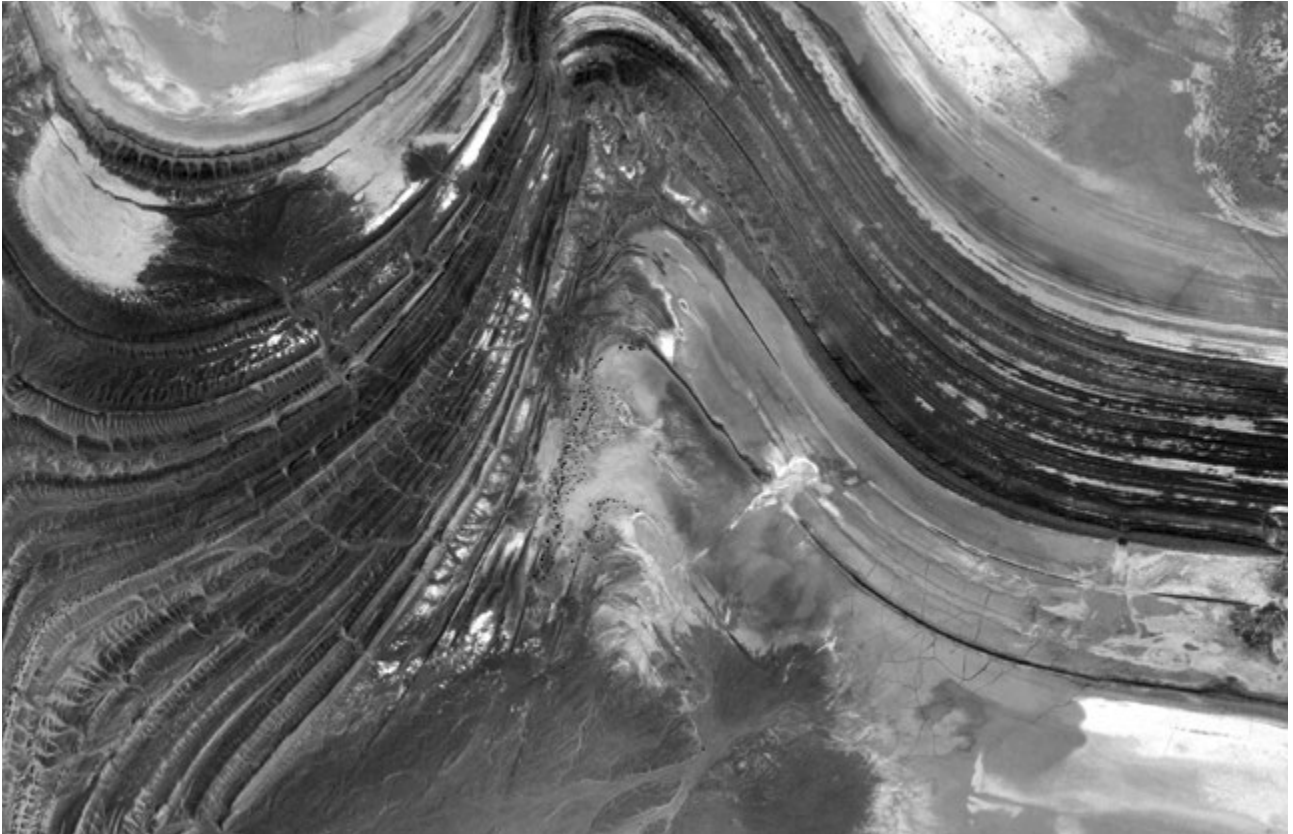
"In order to change internal culture, it is important that organizational leadership communicates continuously with the workforce, allowing real-time recognition and evaluation of challenges at all levels."

In order to change internal culture, it is important that organizational leadership communicates continuously with the workforce, allowing real-time recognition and evaluation of challenges at all levels. It is also important to encourage employees to innovate by expanding existing team structures, creating avenues such as Spark X, our in-house incubation program, and adapting the internal staffing system in order to give them a wide range of experiences.

FUTURE OUTLOOK

Which technology will have the most impact on society in the next five years?

— Web 3.0 is an interesting area that will continue to evolve.

Currently, financial institutions are largely centralized and have nurtured platforms and relations with administrators. SWIFT [the international payments system] is a typical example of this: with the protection of the central administrator, it was used as a significant part of the sanction-based response to Russia's invasion of Ukraine. Web 3.0 is based on DAO [decentralized autonomous organization], and the question is, how do we ensure trust in a world without administrators? It's an interesting question.

Web2.0 focused on embedded finance under the control of large technology organizations such as Google, Apple, Meta(Facebook) and Amazon. With Web3.0, there is a real possibility of universal decentralization. This promises big changes across sectors, not just for financial services.

I also find the metaverse interesting. In Japan alone, I think there are more than 10 million people who cannot go outside freely due to various circumstances. The metaverse has the potential to benefit many of them. Currently, VR devices are heavy and unsuitable for general use, but I believe innovation will soon find a solution to that, making them accessible to a much wider range of consumers.

Masakazu Osawa
Group Head,
Digital Service Business Group
& Group CDTO
Mitsubishi UFJ Financial Group

"Web 3.0 is based on DAO [decentralized autonomous organization], and the question is, how do we ensure trust in a world without administrators?"

Voice of Generation Next...

Con
ver
sa
tions
FOR TOMORROW

GITANJALI RAO
Inventor, scientist, and
Time Kid of the Year 2020

INNOVATION HAS NO MINIMUM AGE

Photo credit: Sharif Hamza

Photo credit: Sharif Hamza

Gitanjali Rao
Inventor, scientist, and
Time Kid of the Year 2020

Gitanjali Rao is an inventor, an aspiring scientist, author, speaker and an active promoter of STEM around the world. She was recognized as America's Top Young Scientist and was a recipient of an EPA Presidential Award.

She was honored as Forbes "30 Under 30 in Science" in 2019 and Time's "Top Young Innovator" and "Kid of the Year" for her innovations and STEM workshops she conducts globally.

She was also appointed as a UNICEF Youth Advocate 2021 for using science for solving social problems such as cyberbullying and developing solutions for environmental protection.

In 2020 you were named the first Time Kid of the Year. Can you give us more background on Tethys, the device you created to detect contamination in water?

— When I heard about the water crisis in Flint, Michigan [in 2014-16], that's when I started thinking about how to detect contaminants in water. The lack of knowledge of the nature and extent of contamination is a huge problem in many countries, including some parts of the US. On top of this, in many countries, there are no specific regulations that require testing of drinking water. Tethys is a simple and inexpensive tool for detecting lead contamination in water. My ambition is to put a cheap tool in everybody's hand, so people can act at source and save lives in their communities. While Tethys focuses on lead in drinking water, the technology could easily be adapted to detect other contaminants. Tethys uses carbon nanotubes with chloride dopants to detect lead; the combination of nanotube and other dopants with the right resistance signatures can be used to detect other contaminants.

"

I imagine a world in ten years with personalized medicine and home kits for everything from disease diagnosis to cures for degenerative diseases."

"Kindly is an AI-based service designed to detect cyberbullying at an early stage and prevent it from escalating."

You have also developed an AI-based anti-cyberbullying service, Kindly. Can you expand on what the service is and how it works?

— Kindly is an AI-based service designed to detect cyberbullying at an early stage and prevent it from escalating. It uses developments in machine learning and natural language understanding/processing to identify words and phrases in everyday interactions that could be construed as bullying. The service can be seamlessly adapted to work with a variety of front ends. While I created a beta standalone app and browser extension as an example, it is now powered by UNICEF and has been rolled out worldwide.

The solutions currently on the market, while effective in some contexts, are limited to fixed vocabularies. In reality, the informal language typically used in bullying, as with all spoken language, is continuously evolving. Kindly's self-learning service adapts to this, including learning about the latest emojis, memes, and slang. Kindly attempts to be non-punitive and encourages self-moderation by allowing users the option of rephrasing or editing their messages.

Anyone, anywhere in the world, can contribute to its self-learning algorithm on the UNICEF website: **https://www.unicef.org/innovation/kindly**

You conduct innovation workshops for organizations across the world and you have mentored tens of thousands of students. What are your key recommendations for organizations/students?

— To date, I have conducted innovation workshops for over 68,000 students in about 40 countries, and this figure continues to grow.

Using my own experience in product development, I have codified the innovation process into five steps which are observe, brainstorm, research, build, and communicate. In my workshops, I elaborate on these steps using examples. Students are encouraged to use this process as a template to help them find solutions to problems local to them. Some students come up with great, workable solutions there and then that they can take away to scale up but, more importantly, all go away with a sense that they can be true innovators and problem-solvers in their communities.

FORTY COUNTRIES

68,000 STUDENTS

"I have conducted innovation workshops for over 68,000 students in about 40 countries."

From portable spacesuits to robotic companion dogs, to shoes that can call 911, the ideas that these students have come up with prove to me that innovation has no minimum age and that important ideas can be developed without a huge R&D budget. All students need is a mentor to guide them and give them the confidence to share their ideas.

To sustain the impact of the workshops beyond my personal contact with students, in 2021 I published a book: A Young Innovator's Guide to STEM, which is now available around the world and translated into five languages. My dream is to lead an innovation movement in early education. With an army of inspired and passionate students solving problems in their communities, we could make a massive difference to society.

"
Innovation has no minimum age."

My recommendation to organizations is to invest in students: open your labs / maker spaces / R&D departments to elementary- and middle-school students; allow them to shadow you and, if you can, offer them mentoring. My only advice to students is to dive in! Many students reach out to me wanting to know how to gain recognition for their ideas, but my advice to them is that recognition will follow hard work. Failure is the first step in learning, so develop your ideas without fear.

> **"My recommendation to organizations is to invest in students: open your labs / maker spaces / R&D departments to elementary- and middle-school students; allow them to shadow you and, if you can, offer them mentoring."**

"

Science and technology are about more than coding and research; they are about having a real impact on the world we live in and the people around us."

How can we make STEM subjects more attractive to and inclusive for girls?

— I clearly remember science and programming camps a few years back, where I would be the only girl. It made me want to run away! I would be alone during lunch or would sit with the instructors. It made me feel that I did not belong there. However, when I realized that I really did want to be there, I relaxed and started to make friends. The boys were happy to include me in their chats and games; they just hadn't thought to do so before. They made an effort and included roles for me when I asked them to. You just need to have confidence in yourself.

That changed my perspective on the idea that someone is stopping women or girls from doing science. At some point, we have started to presume that, because we don't always see role models, this is not for us. Today, there are several girls in STEM organizations, but few are staying in research or developing products. Science and technology are about more than coding and research; they are about having a real impact on the world we live in and the people around us. Gender should not stop you from solving problems in the real world and everybody should be able to be part of it. Most girls lose interest in science after middle school; this could be because we are stereotyped, and society has decided a role for us, but also because we make a choice to exclude ourselves.

We need to recognize that we all learn differently. Coding and programming with robots and machines all around may not be a great introduction for all girls. I usually start my workshops by finding out what everyone likes to do and finding problems to solve in those fields, whether it is sports, nature, animals, food, etc., and then look for new solutions that use some of the latest technology. Technology can be combined with art and music in solving problems, as well.

"I clearly remember science and programming camps a few years back, where I would be the only girl. It made me want to run away!"

We need to introduce girls to a variety of topics and let us pick and choose or mix and mash them. I have had girl students who came up with ideas to help dyslexic students and wanted to find a way to allow their teachers to understand how they see letters differently to most students. The point is girls can bring a different perspective.

5. Is there a specific technology that you are particularly excited about?

— I believe that the future is personalized medicine. This is based on the genetic makeup of every individual and living organism. Diagnosis techniques and traditional drug-based treatment will, in most cases, be replaced by gene-based methods. My belief is that these solutions will be more powerful when developed using a combination of several technology disciplines that are traditionally separate.

I imagine a world in ten years with personalized medicine and home kits for everything from disease diagnosis to cures for degenerative diseases. Thinking about possibilities like this makes me feel excited about the future.

"Most girls lose interest in science after middle school; this could be because we are stereotyped, and society has decided a role for us, but also because we make a choice to exclude ourselves."

From the desk of...

FUTURE TODAY INSTITUTE,

GENOME PROJECT-WRITE, HUMANE GENOMICS INC.

Should Life be a game of chance?
Amy Webb, CEO, Future Today Institute
Andrew Hessel, Geneticist, Co-founder, Genome Project-write,
Humane Genomics Inc.

