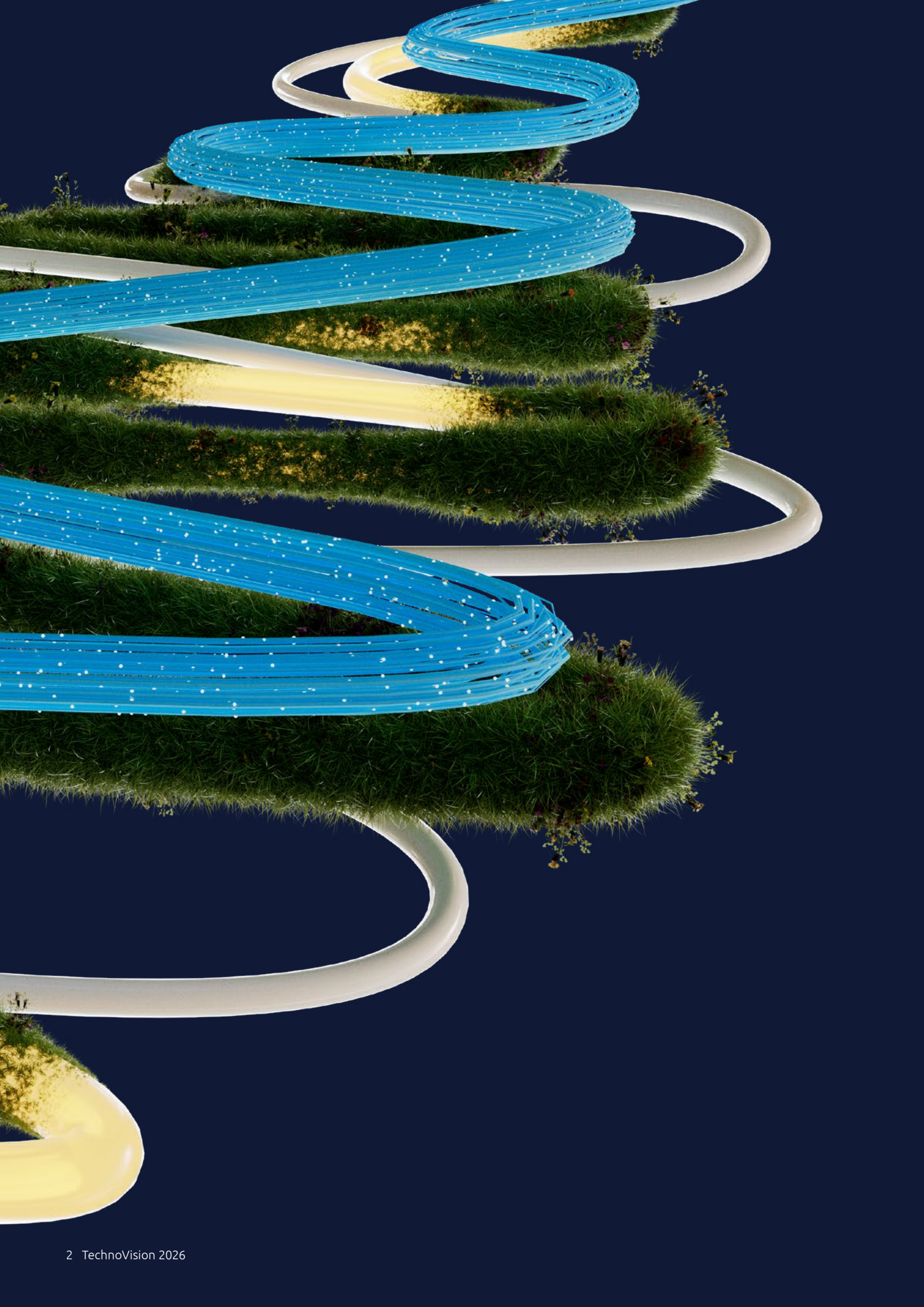
Techno Vision 2026

Capgemini



Foreword

Pascal Brier

Group Chief Innovation Officer, Member of the Group Executive Committee, Capgemini

Every year, the scope of innovation seems to widen. What once lived purely in software now extends into machines, materials, and even biology. Artificial intelligence scales across every dimension, from copilots to autonomous agents. Physical systems are learning to sense and decide. Biological principles increasingly inform the way we compute, design, and operate. Innovation has become a multi-domain force—faster, broader, and more interdependent than ever.

This expanding landscape brings opportunity, but also complexity. Organizations must navigate powerful crosscurrents: the acceleration of AI, the rise of intelligent products and operations, the pressure for sustainability, the reconfiguration of supply chains, and the growing importance of sovereignty and trust. None of these forces act alone. They shape one another, constantly in motion.

That is why TechnoVision evolves again this year. For the first time, we introduce two new containers—*Physical Matters* and *Nature's Code*—reflecting a world where digital, physical, and biological technologies now advance together. The familiar boundaries of IT and OT are giving way to a wider ecosystem where biotech, engineered materials, robotics, data, and AI converge. Transformation is no longer a single track, it is a system of interconnected rhythms.

In this context, clarity matters. Leaders need the ability to distinguish signal from noise, short-term hype from substantive shifts, and isolated innovations from those that will reshape entire value chains. TechnoVision 2026 provides this structure. It offers a coherent view of technology's evolution, grounded in real-world use cases, practical design principles, and a framework built to navigate motion rather than resist it.

As you explore this edition, I invite you to look not only at individual trends, but at how they reinforce one another. Innovation now happens in the connections, in the way multiple forces move and countermove.

This dynamic is at the heart of our theme this year, *The Sync Swing*. And with that, let's turn to the reflections that open this report and set the rhythm for the year ahead.

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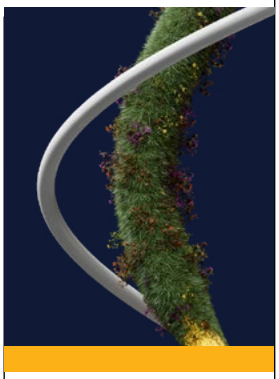
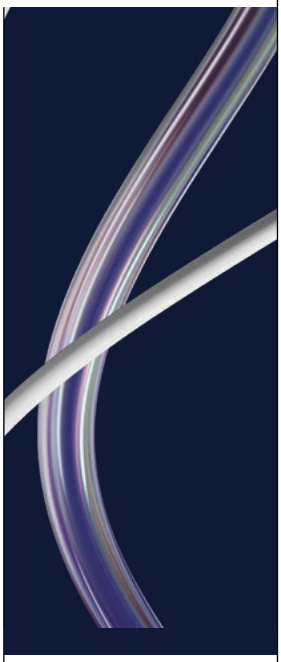
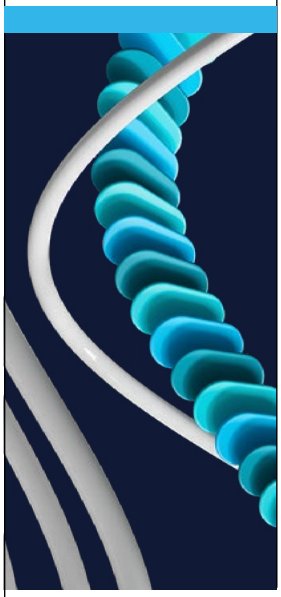
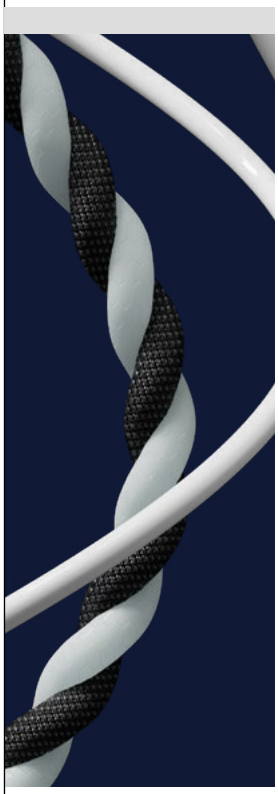








The Sync Swing

Somewhere between the second and third courses, it started to happen.

At PrivéPrivée, a small, intimate restaurant tucked away in the heart of Antwerp, twenty strangers had gathered. The setting: a long table, a bold menu, and the creative vision of Dutch culinary icon Sergio Herman. All guests seemed to arrive with their own tempo, their own backgrounds, expectations, business agendas, dietary quirks, conversational volume settings, and personal motivations. There were young aspiring chefs, a culinary critic, two ladies celebrating fifty years of friendship, tennis buddies, a mother and her tattooed son in a heavy metal t-shirt, captains of industry, foodies. The room buzzed with asymmetry.

And then, something changed.

As the meal unfolded—meticulously plated, surprising, almost provocative in places—the chatter softened, then synchronized. Smiles became shared. Utensils clinked in unison. By dessert, this once-dissonant group moved in harmony, as if some invisible force had tuned their frequencies.

Later, flipping through the menu, we found it on the cover: a reference to the **Kuramoto Model**, a concept from physics that explains how chaotic, individual oscillators, when gently nudged, tend to fall into sync. Turns out, nature does it all the time. Fireflies along the rivers of Thailand flash in perfect unison, each adjusting its rhythm to the glow of its neighbors. Heart cells, pulsing independently, align into a single, steady heartbeat that sustains life.

The same synchrony shapes the croaking of frogs after rain, the rippling of seaweed in a shared current, and the murmuration of starlings swirling across the evening sky—many individual entities yet forming joined patterns of breathtaking coherence.

When coupling strength—that invisible connection between them—becomes strong enough, unity appears. And perhaps, that evening in Antwerp, it was the same. The creative food, the delicate light, the music, the timing, the shared attention, the vision of the chef—together they formed a quiet equation of synchrony. Still different frequencies, yes. But one rhythm and reflection.

It's a striking metaphor for where we find ourselves today in technology-powered innovation. So many possibilities, priorities, and ambitions, each moving at its own pace, in its own direction. Artificial intelligence accelerating ahead; regulation catching its breath. Sustainability demanding restraint while markets reward speed. Humans seeking meaning somewhere between augmentation and overload.

Each of these forces has its own rhythm—none of them wrong, all of them essential. Yet together, they rarely stay in sync for long. Innovation today feels less like a straight line and more like a field of oscillating energies—a whirlwind of intent, momentum, and counterforces.

More Pendulums

That's what led us, in last year's TechnoVision edition, to call our theme *The Pendulum Swing*. We described a world that no longer seeks a perfect midpoint but learns to balance by moving—an ongoing negotiation between speed and security, abundance and sustainability, global openness and local sovereignty, virtual experiences and physical presence, automation and human judgment.

Every advance seems to come with its counterforce: as AI grows more capable, trust becomes more fragile; as computing expands, so does its energy footprint; as work becomes borderless, belonging becomes harder to define. We swing, not out of indecision, but out of necessity: because movement itself has become the only form of balance that works.

And it's not just technology that moves this way. The world around it oscillates just as wildly. Political alliances shift, dissolve, and reform with disorienting speed. Economies pulse between protectionism and globalization. Trade routes, once steady, bend under the weight of conflict, scarcity, and climate pressure. The climate itself has become the ultimate pendulum, swinging between drought and deluge, fire and flood.

Meanwhile, the unfortunate reality of ongoing wars and regional conflicts reminds us that progress and peace are never guaranteed. These fractures ripple far beyond their borders, redrawing energy routes, reshaping supply chains, accelerating the drive for sovereignty, and exposing the fragility of our interdependence. Every front of instability becomes a signal that travels through the global system: data, markets, infrastructure, migration, trust.

Last year, we noted that such swings were redefining the business context in which technology operates. In 2026, those forces haven't calmed—they've multiplied. Fragmented supply chains meet autonomous logistics. Energy transition collides with digital acceleration. Trust in institutions flickers while trust in machines somehow rises. Regulation races to catch up with innovation, and innovation races to stay one step ahead.

The pendulums of society and technology no longer move separately. They have become coupled systems, each amplifying the other's motion. What happens in geopolitics ripples instantly through data flows and supply chains; what happens in technology reshapes social behavior, labor markets, even democracy itself.

Meanwhile, AI is scaling in every direction, from the datacenter to the factory floor, from copilots to autonomous agents, from synthetic creativity to self-optimizing operations. What used to live purely in software is now gaining embodiment: in machines, in robots, in sensors that see, move, and decide. Intelligent systems are sensing, learning, and acting with a degree of independence that blurs the line between the digital and the physical.

At the same time, the logic of life itself is entering into technology: data behaving like DNA, materials that sense and adapt, systems that evolve rather than merely execute. Nature, it seems, is becoming the new codebase. Meanwhile, a different kind of intelligence is emerging—one that doesn't just compute faster but thinks differently. Quantum technologies are beginning to reshape how we model reality itself, inviting us to hold multiple possibilities open until the moment truly matters. And all of this unfolds under a growing awareness that technology must not only be powerful, but sustainable: responsible in its use of energy, resources, and trust.

New Worlds

And now, a new dynamic enters the picture.

In a world where AI is becoming pervasive, enterprises are increasingly rethinking their foundations in terms of cloud, operations and sovereignty. In addition, the physical and biological worlds are increasingly becoming an integral part of the technology equation. Smart products, adaptive materials, connected machines, living systems, and bio-inspired computing are no longer side shows—they're part of the main act.

It means the innovation landscape has evolved from two familiar dimensions—IT (Information Technology) and OT (Operational Technology) to include a third, transformative one: BT (Biotechnology). This triangle of IT/OT/BT forms the new foundation of progress: digital intelligence meeting physical reality and biological principles. That's why, for the first time ever, TechnoVision itself expands to reflect this shift, covering two new areas (**Physical Matters** and **Nature's Code**), that capture the growing convergence between bits, atoms, and cells.

We're no longer watching a single pendulum swing. We're standing in a room full of them—all in motion, all influencing one another. And they are desperately in need of resonating more together. That's why this year, we speak of *The Sync Swing* as our overarching theme. The task ahead isn't to stop the swings, but to find coherence in their movement.

The result is a landscape not just of pendulums, but of entangled systems—social, economic, political, physical, digital, biological, and human—influencing one another in real time. Each oscillates with its own agenda, yet their outcomes depend increasingly on how well they connect.

TechnoVision provides a way to make sense of it all, not by simplifying, but by structuring. We group the ever-evolving landscape of technology-powered innovation into "containers": distinct yet connected perspectives

that help us see how ideas, architectures, and capabilities move and mature together.

Each container holds a set of evolving trends—practical, visionary, and occasionally provocative—that reveals how technology finds balance through motion. Together, these containers form a map of modern innovation: how people and business experience technology, how they collaborate, how organizations operate, how data fuels decisions, and how systems, infrastructure, and design principles adapt to an increasingly fluid world.

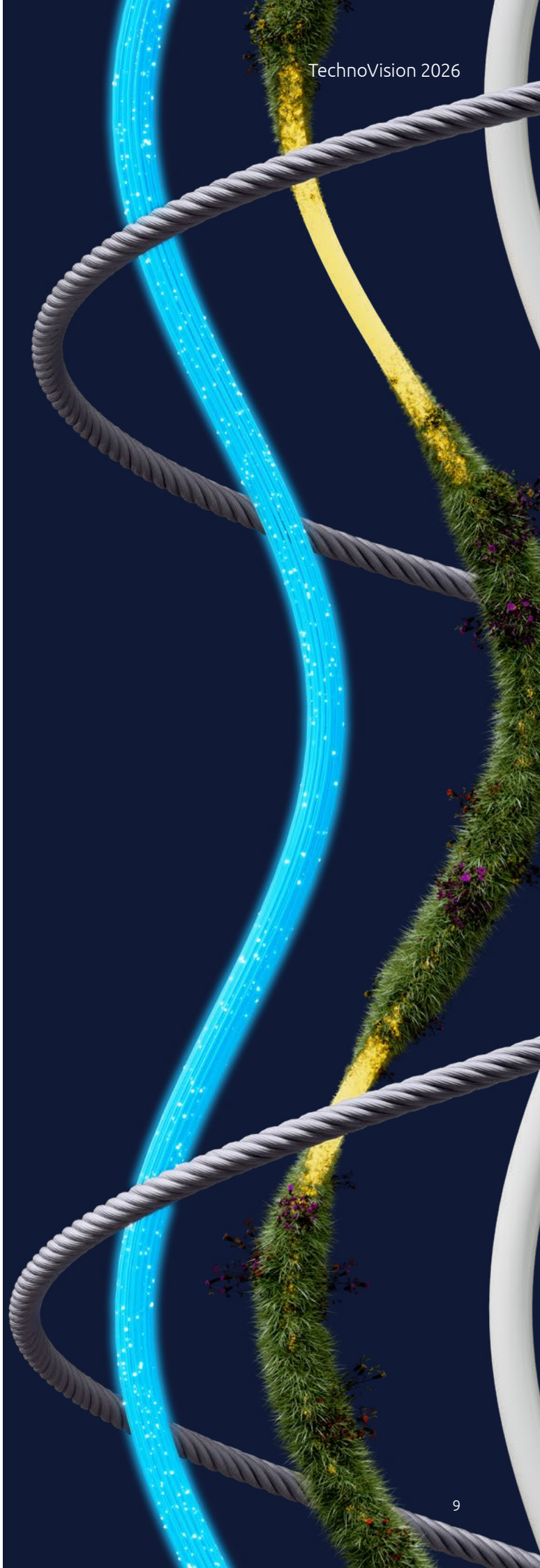
Pervasive AI is no longer a side project; it's the enterprise backbone, quietly weaving itself into decisions, software, and customer moments at scale. That backbone enables truly intelligent operations—sense-and-respond chains that learn, optimize, and adapt in real time rather than merely execute tasks. And because advantage now hinges on resilient interdependence, sovereignty becomes a design principle: open, multi-cloud architectures that keep you globally connected while maintaining control over data, models, and critical infrastructure.