→ **p.140**

ALGORAND

Building a sustainable and scalable blockchain
Silvio Micali, Founder of Algorand &
Ford Professor of Engineering at MIT

→ **p.148**

HENG HIAP INDUSTRIES (HHI)

Towards a plastic-neutral society
Kian Seah, Founder and CEO

→ **p.156**

Con
ver
sa
tions
FOR TOMORROW

Amy Webb
CEO,
Future Today Institute

Andrew Hessel
Geneticist,
Co-founder, Genome
Project-write, Humane
Genomics Inc.

SHOULD LIFE BE A GAME OF CHANCE?

Amy Webb is CEO of the Future Today Institute, a leading foresight and strategy firm that helps leaders and their organizations prepare for complex futures. She is a professor of strategic foresight at New York University Stern School of Business, where she developed and teaches the MBA-level strategic foresight course with live case studies. She is also a Visiting Fellow at Oxford University's Säid School of Business.

Andrew Hessel is the co-founder of Humane Genomics Inc., which engineers synthetic viruses to target cancer cells. He is the catalyst, chairman and co-executive director of the Genome Project-write / The Center of Excellence for Engineering Biology, an international research and development effort that lays the technical and societal foundations for responsible applications of synthetic biology.

From the Desk of

Right now, scientists are rewriting the rules of our reality. The anguish we both experienced as we struggled to become parents could be an anomaly in the coming decades. An emerging field of science promises to reveal how life is created and how it can be recreated, for many varied purposes: to help us heal without prescription medications, grow meat without harvesting animals, and engineer our families when nature fails us. That field, which is called synthetic biology, has a singular goal: to gain access to cells in order to write new—and possibly better—biological code.

In the twentieth century, biologists focused on taking things apart (tissues, cells, proteins) to learn how they functioned. This century, a new breed of scientists is instead attempting to construct new materials out of life's building blocks, and many others are already achieving successes in the nascent field of synthetic biology. Engineers are designing new computer systems for biology, and startups are selling printers capable of turning computer code into living organisms. Network architects are using DNA as hard drives. Researchers are growing body-on-a-chip systems: picture a translucent domino embedded with nanoscale human organs that live and grow outside a human body. Together, biologists, engineers, computer scientists, and many others have forged a genesis machine: a complex apparatus of people, research labs, computer systems, government agencies, and businesses that are creating new interpretations, as well as new forms of life.

"Synthetic biology, has a singular goal: to gain access to cells in order to write new—and possibly better— biological code."

The genesis machine will power humanity's great transformation— which is already underway. Soon, life will no longer be a game of chance, but the result of design, selection, and choice. The genesis machine will determine how we conceive and how we define family, how we identify disease and treat aging, where we make our homes, and how we nourish ourselves. It will play a critical role in managing our climate emergency, and eventually, our long-term survival as a species.

The genesis machine incorporates many different biotechnologies, all of which were created to edit and redesign life. A series of new biological technologies and techniques, which broadly fall under synthetic biology's umbrella, will allow us not just to read and edit DNA code but to write it. Which means that soon, we will program living, biological structures as though they were tiny computers.

From the Desk of

It's been possible to edit DNA code since the early 2010s using one of those technologies: CRISPR-Cas9. Scientists refer to a pair of "molecular scissors" to describe the technique, because it uses biological processes to cut and paste genetic information. CRISPR routinely makes headlines about groundbreaking medical interventions, such as editing the genes of blind people to help them see again. Scientists have been using CRISPR's physical molecular scissor technique and splicing the DNA molecule back together in a sort of biological collage with letters rearranged into new places. The problem is that researchers can't directly see the changes being made to the molecule they're working on. Each move requires laboratory manipulations that must then be experimentally validated, making it all very indirect, labor intensive, and time consuming.

Synthetic biology digitizes the manipulation process. DNA sequences are loaded into software tools—imagine a text editor for DNA code— making edits as simple as using a word processor. After the DNA is written or edited to the researcher's satisfaction, a new DNA molecule is printed from scratch using something akin to a 3D printer. The technology for DNA synthesis (transforming digital genetic code to molecular DNA) has been improving exponentially. Today's technologies routinely print out DNA chains several thousand base pairs long that can be assembled to create new metabolic pathways for a cell, or even a cell's complete genome. We can now program biological systems like we program computers.

These scientific innovations have fueled the recent and rapid growth of a synthetic biology industry intent on making high-value applications that include biomaterials, fuels and specialty chemicals, drugs, vaccines, and even engineered cells that function as microscale robotic machines. Progress in artificial intelligence has provided a significant boost to the field, as the better AI becomes, the more biological applications can be tested and realized. As software design tools become more powerful and DNA print and assembly technologies advance, developers will be able to work on more and more complex biological creations. One important example: we will soon be able to write any virus genome from scratch. That may seem like a frightening prospect, given that the coronavirus known as SARS-CoV-2,

which causes COVID-19, has, as of this writing, resulted in the deaths of more than 4.2 million people worldwide.

What makes viruses like SARS-CoV-2—and SARS, H1N1, Ebola, and HIV before it—so difficult to contain is that they are powerful microscopic code that thrive and reproduce with an unprotected host. You can think of a virus as a USB stick you'd load into your computer. A virus acts like a USB by attaching itself to a cell and loading new code. And as bizarre as this might sound at a time when we're living through a global pandemic, viruses could also be our hope for a better future.

Imagine a synthetic biology app store where you could download and add new capabilities into any cell, microbe, plant, or animal. Researchers in the United Kingdom synthesized and programmed the first Escherichia coli genome from the ground up in 2019. Next, the gigabase-scale genomes of multicellular organisms—plants, animals, and our own genome—will be synthesized. We will someday have a technological foundation to cure any genetic disease in humankind, and in the process we will spark a Cambrian explosion of engineered plants and animals for uses that are hard to conceive of today, but will meet the global challenges we face in feeding, clothing, housing, and caring for billions of humans.

"We can now program biological systems like we program computers."

The code for our futures is being written today. Recognizing that code, and deciphering its meaning, is where humanity's new origin story begins.

Life is becoming programmable, and synthetic biology makes a bold promise to improve human existence. Within the next decade, we will need to make important decisions: whether to program novel viruses to fight diseases, what genetic privacy will look like, who will "own" living organisms, how companies should earn revenue from engineered cells, and how to contain a synthetic organism in a lab. What choices would you make if you could reprogram your body? Would you agonize over whether—or how—to edit your future children? Would you consent to eating GMOs (genetically modified organisms) if it reduced climate change? We've become adept at using natural resources and chemical processes to support our species. Now we have a chance to write new code based on the same architecture as all life on our planet. The promise of synthetic biology is a future built by the most powerful, sustainable manufacturing platform humanity has ever had. We're on the cusp of a breathtaking new industrial evolution.

The conversations we're having today about artificial intelligence—misplaced fear and optimism, irrational excitement about market potential, statements of willful ignorance from our elected officials—will mirror the conversations we will soon be having about synthetic biology, a field that is receiving increased investment because of the novel coronavirus. As a result, breakthroughs in mRNA vaccines, home diagnostic testing, and antiviral drug development are accelerating. Now is the time to advance the conversation to the level of public consciousness. We simply do not have the luxury of time to wait any longer.

The promise of this book is simple and straightforward: if we can develop our thinking and strategy on synthetic biology today, we will be closer to solutions for the immediate and long-term existential challenges posed by climate change, global food insecurity, and human longevity. We can prepare ourselves now to fight the next viral outbreak with a virus we engineer and send into battle. If we wait to take action, the future of synthetic biology could be determined by fights over intellectual property and national security, and by protracted lawsuits and trade wars. We need to ensure that advances in genetics will help humanity, not irrevocably harm it.

The code for our futures is being written today. Recognizing that code, and deciphering its meaning, is where humanity's new origin story begins.

Excerpted from The Genesis Machine: Our Quest to Rewrite Life in the Age of Synthetic Biology by Amy Webb and Andrew Hessel. Copyright © 2022. Available from PublicAffairs, an imprint of Hachette Book Group, Inc.

Silvio Micali
Founder of Algorand &
Ford Professor of
Engineering at MIT

BUILDING A SUSTAINABLE AND SCALABLE BLOCKCHAIN

Silvio Micali is the recipient of the Turing Award in Computer Science (Editor's note: colloquially known as the Nobel Prize in Computing), the Gödel Prize in Theoretical Computer Science and the RSA Conference Award for Excellence in Mathematics (for his pioneering work in cryptography).

He is a member of the National Academy of Sciences, the National Academy of Engineering, the American Academy of Arts and Sciences, and the Accademia dei Lincei. Silvio received his Laurea in Mathematics from the University of Rome, and his PhD in Computer Science from the University of California at Berkeley. In 2017, Silvio founded Algorand, a fully decentralized, secure, and scalable blockchain cryptocurrency protocol that provides a common platform for building products and services for a borderless economy.

Meet the blockchain

The blockchain is a shared database that is not centrally organized. It is a shared database in which everybody can write, everybody can read, and nobody can alter what has been written. Here, trust in people or entities is replaced with algorithmic trust. What does this mean for large organizations or the economy itself?

1. The current lack of trust implies that, if two entities or individuals need to transact at distance, they must rely on an intermediary, who will extract 6% of the value of a transaction. Six percent of global GDP is a lot of money. It is also a lot of time; traditional intermediary settlement takes T+2 days. In 24 hours, a lot can change in the world. On the blockchain, this happens in a few seconds. Such speed lowers counterparty risk.

2. Blockchain helps drive democratization of finance. Intermediaries do not care about the poor as they cannot extract value from them. Blockchain can step in there. .

3. Blockchain brings an important ability to tokenize assets for everyone. It is much easier to sell a small share of an office building than to sell the entire office building. It can help make illiquid markets liquid, at speed.

BLOCKCHAIN CAN HELP MAKE ILLIQUID MARKETS LIQUID, AT SPEED

The smart contract is the secret sauce

A smart contract executes automatically when certain conditions are met. Smart contracts make blockchains programmable, increasing security and reducing the need for user involvement in transactions by establishing a clearly defined procedure for transferring assets. Decentralization makes blockchain a much more secure platform; whenever you have a single point of failure or endpoint of failure, it's much easier to subvert.

Take the case of selling a large building. With the blockchain, it is possible to tokenize the building and conduct a large-scale Dutch auction. The transparent nature of the blockchain allows participants to see all bids worldwide and to know who has won what and at what price. The winner receives shares of the building and payment is debited automatically.

To summarize, smart contracts bring forth several advantages:

- **Security:** Unlike credit- or debit-card purchases, transactions on the blockchain don't require the purchaser to entrust a third party with sensitive information, greatly reducing risk of data theft, fraud, and financial loss. Transactions are final and irreversible, so there is no risk of chargebacks or cancellations, another common route for fraud.

- **Transparency:** Transactions made by smart contracts can take place on public blockchains, meaning that anyone can verify each transaction.

- **Autonomy:** Because smart contracts are autonomous, they eliminate the risk of manipulation by third parties and intermediaries.

- **Cost savings:** Smart contracts eliminate the need for multiple intermediaries to process complex payments, saving money on service fees.

- **Accuracy:** Calculations are made automatically, eliminating human error.

- **Speed:** The automation of calculation, verification, and approvals can save hours of manual labor, freeing workers up for strategic tasks.

What are some use cases for smart contracts?

Improved security and increased efficiency through automation are the most obvious areas where companies can benefit from implementing smart contracts. However, the combination of security, trust, and transparency can enable a variety of services:

Escrow services

Large transactions, such as real-estate purchases or trade deals, currently require escrow: that is, a trusted third party holds the fee while a sale takes place. A smart contract can be programmed to hold the money and automatically release it to the seller once the legal requirements are fulfilled.

Global payments

Smart contracts can be used to execute multi-layered global payments based on predetermined criteria between two or more parties across borders, at minimal cost, with near-instant settlement speeds.

Payroll

The structure of work is changing and, with it, the structure of payroll systems. Smart contracts can automate payroll for thousands of employees. Hourly contracts, monthly salaries, bonuses, and commissions can all be integrated into smart contracts and processed instantly.

Dividends

Many publicly traded companies pay out dividends to shareholders on an annual or quarterly basis. Smart contracts can automate this process, updating details automatically if the stock changes hands. This also has the potential to lower dramatically barriers to issuing stock to investors.

Treasury management

Blockchain-based treasury management offers a number of benefits, especially for large organizations. Corporate treasury managers, for example, can view the disposition of accounts of different entities worldwide, in real time. This can enhance decision-making processes via improved cashflow forecasts and capitalizing on time-sensitive investment opportunities.

Blockchain challenges

Many blockchains waste tremendous amounts of energy. Another key challenge is decentralization. If you go to a centralized blockchain, you're essentially leaving yourself at the mercy of a few agents, who then decide whether you can transact or not. If you want an institutional-grade blockchain, it should be decentralized.

Another challenge is uptime. Uptime does not matter when the blockchain is used for speculation, but it becomes a major issue with real-time applications. Another big issue is the lack of universal definitions, so it's very hard to compare blockchain to blockchain.

Why blockchain sustainability is important

We have a moral obligation to the planet, and that includes creating a blockchain that brings advantages without wasting energy. Global, borderless, open-source technologies must consider their impact on the environment. Providing inclusive access to new Internet-native financial products and services cannot come at the expense of the environment. Rather, the industry needs to ensure that new blockchain-powered solutions not only benefit businesses and consumers but the environment as well; or, at the very least, not harm it in the way that many legacy technologies have done. To achieve a sustainable blockchain industry, businesses and open-source projects should focus not only on deploying carbon-neutral technology but also supporting use cases that drive eco-friendly initiatives. In this context, evolvability is a key component of sustainability, because nothing lives or remains relevant for very long unless it has the ability to adapt.

> **"To achieve a sustainable blockchain industry, businesses and open-source projects should focus not only on deploying carbon-neutral technology but also supporting use cases that drive eco-friendly initiatives."**
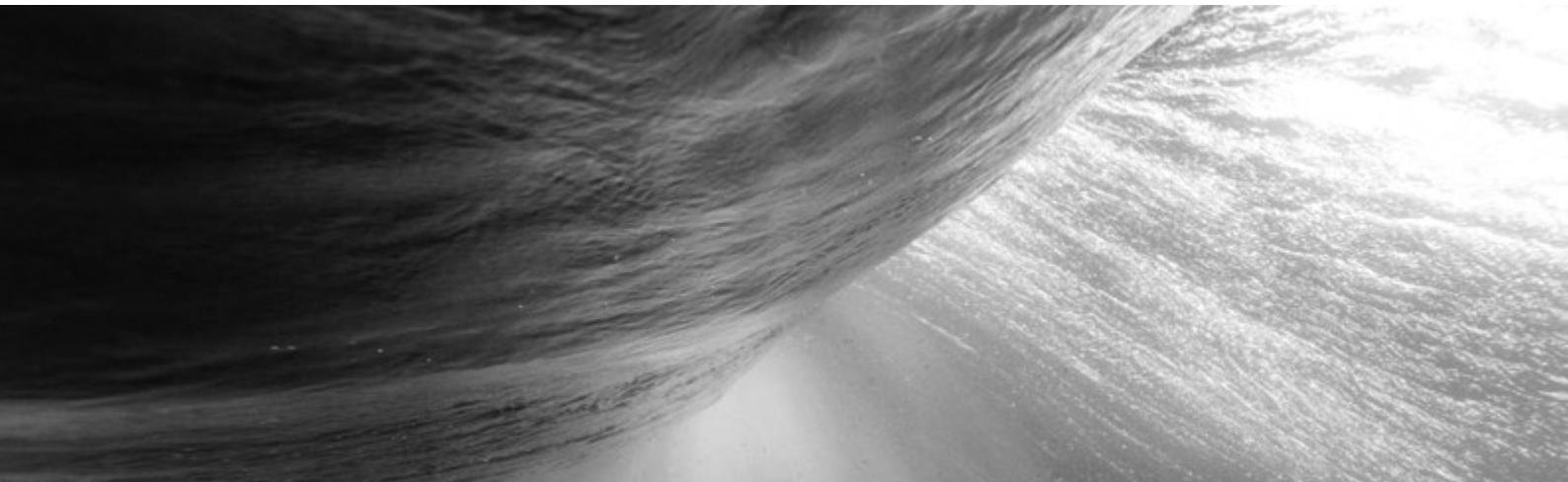
The rise of the sustainable blockchain and Algorand

In the crypto world, it has been defined as the famous blockchain trilemma: the impossibility for a blockchain to be simultaneously secure, decentralized, and scalable. That did not sit well with me, wearing my cryptographer's hat. I admired the ethos and the idea of Bitcoin but I believe the way they implemented the achievement of this goal was not exactly as beautiful as the idea itself. So, I wanted to design something that retained the ethos and the goals of Bitcoin but in a technologically sound way.

Algorand takes a proactive approach to blockchain sustainability by deploying an environment-friendly consensus protocol and focusing on providing green blockchain solutions. Pure proof of stake (PPoS) is a protocol that enables Algorand to address the blockchain trilemma, ensuring that none of the three key elements of an ideal blockchain – scalability, security, and decentralization – is compromised.

"

Algorand takes a proactive approach to blockchain sustainability by deploying an environment-friendly consensus protocol and focusing on providing green blockchain solutions."

The PPoS enables Algorand to build a sustainable and scalable blockchain ecosystem that sets the standard for the future of finance. This makes it ideal for a variety of use cases for future finance (FutureFi), such as DeFi (decentralized finance), tokenization, NFT (non-fungible token) creation, stablecoins, payments, and more. By virtue of its network structure, Algorand is theoretically able to scale up to billions of users, while maintaining low costs and high levels of security and performance.

Embrace the blockchain

If you are the CXO of a large organization, there are some things you need to understand about blockchain:

1. It is here to stay. It is not a fad and it is not going away.

2. Not all blockchains are alike. Ask the questions that matter so you understand the tech:
   a. Is the blockchain green?
   b. Is it decentralized?
   c. Does it have the ability to evolve consensually?

3. Being an informed early adopter is key to success. Latecomers may not benefit.

Once you have done this, you should embrace blockchain. It's a wonderful technology, and can transform your industry, your nation, and the world at large.

> "Smart contracts eliminate the need for multiple intermediaries to process complex payments, saving money on service fees."

Con
ver
sa
tions
FOR TOMORROW
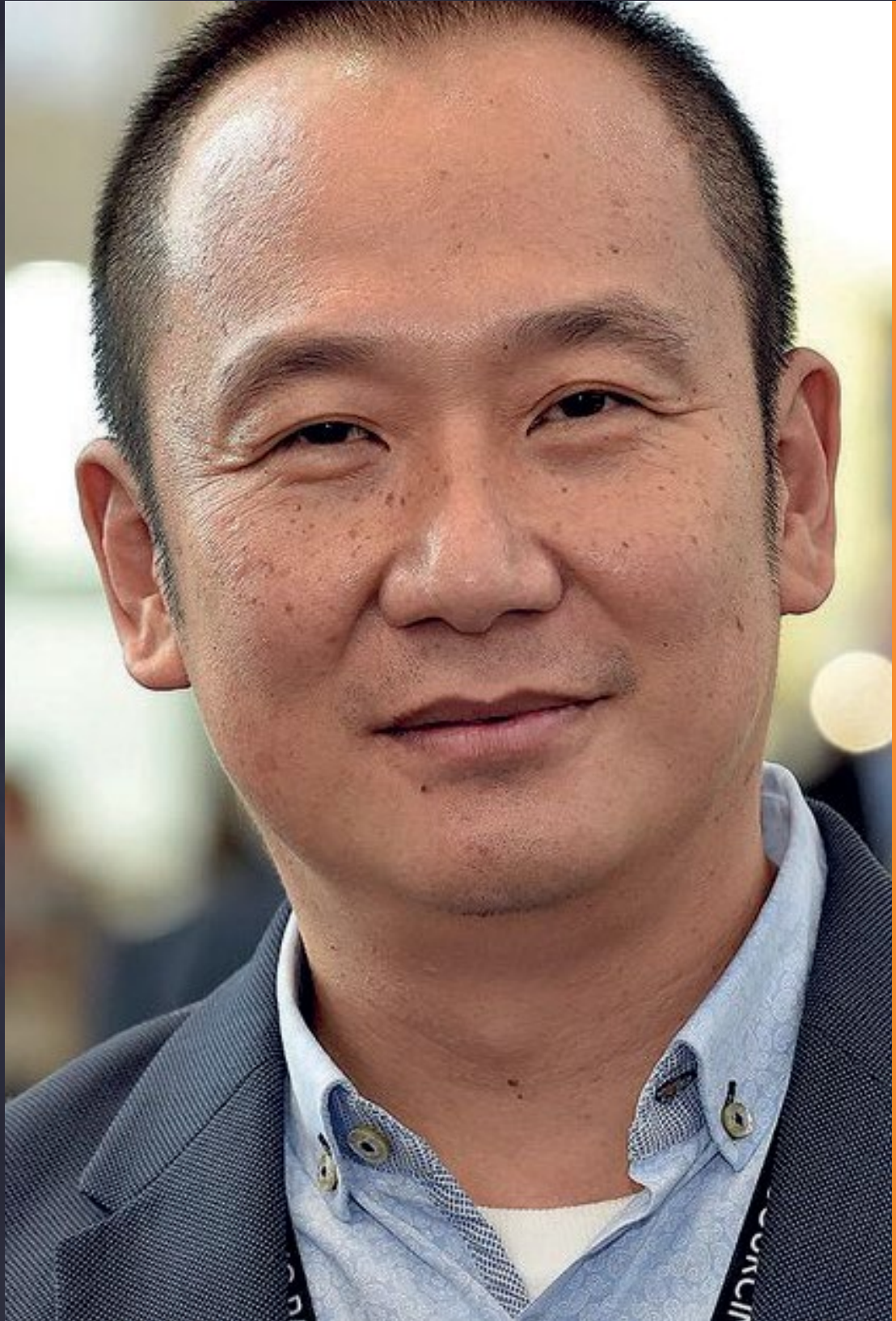
Kian Seah
Founder and CEO,
Heng Hiap Industries
(HHI)

TOWARDS A PLASTIC-NEUTRAL SOCIETY

Kian Seah is the founder and CEO of Heng Hiap Industries (HHI). Based in Malaysia, HHI is the world's first end-to-end integrated plastic-recycling company. HHI works with 28,000 independent plastic recyclers to create high-performance, niche plastic material that is exported to 38 countries and is the first company anywhere in the world to receive the Ocean Bound Plastic (OBP) certification.

The oceans are getting dirtier

I n the first decade of the new millennium, the volume of plastic waste generated by humanity rose more than it had in the previous 40 years as a whole. Less than 10 percent of the seven billion tons of plastic waste generated globally has been recycled[1] and this is now impacting humans directly, with recent research from the Netherlands finding microplastics in the human body.[2] Plastic pollution has four different aspects: mismanaged landfills, leakage into rivers, leakage into oceans, and pollution from open fires. Of the four, ocean plastic has the greatest harmful impact, because it reduces marine diversity. Plastic waste entering aquatic ecosystems is currently projected to grow to 23-37 million tons per year by 2040.[3] The financial damage due to the plastic pollution in the marine ecosystems is nearly $13 billion.[4]

To abort this damaging process, we must amend plastic-consumption patterns to become circular, rather than linear, with reuse and recycling predominating, and the plastic waste channeled back into the industrialization cycle. Below, we lay out the key recommendations for an innovation-led approach to becoming a plastic-neutral world.

" Less than 10 percent of the seven billion tons of plastic waste generated globally has been recycled"

1. UNEP,"Our planet is choking on plastic"
2. The Guardian, "Microplastics found in human blood for first time," March 2022
3. UNEP,"Our planet is choking on plastic"
4. Heng Hiap website, accessed on 16th June 2022

Circular economy: A way out of the mess we have created

Linear design looks at how the product is manufactured, branded, and consumed by the customer; however, the design function does not address what happens once the product has been consumed and discarded. In a linear consumption pattern, the carbon footprint is very large. An estimated 63% of consumers are aware of the enormity of the global plastic waste problem,[5] and consumer behavior is shifting from a linear consumption pattern. Around half of consumers claim to be interested in purchasing zero-waste products, and 48% say they already reuse plastic bottles.[6] Each time the plastic is recycled, the carbon footprint is halved, meaning that, if circularity can be implemented on a global scale, plastic has the potential to become one of the resources with the lowest carbon footprint.