You Experience - Technology that feels. Technology meets human intuition. Experiences are no longer built around screens, but around presence—blending spatial computing, immersive interfaces, and digital twins into seamless environments where physical and virtual overlap. AI gives these interfaces personality, empathy, and context. From **Face to Interface** to **Knowing Me, Knowing U(X)**, the shift is clear: the best user experience is the one that understands you before you even touch it.

We Collaborate - Alliances of minds and machines. Collaboration itself has become intelligent. Teams are augmented by AI-powered autonomous agents, machine collaborators, and digital identities that drive trust, speed, and synergy across boundaries. The trend **Autonomous Agent Alliance** shows how AI partners are joining workflows; **Synergy²** explores how human creativity and machine precision amplify each other. And the future of work? A tight team of biological and silicon colleagues.

Thriving on Data - The heartbeat of AI-first enterprises. Data has become the bloodstream of innovation, and the fuel of AI. It flows across ecosystems, fueling decisions, insights, and automation—but it also demands care, trust, and responsibility. Trends such as **Data Sharing is Caring (But Take Care!)** and **AI Meshed Up** show how organizations are mastering federated, ethical, and composable data practices. The goal isn't just data-powered decisions but also a continuous flow of data-powered value, sustained in real time.

Process on the Fly - Operations that think for themselves. Business processes no longer follow fixed



paths; they self-adapt in response to change. From **Whole Lotta Fusion** to **Autonomous Enterprise**, the idea of process as code has matured into process as an adaptive organism. Automation, AI, and human judgment now combine into responsive systems that learn, self-heal, and improve continuously—the operational equivalent of a living pulse.

Physical Matters - Intelligence made tangible. For the first time, TechnoVision ventures into the realm where bits meet atoms. Objects, materials, and machines are becoming increasingly active participants in innovation: smart, responsive, and autonomous. From **Material World** to **Mission: Adaptable**, we see products that reconfigure themselves, vehicles that make real-time decisions, and devices that continuously learn from their environment. The physical world is no longer a fixed constraint, it's a computing platform in its own right.

Nature's Code - Life as inspiration. Innovation increasingly takes its cues from biology. Systems that grow, heal, and adapt naturally are becoming the model for sustainable, regenerative design. In trends such as **My Chemical Advance, Language of Life**, and **Mind over Machine**, we explore a world where the boundaries blur between biological processes and digital architectures: think photonic chips, DNA storage, bio-inspired algorithms, and AI systems that learn like ecosystems rather than machines. This is where technology stops imitating life and starts participating in it.

Applications Unleashed - Software with agency. Software is no longer a static asset but an evolving network of smart, connected capabilities. Microservices, APIs, and AI-powered logic turn monolithic applications into living systems that learn and collaborate. Whether it's **Honey, I Shrunk the Applications** or **Chat is the New Super App**, the message is clear: apps are becoming smaller, smarter, and surprisingly social. Some, like those described in **App = A Robot**, are literally stepping off the screen.

Invisible Infostructure - The quiet power beneath. Behind every intelligent system is an invisible architecture: a cloud continuum stretching from data center to edge, increasingly infused with AI and soon, quantum computing. Trends such as **Cloud Encounters of the Third Kind** and **OK Qompute** explore the frontier where sustainability, sovereignty, and sheer performance meet. Infrastructure is no longer background; it's the subtle force that keeps everything, everywhere, all at once connected.

Balance by Design - Motion with meaning. The design principles of this container provide the tools to keep balancing the different dimensions of technology-powered change, through mindset and approach. Principles like **Do Good, Do Less, Do Well** and **Be Like Water** remind us that balancing is not a luxury—it's a key design feature. **WE augment!** is our continuing reminder to put humans at the center of change, even when surrounded by breakthrough technology that seems to be able to run itself.

With these nine containers, TechnoVision 2026 reflects an innovation landscape that's expanding and entangling at the same time. Technology no longer sits neatly in domains; it flows, fuses, and feeds back. The digital shapes the physical, the physical shapes the biological, and humans, still, shape it all. It's a richer world. A more complex world. And as always, the challenge remains the same: to make it real.

Making It Real

Last year's edition, *The Pendulum Swing*, showed how balance in technology and society is never static—it's found in motion. But as the world around us became more turbulent, and the innovation landscape more intertwined, a single pendulum no longer told the full story. Dozens of forces now oscillate at once, shaping each other in real time. The task ahead is not to stop them, but to find coherence in their movement, and, true to our new mantra, to make it real.

So how do we find coherence in a world that refuses to stand still?

Perhaps, as our Antwerp dinner quietly suggested, we can take a hint from the Japanese physicist who spent his career studying rhythm. In the 1970s, Yoshiki Kuramoto set out to understand how chaos becomes coordination. He studied everything from flickering fireflies to oscillating chemical reactions, looking for the hidden principle that makes independent actors—each with its own rhythm—suddenly fall into sync.

He captured it all in one equation:

$$\dot{\theta}_i = \omega_i + \frac{K}{N}\sum_{j=1}^{N}\sin(\theta_j - \theta_i)$$

You don't need to remember the symbols, just the **K**. Kuramoto called it the coupling strength: the invisible connection between individual parts of a system. If **K** is weak, every element moves to its own beat—beautiful, perhaps—but noisy and incoherent. If **K** is strong, synchrony emerges: a pattern, a pulse, a shared tempo. Not because someone is leading, but because everyone is listening. Kuramoto's insight was that order doesn't come from control—it comes from connection. And that's exactly what our world of technology, data, and human ambition needs now: a stronger **K**.

Kuramoto's lesson translates surprisingly well into our own reality. In a business, every team, every function, every initiative has its own rhythm. Some move fast,

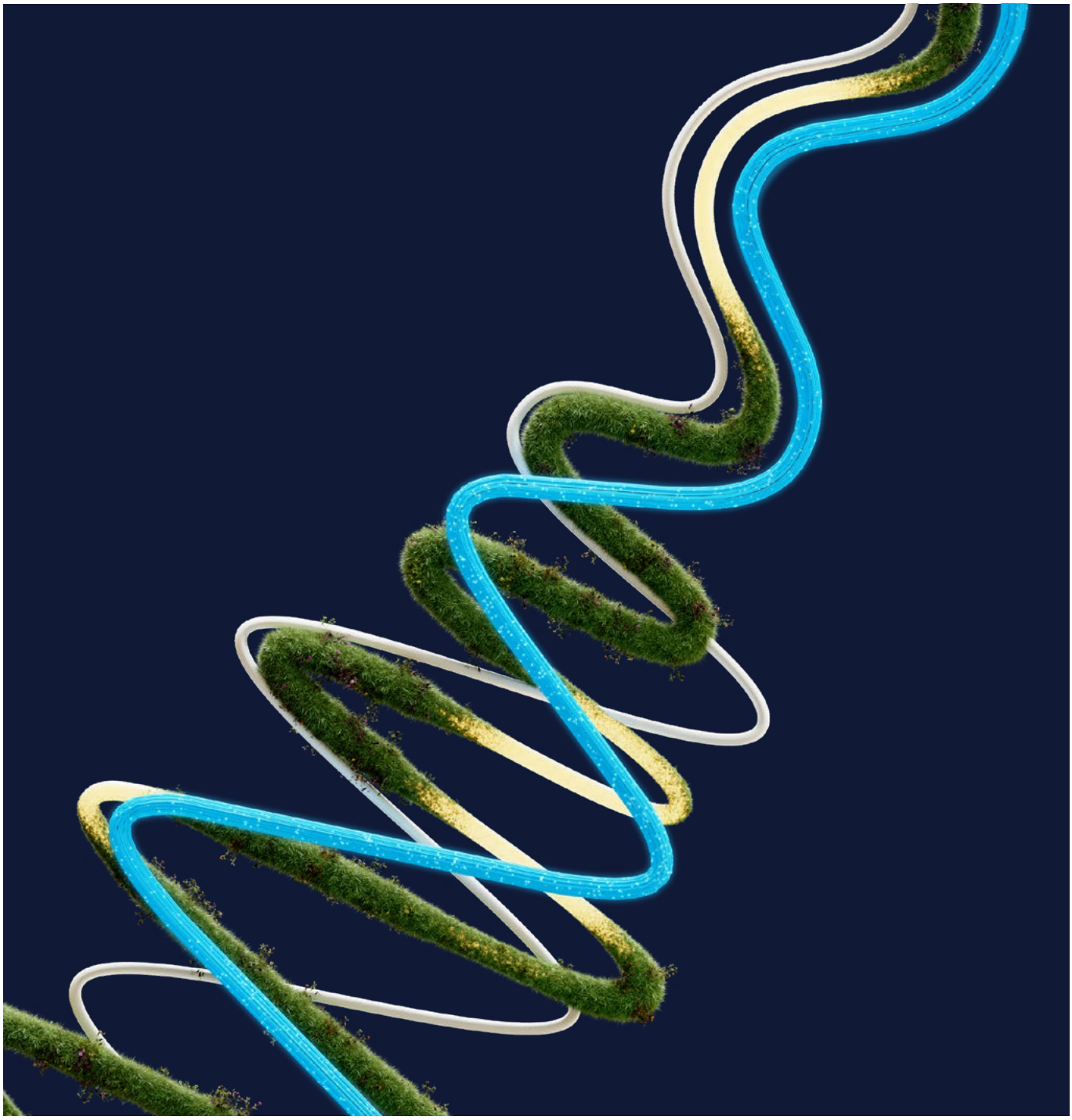
others take their time. Some play melodies of innovation, others keep the baseline of stability. What binds them together—what raises our collective 'K'—are the shared mechanisms of connection: common objectives, aligned value, and a sense of meaning that transcends department, role, or KPI.

When people, business strategy, and technology are connected by purpose, a strange thing happens: information flows more freely, decisions align naturally, and innovation accelerates almost without effort. The system begins to find its own rhythm.

Information moves where it's needed. Teams anticipate each other's actions. Technology amplifies human purpose instead of pulling focus away from it.

No central command is required, just a strong enough pulse of shared direction and continuous feedback.

That's when the pendulums truly swing together: many rhythms, one flow, truly synced.



And So, the Evening Ends

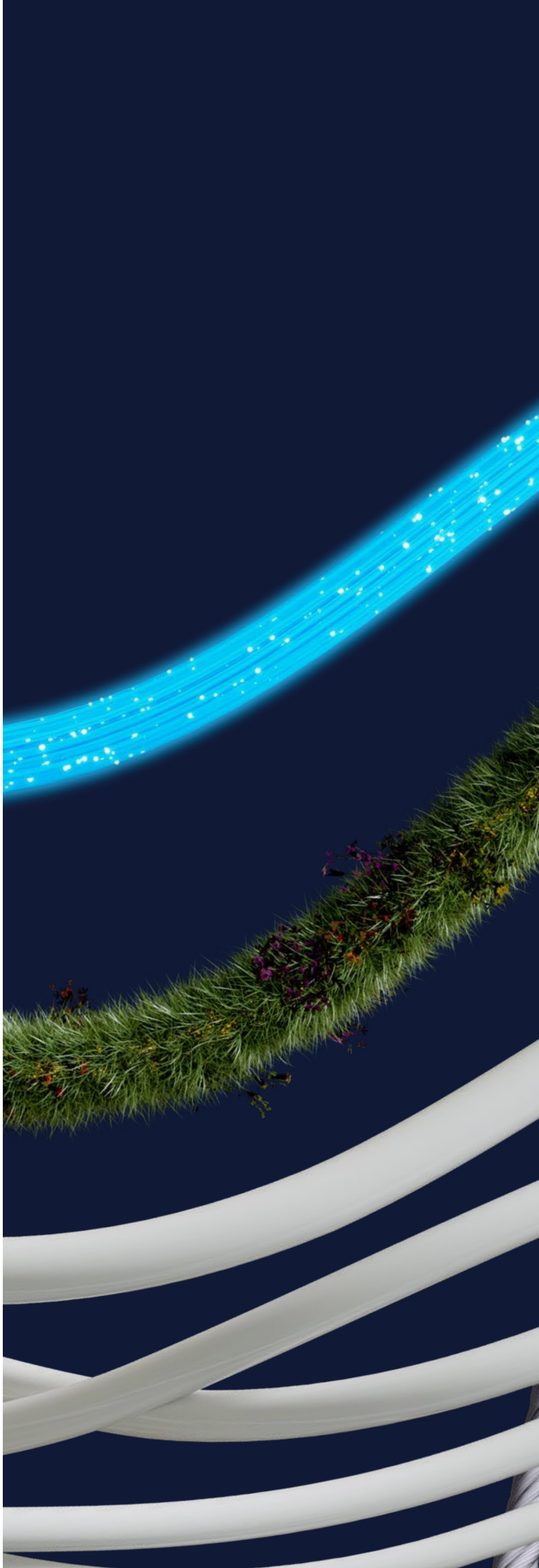
By the time dessert arrived at PrivéPrivée, the room had fully synchronized. Conversations overlapped just enough to feel alive, not chaotic. Glasses clinked in rhythm. Even the quiet ones were smiling as if everyone had, somehow, tuned into the same frequency. When it was finally time to leave, the harmony briefly faltered. The two ladies celebrating their fifty years of friendship accidentally took *our* taxi—not their pre-booked one—probably costing them more than expected. A gentle reminder that flow doesn't always follow the plan. Then again, coherence isn't about control; it's about connection.