Traceability: The key to the recycling process

Firms have always competed to make their products prettier, smarter, cooler, better, and faster. However, especially among the younger demographic, another consideration is now driving consumer demand: sustainability. At Dutch multinational Philips, green products and solutions contributed 71% of total revenue in 2020, with 15% coming from circular-economy products and solutions.[7] Consumers are willing to pay more for sustainable products, and 61% of consumers will be less willing to buy products if they found they performed poorly on environmental practices.[8]

5.   Our World in Data, "Plastic Pollution"; Capgemini Research Institute, circular economy survey, August–September 2021, N=7,819 consumers

6.   Capgemini Research Institute, circular economy survey, August–September 2021, N=7,819 consumers.

7.   Philips, 2020 annual results, https://www.results.philips.com/#livesimproved, accessed April 15, 2021.

8.   WARC," Consumers will drop environmentally unfriendly brands", February 2020.

Consumers nowadays demand extensive product information, including the product source, compliance certification, and evidence of sustainable production methods. The brand that provides customers with the fullest evidence of sustainability will win their business. For instance, while one organization may state opaquely that they use 25% of recycled content, a competitor could specify the use of 25% ocean-bound recycled plastic, and provide a fully traceable history. Organizations should begin putting in place the technology to achieve a high degree of traceability; blockchain application will be very important in achieving this.

The UK government introduced a plastic-packaging tax, effective from April 2022, which taxes UK manufacturers and importers on plastic packaging with under 30% recyclable content. This highlights the need for **traceability** of the source of recycled materials.[9]

Implement an end-to-end value chain

An integrated recycling value chain reduces labor and logistics costs. The recycling industry is largely informal, with communities of hard-working people sorting through trash and picking out useful materials to recycle. However, this process was manual, complex, and involved pen and paper transactions, and in-person negotiation. The demand for quality recycled plastic is so high that HHI was struggling to keep pace. There are multiple possibilities offered by digital transformation in the waste sector to simplify and digitize this process. HHI developed an app that allowed households to order the collection of their recyclable materials. This removed a lot of inefficiency from existing processes, leading to collection of higher-quality plastics in greater volumes. HHI has collected up to 60,000 tons of plastic waste and aims to recycle over 100,000 tons of plastic by the year 2025.[10]
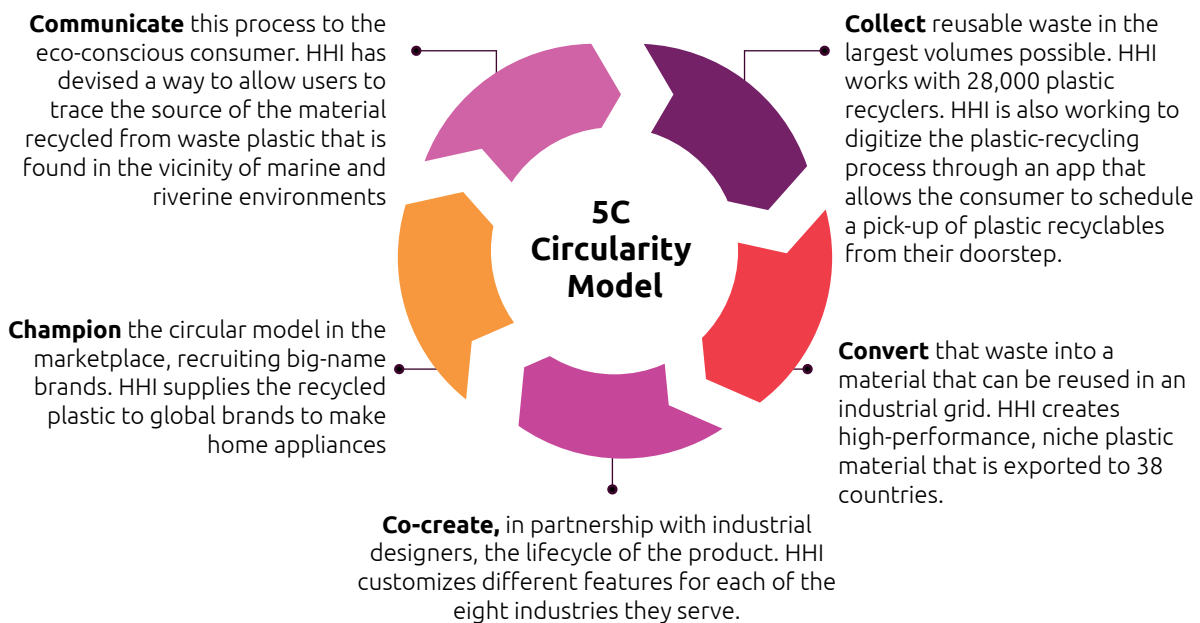

9. Packaging Gateway, "Will the UK plastic packaging tax force businesses to act sustainably?" May 2022.
10. Heng Hiap website, accessed on 16th June 2022

HHI HAS COLLECTED UP TO 60,000 TONS OF PLASTIC WASTE AND AIMS TO RECYCLE OVER 100,000 TONS OF PLASTIC BY THE YEAR 2025.

HHI has a 5C circularity model:

Communicate this process to the eco-conscious consumer. HHI has devised a way to allow users to trace the source of the material recycled from waste plastic that is found in the vicinity of marine and riverine environments

Collect reusable waste in the largest volumes possible. HHI works with 28,000 plastic recyclers. HHI is also working to digitize the plastic-recycling process through an app that allows the consumer to schedule a pick-up of plastic recyclables from their doorstep.

5C Circularity Model

Champion the circular model in the marketplace, recruiting big-name brands. HHI supplies the recycled plastic to global brands to make home appliances

Convert that waste into a material that can be reused in an industrial grid. HHI creates high-performance, niche plastic material that is exported to 38 countries.

Co-create, in partnership with industrial designers, the lifecycle of the product. HHI customizes different features for each of the eight industries they serve.

Ensure technology and industrial design are pillars of your sustainable innovation

We need to look at all the materials and their chemical properties to give plastic a second life. Recycled plastic must be useable in high-value-added products, such as home appliances, and the quality of plastic must be retained in the recycling process. To achieve this, the plastic waste must be crushed correctly and cut to the right size, with no contamination by other materials. The temperature must not be too high to prevent the oxidization of the raw materials, and the recycling process must observe careful collection and sorting of the waste. It is important that these steps are followed to prevent deterioration and preserve the inherent property of this plastic.

Organizations must ensure that this operation is governed by a clear set of standards – an industrial "playbook," so to speak. It is important to preserve the integrity and inherent properties of the base material throughout the process, using the technologies available to customize and enhance the functionality and performance of the feedstock. This ensures the production of a safe, high-quality material that can be molded into aesthetically pleasing forms and minimizes the production of volatiles.

Many companies are integrating these principles into their manufacturing processes. Renault, for instance, has developed a network of over 330 salvage organizations in France to recycle materials. Renault cars currently sold in Europe contain on average 10–20% recycled plastics.[11]

Innovation for a sustainable future

It is up to us to utilize natural resources responsibly and to best advantage. The magic word is: innovation. Sustainable production design does not seek to take solely for the benefit of an individual organization, but to benefit society and the planet, in terms of both health and wealth. This is innovation at its purest: finding a way to bring good to society and the world while doing no harm.

11 Automotive recyclers of Canada, "Renault interview: An OEM's perspective on the circular economy and auto recycling," October 2019.

"Plastic waste must be crushed correctly and cut to the right size, with no contamination by other materials"

Perspectives from Capgemini
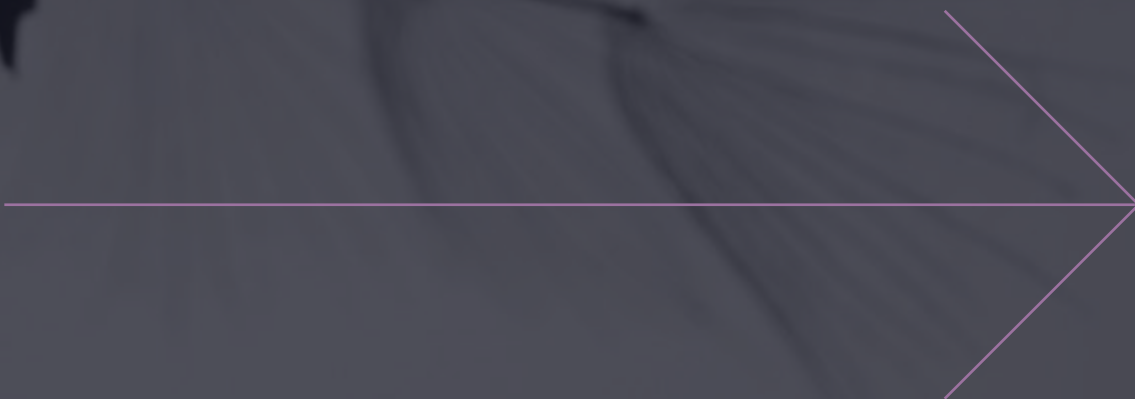
Con
ver
sa
tions
FOR TOMORROW

THE EVOLVING ROLE OF THE CHIEF INNOVATION OFFICER

Elisa Farri and Gabriele Rosani
from The Management Lab by Capgemini Invent

→ **p.176**

INNOVATION AXIOMS FOR TODAY'S LEADERS

Pascal Brier, Group Chief Innovation Officer, Capgemini

→ **p.166**

THE BIOECONOMY IS ABOUT TO CHANGE EVERYTHING. ARE YOU READY?

Mike Dunkley and Karen Weisinger
from Cambridge Consultants, part of Capgemini Invent

→ **p.188**

Con
ver
sa
tions
FOR TOMORROW

Perspectives from Capgemini

Capgemini Research Institute   Breathe In(novation)—Uncover Innovations that Matter

INNOVATION AXIOMS FOR TODAY'S LEADERS

Pascal Brier
Group Chief Innovation Officer, Capgemini

Pascal Brier is Capgemini's Group Chief Innovation Officer and a member of the Group Executive Committee. Prior to this, Pascal was a member of the Executive Committee and Executive Vice-President of the Altran group, in charge of Strategy, Technology & Innovation, based in the Silicon Valley. Pascal began his career at NCR and AT&T and then held various leadership positions at Microsoft.

Innovation as self-reinvention

Why do organizations need to innovate? While innovation is often seen as the linchpin for sustained growth and a way for a company to differentiate itself from the competition, a more fundamental driver of innovation in business is the need to stay relevant. When Airbnb launched, many large hotel chains did not feel threatened. It didn't take long, however, for Airbnb to be able to boast more listings than the combined number of rooms held by the top 5 global hotel brands.

This example highlights one key message: when it comes to innovation, companies need to be on their toes. Innovate, or abdicate and be shown up.

Depending on the style and approach of their leadership, organizations can either take an aggressive approach and ride the innovation or adopt a defensive strategy and try to ride out market disruption. Which is the right response will depend on the nature of the industry and the individual organization's market position. A good starting point for making sure executive teams and innovation teams are aligned in their thinking is to ask the following questions:

Timing – Are you generally seeking to be a first mover, an early adopter, or a fast follower? Where do you see competitive advantage and why?

Risk – What is the organization's attitude to risk? Are you looking for incremental or disruptive innovation? What's the right balance of these two aspects and what are your leaders' expectations?

" **A more fundamental driver of innovation in business is the need to stay relevant.**"

Process – How do you approach innovation? Is it something that you want to build and defend in house, or are you open and collaborative and seeking the best ideas wherever they emerge?

Method – Do you see innovation as a way of exploring lots of different ideas, or do you want to place a few, limited bets – but bets that count?

"Depending on the style and approach of their leadership, organizations can either take an aggressive approach and ride the innovation or adopt a defensive strategy and try to ride out market disruption."

Technology leads innovation

Marc Andreessen, in his famous 2011 essay, said software is eating the world.[1] In 2022, it is clearly visible all around us that software has eaten the world. Eight of the world's 10 biggest companies by market capitalization are technology companies, compared to just two in 2010.[2] Today, there is no organization where technology has not impacted every function, across every sector. This is also true of innovation. Organizations need to bear in mind that, at its core, innovation is led by technology.

1   Wall Street Journal, "Why Software Is Eating The World", August 2011
2   FT, Global 500, December 2010 and December 2021

Software-driven transformation is redefining the global automotive industry, for instance. It is transforming vehicles, organizational structure, processes, methods, and tools. Automotive manufacturing is now primarily defined, designed, and operated by software. Our research suggests that, by 2031, software-based features and services will be a $640 billion global market, growing in this period from 8% of OEMs' current annual revenues to 22%.[3]

" At its core, innovation is led by technology."

3   Capgemini Research Institute, "Next Destination: Software", September 2021

Perspectives from Capgemini

Across industries, companies are building large-scale technology foundations in a bid to harness data and drive innovation. For example, in the utilities market, a robust data and technology foundation is a prerequisite for successful implementation of new-energy models. Sustainability and reduction of carbon footprints are top of the agenda in the energy sector. Here, too, solutions are invariably based on new technologies.

We are entering a new era of tech-led innovation. Researchers estimate that technological innovations across virtual reality (VR), the metaverse, quantum, and the circular economy could contribute trillions of dollars of new value to the global economy by the end of the decade.[4] Take quantum technology – the development of quantum computation during the next decade will allow the production of complex mathematical models and superior processing power, making possible the simulation of processes not considered feasible previously.

EIGHT OF THE WORLD'S 10 BIGGEST COMPANIES BY MARKET CAPITALIZATION ARE TECHNOLOGY COMPANIES, COMPARED TO JUST TWO IN 2010.

4   WeForum, "Circular Economy and Material Value Chains", January 2018

Get to know the technology

Leaders need to increase their own technological knowledge so they can stay on top of new deployments. They will need to consciously drive a digital mindset in their organizations. Research shows that, currently, only 7% of companies have digitally savvy executive teams. Fewer than one in four CEOs and only about one in eight CFOs can be classified as digitally savvy.

Companies with digitally savvy executive teams have 48% higher revenue growth and 15% higher net margins than those who do not.[5] One example of a company that brought in the right tech skills at the top is Goldman Sachs, which launched its consumer banking business in 2016. The intention was to build a modern digital business within a 150-year-old traditional financial institution. By the first quarter of 2022, the Marcus brand was already serving over 13 million customers (including through the Apple Card partnership).[6] Today, it is headed by a partner who sharpened their tech skills at Uber and, before that, at Amazon, managing Alexa's machine-learning (ML) platform service.

5   MIT Sloan Management Review, "Does your C-Suite have enough digital smarts?" March 2021.
6   The Financial Brand, "Inside Goldman Sachs' plans for Marcus to be the dominant digital bank," April 2022.

Objectives for executive teams

"Leaders need to increase their own technological knowledge so they can stay on top of new deployments."

Innovation leaders need to look beyond the underlying philosophy and set solid business objectives. Objectives ground innovation leaders in delivery and accountability. The key objectives to propagate are:

a. Identify weak signals and ensure you are never late on any technology wave. This doesn't mean you have to always be the first mover. It's about not being late.

b. Focus on understanding the use cases for any technology, building towards a future portfolio.

c. Manage the innovation continuum. A key focus is to build an inclusive spirit throughout the organization. Innovation is not an elitist activity but rather one that should call on all the resources in an organization.

Today's market dynamics present a critical opportunity for business leaders to revisit their innovation strategies. The imperative for enterprises to be fast, agile, responsible, and innovative brooks no exception. Innovation starts with a mindset to challenge the status quo, a mindset to move more rapidly than business as usual. Getting started with innovation is the easy part. Sustained success comes to those organizations that constantly reassess the role of innovation in their journeys, build the right technology capabilities, and ensure they equip their leaders with the right skills to create new modes of distinction for the organization.

Con
ver
sa
tions
FOR TOMORROW

"

Sustained success comes to those organizations that constantly reassess the role of innovation in their journeys, build the right technology capabilities, and ensure they equip their leaders with the right skills "

EVOLUTION OF THE CHIEF INNOVATION OFFICER

Elisa Farri
Co-Lead of The Management Lab By Capgemini Invent

Elisa Farri is a Vice President and Co-lead of Capgemini Invent's Management Lab, bridging the academic and business worlds. Over the last ten years she worked in strategy and innovation consulting, advising Fortune 500 corporations in transformative projects. Prior to consulting work, she worked at the Harvard Business School's Europe Research Centre in Paris, France. Elisa is a regular contributor to leading management reviews and business magazines like HBR.org and Rotman Management, and a speaker on strategy and innovation management.

Gabriele Rosani
Director Content & Resarch at The Management Lab By Capgemini Invent

Gabriele is Director of Content and Research at Capgemini Invent's Management Lab. He has more than fifteen years of strategy consulting experience with particular focus on innovation management and business transformation. In parallel to his consulting experience, Gabriele is a contributor for leading management magazines including HBR.org, Dialogue Review, "I" by IMD, The European Business Review. He also contributed to management books in collaboration with Thinkers50, PMI and the Business Ecosystem Alliance.

At the end of the 20th century, innovation was still considered to be exclusively the remit of R&D functions, who would be tinkering away in a workshop or laboratory on new technological features for a company's products. As the new century arrived, things started to change. Simply coming up with a strong product was no longer enough to win against emerging business models (the demise of Blockbuster and Kodak in the face of digital competitors are well-known cases). The new dynamics of markets and technology demanded a more strategic approach to innovation and a new role appeared in C-suites to manage this: that of the chief innovation officer, or CINO.

> "Until 20 years ago, the chief innovation officer (CINO) was a position virtually unheard of. Today, most large companies have appointed one, although the actual job specs can vary."

Unlike more established C-suite roles, whose job specs are relatively standardized, the chief innovation officer's role varies significantly depending on the organization, business context, and the individual themselves. Drawing on our research and experience with Fortune 500 corporations, we have developed an 8-role framework[1] for the multifaceted CINO position. The role is divided into two main categories: managing the innovation funnel (e.g., identifying new market spaces, funding and supporting early-stage initiatives, and managing the experiment portfolio) and building innovation capabilities (e.g., developing internal skillsets and disseminating best practices).

---

1   We have published a first version of this framework in the Harvard Business Review (HBR.org link).

In some firms, the CINO has a fairly narrow remit, while in others, they play a wider range of roles with different levels of intensity and focus. A simple visual tool, the 8 roles spiderweb (see Figure 1), can help us visualize the different degrees of coverage of the various roles. Comparing spiderwebs of different firms, common patterns emerge; an important trend is related to the CINO as "facilitator" or "owner" of innovation initiatives within the organization. In the first case, the CINO advises on, facilitates, and accelerates initiatives, while business units and functions maintain ownership. In the second case, the CINO directly initiates, funds, develops, and conducts experiments around new ideas (typically focusing on discontinuous innovation), with a dedicated budget and team, and setting their own targets.

Figure 1: The changing focus of the chief innovation officer
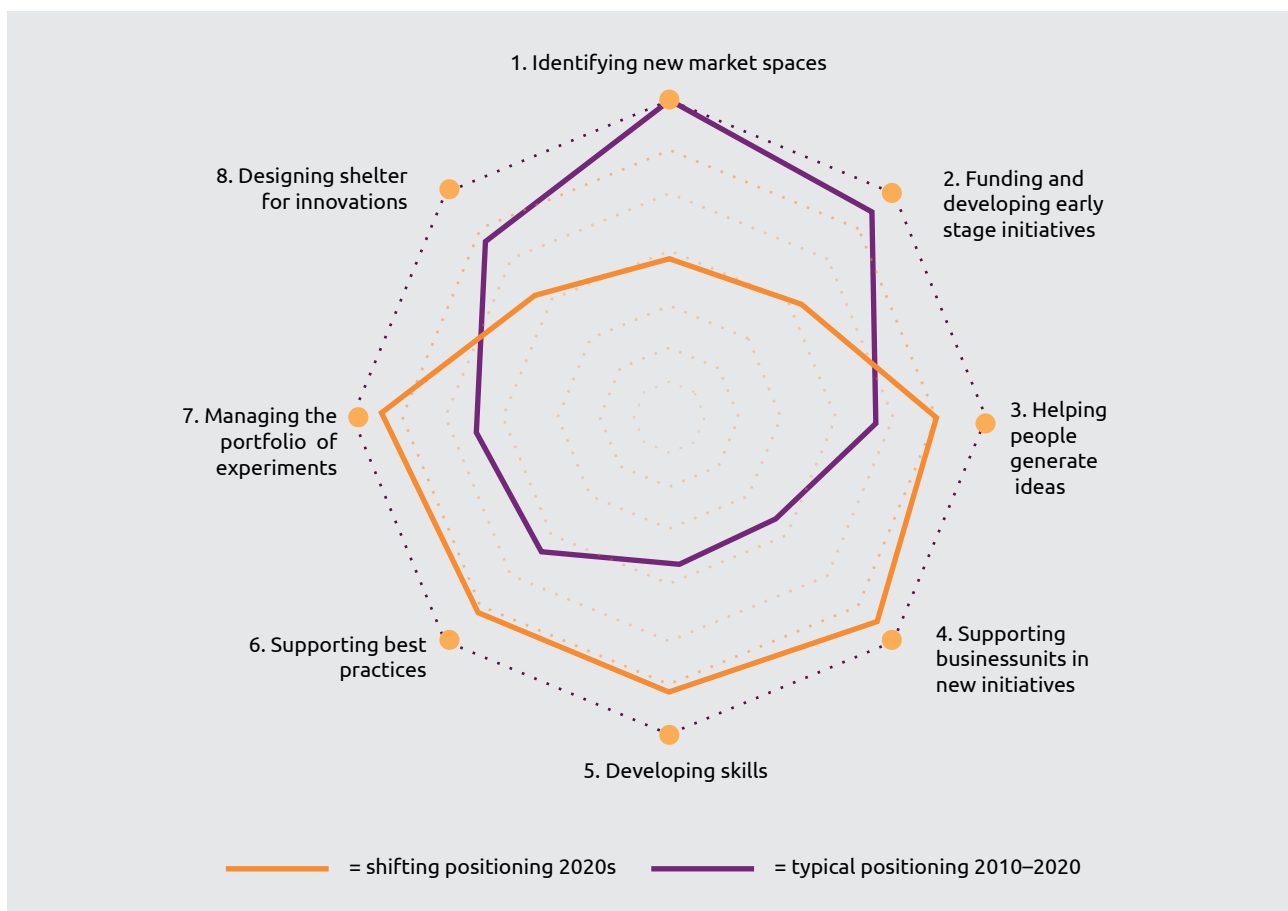
Source: The Management Lab by Capgemini Invent

The future role of CINO

"

The future CINO role will evolve towards coaching, facilitation, and support to enable other functions to innovate, rather than being the sole owner of innovation."

Looking at how the typical spiderweb has evolved over the last few years, we see evidence of a gradual shift in the coverage of the roles. Today, greater focus is given to the roles leaning towards "facilitation": supporting methods for innovation; helping and coaching projects, rather than "owning" them; and developing capabilities in the wider organization.

In our view, such a shift is determined by two aspects. First of all, in some cases, the appointment of a CINO gives the unproductive and negative message that innovation is somebody else's responsibility, rather than a task to be shared across all functions. The CINO should be regarded as the enabler and facilitator, in which case the cognitive bias ("it's not my job") will be eliminated.
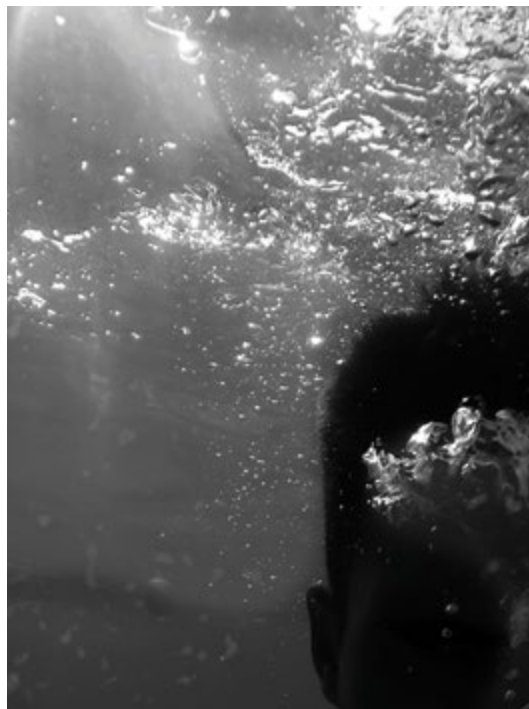
Innovation will become more pervasive

The second and more fundamental factor is related to the broadening scope of innovation (see insert) towards the reinvention of management models to promote a sustainable stakeholder capitalism.