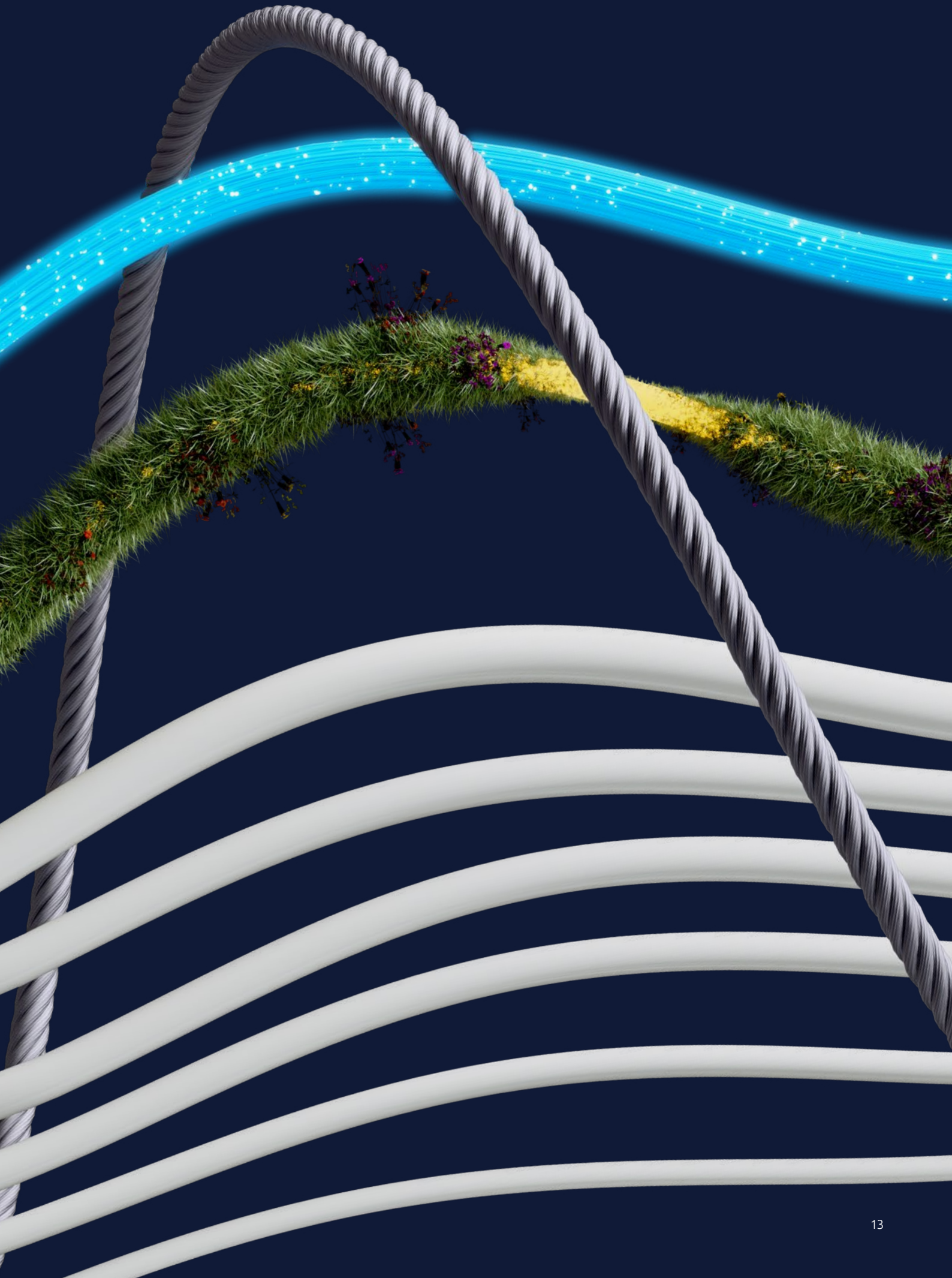
That, in essence, is what *TechnoVision 2026* is about: how to move through complexity without losing rhythm, how to connect technology, people, and purpose without forcing uniformity, and how to let innovation emerge through resonance rather than command.

This edition aims to do both: to spark inspiration and fresh perspectives through a rich collection of trends and real-world use cases, where new connections and insights may emerge in surprising ways—and at the same time, to offer structure and cohesion, helping organizations craft compelling change stories that resonate in unison across teams, technologies, and ambitions.

In a world of many moving parts—humans, algorithms, businesses, and ideas—it's easy to drift out of tune. Yet when we listen, align, and share a clear sense of direction, things begin to move together almost naturally. That's when strategy finds its beat, technology becomes tangible, and progress feels effortless.

Our wish for this year's edition is simple: may it help you and your organization weave together your own, unique, technology-powered innovation stories—stories that move with purpose, flow with energy, and, above all, help you make it real.





Overview of TechnoVision

TechnoVision is more than just a collection of technology trends. It's a **framework**, a way to make sense of innovation as it moves, swings, converges, and transforms. At its heart are containers: structured lenses through which we observe and categorize the changing technology landscape. Each container represents a distinct perspective, helping us explore how technologies impact everything from user experiences to organizational design, infrastructure to intelligence—and now, even biology and the physical world.

Think of the containers as nine harmonized instruments in an orchestra. Individually, they offer sharp insights. Together, they create a coherent view of technology's role in shaping business and society.

Nine Containers, One Frame

Until now, TechnoVision grouped its trends into seven containers. For 2026, we expand that to nine, adding two new perspectives that reflect the growing complexity—and convergence—of digital, physical, and biological innovation.

Eight of these containers represent the **what** of technology: the areas where innovation manifests:

- **You Experience**: Trends in user interaction, personalization, and immersive engagement
- **We Collaborate**: The future of teamwork, co-creation, and human-agent collaboration
- **Thriving on Data**: Data mastery, AI-powered business, and knowledge as an asset
- **Process on the Fly**: Flowing, agile, intelligent automation of work and operations
- **Applications Unleashed**: The modernization, liberation, and reinvention of applications
- **Invisible Infostructure**: Intelligent, resilient, and often unseen infrastructure
- **Physical Matters (new)**: Smart products, robotics, edge devices, and sentient materials
- **Nature's Code (new)**: Biotech, organic systems, and nature-inspired innovation

The ninth container, **Balance by Design**, is different. It focuses on the **how**: a set of five design principles (and their often more easily spotted antiprinciples) that help organizations apply these trends effectively, ethically, and sustainably.

Together, these nine containers offer a dynamic, yet structured way to explore technology's impact across domains, weave together compelling stories, and translate trends into action.

New Containers

TechnoVision evolves as the world evolves.

The introduction of the **Physical Matters** container acknowledges that digital is no longer confined to screens or software. From autonomous vehicles to sensor-rich environments, physical things are becoming intelligent participants in business ecosystems.

With **Nature's Code**, we are building an era where Biotechnology (BT) stands shoulder to shoulder with Information Technology (IT) and Operational Technology (OT). Innovation is now inspired as much by biology as by code and systems are being built to regenerate, adapt, and even self-heal.

We have added these containers not to stretch the model, but to complete it as the pendulums swing between disciplines, building bridges between technology, biology, and the physical world.

A Framework in Motion

The TechnoVision 2026 visual (on your left) represents a framework in motion—a living structure where technology, business, and human experience converge.

At its foundation lie the **enabling technologies**: Invisible Infostructure, Thriving on Data, and Process on the Fly. These are the engines of digital transformation—ensuring that whatever sits above them can operate, scale, and adapt.

On top of that base, three **interconnected domains**—Applications Unleashed, Physical Matters, and Nature's Code—show how software, engineered products, and biological innovation merge. Together, they form the new heart of technology-powered transformation, bridging IT, OT, and BT.

Above them rise the **human-centric layers**—We Collaborate and You Experience—the places where all technology eventually becomes tangible, meaningful, and personal.

Finally, Balance by Design forms the **overarching dome**—a reminder that innovation without balance and design is chaos, and that true transformation only happens when design, ethics, and purpose align.

Together, these nine containers form a **harmonized ecosystem**—from invisible enablers to visible impact. It's how TechnoVision 2026 transforms complexity into clarity, and motion into meaning.

The Trend Format: Crisp, Actionable, Synchronized

Each TechnoVision trend is designed to be:

- **Crisp**: A one-page summary, easy to digest but rich in insight
- **Actionable**: Clear real-world use cases and practical examples
- **Synchronized**: Aligned with the broader pendulum dynamics, and with other trends across containers

Each trend is structured into four simple sections:

- **What**: A clear description of the trend
- **Use**: Best practices and real-world applications
- **Impact**: The transformational potential and business relevance
- **Tech**: The underlying technologies and standards

And because we believe in the power of human connection, each trend includes an **Expert in Residence** you can always reach out to for more.

A Framework with a Twist

As always, **TechnoVision remains playful**. You'll find references to music, cinema, literature, and pop culture sprinkled throughout. Not just to lighten the tone, but to spark recognition and memory. These Easter eggs (some well-hidden) aren't gimmicks; they are part of what makes the trends sticky, shareable, and, dare we say, fun.

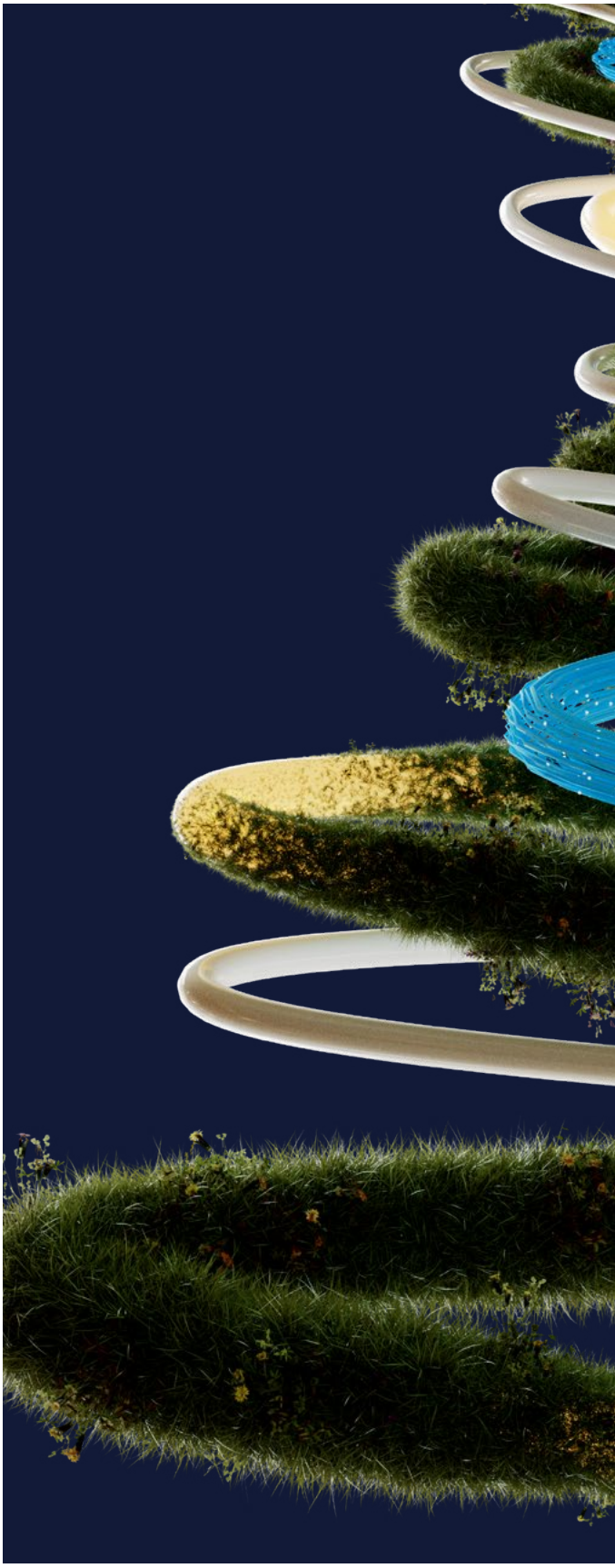
What's Inside, and What's Next?

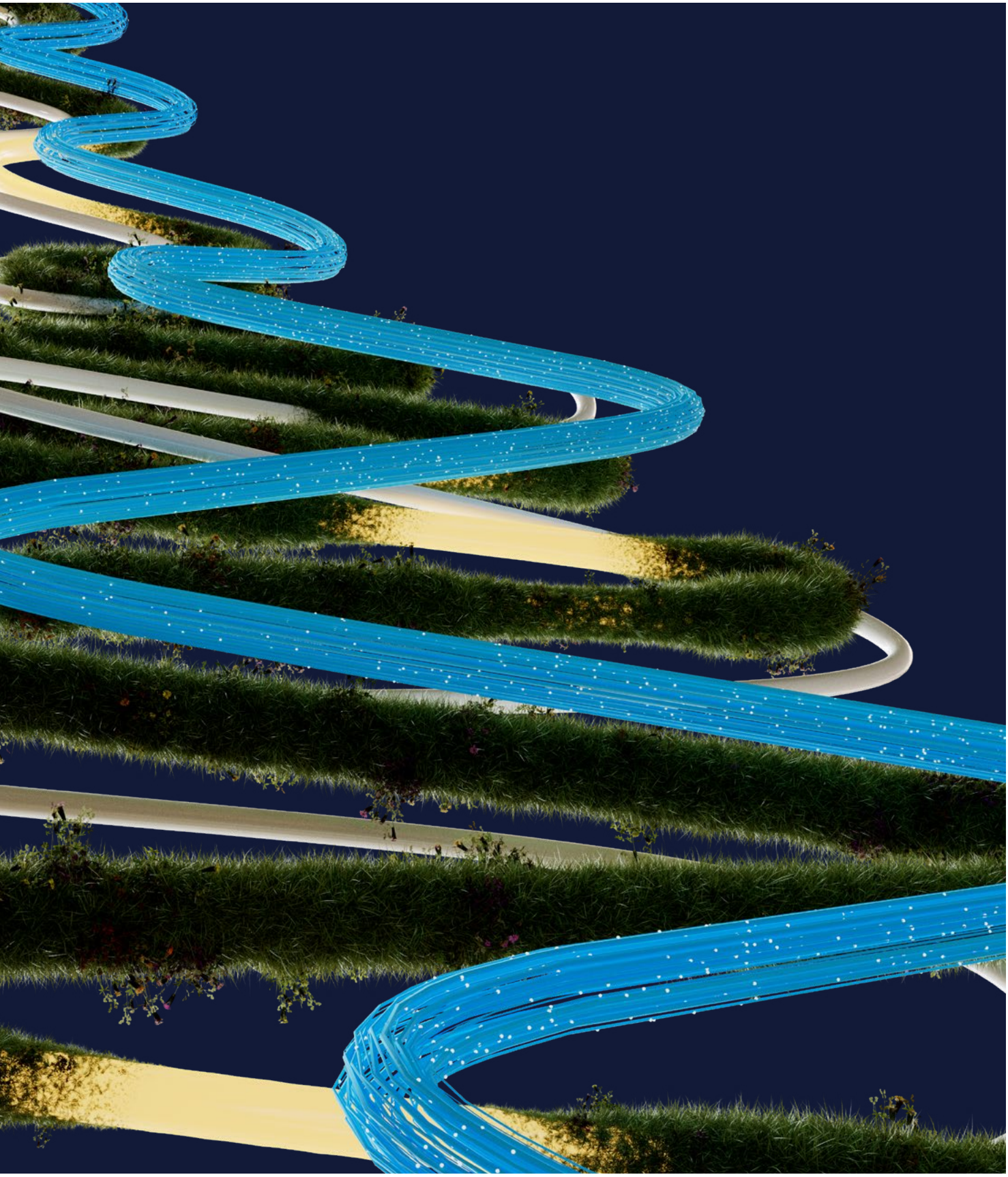
With nine containers, 37 synchronized trends, and a unifying theme, *The Sync Swing*, TechnoVision 2026 sets the stage for bold, balanced, and creative transformation. It invites you to explore not just isolated innovations, but the deeper rhythms and counterforces at play in technology, business, and society —in a search for value from their joint resonance.

Use it to shape roadmaps, inspire workshops, build strategies, or simply rethink what's possible.

And keep an eye out: our **industry playbooks, TechnoVision cards** and other assets offer even more ways to bring the framework to life across portfolios, programs, and projects.

So, whether you're orchestrating a technology-powered transformation, designing the next smart product, or wondering how AI and fungi might someday work together: this is your go-to toolkit.





01. You Experience

Where We Are

Technology-driven experiences evolve from personal to perceptive. Human-machine understanding reshapes how systems behave, moving from simple responses to subtle recognition. Interfaces no longer just react; they listen, interpret, adapt, and occasionally get ahead. Whether screenless, conversational, or embodied in virtual humans or humanoid robot forms, today's interfaces simply feel more like humans. From meticulously generated faces to invisible copilots, AI is stepping into lives with surprising ease. Some whisper advice in your ears; others walk beside you. The result? Increasingly smarter "you experiences" that anticipate and adjust to who you are and what you need, not just telling you what to do. Seamless, sensitive, reasoning, and acting before you even think of it. Almost.

Balancing Acts

As agents gain autonomy and interfaces become more lifelike, *You Experience* walks a finer line. Anticipating needs is helpful, but assuming control isn't. Behind every smooth interaction lies a tension between personalization and privacy, automation and agency. When AI systems start talking to each other, who stays in the loop? Hyper-personalized experiences demand trust, transparency, and inclusion by design. Add concerns around deepfakes, bias, or emotional manipulation, and the stakes rise quickly. Experience should empower, not overstep. The smartest systems will be the ones that know when to pause, when to explain and justify, and when to ask first.

Alexandre Embry

Expert in Residence

The Trends

1. **Face to Interface:** When AI agents look, sound, and act like us, interaction feels as natural as human-to-human.
2. **You're Something Spatial:** Spatial computing, digital twins, and real-time 3D are syncing up to transform industries with immersive, sustainable, and intelligent experiences.
3. **Internet of Twins:** Digital twins, virtual representations of real-world entities and processes, deliver better mastery of real-world challenges, with less strain on resources and energy.
4. **Knowing Me, Knowing U(X):** Interfaces that listen, anticipate, and adapt, turning every interaction into one that truly understands you.

3 Steps to Take

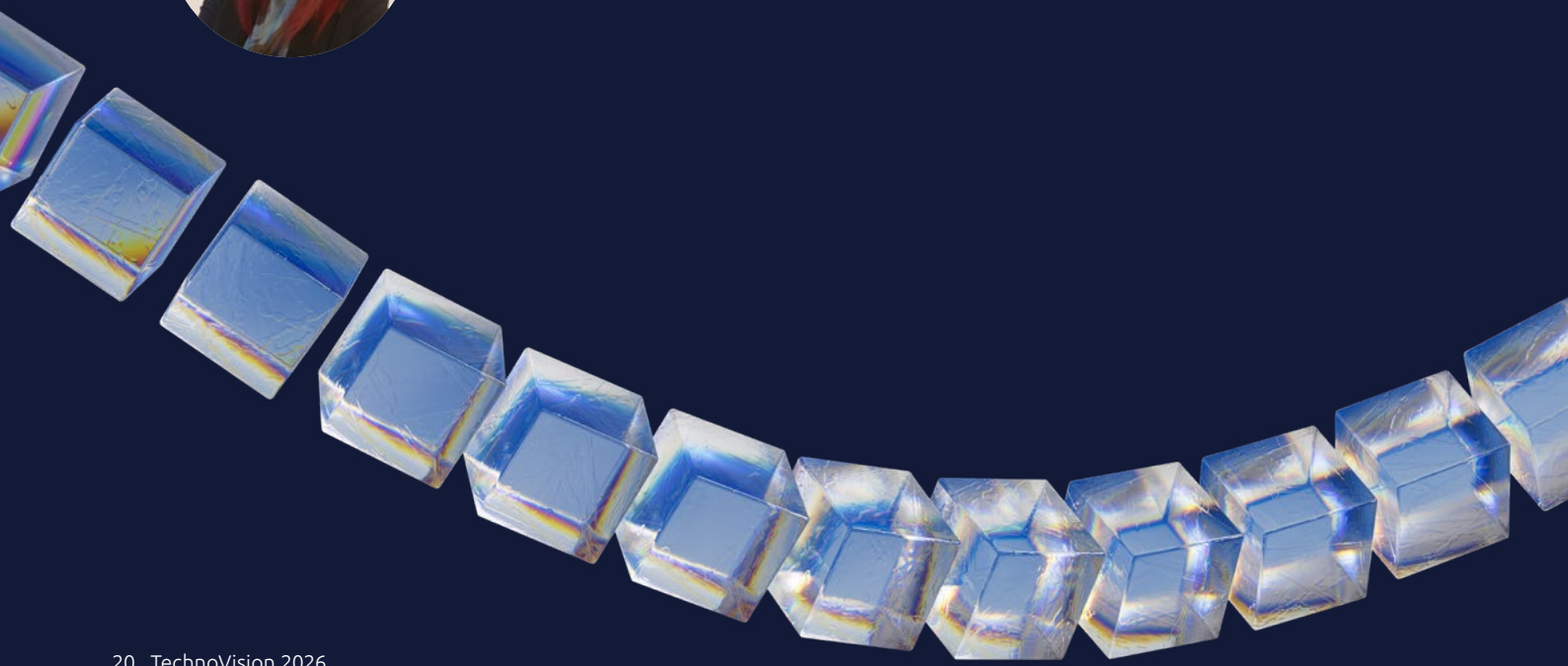
1. **Design for humanized interaction.** Technology-driven experiences become conversational, spatial, and embodied. Embrace screenless design, natural language, and interfaces that show empathy, understand, and adapt to people. Whether through voice, facial expressions, gestures, or even physical form, the goal is engagement that feels natural and inclusive.
2. **Connect your agent ecosystem.** One assistant is helpful. Many working together are transformative. Break down silos between agents operating in different apps, devices, or workflows. Let them share context, learn from patterns, and coordinate in the background without adding visible complexity. They quietly adapt to your needs, including how present they are, shaping themselves into your ideal companion.
3. **Make trust the foundation.** As interfaces grow more intelligent and humanlike, trust becomes essential. Be clear about what the system knows, how it decides, and when it acts. Let users interrupt, override, or opt out with ease. Design for inclusivity and fairness across geographies, cultures, and accessibility needs. From ethical defaults to explainable AI, every element of the experience should respect the user's digital dignity. Because when machines start thinking with us, the most human thing you can build is confidence.

Face to Interface

When AI agents look, sound, and act like us, interaction feels as natural as human-to-human.

This is the year of widespread agentic awareness. Agentic AI is on everyone's agenda, whether it is curiosity-driven or application-driven, as AI agents increasingly engage with us with more human interfaces and opening up new opportunities for innovation. These agents are designed to work with us, making interactions as natural as a conversation with a colleague. They relate to us through interfaces that were not possible just a few years back and are transforming how we connect with technology. The result? The interface between human and machine is becoming seamless. It feels less like talking to a machine and more like teaming up with an ally. Something we'd all like to face.

Carolina
Sanchez Hernandez
Expert in Residence



What

- Agents are getting a face and a voice. A design with human-like characteristics can offer interfaces that are easier to relate to and feel familiar, tailored to diverse yet specific contexts (e.g., healthcare, education, customer services).
- These agents, either in single or multi-agent solutions, are being embedded in all sorts of applications such as manufacturing (anomaly detection), transport (intelligent systems), fintech (automating processes), and consumer (customer services, recommendation engines), and even in bringing history to life.
- This rapid advancement of AI agency, and its speed of scale, has prompted the need for everyone to be able to understand and interact with agents to benefit from their value. This has opened up a huge opportunity for designing AI agents that are more relatable to us and can use human-like communication channels. Agents enable non-technical users to build apps and solutions using natural language and interactive designs, no coding required.
- Communication is becoming two-way, allowing humans to issue commands in natural language and agents responding likewise with explanations and dialogue. Agentic AI systems are being developed as personal assistants that execute complex tasks from instructions, interact with users, and clarify details through conversation.

Use

- **Capgemini** is leveraging Gen AI at the **Women's Rugby World Cup 2025** through TryZone IQ, an LLM-powered platform that delivers real-time match analysis and contextual insights. It supports commentary teams across broadcast, digital, and social channels, enhancing storytelling and fan engagement.
- **Schaeffler** is leveraging Microsoft's Factory Operations Agent, a chatbot powered by large language models via Azure, to quickly identify causes of defects, downtime, and energy waste, essentially acting as ChatGPT for factories.
- **Apollo Tyres** is unlocking machine insights using their agentic AI-powered Manufacturing Reasoner, built on AWS (Amazon Bedrock) that interacts with real-time IoT data using natural language. Operators can ask questions and receive diagnostics and optimization suggestions instantly.
- **Qatar Airways** is leveraging UneeQ's AI-powered digital human, Sama, a virtual cabin crew ambassador. Sama engages audiences through Instagram, sharing insider travel tips, showcasing destinations during layovers, and offering glimpses into cabin crew life.
- **Tsinghua University** in China has launched Agent Hospital, an AI-powered virtual hospital, with a fully immersive system where 42 AI agents act as doctors across 21 medical departments capable of treating 10,000 patients in days, something that would take human doctors over two years.

Impact

- Democratizing and personalizing the use of AI. Development of natural interactions with agentic AI allows more technology uptake from all technical and non-technical backgrounds and lowers the barriers to access the use of advanced technology.
- Embracing agents within the workplace. There is an acceleration on workforce uptake of new technological solutions enabled by more natural ways of working with new AI agents that speed up understanding and safe adoption.
- Organizational workforce can take advantage of huge data sources and through natural AI interactions with agents, develop new solutions in all types of industries that would not be within their reach otherwise, including applications such as in live sports agent interaction or making historical archives and voice records accessible to wider audiences.
- With new developments and interfaces such as agents' avatars, there's an acceleration of the development of AI ethics and AI safety skills within all types of organizations. This is to ensure the positive role and benefits of interactions with AI agents and that they are built with safety, transparency and assurance.
- Revolutionary innovations on human-AI interfaces through different channels (visual, sound, text, tactile, brain waves) allow for inclusive communication channels, increasing equitable access to AI interactions and developments so all humans can benefit from it and evolve with it.

Tech

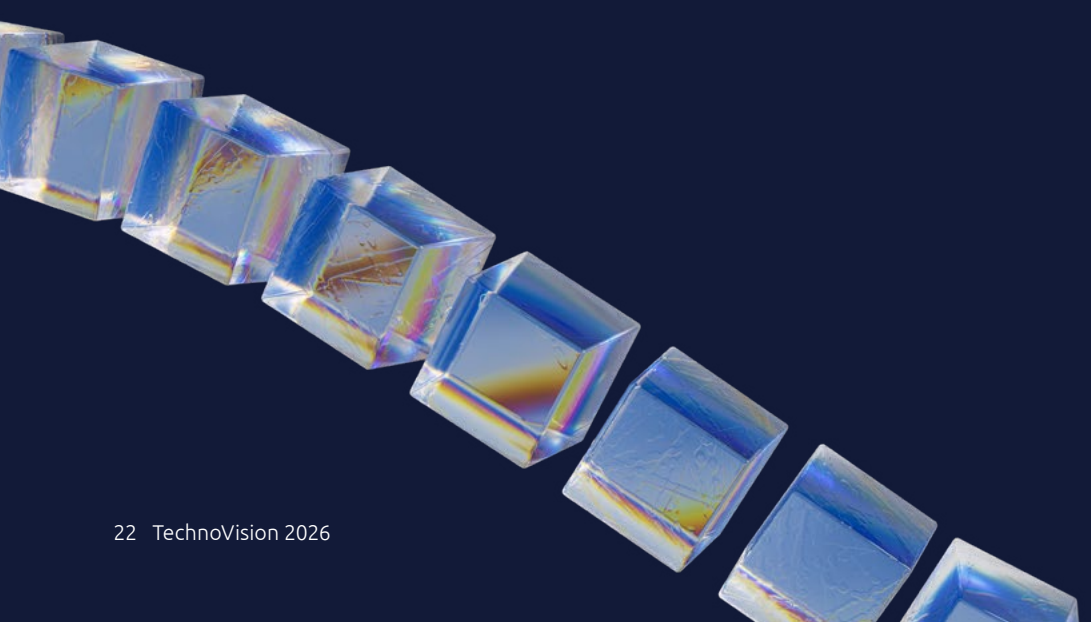
- **Digital Human**: Meta, Google, AWS Q, Microsoft's Project xCloud, Unity, Soul Machines, Dimension Studio, Synthesia, Ravatar, Eisko
- **Intelligent Agent/Advisor**: IBM Watson, Google, Salesforce, UNeeQ, Sema4.ai, Agentifai, DeepVu, Zelros
- **Agentic Systems**: Open AI, Google DeepMind, IBM Watson, Microsoft Azure AI, AWS AI, ServiceNow, Databricks, Salesforce, AgentOps.AI
- **Multi-Agents:** IBM Watson, Microsoft AutoGen, AgentForge, AgentVerse, AgentFlow, CrewAI, LangChain, Kore.ai, Relevance AI

You’re Something Spatial

Spatial computing, digital twins, and real-time 3D are syncing up to transform industries with immersive, sustainable, and intelligent experiences.

Have we got something for you! Where digital layers interact with the physical, there’s the magic of spatial computing—blending virtual data with real environments. Alongside digital twins and real-time 3D, it’s revolutionizing industries by delivering immersive, real-time insights and hyper-personalized experiences. Whether it’s optimizing factory floors, enhancing medical procedures, or reshaping smart cities, these technologies merge what we see with what we need to know. Large vision models and AI power this shift, enabling machines to both read and show the world. It all brings greater efficiency, lower costs, and smarter decisions. And you’re not just witnessing this change—you’re something special in driving it forward.

Monika Underwood
Expert in Residence



What

- Spatial computing, the spatial web, digital twins, large vision models, and real-time 3D are converging to drive a unified digital revolution—once independent innovations, now synchronized across industries through shared platforms and collaborative ecosystems.
- These technologies fuse the physical and digital worlds, enabling immersive experiences through intelligent systems and advanced visualization. The spatial web connects physical and digital objects into a unified, real-time data ecosystem, fostering universal access and cross-industry collaboration.
- Spatial computing overlays digital information onto the physical world, offering intuitive user experiences that feel natural and interactive. It enables context-aware digital content in physical environments —bridging the gap between people and technology.
- Digital twins allow real-time simulation and optimization of physical assets. Further, large vision models enhance machine perception and responsiveness to user needs. Together, they drive innovation aligned with climate goals and operational excellence.
- RT3D technology powers immersive, live simulations, enriching everything from gaming and entertainment to industrial design and healthcare training. High-fidelity 3D environments enable real-time global collaboration, democratizing expertise and accelerating innovation.

Use

- **Mercedes-Benz** is taking the MB.OS infotainment system to the next level by integrating Unity's Real-Time 3D (RT3D) engine in the new Mercedes CLA to provide hyper-realistic graphics, immersive navigation, E2E development, and performance optimization.
- **UC San Diego Health surgeons** have tested spatial computing in surgery using an Apple Vision Pro app, improving precision and ergonomics by integrating real-time data into the surgeon's view.
- **GE Aerospace** is leveraging TeamViewer's Frontline Spatial AR solution to deliver remote training and support for technicians worldwide. In collaboration with Siemens, it creates interactive digital twins of aircraft engines, enabling efficient, cost-effective training across locations.
- **Dallas Fort Worth Airport** is using Outsight's 3D LiDAR Spatial Intelligence to boost safety, operations, and passenger flow. The system delivers real-time, anonymous movement insights via edge computing—without cameras or phone data—helping teams detect congestion, manage crowds, and make instant data-driven decisions.
- **Flybits** has unveiled XRCard, a spatial computing-enabled payment card that works independently of mobile phones. Combining generative AI, AR, and smart glasses, it allows hands-free, app-less financial interactions via voice and spatial visuals.

Impact

- The integration of these technologies drives significant efficiency gains, reduces costs, and enhances personalization across industries.
- Real-time monitoring and predictive analytics through digital twins minimize downtime and improve resource allocation, resulting in less waste.
- Personalized customer experiences in retail, powered by spatial computing, increase engagement and conversion rates.
- In healthcare, real-time data and immersive training tools reduce the risks associated with surgeries, leading to improved patient outcomes.
- Education becomes more accessible and effective through immersive learning environments, while manufacturing sees faster go-to-market and reduced operational errors.
- Overall reduction of energy consumption and physical footprint, contributing to sustainability goals across sectors.

Tech

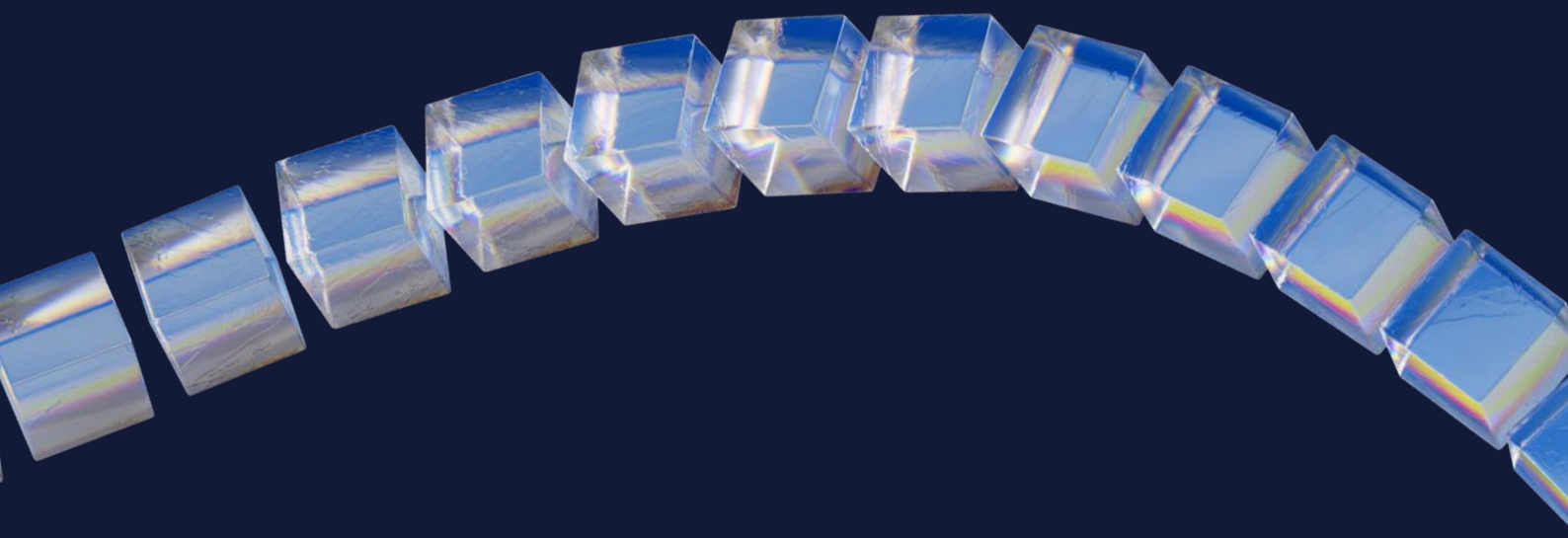
- **Real-Time 3D Engines:** Unity, Unreal, Panda3D, Enscape, NeoAxis Engine, Torque 3D, CryEngine 3
- **Spatial Vision:** NVIDIA, Intel, AWS, Qualcomm, Universal Logic, Leap Motion
- **Spatial Web:** Meta, Google, Apple, Microsoft, Cesium, Mapbox, Unity, SafeGraph, Anditi, ESRI
- **Spatial Computing:** Unity, NVIDIA, Microsoft, Meta, Apple, AWS, Qualcomm, PTC, Snapchat, ARway, Magic Leap, NavVis, Hadean, Rokid
- **Large Vision Models (LVM):** OpenAI, NVIDIA, Hugging Face, Google, Meta, Microsoft, AWS, Landing AI, World Labs, Solulab

Internet of Twins

Digital twins, virtual representations of real-world entities and processes, deliver better mastery of real-world challenges, with less strain on resources and energy.