> "Innovation will become more pervasive, being applied well beyond technology and products into new business models, new supply chain paradigms, new management styles, and innovative cultures. "

Figure 2: The broadening scope of innovation

Products	Business Models	Industry Ecosystems	Management Models	Sustainability
1980s–1990s	2000–2010	2010s	2015–2020	2020+
New thinking: ■ Blue Ocean Strategy (Chan Kim, Rene Mauborgne) ■ Business Model Canvas (Alexander Osterwalder, Yves Pigneur) **Examples:** ■ Nintendo Wii ■ Nespresso ■ Hilti		**New thinking:** ■ Platform Revolution (Geoffrey G. Parker, Marshall W. Van Alstyne, Sangeet Paul Choudary) ■ Ecosystem Economy (Michael Jacobides) **Examples:** ■ Nest ■ John Deere ■ Philips	**New thinking:** ■ Humanocracy (Gary Hamel, Michele Zanini) ■ No Rules Rules (Erin Meyer, Reed Hastings) ■ The Heart of Business (Hubert Joly) **Examples:** ■ Netflix ■ Handelsbanken ■ Best Buy	**New thinking:** ■ Net Positive (Andrew Wiston, Paul Polman) ■ Deep Purpose (Ranjay Gulati) **Examples:** ■ Unilever ■ IKEA ■ Enel

Source: The Management Lab by Capgemini Invent

Over the course of the past two decades, innovation as a business concept has grown. In the 1980s and 1990s, innovation meant R&D and product development. However, companies subsequently learned that they could avoid head-to-head competition by shifting their views on business models. Thought leaders such as Chan Kim and Renée Mauborgne from INSEAD, authors of the bestselling book Blue Ocean Strategy, brought fresh perspective on innovation beyond product/technology orientation, showing how it is possible to unlock new value and attract new customers with novel value propositions.

Nintendo Wii is a case in point. By applying the Blue Ocean Strategy, Nintendo beat the competition, not because of superior technology (in fact, its offering was widely regarded as less advanced than that of competitors) but due to a completely new consumer experience of video games. Rather than focusing on young males, it offered sport and yoga activities to a wider range of users, including women and older people, made available by harnessing new technology such as motion sensors.

Other examples of business-model reinventions are Nespresso (shifting from coffee powder to coffee capsules sold through dedicated Nespresso boutiques) and Hilti (from selling individual products to retail customers to offering complete turnkey solutions to the building industry).

With the advent of the digital economy in around 2010, many sectors suddenly became vulnerable to disruption from digital-native companies (think of the fate of Blackberry and Nokia). To stay competitive, innovative companies broadened the scope of their businesses to encompass platforms and ecosystems. For example, US agricultural machinery company John Deere, as part of a network of partners and complementors, became a digital pioneer by combining tractors (its traditional product) with sensors and data collection, to help farmers achieve higher yields.

The rapidly changing markets and business models of the digital age demand a realignment of operating models. To achieve this, thinkers and practitioners have promoted innovative paths towards organizational agility and new forms of empowerment and control. Companies such as banking services company Handelsbanken and domestic appliance manufacturer Haier have adopted decentralized models, providing greater autonomy and decision-making power to their front lines, while cutting bureaucracy and the need for authorizations.

In the 2020s, the scope of innovation is increasingly leaning towards sustainability, in a bid to tackle the daunting challenges of environmental, social, and governance (ESG) issues. Modern firms cannot think about innovation without thinking about sustainability, and vice versa: Enel, a world leader in renewable energy, has even coined the term "Innovability," combining the two concepts.

The call for reinvention is relevant across organizations, from human resources to marketing to operations:

Chief human resources officers have the mandate to reshape working life post-COVID-19, with hybrid working models and more agile workforces. As there are no off-the-shelf solutions or benchmarks to rely on, CHROs must be creative, experimental, and willing to learn. They will need to revise operating models extensively, including leadership behaviors and management processes, as well as enabling technologies to empower and motivate employees.

Chief marketing officers are under pressure to rethink their firms' journeys to market in light of a shift in consumer behaviors and technology channels: these include the rise of entirely new domains such as the metaverse, with uncertain implications for brands, offerings, and business models.

Chief operating officers are learning to cope with the rise of intelligent operations and supply chains. The rapid development of technologies such as 5G, edge computing, artificial intelligence (AI), and the internet of things (IoT) means that every type of company, in sectors as diverse as healthcare, automotive, and manufacturing, can start conducting business in a new way.

The CINO will act as a catalyst of change

For all these domains (from HR to marketing to operations and supply chain), such deep transformations will pressure CXOs into leaving their traditional comfort zones and navigating uncharted waters. The pressure will be on them to remodel their function for a new era. This is easier said than done; historically, many CXOs were focused (and built their careers) on keeping the ball rolling, rather than having to reimagine the game. It's no surprise that they often lack the innovative mindset and the capabilities for creative thinking. For this reason, CXOs may feel lost in the new business environment.

But CXOs need not embark alone upon this experimentation journey: CINOs can function as a catalyst and facilitator in these aims. As an agent of change, the CINO will need to create a new corporate culture of innovation. One example of how the CINO can influence culture is by promoting a more experimental mindset (exploring new approaches and developing and testing hypotheses from which their function can derive learning and insights).

While the CINO can provide their organizations with the required coaching and toolkit (from design thinking to ecosystem thinking to lean experimentation and fast prototyping), it's important that every CXO "owns" some experiments themselves, in their own business context. For instance, we are seeing CHROs (chief human resources officers) experimenting with solutions for the new hybrid work context and CMOs exploring the emerging field of the metaverse with pilot projects on non-fungible tokens (NFTs).

"The CINO will act as a catalyst of change, helping CXOs step out of their comfort zone, explore new territories, and learn from a trial-and-error approach."

Figure 3: Innovation challenges for CXOs and how the CINO can support

CXO	Challenges that require reinvention (examples)	How the CINO can help
CHRO	■ De-bureaucratization ■ Purpose-driven leadership	■ Design and experiment with new models for data-informed decision-making
CMO	■ Metaverse ■ New consumer experiences	■ Explore the new paradigm and study pioneers ■ Experiment with NFT projects ■ Test new VR/AR use cases
CIO	■ Quantum computing	■ Design and experiment with use cases (e.g., materials modelling, drug development)
CSO	■ From competition to ecosystems	■ Open up strategy discussions; co-creation with partners and stakeholders
CFO	■ ESG measurement and reporting	■ Participate in new accounting standards

Source: The Management Lab by Capgemini Invent

In Summary

In a business environment increasingly dominated by transformations, the C-suite's new imperative is to achieve systemic innovation. All roles need to embrace an innovative mindset and start experimenting. This is leading to a significant shift in the roles of CINOs: while in the past the CINO was the owner of the innovation portfolio, with a focus on new products and business solutions, today the mandate will shift more towards disseminating innovative thinking and methods across the broader organization, creating the conditions for the other functions to be innovators in their specific management fields.

Capgemini Invent's Management Lab

Capgemini Invent's Management Lab originates from the European Centre for Strategic Innovation, a management research and strategic advisory center founded in 2013 by Alessandro di Fiore (1965-2021), one of the most influential global voices in strategy and innovation.

The Management Lab by Capgemini Invent forges new ways of thinking about strategic and organizational innovation. It builds its own research and collaborates with selected faculty partners at the world's leading business schools: Harvard Business School, MIT, IMD, LBS, and INSEAD. By bridging new ideas into practice, the Management Lab tests and develops actionable frameworks, practices, and tools which can be applied to the real world of business.

The Management Lab is a regular contributor to leading management magazines: HBR.org, "I" by IMD, Dialogue Review, the European Business Review, and LSE Business Review

THE BIOECONOMY IS ABOUT TO CHANGE EVERYTHING. ARE YOU READY?

Mike Dunkley
SVP Bioinnovation, Cambridge Consultants, part of Capgemini Invent

Mike has over 20 years of experience spanning product and technology consulting, design consulting, and technology leadership in start-up environments. His primary market experience focuses on medical technology, pharmaceutical drug delivery, and healthcare delivery and has included biomanufacturing, agricultural technology, food production, and energy generation. Mike rejoined Cambridge Consultants in May 2019 to lead growth of the Bioinnovation business in the US.
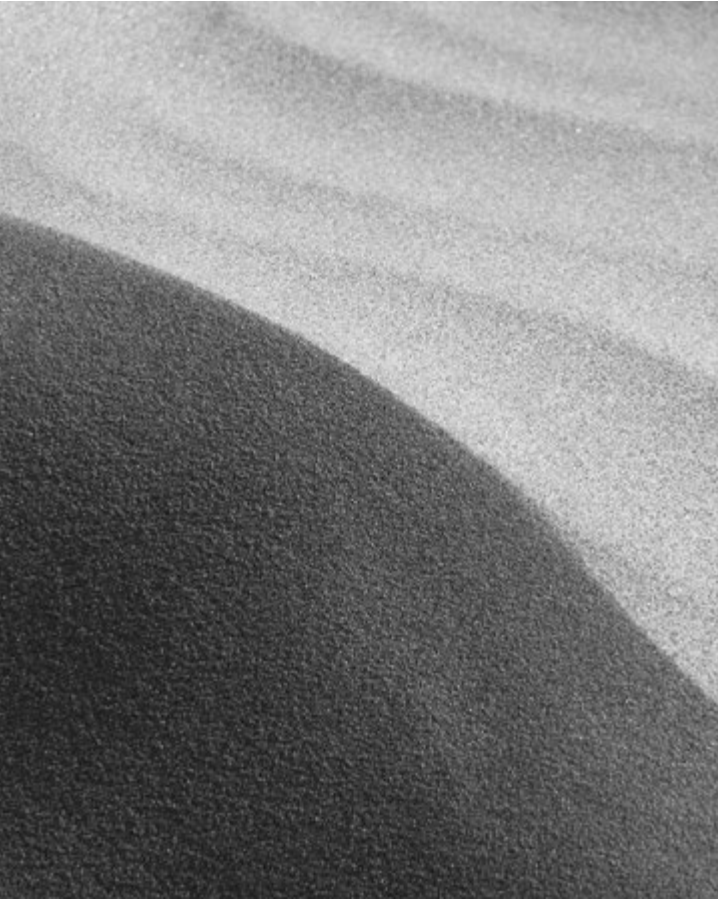
Karen Weisinger
PhD. Head of cell biology, US, Cambridge Consultants, part of Capgemini Invent

Karen has over 15 years of experience in several fields including iPSCs, neurodegenerative disease modelling, cardiac regentation, and synbio for cancer immunotherapy. She currently leads the Boston based biology effort to support clients with their ambitions in the cell therapy space.

As technological innovation battles geopolitical headwinds, C-suite executives worldwide are grappling with unprecedented challenges while trying not to overlook the extraordinary opportunities they bring. Amid the clamor of competing strategies and solutions, we advise paying close attention to the inexorable rise of the bioeconomy.

Bio-based breakthroughs could rise to humanity's most pressing challenges, such as climate change, sustainability, and food and water security. Moreover, biologics offer the possibility of powerful diagnostics and curative medicines. The pioneering work that underlies the growth of the bioeconomy embraces the fields of synthetic biology, biotechnology, bioengineering, and bioinnovation. Whichever identifier the industry eventually aligns itself with, the exciting intersection of biology, engineering, and advanced computation is driving a revolution – and it is already upon us.

Existing industries will be entirely replaced by new ones. New, unexpected partnerships will spring up. Global supply chains will be completely reconfigured. More of these themes in a moment; for now, let's remind ourselves of the formidable power of this new field of innovation. Biology, as a scientific discipline, concerns the very essence of life. A tiny seed contains all the biological information necessary to harvest water and nutrients from soil, CO_2 from the atmosphere, and energy from the sun, eventually producing a fully mature tree.

"Bio-based breakthroughs could rise to humanity's most pressing challenges, such as climate change, sustainability, and food and water security"

For centuries, humans have attempted to harness the power of biology. Long before the discovery of DNA, scientist and mathematician Gregor Mendel (1822–84) successfully selectively bred peas based on their observable traits. Since its discovery in 1928, penicillin, a naturally occurring fungus, has become an effective treatment for the bacterial infections that had claimed the lives of so many.

However, the past few decades have seen a rapid acceleration of our understanding of biology, and of our corresponding capacity to engineer and exploit this new technology to tackle a vast array of challenges and opportunities. From the discovery of DNA and genetics, we have developed a profound knowledge of cell and organism behavior.

The next step in bioengineering

The biological behaviors we observe and seek to exploit function through cells, tissues, organs, and even whole organisms. To decode and manipulate biology effectively at this level, precise measurements and observations are imperative. The emergence of sophisticated measurement techniques, such as single-cell sequencing, spatial transcriptomics, proteomics, and metabolomics is transforming our biological engineering capabilities.