Definitely no evil twins involved here! The goal of the digital twin is to create the most realistic representation of real-world entities and operations—one that is as close to the actual experience as possible. Collaboration between twins to model complex experiences should be guided by human orchestration remaining the ultimate reference point for making real-world decisions. These cognitive twins self-improve and operate autonomously, representing the acquired and evolving knowledge space of a person or an organization. They are no longer just mirrors; they augment us in the real world. Just think of it as a trusty sidekick, minus the scary movie vibes.

Jacques Bacry
Expert in Residence



What

- Let's consider the virtual replica, the digital twin, as an object that represents the knowledge space of its physical counterpart. This knowledge space can be extended by the cognitive digital twin, which not only enhances the digital twin itself but also improves collaboration between twins within a network. The more these collaborations are based on human artifacts, the greater the complexity becomes.
- As humans, we are inherently social and require a certain level of interaction to function effectively. What then are the appropriate modes of communication in virtual environments? We instinctively rely on non-verbal cues, and it is complicated to represent these signals in a virtual context.
- Incarnations and remote presence in virtual environments rely on self-identification, where extending the user's representation through avatars is essential for psychological grounding. Although many academics are exploring this area, key challenges persist around fidelity of self-representation, action perception, and capturing emotion.
- A logical first step in addressing these challenges is to federate all relevant data for use within a standard digital twin, whether process- or organization-based, or to establish the right connections with a dedicated twin. In this context, technologies that identify the right data (AI) and ensure interoperability between twins (ontologies) will be essential.

Use

- **Apollo Energy Analytics** combines agentic AI with digital twin technology to create self-regulating solar and wind systems that maximize efficiency and minimize downtime. It delivers up to 7% higher energy yields, 15-20% lower maintenance costs through proactive fault detection, and smarter decision-making.
- **Pegatron**, a Taiwan-based electronics manufacturer's PEGAVERSE platform fuses digital twins with AI agents to simulate and optimize factory operations in real time, shrinking development cycles from days to minutes, ensuring consistent quality, and scaling smart factory automation.
- **IBM and NASA** launched Surya, a dynamic AI-powered digital twin of the Sun. It provides two hours of advance warning for solar flares, doubling traditional lead times, and boosts accuracy in flare detection by 16%.
- **Hesperos** has published a breakthrough in advanced science, introducing the first true digital twin capability derived from an organ-on-a-chip platform. This advance in micro physiological systems (MPS) represents a major step toward human-relevant, non-animal testing for disease modelling, drug screening, and regulatory decisions.
- **EU** has launched a strategic initiative for the development and integration of Virtual Human Twins (VHTs)—digital representations of human physiology, from cells and tissues to entire organ systems to advance personalized healthcare.

Impact

- A crucial research question in the digital transformation of companies concerns learning processes in immersive environments and how they can be improved with human support.
- Another key challenge is how to measure the incremental added value and benefits of using digital twins' environments, both in the shorter and longer term. Many sensors already exist for gauging quantitative biophysiological and cognitive factors in the real world, but their application in the virtual world is still lacking. Once the data is retrieved, both as streams and in permanent storage, analytics are performed, followed by ML/DL model generation. Finally, in the UX part, the cognitive digital twin is presented to the users in different forms, including 1D/2D/3D, XR, GIS, etc.
- In creating virtual environments, the user will need to make decisions (such as requiring technical help or choosing between design options). We need to consider the relationship between the real and virtual, and the impact of decisions made in the digital on peoples' reality. This convergence between digital and people enables cognitive digital twins to adapt proactively to varying conditions and anticipate future scenarios. It also provides a way to optimize industrial processes and embody the ideals of resource efficiency and environmental sustainability from a human-centric perspective.
- In assessing the above questions, we gauge that the digital twin reality is moving toward an integration environment of augmented life. The approach is to combine reality with some virtual extensions and then integrated into the real world.

Tech

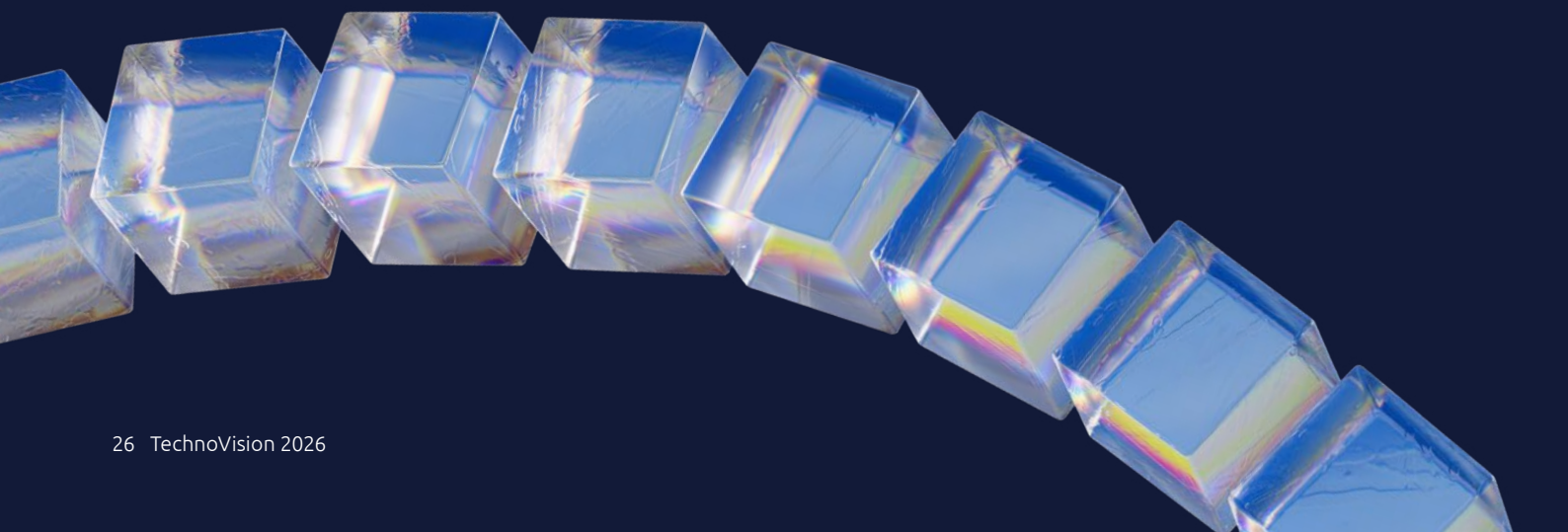
- **Digital Twin Platforms (generic):** Matterport, Microsoft Azure, AWS, IBM Digital Twin Exchange, Siemens, Bosch, Dassault Systems, ANSYS, PTC, General Electric, ABB
- **Multi-agent-driven Digital Twin**: Sev1Tech Vertasyn, Aerogility, EdgeAgentX-DT
- **Federated Digital Twin:** Bentley iTwin, DTaaS Federated Extension
- **Cognitive Digital Twin:** Digital Twin Consortium, Cloudworx.ai
- **Cognitive Twins for Supporting Decision-makings of IoT Systems:** arxiv.org

Knowing Me, Knowing U(X)

Interfaces that listen, anticipate, and adapt, turning every interaction into one that truly understands you.

No more dancing to technology's tune (even when it comes from Sweden): Human-machine understanding flips it around. Systems now read context, sense emotions, and adapt in real time—across voice, XR, robotics, or whatever interface is at hand. As agentic AI, physical matters and edge computing converge, experiences shift from mechanical to meaningful: timely, trustworthy, and tuned to the rhythm of human goals and states. From clinical reasoning to collaborative robots, the choreography is clear: performance stays high, while judgment and well-being stay in the loop. There is a catch though. Safety, privacy, and compliance must keep pace, building on evolving rules and regulations. Done right, technology doesn't just respond, it harmonizes. It becomes a teammate that helps us decide, act, and learn. And when the system truly knows me, knowing U(X), there really is nothing we can't do.

Ali
Shafti
Expert in Residence



What

- Human-machine understanding (HMU) is moving past interaction into interpretation. It progresses in three stages: sense (capturing multimodal human, task and environmental data), understand (using perceptual, cognitive, affective and behavioral models in context), and support (providing adaptive guidance through the right channel, timing and level of autonomy).
- HMU enhances decision-making with context-aware insights and turns machines into teammates through shared autonomy. Instead of fixed responses, systems deliver experiences that adapt to preferences, states, and situations.
- Healthcare emphasizes reliability and explainability, industry focuses on efficiency and integration with legacy systems, while consumer technology pushes hyper-personalization yet must protect privacy.
- HMU connects with agentic AI, XR, robotics and edge computing to enable responsiveness, distributed intelligence and privacy-preserving performance in real time.
- Real adoption depends on assurance frameworks, explainability aligned with human mental models, and compliance with evolving regulation such as the EU AI Act. These ensure that systems remain intelligent, safe, and human-centric.

Use

- **Figure AI** has demonstrated its Helix visual-language-action, or VLA model in a simple household task. It's done by having two Figure 02 robots sort household items together, responding to spoken commands without extra programming, and demonstrating natural, speech-driven robot-to-robot coordination.
- **Ralph Lauren** has introduced "Ask Ralph," an AI-powered shopping assistant that uses conversational AI and natural language processing to interpret open-ended prompts and deliver tailored recommendations.
- **Google** has launched a Gemini-powered personal health coach for Fitbit that doubles as a fitness trainer, sleep advisor, and wellness guide. It tracks users' rest, spots trends, offers recovery tips, and answers questions like whether to skip a workout.
- **Y-12 National Security Complex** workers are being trained on hazardous materials using a virtual glovebox simulation. HaptX gloves with force and tactile feedback mimic real-world tools and controls, allowing trainees to build both physical and mental muscle memory in a safe VR environment.
- **Intent HQ's** Edge AI SDK powers personalization directly on devices, without identifiable user data. It analyzes dozens of phone signals on-device, offering context-aware recommendations without sending personal data to the cloud.

Impact

- HMU marries machine throughput with human oversight, elevating decision speed and accuracy, stabilizing outcomes, and improving experience quality across sectors (LLM-enabled work gains, call-center uplift, and clinical throughput indicators point the way).
- Explanations aligned to a user's mental model boost confidence and right reliance. In high-stakes contexts, transparency, assurance, and interoperability move adoption from pilots to practice.
- HMU reframes automation as augmentation: operators move to higher-skill, safer roles (one-operator-many-systems), supported by upskilling and clear teaming rituals between people and machines.
- Behavior-in-context becomes a strategic asset. HMU creates the virtuous cycle: better interactions, lead to richer behavioral data, which leads to better models and ultimately to even better interactions! Edge computing and robust governance deliver this without compromising privacy.

Tech

- **Proactive/Contextual Agentic AI**: OpenAI (GPT agents and Operator API), Anthropic (Claude Opus 4/ Sonnet 4), Microsoft (Copilot Studio, Azure Agent Tools), Google DeepMind/ Gemini
- **Proactive Coding Agent/ IDE Platforms**: Cursor, Sourcegraph Amp/ Cody, Google Jules, GitHub Copilot Agent, Kiro, jetbrains.com, Poolside AI
- **Edge Multimodal Perception**: Google MediaPipe, Intel RealSense, Smart Eye (Affectiva), Eyeris, BrainChip (Akida)
- **Human-centric Robotic Platforms**:
  - **Humanoids**: Tesla Optimus, Figure AI, Boston Dynamics (Atlas), Agility Robotics (Digit), Apptronik, 1X, Neura Robotics, Unitree Robotics, Engineered Arts (Ameca)
  - **Collaborative Robots**: Universal Robots, KUKA, FANUC, ABB, Doosan Robotics, Neura Robotics
- **XR and Haptics Providers**: SenseGlove, Varjo, Loft Dynamics, AdapTics, UltraBots
- **Edge Computing for Real Time, Privacy Preserving Responsiveness**: webAI, NVIDIA Jetson Platform, Google Edge TPU

02. We Collaborate

Where We Are

Collaboration is no longer a linear exchange—it's a dynamic dance of synchronized identities, agents, systems, and workplaces, collectively harmonizing to a shared rhythm. Business and technology ecosystems are discovering new ways for employees, partners, and customers to collaborate in sync, each keeping their unique tempo while resonating with the whole.

At the heart of this beat is digital identity—the cornerstone of trust and privacy for every participant, human or machine, catalyzing innovation and enabling seamless, secure collaboration across boundaries. AI agents act as the conductors of this symphony. They don't just assist, they anticipate, adapt, and orchestrate workflows with precision. Connected technologies form the instruments, context-aware and resilient, tuned to redefine value creation and exchange. New ways of working keep the groove alive with perfect choreography, as fluid workforces and minimum viable organizations reimagine the future of work.

In this new era, collaboration isn't about control, it's about coherence. Enterprises that sync, adapt, and harmonize will thrive in a world where alignment and shared purpose drive collective success.

Balancing Acts

Collaborating in a chaotic world demands constant alignment, not just innovation, but synchronization across technology, business strategy, and human-machine layers for meaningful value creation. Enterprises must balance emerging tech adoption with operational readiness. Strategic decisions like build vs buy and pioneering vs fast-following must align with long-term agility and trust. Autonomy and coherence must coexist, enabling independent rhythms to resonate as one. As human-machine collaboration deepens, organizations must balance machine efficiency with human creativity to deliver contextual outcomes. Human judgment remains a guiding instrument for resilience, regulatory compliance, and risk mitigation. Success lies in mastering these harmonies, not eliminating them.

Sudhir Pai

Expert in Residence

The Trends

- **My Identity, My Business:** A shift towards dynamic, context-aware authentication, where individuals and systems reclaim control over identity amidst rising threats from AI-driven social engineering.
- **Autonomous Agent Alliance:** The rise of AI agents that collaborate, adapt, and coordinate in real-time, forming intelligent agentic systems operating with seamless autonomy and collective intelligence.
- **Synergy²:** The new workplace has extended beyond just human-to-technology interaction; it's a dynamic synergy between humans, intelligent systems, and inter-agent communication.
- **Economy of Things:** When every "thing", from physical robots to software agents, becomes an assisted or autonomous business actor, they seamlessly transact to unlock brand new economic models.

3 Steps to Take

1. **Reimagine human-centric operating models for continuous collaboration.** As AI agents evolve from productivity tools to autonomous collaborators, transitioning from copilots to co-thinkers, operating models must adapt to unlock their full potential. Enterprises should redefine organizational structures to support agile, cross-functional teams with redefined roles and responsibilities to enable AI orchestration. Governance mechanisms must also transform, from static, centralized controls to dynamic frameworks that balance autonomy with coherence.
2. **Build enterprise platforms for interoperability and intelligence.** Enterprises must rethink how collaboration is structured. It compels a re-evaluation of platform strategy: moving from monolithic systems to modular, composable, AI-native infrastructures that enable real-time data, edge intelligence, decentralized interactions, and multi-agent interoperability.
3. **Cultivate a culture with AI-powered talent.** Empower the workforce to collaborate with digital peers and autonomous systems through personalized, AI-powered learning ecosystems. Foster a culture of trust, openness, and experimentation, where diverse rhythms harmonize to drive innovation. The future workforce isn't just tech-savvy; it's AI-fluent and adaptive.