Huge datasets of immense complexity, previously unusable owing to the limitations of human workforces, are being unlocked by advances in artificial intelligence (AI) and machine learning (ML), revealing hitherto hidden insights. Google's AlphaFold 2 technology, for instance, has the ability to predict the 3D structure of a protein directly from its amino acid sequence. Structure is fundamental to understanding the mechanistic function of a protein, so this is a technological leap that will greatly facilitate and accelerate research.

Why is this important? The manner in which a protein folds is based on its sequence. The function of a protein is directly related to its folding, with the function's dynamic ranging from completely non-active, to different shades of activity, to very active. Understanding the activity based on protein sequence and folding will enable the engineering of proteins that will be super functional for medical purposes (such as diseases with a protein deficiency) or in industrial biotech where processes are reliant on enzyme activity.

These new AI tools are driving new capacity to create enhanced medicines and biobased manufacturing systems from renewable natural sources. Benefits could include more active medications with reduced dosage, which would be particularly beneficial to therapeutics that have severe secondary effects. The benefits of biobased manufacturing include the reduction in costs of the bioprocess as a direct effect of the enhanced enzymes deployed in the process.

The pivot towards the bioeconomy is already under way. From the incredible amount of current activity, below is just a selection of cross-industry examples that harness the power of biology.

Perfect Day is in the cow's milk business. Without cows. The company has figured out how to modify a naturally occurring fungus that contains the genetic machinery required to produce beta-lactoglobulin (a type of whey protein), at scale. It has done this not just because it can, but in response to soaring consumer demand. Less land, less water, less energy, less waste, less methane. Technologies like this, deployed at scale, can help address climate change, sustainability, and food security.

LanzaTech uses carbon emissions to feed trillions of carbon-hungry microbes that turn pollution into valuable raw-material commodities. The firm has partnered with **Unilever** in manufacturing laundry detergent from the CO_2 emissions of a Chinese steel mill.

Vertex and **CRISPR Therapeutics** are tackling sickle cell disease, a debilitating inherited blood disorder that affects millions globally, predominantly those of African descent. Conventional management of the disease requires frequent blood transfusions. Now, new treatments are showing tremendous promise[1] in first clinical use. By using gene-editing techniques to enable the patient's own cells to produce fetal hemoglobin, the treatment allows patients to remain transfusion-independent for up to 26 months.

1   First sickle cell patient treated with CRISPR gene-editing still thriving: https://www.npr.org/sections/health-shots/2021/12/31/1067400512/first-sickle-cell-patient-treated-with-crispr-gene-editing-still-thriving

As part of the trend in the production of bio-based materials that take advantage of local feedstocks, **Solugen** is using synthetic biological tools to create chemicals for water treatment and molecules to harden cement. Sugar replaces fossil fuels but, rather than fermentation, which converts half the sugar to CO_2, engineers utilize synthetically engineered enzymes. This dramatically increases efficiency and reduces costs, leaving a zero-carbon footprint.

"Perfect Day is in the cow's milk business. Without cows."
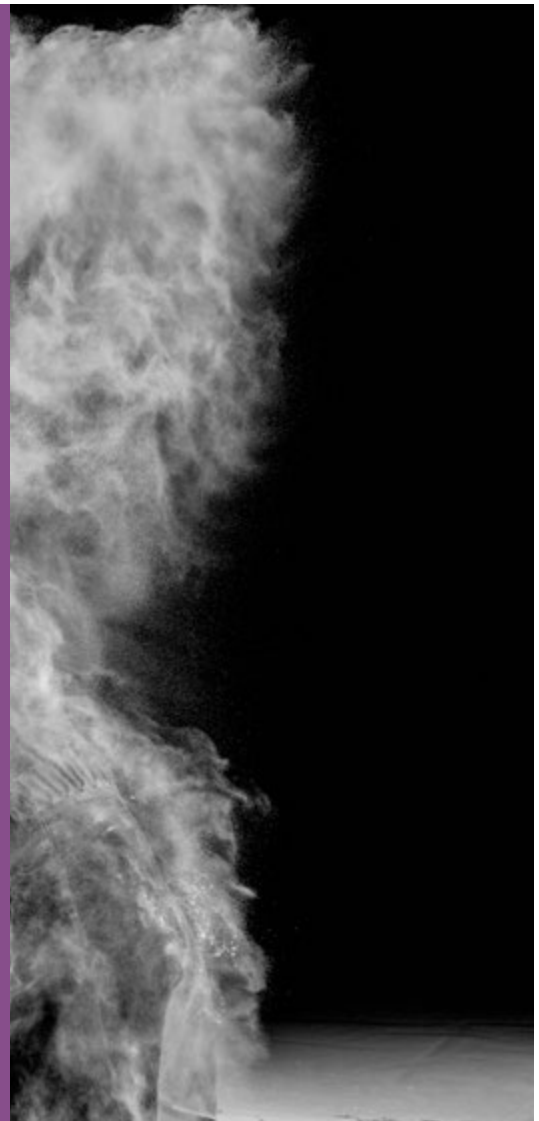
Massive data storage and computation

A crucial driver of much of this bio-based innovation and technological progress is the convergence of biology, engineering, and advanced computation. In one example, **CATALOG Technologies** is trying to build the world's first DNA-based platform for extensive digital data storage and computation. In the newly digitized world, humanity has an unlimited appetite for data storage. Conventional data storage using optical or magnetic media lacks the longevity, data density, and cost-effectiveness to meet global demand, while datacenters can consume as much power as a city. A landmark in this initiative to address the data-sustainability challenge came in July 2019 when CATALOG's "terabit machine" encoded the whole of the English language Wikipedia into DNA.

One of the most exciting and transformative areas of medicine is the cell and gene therapy space. The highly sophisticated manufacturing process is currently hindered by labor-intensive manual procedures that require constant monitoring. This, in turn, drives the exorbitant costs of the therapies: around $500,000 or more per dose. One of the technologies that Cambridge has created in response to this issue is a fully automated in-line contamination-detection system. Once a development partner is in place, this scalable technology can make a big impact on the market through delivering significant time and cost savings – and improving patient outcomes.

> " **A crucial driver of much of this bio-based innovation and technological progress is the convergence of biology, engineering, and advanced computation."**

"LanzaTech uses carbon emissions to feed trillions of carbon-hungry microbes that turn pollution into valuable raw-material commodities."

The potential of these "living medicines" is, without doubt, awe-inspiring. We are developing the knowledge and ability to engineer cells to recognize and respond to specific diseases. These will patrol the body in a latent state, springing into preprogrammed action only when they detect certain triggers.

Another possibility on the horizon is the application of genetic logic-gate circuits. One use case for this is that a crop could be engineered to sense and assess its own environment and then use that information to optimize its own growth rate. We can see a future where we engineer cells from scratch, taking cell therapies to the next level. Another exciting possibility is that of writing and recording genetic code into the genome, allowing monitoring of diseases and, in microbial systems, environmental conditions.

There is still an unquantifiable amount of work to be done and countless hours of debate around the ethical and moral questions, as business and society adjust to this new world. As advocates of the emerging bioeconomy, however, we firmly believe that humanity has much to gain from embracing the biological revolution.

Crop could be engineered to sense and assess its own environment and then use that information to optimize its own growth rate."

Con
ver
sa
tions
FOR TOMORROW

Insights from the Capgemini Research Institute

WHAT'S THE BIG IDEA?

Why most innovations fail to scale and what to do about it

$\rightarrow$ **p.199**

QUANTUM TECHNOLOGIES:

How your organization can create a quantum advantage

$\rightarrow$ **p.202**

WHAT'S THE BIG IDEA?

WHY MOST INNOVATIONS FAIL TO SCALE AND WHAT TO DO ABOUT IT

For details on the research methodology and to read the full report, please visit:
https://www.capgemini.com/insights/research-library/scaling-innovation/

In a disrupted, fast-moving world, organizations are betting big on innovation

Organizations understand the criticality of innovation to meeting new customer needs, driving new levels of operational performance, and building long-term value and growth
However, these ambitions run into a major obstacle: the difficulty of achieving scale with innovations in processes, products, or services
Achieving scale is often cited as the number one barrier to realizing commercial goals across sectors and technologies

Organizations are challenged with low rates of scaled implementation across technologies and sectors

Automotive Smart Factories
10%
Percentage of automotive smart factories that have mastered the core areas of smart factories to be ready to drive them to scale

Artificial Intelligence
13%
Percentage of organizations across sectors that have successfully deployed AI use cases in production and continue to scale more throughout multiple business teams

Agile
<20%
Percentage of organizations across sectors that have achieved a high level of competency with agile practices across the organization

Retail Store utomation
21%
Percentage of stores that retailers, on average, have implemented automation use cases in today

Source: Capgemini Research Institute, "How automotive organizations can maximize the smart factory potential," February 2020; "Smart stores: Rebooting the retail store through in-store automation," January 2020; "Agile at scale: Four ways to gain enterprise-wide agility," November 2019; "The AI-powered enterprise: Unlocking the potential of AI at scale," June 2020.

Three action points for how organizations can successfully scale innovation

Based on in-depth interviews with 40 senior executives from global organizations with combined revenues of over $1.7 trillion, as well as academics, and drawing on innovation best practices, we offer three recommendations for successfully scaling innovation.

Treat scaling as its own discipline within the innovation journey

Design innovation governance to include scaling as a key responsibility

Build a culture that is willing to take tough decisions on scaled innovations

Treat scaling as its own discipline within the innovation journey

1

Set up specialized roles dedicated to scaling within the business to ease and accelerate wider business adoption

2

Cross-train teams across scaling and generating functions

3

Place innovation generators into the scaling function to build awareness of future challenges

4

Make viability and feasibility analyses integral aspects of the innovation journey

Design innovation governance to include scaling as a key responsibility

1

Give more ownership to business lines for scaling innovation

2

Consider implementing a **corporate-venture builder model**

3

Learn from accelerated scaling approaches driven by the COVID-19 pandemic

Build a culture that is willing to take tough decisions on scaled innovations

1

Promote a "learning" culture while scaling

2

Kill or scale back successful innovation when necessary

3

Introduce flexibility when scaling innovation to respond to changing market conditions

Source: Capgemini Research Institute and Capgemini Technology, Innovation and Ventures analysis.

202

QUANTUM TECHNOLOGIES:

HOW TO PREPARE YOUR ORGANIZATION FOR A QUANTUM ADVANTAGE NOW

For details on the research methodology and to read the full report, please visit:
https://www.capgemini.com/insights/research-library/quantum-technologies/

Quantum technologies

Quantum computing
Use of quantum properties to perform computations.

Quantum comms and security
Transmitting and controlling information using laws of quantum mechanics in the most secured manner

Quantum sensing
Use of quantum properties or phenomena to measure a physical quantity with high precision

Advances in quantum technologies are gathering pace

23%
Nearly one in four organizations are working with, or planning to work with quantum technologies

19%
Nearly one in five organizations believe early commercial applications will arrive within five years

85%
of the organizations working/planning to work with quantum expect to increase investments in the technology in the next year

Energy and chemicals, Life Sciences, and Aerospace & Automotive lead in quantum implementation

State of quantum technology implementation by industry
(for organizations that are working or planning to work on the technology)

Industry	Beginners	Planners	Implementers
Energy and chemicals	55%	25%	20%
Life sciences	58%	22%	20%
Aerospace and automotive	63%	20%	17%
Banking and insurance	56%	27%	17%
Telecom and public sector	67%	20%	13%

■ Beginners ■ Planners ■ Implementers
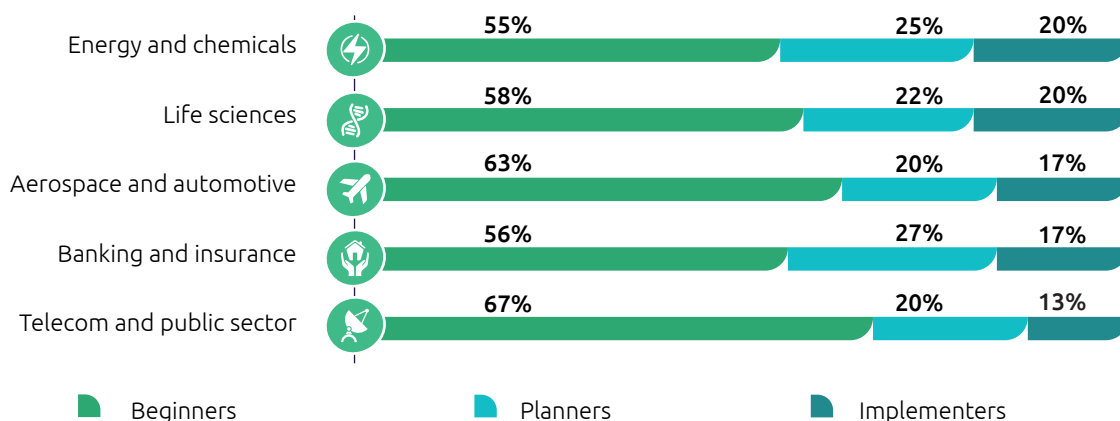
Source: Capgemini Research Institute survey, N=200 organizations working or planning to work on quantum technologies
Note: The data points are directional in nature.
Definitions:
Implementers: Organizations which are conducting experiments with quantum technologies
Planners: Organization which have identified the right problems and are now integrating quantum technologies in their tech/R&D agenda/roadmap.
Beginners: Organizations which are identifying the right problems to solve with quantum technologies or started the research to understand their fundamentals.