My Identity, My Business

A shift towards dynamic, context-aware authentication, where individuals and systems reclaim control over identity amidst rising threats from AI-driven social engineering.

It's easy to lose track of who you are while navigating the complex jungle of today's digital ecosystems. Cue next-gen identity: firmly founded on distributed technologies such as blockchain and zero-trust security, it thrives on federation. With self-sovereign identity and smart contracts, we're rewriting the collaborative script, placing the control firmly back in our own hands. At the same time, defending against bad actors and social engineering becomes critical. The payoff? Businesses reduce identity fraud and theft and unlock new possibilities while building customer trust like never before. Sounds like we're in business.

Keerthi
Anantapur Guggila
Expert in Residence

What

- In a hyperconnected world, identity is the core of digital interactions. Decentralized technologies offer secure, verifiable identity management, while zero-trust models become the cornerstone of security to combat evolving cyber threats.
- In the agentic era, the concept of "identity of the agent" becomes central, where identity extends beyond individuals. It's no longer just about the user, but also about what the agent is, who it represents, what it's authorized to do, and how its actions are audited. Robust identity management systems can help verify agent identities, securing machine-to-machine interactions.
- With cyber threats growing more sophisticated, the zero-trust security model has gained traction. Identity and access management (IAM) solutions are evolving to apply zero-trust principles not only to human users but also to autonomous agents.
- AI and ML are transforming IAM by enabling real-time, adaptive authentication and threat detection. In an agentic world, these technologies will be critical for monitoring agent behavior, detecting anomalies, and enforcing dynamic access controls.
- Sophisticated identity systems demand standardized frameworks for both human and agent identities. Interoperability across platforms, combined with privacy-preserving architectures, is key to scaling secure digital collaboration, while meeting privacy requirements.

Use

- India's **Digi Yatra platform**, which uses Self-Sovereign Identity (SSI) and facial authentication technology, is transforming air travel, crossing over 15 million downloads. Launched in 2022, Digi Yatra enables biometric-supported, contactless, and privacy-first processing and aims to serve 80% of domestic air travelers by 2028.
- **Cloud Security Alliance (CSA)** introduced an agentic AI IAM framework that accounts for autonomy, ephemerality, and delegation patterns of AI agents in complex multi-agent systems. It provides security architects and identity professionals with a blueprint to manage agent identities using decentralized identifiers, verifiable credentials, and zero-trust principles.
- **Amazon** introduced AgentCore Identity, a purpose-built IAM service designed specifically for AI agents operating at scale. It enables secure access to AWS resources and third-party tools like GitHub, Salesforce, and Slack, either on behalf of users or autonomously with pre-authorized consent.
- **Cisco** is advancing its Universal Zero Trust architecture to secure agentic identities, enable seamless zero-trust access to enterprise resources, and provide comprehensive tracking of agent actions. It's powered by innovations such as Cisco Duo IAM, Cisco Identity Intelligence, Cisco Secure Access, and Cisco AI Defense.
- **Okta** extended its identity platform to treat AI agents as first-class identities, managing their lifecycle from provisioning to decommissioning. Using their Auth0 platform for Gen AI, Okta ensures agents act on behalf of users with proper authorization, preventing misuse of credentials and enabling granular access control.

Impact

- Enterprise adoption of decentralized identity solutions will not only mitigate identity fraud and streamline authentication processes but will also enable secure agent identity management. Organizations can eliminate the need to store user and agent data, significantly reducing security risks.
- The rise of sophisticated social engineering attacks demands context-aware identity systems that can detect manipulation, enforce behavioral safeguards, and maintain trust in digital interactions.
- Small businesses can not only improve their security and operational efficiency but also foster stronger relationships with their customers through enhanced privacy that preserves agent interactions. It will ensure that digital agents act transparently and ethically on behalf of users.
- Knowing that agents operate under verifiable identities, users will develop greater trust in online services. Enhanced transparency and security will help users feel more secure in sharing their identities on an as-needed basis, fostering a healthier digital ecosystem.
- The ability to manage user consent and control agent data access will help organizations avoid hefty fines while building a reputation for ethical data management. This is critical as agents increasingly handle sensitive tasks and make autonomous decisions.

Tech

- **Agent AI Identity Management:** Microsoft Entra Agent ID, Amazon Bedrock AgentCore Identity, Okta, IBM AskIAM
- **Decentralized Identity:** Microsoft Entra Verified ID, IBM Digital Credentials, Self ID, PingOne Neo, 1kosmos, Evernym, Fractal ID, SpruceID, Dock, Walt.Id
- **Self-Sovereign Identity (SSI):** The Hashgraph Group ID Trust, Walt.Id, Helix ID, iden3, Evernym, Dock, Veramo, Netcetera, Galxe
- **Web3 Identity Management:** Fractal ID, Polygon ID, ONT ID, iden3, SPACE ID, Civic
- **Digital Wallets:** Thales, IDnow, ID.me, The EU Digital Identity (eID), Identyum ID Wallet, GoodID, Walt.Id

Autonomous Agent Alliance

The rise of AI agents that collaborate, adapt, and coordinate in real-time, forming intelligent agentic systems operating with seamless autonomy and collective intelligence.

Every mission (possible or impossible) needs the right agents—sometimes undercover, sometimes out in the open. As businesses embrace autonomy, intelligent AI agents are stepping up as key collaborators, tackling challenges with adaptability and focus, while continuously learning and evolving. Yet, the secret sauce remains the human touch, which is crucial for building trust, safeguarding privacy, and ensuring resilience. It's not about replacing humans; it's about crafting a seamless alliance between minds and machines. Soon, your secret agents may not remain undercover.

Rajesh Iyer
Expert in Residence

What

- Agentic systems represent the next generation of automation, intelligently breaking down complex tasks into organized steps and executing them by coordinating existing digital tools and services. Unlike traditional automation that follows fixed rules, these systems understand goals and orchestrate resources to accomplish them.
- When analyzing portfolio risk, these systems determine and sequence all required steps automatically. They coordinate the gathering of data, pull market indicators, apply risk models, validate against compliance requirements, and generate reports, ensuring each step flows naturally into the next.
- Adaptation is central to their operation. When faced with obstacles, whether missing data, system outages, or unexpected conditions, they adjust their approach by finding alternative data sources, rerouting workflows, or reorganizing task sequences.
- Over the past year, we've seen remarkable advancements in AI agent collaboration frameworks such as MCP (Model Context Protocol) and A2A (Agent-to-Agent Protocol), paving the way for seamless process-layer autonomy and sophisticated coordination among agentic systems.

Use

- **Microsoft** has enhanced GitHub Copilot with autonomous coding capabilities, allowing it to independently create, modify, and submit code within GitHub workflows. This shifts Copilot from a passive assistant to an active coding agent. It streamlines collaboration, accelerates development cycles, and redefines programming roles.
- **Databricks** uses AI Agent Orchestrators powered by Uplimit to manage multiple specialized AI agents that personalize virtual instructor-led training. They collaborate with human instructors, reducing development time and enhancing learner engagement through real-time feedback and recommendation.
- **Walmart** is launching four AI-powered "super agents" to enhance customer experience, automate workflows and boost e-commerce growth. These agents consolidate fragmented tools into unified interfaces, enabling tasks like personalized shopping, inventory insights, and ad campaign creation.
- **Workday** launched Illuminate Agents, a new suite of AI-powered tools designed to automate and optimize workflows in HR and Finance. They handle tasks like hiring, contract management, accounting, absence reporting, and employee self-service.
- **Freshworks** launched its upgraded Freddy agentic AI Platform, a continuously learning system that autonomously handles service tasks like refunds, bookings, claims, and account updates across apps like Shopify and Stripe. With new tools like AI Agent Studio, email support, unified search, and root cause analysis, it simplifies support across industries like retail, travel, finance, IT, and more.

Impact

- Operational agility can reach new levels as systems adapt to changing conditions in real time while improving their performance through continuous learning. While responses to market changes are faster, this heightened interconnectivity can amplify the impact of any system failures.
- Security and control considerations will become increasingly critical as operations become more interconnected. While automation can reduce routine, system failures can cascade rapidly through operations.
- The share of workflows using AI, especially those incorporating agentic AI, is expected to rise sharply from 3% in 2024 to 25% in 2026, indicating an eightfold increase over two years.
- Agentic systems tailor experiences across customer, employee, and partner journeys without manual intervention. Recently companies have seen significant increase in lead conversion and customer satisfaction scores, proving that agentic systems can drive engagement and loyalty at enterprise scale.
- Enterprises leveraging agentic orchestration have reported acceleration in onboarding and business processes, and reduction in manual effort, unlocking agility to experiment, adapt, and lead in fast-moving markets.

Tech

- **Agent Builder Platforms:** Microsoft Copilot Studio, Google Agentspace, Amazon Bedrock Agents, Salesforce Agentforce, SAP Joule Agents, IBM AI Agents
- **Multi-Agent Platforms and Frameworks:** CrewAI, IBM watsonx Orchestrate, Autogen, LangGraph, MetaGPT, Agno, Greymatter, Moveworks, Ema, Leena.ai, Talkdesk
- **Large Language Models (LLMs):** OpenAI, Google Gemini, Meta llama, Anthropic Cluade
- **AI and Robotics Platforms:** NVIDIA Isaac, Figure AI, Dexterity, Osaro, Vecna Robotics, Symbotic, Locus Robotics
- **Decentralized:** Fetch.ai, Ocean Protocol, SingularityNET
- **AIOps:** Bigpanda, Splunk, Dynatrace, DataDog
- **Enterprise and Financial:** ServiceNow, Workday, AgentFlow, Akira AI
- **Conversational:** PolyAI, Replicant, Maven AGI, Automaise, Synthflow, Soundhound AI

Synergy^2

The new workplace has extended beyond just human-to-technology interaction; it's a dynamic synergy between humans, intelligent systems, and inter-agent communication.

The future of work has already been deployed. We now operate in connected ecosystems where humans, AI systems, and autonomous agents all contribute reasoning, insight, and decision-making once limited to people in the room. And the partnership rapidly evolves; digital co-workers have graduated from assistants to specialists, executing complex, multi-step tasks that accelerate outcomes at an unprecedented scale. This deep integration demands a more intentional approach to the workplace itself, blending asynchronous AI-powered workflows with critical moments of in-person human collaboration. A well-orchestrated human/AI agent team isn't just additive, it multiplies.

Ranjan Pradhan
Expert in Residence

What

- By 2027, 63% of jobs will undergo transformation, driven by increased AI collaboration. This transition of direct collaboration with AI agents is expected to nearly double from 31% to 58%. To adapt, organizations aim to upskill 65% of employees in hybrid human-AI workflows, marking a major operational shift in workforce dynamics.
- The modern workplace now thrives on human-AI collaboration, with AI embedded in daily tools. Adoption surged from 6% in 2023 to 30% in 2025. As integration deepens, focus shifts to smaller, specialized AI models trained on proprietary, trusted data, ensuring relevance, accuracy, and security in evolving workflows.
- The human-AI collaboration is entering a regulated era, with landmark legislation like the EU's AI Act establishing new rules of engagement for the workplace. HR systems now widely classified as high-risk, due to sensitive nature of employee data. To support this shift, mandatory AI literacy training is now being rolled out, aiming to enable the entire workforce to operate effectively.
- A strong foundation of employee trust is emerging as a critical asset for enabling this human-AI collaboration. Recent research shows that a significant majority, 71% of employees, trust their own organization to implement AI ethically and safely. This powerful trust dividend provides the organizational stability required for employees to engage with AI as a reliable partner.

Use

- **JPMorgan Chase** has fundamentally re-engineered its operations, making artificial intelligence a core business function. The organization is running over 400 AI use cases in production and has given more than 200,000 employees access to their flagship generative AI platform, achieving 83% reduction in research time, enhancing fraud detection capabilities, and revolutionizing operations.
- **Goldman Sachs** is rolling out its proprietary GS AI Assistant, framing the technology not just as a tool, but as a new digital employee set to "learn the Goldman Way." Starting with 10,000 bankers and traders, the assistant currently handles tasks like summarizing documents and translating code.
- Enterprise software provider **Workday** is embedding its Workday Assistant across its HR and finance platform, offering customers a powerful tool to combat inefficiency. The AI companion targets employees who spend 20% of their work day searching for essential information, providing them personalized answers and guiding them through administrative tasks.
- **Verizon** is demonstrating a clear link between AI-augmented human agents. By deploying a Google AI-powered assistant to its 28,000 customer service representatives, the company provides real-time on-screen support to help agents resolve queries faster. This efficiency gain has freed up agents to focus on sales opportunities, directly resulting in a sales increase of nearly 40% through the service team.
- **Walmart** is empowering its massive frontline workforce by deploying a suite of AI tools to its 1.5 million US associates. The initiative aims to streamline daily operations and enhance the employee experience. Key examples include an AI-driven task manager that reduces shift planning time from 90 to 30 minutes and a real-time translation tool supporting 44 languages to eliminate communication barriers.

Impact

- The economic impact of human-AI collaboration is massive, projected to add up to $15.7 trillion in global value by 2030 by amplifying human capabilities. This shift elevates demand for human skills like critical thinking as AI automates routine tasks. However, significant ethical risks exist; without careful oversight, AI can scale biases, as shown in studies of inequitable, automated grading.
- A significant perception gap has emerged regarding the impact of AI. This disconnect is most stark concerning AI's effect on employee retention, where leaders are five times more likely than workers (30% vs 6%) to see a positive impact. Similar gaps exist for fostering creativity (35% vs 19%) and improving work quality (42% vs 32%).
- On the darker side, AI adoption is fueling a new productivity paradox and giving rise to "AI technostress." Instead of reducing workloads, the efficiency gains from AI are often met with increased employer demands, creating a perpetual speed-up for knowledge workers. This is validated by research showing 77% of employees using AI report it has actually added to their workload. This misalignment between technological capability and work design is a primary driver of employee burnout, cognitive overload, and work-life conflict.

Tech

- **Meeting Assistants:** Otter.ai, Read.ai, Sembly AI, TimeOS, Granola.ai
- **Productivity and Collaboration Tools:** Clickup, Asana, Miro, Notion AI, Google Workspace, Bloomflow, Whoz
- **Workflow Automation:** Workato, Camunda, n8n, Bardeen, Flowable
- **AI-powered Assistants:** Microsoft 365 Copilot, IBM Watsonx, GitHub Copilot, Amazon Q
- **Brain-Computer Interface (BCI):** Neuralink, NextStem, Neurable, Emotiv, OpenBCI

Economy of Things

When every "thing", from physical robots to software agents, becomes an assisted or autonomous business actor, they seamlessly transact to unlock brand new economic models.

Things aren't what they used to be. With every human, object, machine, and line of code carrying its own sovereign digital identity, interactions now flow seamlessly across decentralized, intelligent networks—leaving no thing behind. Powered by robots and humanoids, IoT, distributed ledgers, AI, and deep connectivity, these ecosystems don't just collaborate, they synchronize across networks to redefine value creation. When we successfully navigate the complexity levels of this yet unheard economy, things don't just work, they resonate.

Muhammed Ahmed
Expert in Residence

What

- The economy of things is the next frontier of technology convergence, where the synergistic impact of technologies (robotics, AI, industrial IoT, DLT, 6G, etc.) creates unprecedented value and impact.
- Robots and humanoids, connected devices, decentralized identities, intelligent agents, federated learning, smart contracts, and edge/distributed computing all work hand in hand to enable the economy of things. This is where objects, devices, or even lines of code can identify themselves and transact independently or with assistance, in a secure manner.
- By combining cross-domain expertise with a fusion of emerging technologies, organizations can unlock new possibilities, namely bridging traditional silos, converging value chains, and building synchronized ecosystems that deliver transformative impact.
- As humanoids and intelligent agents increasingly mirror human behavior, emotional intelligence becomes a design imperative. It allows machines to sense, interpret, and respond to human emotions with empathy, trust, and contextual awareness.
- Security, standards, and interoperability are foundational to scaling the economy of things, ensuring seamless communication and trusted exchange across diverse machines, devices, platforms, and networks.

Use

- Organizations are redefining commerce by empowering AI agents to act on behalf of users and enterprises across the value chain. From **PepsiCo's** use of Agentforce AI to modernize B2B operations, to **Amazon's** "Buy for Me" pilot and **EDEKA Beckesepp's** AI-powered self-checkouts, industries are using agentic systems for autonomous, intelligent transactions.
- Financial institutions are embracing stablecoins and programmable payments to modernize the global payment infrastructure. **Visa** and **Mastercard** are integrating stablecoins into their networks for real-time, low-cost settlements, especially in cross-border payments. Platforms and services like **JP Morgan's** Kinexys and **Citi**'s Token Services are enabling programmable intra-bank payments and treasury automation.
- Intelligent robots can augment human capabilities to automate complex tasks and enhance operational efficiency. **BMW** is using humanoid robots for ergonomically challenging tasks in manufacturing, **DHL** has deployed autonomous mobile robots (AMRs) to double warehouse throughput, while **Taichung Veterans General Hospital** has rolled out Nurabot to assist nurses by operating autonomously within hospital wards.
- **Aramco Digital** is deploying edge AI-powered industrial IoT solutions over its private 5G network for applications such as predictive maintenance, asset monitoring, digital worker tools and visual anomaly detection.
- **Google Cloud** and Swift, in partnership with Capgemini, has pioneered advanced AI and federated learning to help combat payments fraud, enabling collaborative intelligence without compromising proprietary data.

Impact

- The economy of things supports peer-to-peer autonomous transactions, facilitating real-time value exchange, streamlining operational efficiency, reducing costs, and driving new business models across industry value chains.
- Agentic systems and AI-powered robotics deliver real-time, personalized, and seamless interactions for both customers and employees, transforming experiences across retail, manufacturing, healthcare, and logistics.
- New business models emerge through the economy of things, enabling machine-to-machine commerce, autonomous supply chains, and decentralized marketplaces, reimagining how value is created, exchanged, and scaled in a hyperconnected economy.
- This new economic paradigm, however, introduces critical trade-offs around performance versus scalability, security versus privacy, transparency versus trust, while highlighting the need to balance autonomy with responsible governance, ethical design, fairness, and regulatory compliance.

Tech

- **Agentic AI:** PayPal Agent Toolkit, xalts, AgentFlow, ServiceNow
- **Edge AI:** NVIDIA Jetson, Google Coral, AWS Greengrass, Intel OpenVino, Edge Impulse, Advantech
- **Humanoids:** Apptronik, Figure AI, Unitree, Tesla, Agility Robotics, Sanctuary AI, 1X, UBTech
- **Industrial Robotics:** ABB, Omron, Universal Robots, MiR, Boston Dynamics, Neura Robotics, Blue Ocean Robotics
- **IIoT:** Schneider Electric EcoStruxure, Siemens, Emerson, Cisco
- **Private 5G:** Nokia, Ericsson, Siemens, Celona, HFR
- **Digital Payments Infrastructure:** JP Morgan Kinexys Digital Payments, Citi Token Services, Circle, PYUSD, CoinVertible
- **Tokenization:** Securitize, Tokeny, Ondo Finance, Centrifuge, Polymath, tZero, RealT
- **Decentralized AI:** 0G AI, Fetch.ai, IoTeX, SingularityNET, Ocean Protocol, Rhino

03. Thriving on Data

Where We Are

Data and AI are no longer the raw materials of innovation. They are the flow that keeps organizations alive and adaptive. When data and AI move freely, they turn strategy into feedback and operations into insight. That flow only works when data and models are treated as first-class products: easy to find, share, use, and trust. Nurtured where they're created and governed where they grow, they let every part of the enterprise act on truth in real time. Most organizations have strong data foundations yet still struggle to activate them. The challenge isn't structure but connection—linking data to people, products, and performance through trust and adoption. As AI scales, data quality and accessibility become its greatest accelerator. And as intelligence extends into the physical world and even into life itself, data becomes the bridge—the shared language where insight, intelligence, and impact flow as one.

Balancing Acts

Thriving on Data is all about finding perpetual balances. Businesses swing back and forward between central data control and handing the reins to individual domains. They are, indeed, aiming for agility without chaos. Nobody owns it all, and without sharing data, intelligence has difficulty emerging. But oversharing might damage your competitive advantages. And with growing experience, challenges with generative AI surface, moving the pendulum into mixed, hybrid AI models might be the correct path to regain trust. Swinging with an increasing momentum into working at scale, the rising consumption of resources needs to be sustainable too to keep the passion alive. The trick lies in learning to build data ecosystems that let businesses thrive with speed and purpose, with just enough order and care to keep it fun.

Robert Engels
Expert in Residence

The Trends

- **Data Sharing is Caring (But Take Care!)**: When shared with trust, care and commitment, data becomes a collaborative asset that accelerates innovation and AI-powered value creation, inside and outside the organization.
- **AI Meshed Up:** A diverse mesh of different AI components, all with their own unique capabilities, provide better solution options while boosting the confidence level.
- **Net Ø Data:** Data and AI are key to delivering net-zero ambitions. But in themselves, they need to be sustainable too. The battle against data waste is on.
- **The Thing with Data:** An abundance of data going around at the edge within the Internet of Things turns objects into hyper-intelligent, connected assets near us.

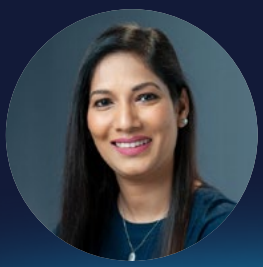
3 Steps to Take

1. **Empower business-driven data ownership.** Shift from centralized control to federated management, with data ownership and nurturing close to business. Ensure data is accessible, trustworthy, easy to use with open standards and automated platform services, while sensitive data stays protected. Doing so enables agility while maintaining coherence across the organization, turning data into actionable intelligence.
2. **Build hybrid AI solutions for real-world challenges.** Leverage a mix of traditional tech, combined with AI technology and generative AI models tailored to specific business needs. Balance innovation, right choice of AI, with transparency and ethical oversight to maintain trust. By adopting diverse, purpose-built AI solutions, organizations can optimize operations, enhance customer experience, and address challenges with flexibility and precision.
3. **Optimize data and AI for efficiency and sustainability.** Adopt frugal data and AI practices through governing right-sized datasets, infrastructures and models for your tasks. Streamline processes to minimize energy use, CO_2 emissions, and waste while driving actionable insights. This dual focus on efficiency and sustainability ensures businesses can thrive responsibly in an increasingly data-intensive world.

Data Sharing is Caring (But Take Care!)

When shared with trust, care and commitment, data becomes a collaborative asset that accelerates innovation and AI-powered value creation, inside and outside the organization.

Collaborative data ecosystems are transforming the way organizations share, innovate, and thrive—even alongside competitors. Think of it as everyone bringing their best to the table: data that's secure, consumable, and shared in real time. What works externally can also boost collaboration within. But with the rise of AI in its various instances, the stakes are raised with more risk of data breaches. There's no room for shortcuts: data readiness, protection, integrity, privacy, and authenticity are all non-negotiable. Both providers and consumers of data products must take responsibility to avoid missteps and ensure compliance. The result? A smarter, faster, and more connected ecosystem where everyone has a seat at the data table. Can we get a like for that?



Rajashree Das
Expert in Residence

What

- With the advent of Gen AI and agentic AI, the need for collaborative data ecosystems is becoming even more prominent. Different organizations sharing data under more stringent regulations are creating new value for all participants. It can take many different forms relying on foundational capabilities such as privacy, ethics, ownership, trust, compliance, and accessibility.
- Approaches like data mesh and data fabric are coming together to complement pushing for collaborative design along with business domains to truly own and manage their data and its uses, and collaborate with internal and external partners.
- Interoperability and open data protocols are required to allow systems to communicate and exchange information timely and securely. There is especially a lot of push for interoperability in the health sector for accelerating patient-centric data sharing.
- Organizations need to comply with more stringent Data Protection and Privacy laws enforced across the world. Therefore, it is important to have even stricter data sharing agreements, and have the data privacy officer sign off on certified and trusted data. They also need to make sure that certified LLMs are being used within the enterprise.
- By further harnessing Gen AI, data governance platforms and marketplaces can leapfrog data monetization, unlocking data value/actionable intelligence for competitive advantage, operational efficiency, customer experience, product enhancements.

Use

- The **Danish government** announced a landmark change to its copyright law to control AI-generated deepfake content. This law will grant individuals explicit legal rights over their identity, encompassing their face, body, and voice.
- **Apple** stated that it will analyze data on customers' devices by utilizing methods like differential privacy and synthetic data generation. These techniques allow Apple to understand overall trends, without compromising user data.
- Researchers from **Flatiron Health**, a US-based health tech company, enabled a secure global sharing of oncology real-world data using a harmonized cancer-specific model. It is built on Flatiron Health's 12-year database, supporting treatment comparisons and regulatory insights while preserving privacy.
- **Qualified Health Information Networks (QHINs)** like Health Gorilla is a network of organizations that work together to share data. A QHIN is aided by the Trusted Exchange Framework and Common Agreement (TEFCA), which creates a nationwide system that enables safe and easy healthcare information sharing.
- **Elix**, a Tokyo-based AI drug discovery company and the **Life Intelligence Consortium (LINC)**, a consortium supporting industry-academia collaboration, launched an AI-drug-discovery platform using federated learning across 16 pharma companies' data, which is now implemented on Elix's AI drug discovery platform.

Impact

- Capgemini's past research has shown the benefits of data ecosystems for the private sector. These included a 15% improvement in customer satisfaction, 14% improvement in productivity/efficiency, and an 11% reduction in costs annually over 2-3 years.
- Collaborative data ecosystems are key to addressing societal challenges and organizational purposes, for example in health, public and citizen services, energy consumption, agriculture, and sustainability.
- In collaborative data ecosystems, organizations are likely to find unexpected new partners—fueling new, data-powered value streams, data monetization, and even breakthrough innovative business models.
- Embracing ownership and data-product management by business domains is vital to create an organization-wide, data-powered culture. Sensitive data can be anonymized through the generation of synthetic data, which can be fed into AI models as data-products.

Tech

- **Data Exchanges and Marketplaces:** AWS Data Exchange, Snowflake Data Marketplace, Dawex, HUDI, Harbr Data Marketplace, Microsoft Azure Marketplace, Centific
- **Data-sharing/collaboration Platforms:** Amazon Redshift Data Sharing, Microsoft Azure Data Share, eightwire, Immuta, baffle, bobsbled, Thoughtspot, Hex, LiveRamp, Scintilla, Narrative, Citrine, Infosum Data Collaboration Platform
- **Federated Learning:** Owkin Open Source FL, Microsoft FLUTE, Sherpa.ai, NVIDIA Flare, FedML, Flower, Duality, acuratio, Katulu
- **Differential Privacy and Cryptography:** Microsoft Differential Privacy, Zama Fully Homomorphic Encryption, Cryptomathic, Triple Blind
- **Data Mesh Enablers:** DataPlex, Cinchy, IBM Data Fabric, Talend, Dremio, Starburst, Dataiku LLM Mesh, Splunk, Databricks
- **Data Equity:** Advancing data equity | World Economic Forum

AI Meshed Up

A diverse mesh of different AI components, all with their own unique capabilities, provides better solution options while boosting the confidence level.

Generative AI solutions have started to outgrow their one-size-fits-all roots, evolving into a much more dynamic mesh of multi-agent, agentic, tool-using, and multi-model capabilities. These interconnected AI agents work together, creating adaptive feedback loops that drive efficiency and autonomy, all focused on achieving specific objectives. But as the mesh becomes smarter, it also grows more complex: transparency, ethical oversight, and calibration are non-negotiable. Progress in the evolving AI mesh relies on an ongoing balancing act of trust-building and solution fine-tuning—because even the most intelligent systems need some help in keeping the threads from unraveling. We don't want a mess, after all.

Mark Roberts
Expert in Residence

What

- The AI mesh consists of a network of AI systems, humans, external systems, and data sources all interacting dynamically, forming a complex web of decision-making and information flow.
- AI nodes operate autonomously, processing data in real time and making decisions independently or in collaboration with human inputs.
- Flexibility is key. Meshing your AI systems allows for greater flexibility to alter, add, and remove functionality from your ecosystem—functionality you defined yourself or adapted from partners, suppliers and the like.
- AI systems continuously analyze, learn, and adapt, creating non-linear knowledge flows that drive continuous system updates and refinements.
- Agents utilizing AI to (semi)automatically run processes for you—it almost looks like "RPA on steroids." Combining such agents in larger, multi-agent systems increases performance, flexibility, and new ways of working emerge.

Use

- **ServiceNow** introduced a suite of agentic AI innovations, led by the AI Agent Orchestrator, to autonomously manage complex enterprise workflows. Rolls-Royce is using these AI agents to reduce manual effort, deflect service desk tickets, and enable faster, data-driven decision-making.
- **Huawei** is rolling out AI Core Network, which will be an autonomous generative network capable of self-optimization and self-O&M. It will allow the whole industry to evolve from connecting everything intelligently to seamlessly interlinking AI-driven agents, terminals, and scenarios.
- **Microsoft** launched Entra Agent ID, which extends identity management and access capabilities to AI agents. These agents, created within Microsoft Copilot Studio and Azure AI Foundry, are automatically assigned identities in a Microsoft Entra directory, centralizing agent and user management in one solution.
- **Oxford** researchers developed TrustedMDT, a multi-agent AI system in Microsoft Teams that supports clinicians in cancer-treatment planning. It will be piloted at Oxford University Hospitals as one of the earliest agentic-AI deployments in real tumour-board settings.
- **Google** has launched agents for the entire data lifecycle, including tools to automate pipeline creation, perform machine learning workflows, and enable advanced Python analytics, all designed to streamline enterprise data operations.

Impact

- Companies embracing AI and meshing it up within their infrastructure can produce better products and services, tackling higher contextual complexity and finding new products and services to deliver.
- The AI mesh accelerates data processing, decision-making, and system optimization, allowing the system to function with greater speed and scale.
- The mesh allows the system to continuously learn and adapt in real time, responding to new data and evolving to meet changing conditions.
- The intricate interactions within the AI mesh trigger the need to tackle a higher complexity that might be harder to predict, boosting development of new ways to monitor and utilize AI.
- Autonomous AI, run within the mesh, needs to have some governance and oversight to ensure ethical operations.

Tech

- **Developer:** SWE-Agent, Amesa, Cognition, OpenHands, Vertex AI Agent Builder
- **Framework:** AutoGen, LlamaIndex, LangChain, AutoAgents, Adala, Letta, ChatDev, Eidolon AI, Qwen, Swarm (Open AI), AgentVerse, Microsoft Semantic Kernel Agent Framework, Claude Agents (Anthropic), MIT NANDA, Agent Development kit (Google)
- **Platform:** FlowiseAI, SuperAGI, Crew AI, Relevance AI, AutoGPT, Aisera, IBM watsonx Orchestrate, Transformers Agents (Hugging Face), Oracle Cloud Infrastructure (OCI) AI Agent Platform, Agentforce (Salesforce), Joule Agents (SAP), ServiceNow AI Agents, AGNTCY
- **Agent Protocols:** Model Context Protocol (MCP), Agent 2 Agent (A2A), Agent Communication Protocol(ACP), Agent Network Protocol (ANP), Eclipse Language Model Operating System(LMOS), Agent Interaction and Transaction Protocol(AITP), Agora Protocol
- **Agents Security:** AuthMind AI Agent Protection, Astrix, Microsoft Entra Agent ID, Outshift Agent Identity Service, Silverfort, NOMA AI Agent Security, CyberArk
- **Governance:** Mosaic AI Agent, Langfuse, Agency AI, AgentOps.ai, Evidently. AI, Arize AI, watsonx. governance, Modulos, Fiddler AI
- **Ethical:** Impelsys – AI Agents, TensorFlow Responsible AI Toolkit, Credo.AI

Net Ø Data

Data and AI are key to delivering net-zero ambitions. But in themselves, they need to be sustainable too. The battle against data waste is on.

Zero is everything! All businesses need clarity on their CO_2 emissions and the impact of their sustainability actions. But you can't manage what you don't measure. To build and adjust net-zero strategies and overcome major sustainability challenges, businesses need to build skills, tools, and culture to measure, forecast, and act on their emissions levels across the whole value chain. For companies, collaboration with their supply chain ecosystem is critical to access reliable data, especially scope 3, which lies outside the boundaries of an organization. But collecting, storing, accessing, and utilizing data comes with its own sustainability price too. It's a matter of being smarter about what data is needed, picking up the quest against data waste, and realizing that big data is not always better data.