China and the Netherlands have the largest share of companies working on or planning to work on quantum technologies, well ahead of Germany and the UK

Quantum technology adoption by country
(% share of organizations working or planning to work with quantum technologies)

Netherlands (42%)

UK (26%)

Germany (26%)

US (22%)

France (23%)

Spain (14%)

Italy (15%)

China (43%)

India (21%)

South Korea (14%)

Japan (19%)
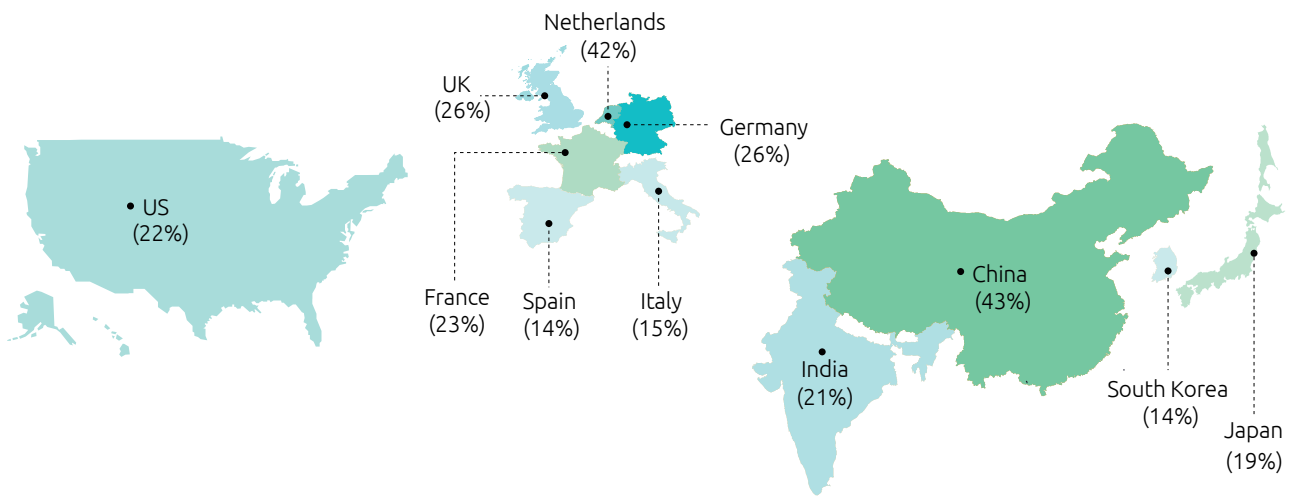
Color gradient from light to dark indicate weak to strong adoption, respectively.
Source: Capgemini Research Institute Quantum Technologies Survey, N=857 organizations, November–December 2021.

Organizations are already securing their critical infrastructure and information using quantum
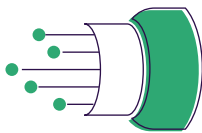
BT and **Toshiba** have collaborated to deploy a quantum-secure network, based on the QKD system. The system was deployed to generate thousands of quantum-secure cryptographic keys per minute over **6 km of fiber-optic cable, with a range extending up to 120 km.**[1]

Netherlands-based **KPN** ran test traffic between Delft and the Hague using QKD from a central node in Rijswijk. Current range between the nodes is **150 km, but KPN is aiming to upgrade the system to reach 250 km.**[2]
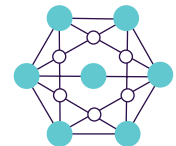
58% of organizations are waiting for standards to emerge before prioritizing quantum-safe security, yet solutions are already available

[1]BT press release, October 1, 2020.
[2]Capacity Media, "KPN aims for quantum-secure network across Netherlands on existing fiber," July 6, 2021.

Several industries stand to be revolutionized with the next generation of quantum sensors

Quantum Gravimeters for prospecting or surveying land or water

Sensors and Oscillators for GPS-free navigation

Magnetometers for biomedical imaging

Quantum sensors for process control and safety
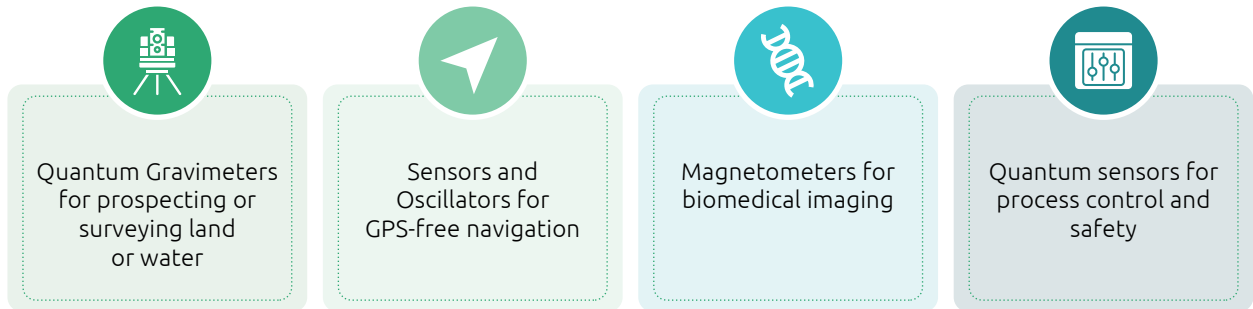
How can your organization prepare for the quantum advantage now?

The road to quantum advantage

Assess the potential of quantum technologies for your business

1

Build a small team of experts

2

Translate the most potent use cases to small-scale quantum algorithms that can run on today's hardware, to demonstrate future value

3

Strike long-term partnerships with technology providers to overcome technical obstacles

4

Develop a long-term strategy to scale up your talent and skills base

5

Source: Capgemini Research Institute analysis.

INNOVATION ECOSYSTEM AT CAPGEMINI

Our experience in the application of technology, innovation and investment in ventures means we have developed an agile and resilient model to help clients navigate their challenging markets and unlock the potential of their innovation opportunities.

1 — WE STAY AHEAD OF THE WAVE,
by tracking emerging signals and preparing Capgemini for the next advances in technology.

- Global orchestration of all Group innovation efforts
- Capgemini Research Institute (23 studies published in 2021)
- TechnoVision, an annual report featuring the key technology trends to watch
- Academic partnerships (including Stanford University, Massachusetts Institute of Technology, Nobel Prize Outreach...)

2 — WE DECODE AND TEST TECHNOLOGIES,
to filter out hype from true and meaningful evolutions.

- Every year we assess 1,000+ technologies and solutions and assess their readiness with technology assessment services (TAS).
- 90+ research labs, three 5G Labs, one quantum lab and one metaverse lab

3 — WE APPLY TECHNOLOGY TO RELEVANT USE CASES
by selecting those that best

- 21 Applied Innovation Exchanges to co-innovate with our clients
- Capgemini Ventures, our fund to invest when we find highly promising opportunities

4 — WE TAILOR OUR APPROACH TO EACH CLIENT
by co-creating and building unique solutions. The nature of our approach varies depending on the impact level and the engagement model.

- 10 priority industries, knowledge for all our sectors to make innovation relevant and accessible
- Leading global creative consultancy frog, part of Capgemini Invent, comprised of 39 design studios
- Capgemini Ventures uses an open-innovation approach with innovative startup technologies and ecosystem management
- Applied Innovation Exchange specialization is able to draw on deep awareness of technologies and sectors

5 — WE DELIVER AT SCALE
to help our clients transform in depth.

- Proven expertise in innovation with the power of data and intelligence built in
- ~150 Centers of excellence
- A global ecosystem of technology partners, including the 10 biggest technology companies worldwide
- 50 local and global delivery centers

HOW WE'RE ORGANIZED

**THOUGHT
LEADERSHIP**

RESEARCH INSTITUTE
Where we explore the future of business and technologies.
Includes our internal think tank.

RESEARCH & LABS PROGRAMS
Where we create new technologies and develop capabilities
to make the future possible. Includes our Quantum Lab in
partnership with IBM.

APPLIED INNOVATION EXCHANGE (AIE)
Where our global network of innovation teams and facilities
provides an open innovation approach. Enabling clients to
immerse themselves in the understanding, experimentation,
and application of emerging technologies and innovative
business processes.

VENTURES
Where we make the future possible through our ecosystem
of partners. Includes startups, tech companies, academics,
scientists, entrepreneurs, venture capitalists, etc.

**STRATEGY
& DESIGN**

FROG DESIGN STUDIOS
Where we partner with passionate leaders and visionary
entrepreneurs, apply creativity, strategy, design and data
to reinvent businesses.

CENTERS OF EXCELLENCE
Where we develop go-to-market strategies for clients; help sales
teams prepare proposals for clients; support communication
towards a common vision; and assist key delivery phases. Includes
industry centers of excellence for deep sector value.

LOCAL & GLOBAL DELIVERY
Where we bring together the Group's services at all levels and
provide a common set of tools across the globe to make our
client's vision a reality. Includes delivery centers.
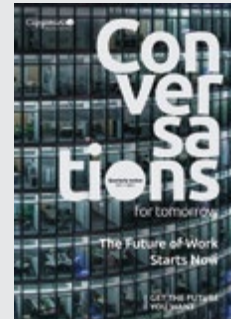
**DELIVERY
AT SCALE**

Discover more about our recent research

Conversations for tomorrow: The New face of Marketing.
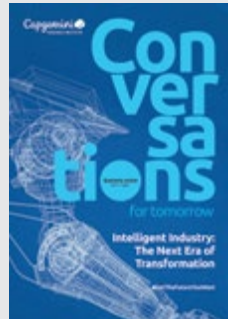
Conversations for tomorrow Intelligent Industry: The Next Era of Transformation.

Conversations for tomorrow: The Future of Work Starts Now.

Conversations for tomorrow: Why sustainability means collective action, bolder leadership, and smarter technologies.

Quantum Technologies: How to prepare your organisation for a quantum advantage now.

What's the Big Idea? Why most innovations fail to scale and what to do about it.

Unlocking the Value in Connected Health: Why now is the time for biopharma companies to transform.

Circular Economy for a Sustainable Future: How organizations can empower consumers and transition to a circular eonomy.

The Key to Designing Inclusive Tech: Creating diverse and inclusive tech teams.

Subscribe to
the latest research from the
Capgemini Research Institute

Receive copies of our reports by scanning the QR code or visiting

https://www.capgemini.com/insights/research-institute/subscribe/

About Capgemini

Capgemini is a global leader in partnering with companies to transform and manage their business by harnessing the power of technology. The Group is guided everyday by its purpose of unleashing human energy through technology for an inclusive and sustainable future. It is a responsible and diverse organization of over 340,000 team members in more than 50 countries. With its strong 55-year heritage and deep industry expertise, Capgemini is trusted by its clients to address the entire breadth of their business needs, from strategy and design to operations, fueled by the fast evolving and innovative world of cloud, data, AI, connectivity, software, digital engineering and platforms. The Group reported in 2021 global revenues of €18 billion.

www.capgemini.com

About Capgemini Research Institute

The Capgemini Research Institute is Capgemini's in-house think tank on all things digital. The Institute publishes research on the impact of digital technologies on large traditional businesses. The team draws on the worldwide network of Capgemini experts and works closely with academic and technology partners. The Institute has dedicated research centers in India, Singapore, the United Kingdom, and the United States. It was recently ranked number one in the world for the quality of its research by independent analysts.

https://www.capgemini.com/insights/research-institute/

#GetTheFutureYouWant

Capgemini