Barbara-Anne Bensted

Expert in Residence

What

- Data is a significant lever in accelerating the journey towards net zero. There must be increased visibility of baseline emissions and identification of emissions hotspots, improvement of existing business processes, and accurate prediction and prescription of business outcomes—all to drive net-zero objectives.
- In addition, AI is playing a growing role in advancing sustainability, with 64% of executives reporting that their organizations use AI to achieve their sustainability agenda.
- While 57% of executives acknowledge that Gen AI's environmental impact is being discussed in boardrooms, only 32% report having taken steps to mitigate it.
- Nevertheless, more than half of the execs (57%) still believe the benefits of Gen AI outweigh its environmental costs; however, this has declined from 67% in 2024, indicating growing caution around its environmental footprint.
- Therefore, businesses must become smart about their data and AI models in use. This starts with categorizing and understanding their assets, their environmental impact, and ends with getting rid of redundant data and AI models or deploying them in more sustainable ways.

Use

- **The United Nations Environment Programme** and the Zero Waste Foundation, a Netherlands-based nonprofit group, launched a geospatial data-driven initiative to combat climate change, biodiversity loss, and pollution, anchored by the Zero Waste Knowledge Hub for real-time environmental insights.
- **Google DeepMind** launched an AI model—AlphaEarth Foundations, that can create highly detailed maps of Earth to help scientists understand environmental changes. AlphaEarth Foundations uses AI and satellite data to monitor environmental changes and support climate action, conservation, and resource management.
- The **Global FoodBanking Network** (GFN), a US-based nonprofit organization, partnered with World Wide Technology, a US-based company, to customize Microsoft Sustainability Manager for tracking and reducing methane emissions. GFN uses the reliable data insights from the enhanced platform to optimize its operations and measure its impact across 54 countries.
- **Buenos Aires** has used Google's Green Light AI project to optimize traffic light cycles along Ruiz Huidobro Avenue, cutting stops by 14% and 6,987 liters of fuel yearly, reducing carbon emissions and improving commuter flow.
- **Royal Mail**, the UK postal service, partnered with Watershed, a US-based enterprise sustainability platform provider, to track emissions using high-resolution data, covering over 3,000 suppliers. This enables granular insights for supply chain decarbonization and supports supplier sustainability reporting.

Impact

- To ensure AI delivers sustainable business value, organizations must take a multi-dimensional and responsible approach that balances innovation with environmental stewardship. This begins with selecting the right mix of technologies tailored to their business needs—combining Gen AI with traditional AI, agentic AI, automation, and RPA—to optimize computational overhead.
- Innovating for process efficiency and product development is accelerated when organizations are equipped with the understanding of net-zero goals, skills, and tools to implement data-powered business decisions.
- Working in global cross-sector and industry-specific alliances with like-minded organizations is key to developing standardized emissions measurement methods. These approaches will help build more reliability into Scope 3 emissions measurement in the future.
- Building data management capabilities to manage emissions data will greatly strengthen a company's overall data mastery.

Tech

- **ESG Data Performance:** IBM Envizi ESG Suite, Microsoft Cloud for Sustainability, Google Carbon Footprint, Snowflake, SAP Sustainability Management, Salesforce Net Zero, MSCI, ISS ESG Index solutions, Electricity Maps, Ethos ESG, CSR Hub, SIX, S&P Global ESG, LSEG ESG Data, D&B ESG Registered Solutions, Microsoft Sustainability Manager, Watershed, Clarity AI, Novisto, Measurabl, Deepki, ESG Book
- **Carbon AI and Analytics:** AWS Customer Carbon Footprint Tool, Normative, IBM Environmental Intelligence Suite, Google Cloud Active Assist, SAP Product Carbon Footprint Analytics, Sievo, Microsoft Emissions Impact Dashboard, Klimametrix, CO2 AI, The Open Group Open Footprint Forum (OFF), MSCI Climate Investing, Net0, Carbon Analytics, CarbonRe, Green project (ACT Company), CarbonChain, Accacia, Sustaira

The Thing with Data

An abundance of data going around at the edge within the Internet of Things turns objects into hyper-intelligent, connected assets near us.

Here's the thing: in the vast ecosystem of technology, data is the lifeblood coursing through the veins of the Internet of Things (IoT) and edge computing. This isn't only a jam of ones and zeros being pumped around; it's the rhythm powering industries and reshaping business landscapes. The IoT is transforming everyday equipment and products into data-powered, intelligent assets, weaving a web of efficiency across factories, supply chains, and our daily surroundings. This evolution isn't just about physical things becoming wiser though; it's about elevating businesses to unparalleled levels of innovation and connectivity. It's also about data and AI becoming entwined with our personal lives.

Padmashree Shagrithaya
Expert in Residence

What

- Edge computing processes data locally, transforming everyday objects into intelligent, connected assets with real-time interaction capabilities.
- IoT, 5G, AI, and edge data centers work together to create decentralized ecosystems for immediate insights, decision-making, and actions.
- Local data processing eliminates the need for continuous centralization, reducing latency and enabling on-the-spot functionality.
- Compression and aggregation technologies optimize data handling, making edge systems faster, more efficient, and adaptable.
- This interconnected system bridges physical and digital realms, empowering seamless integration of technology into everyday operations.
- Synthetic data generation at the edge allows privacy-preserving AI training and rare-event simulation, especially in regulated or data-scarce environments.
- According to IDC, global spending on edge computing was set to $261 billion in 2025 and is projected to grow at a CAGR of 13.8%, reaching $380 billion by 2028.

Use

- **Google DeepMind** has unveiled Gemini Robotics On-Device, a compact local version of its powerful vision-language-action (VLA) model, bringing advanced robotic intelligence directly onto devices. It marks a key step forward in the field of embodied AI by eliminating the need for continuous cloud connectivity.
- **Itron**, a US-based technology company, is enhancing edge operations by integrating NVIDIA's AI platforms and Microsoft's Gen AI Copilot into its grid edge systems. This permits utilities to use AI at the edge for real-time insights, improving resilience, efficiency, and decision-making.
- **Cerence**, a multinational software company, partnered with MediaTek, a Taiwan-based fabless semiconductor company, and expanded collaboration with NVIDIA to deliver CaLLM Edge. Its embedded small language model (SLM) is purpose-built for automotive user experiences, seamlessly integrated into Cerence xUI, the company's hybrid cloud/embedded agentic AI platform.
- **Chang Gung Memorial Hospital** in Taiwan is using NVIDIA Holoscan to accelerate AI integration in colonoscopy diagnostics. It provides real-time identification and classification of colonic polyps.
- **China** has launched the operational space-based edge computing network with 12 AI-powered satellites. It provides real-time in-orbit data processing and autonomous decision-making. The satellites are equipped with AI systems, advanced inter-satellite communication capabilities, and onboard computing power.

Impact

- Edge-enhanced processing empowers businesses with real-time decision-making capabilities, setting the stage for innovative, instantaneous solutions.
- Smart compression and aggregation optimize bandwidth and reduce costs, paving the way for sustainable growth and innovative data strategies.
- Reinvented data dynamics transform passive data reservoirs into proactive assets, driving reliability and fostering novel business processes.
- Human-centric data design enables a future where data, close to the user, seamlessly meets user needs and enhances experience, bridging the gap between technology and human-centric innovation.
- Synthetic data unlocks scalable innovation by allowing AI development in domains where real data is limited, sensitive, or costly—accelerating experimentation without compromising compliance.

Tech

- **Edge Platforms:**
  - **Hardware-focused:** NVIDIA IGX, NVIDIA Jetson, Qualcomm Edge AI Box, Intel Edge AI, Axelera AI, Google Coral (Tensor Processing Units), Hailo AI, MediaTek Edge AI
  - **Software-focused:** IBM Edge Computing Platform, Azure IoT Edge, EdgeX Foundry, Siemens Industrial Edge, Gravio – The IoT & Edge Integration Platform, Edge Impulse, AWS IoT Greengrass, Google Cloud IoT Edge, Oracle Edge Computing, Syntiant
  - **AI/ML-focused:** NVIDIA Deep Learning Accelerator (DLA), Intel Distribution of OpenVINO, EdgeVerve AI Next, NTT Edge AI, Microsoft Azure Machine Learning (AML) Edge, Gemini Robotics On-Device (Google), Viso.ai, Leap (Liquid AI)
- **Edge-embedded Services:** AI Edge Labs, Avassa, Codesys, ST Edge AI Suite, JSquared Commercial/Edge AI, Microsoft Azure Machine Learning (AML) Edge, AWS SageMaker Edge, Google Cloud AI Platform Edge, IBM Watson Edge, AVEVA Edge
- **Edge Processors:** AiM Future, Hailo AI, SiMa.ai, Deepx.ai, STMicro

04. Process on the Fly

Where We Are

In a world that demands speed, adaptability and intelligence, business processes are evolving into living systems. They fuse physical and digital capabilities, powered by digital twins, robotics and agentic AI, to sense, decide and adapt with precision. Micro-sized, modular components bring agility and clarity, rewiring operations in real time, turning processes into intelligent operations. Human intuition and ethical design remain essential, as hybrid workforces blend people and AI to amplify creativity and impact. Autonomous agents orchestrate workflows remotely, optimizing performance and resilience across distributed environments. These processes anticipate change, learn from experience and act with confidence. They are fast, fluid and fearless. This is process innovation reimagined—to inspire, empower and transform. It is innovation in motion.

Balancing Acts

In the *Process on the Fly* container, it's not one pendulum but many, oscillating across dimensions like safety and speed, control and flexibility, human insight and machine autonomy. Each swing represents a micro-adjustment, a decision point in a dynamic system. These balancing acts aren't binary; they're continuous calibrations that shape resilient, responsive processes. The art lies in sensing the rhythm, not resisting it, embracing automation's pace while anchoring it in human judgment. When organizations tune into these subtle shifts, they unlock innovation without tipping into chaos. Harmony isn't static, it's a moving target, and mastering it is the key to thriving under pressure.

Cara Antoine
Expert in Residence

The Trends

- **Whole Lotta Fusion:** A mesh of digital twins, robotics, and agentic AI fuses physical and digital intelligence into neural-inspired process flows. It adapts, evolves, and performs like a living system, driving innovation and resilience.
- **Micro Process Magic:** Micro-sized, modular processes fuse AI, events, and post-agile orchestration into real-time flows that deliver value on a constant pulse.
- **CTRL-ALT-Human:** Blending human intuition with AI to create hybrid workforces in which automation amplifies creativity, ethics guide intelligence, and the human touch drives meaningful outcomes.
- **Autonomous Enterprise:** Intelligent agents in adaptive processes continuously optimize operations, blending seamlessly into their environment to deliver performance, harmony, and innovation without human intervention.

3 Steps to Take

1. **Instrument real-time process intelligence.** Deploy analytics that continuously sense and interpret process signals, enabling swift, informed interventions and fostering a culture of proactive orchestration.
2. **Model digital twins as living systems.** Build digital twins for core processes that simulate, learn, and evolve, allowing experimentation and predictive insight without disrupting live operations.
3. **Codify human-AI collaboration protocols.** Define clear roles for human oversight in automated and autonomous systems. Equip teams to make ethical, strategic decisions in hybrid workflows where intuition and intelligence co-create value.

Whole Lotta Fusion

A mesh of digital twins, robotics, and agentic AI fuses physical and digital intelligence into neural-inspired process flows. It adapts, evolves, and performs like a living system, driving innovation and resilience.

When physical and digital intelligence fuse, it's a highway to living and breathing processes. Digital twins simulate and optimize in flawless detail; robotics increase productivity and precision, while advanced connectivity allows scale and agility. Add agentic AI and human-in-the-loop workflows, and you get neural-inspired flows that sense, decide, and adapt like living systems. This fusion doesn't just bridge worlds, it builds a cognitive nerve center that drives resilient, scalable innovation. The result? A whole lotta impact, delivered through sleek, digitally enhanced processes that truly rock.

Anastasia Karatrantou
Expert in Residence

What

- Digital twins can design products and test their behavior and performance. They also design and stress test operations to evaluate their efficiency and ultimately design the E2E supply chain and optimize its resilience and ability to cope with environmental demands.
- Mixed reality applications can support the workforce in a variety of tasks and roles including onboarding engineers with AR-based training and enabling remote collaboration and connection with rare and remote expertise.
- Robotics, such as autonomous intelligent vehicles and autonomous mobile robots, are adopted to automate the distribution of goods. Simultaneously, cobots are being deployed to collaborate with humans when increased precision and repetition are required.
- IT best practices like software-defined and cloud-native architectures allow for hardware to become a commodity. The software on top of it provides a scalable and flexible value platform. This is mimicked in the operational technology space, as part of the accelerated convergence between the two domains.
- Hyperconnectivity and embedded sensors everywhere allow for a fully connected, flexible, and reconfigurable enterprise environment that can adopt advanced digital use-cases at scale.

Use

- **NVIDIA** has launched Mega, a new Omniverse Blueprint designed to enhance industrial automation by enabling the development, testing, and optimization of robot fleets in digital twins before real-world deployment. Early adopters are using it to create Omniverse digital twins that serve as virtual environments where industrial AI robot brains are trained and tested.
- The **BMW Group** is scaling its Virtual Factory with digital twin-based applications to accelerate production planning across over 30 global production sites. It's a core part of the BMW iFACTORY strategy, aiming to streamline production planning and reduce costs by up to 30%.
- **Audi** is using Siemens' automation portfolio to standardize and optimize its shop floor operations, creating a more agile, flexible, and safe production environment. This software-defined factory automation virtualizes shop floor control, merging IT and OT for agile, scalable production.
- **NASA** is using Virtual Reality (VR) to prepare its astronauts for the Artemis III mission, which is set to return humans to the Moon by 2027. The training combines VR simulations with physical elements like sandboxes, treadmills, and spacesuit mock-ups to replicate lunar surface conditions for extravehicular activities (EVAs).
- **Aker BP** is deploying private 5G and edge computing across its seven oil platforms in the North Sea. The Private Mobile Edge Compute (PMEC)/5G infrastructure, deployed by Tampnet, allows real-time data processing, supports AI-driven predictive maintenance, and enhances safety through autonomous drones and robotics.

Impact

- Data-driven decisions with detailed performance insights create robust and resilient industrial processes. There's also smoother adaptation in case of unexpected change (e.g., supply chain disruption), and anticipation of planned change is optimized.
- Optimizing workforce allocation and leveraging rare expertise reduce onboarding time for complex industrial processes. This also accelerates the resolution of operational disruptions and increases workforce productivity, safety, and well-being.
- An AI-ready infrastructure that is future-proof and easily reconfigurable enables a fully connected enterprise, supporting advanced digital use cases that rely on premium quality of service without coverage gaps.
- A faster innovation cycle results in quicker introduction of services and products to the market with consistent and optimized quality.

Tech

- **Digital twin/Simulation:** NVIDIA Omniverse, Dassault Systèmes 3D Experience, Siemens Digital Twin, Ansys Digital Twin, Aveva, Azure Digital Twins, AWS IoT Twin Maker, Enline, Capgemini, Blackshark.ai, Cognite, Makersite
- **Physical AI:** Neuralink, Ready Robotics, Synthace
- **Mixed Reality:** Apple Vision Pro, Microsoft HoloLens, Meta Quest, RealWear, XReal, Unity, Threekit
- **Industrial Robotics:** ABB, Omron, Universal Robots, MiR, Boston Dynamics, Neura Robotics
- **Humanoids:** Apptronik, Figure AI, Unitree, Tesla, Boston Dynamics, Agility Robotics, Sanctuary AI, 1X
- **Edge AI:** NVIDIA Jetson, Google Coral, AWS Greengrass, Intel OpenVino, Edge Impulse, Advantech, Helin
- **Industrial Automation:** Siemens, Rockwell, Schneider Electric, ABB
- **IIoT:** Schneider Electric EcoStruxure, Siemens, Emerson, Cisco
- **Advanced Connectivity:** Nokia, Ericsson, Siemens, Celona, Cisco, Wirepas

Micro Process Magic

Micro-sized, modular processes fuse AI, events, and post-agile orchestration into real-time flows that deliver value on a constant pulse.

It's a kind of magic. Imagine miniaturizing processes into modular micro-components, helping organizations to unlock real-time adaptability and precision. These tiny, razor-focused micro-components enable rapid adaptation to market shifts and help reduce bottlenecks. They also optimize resource usage and minimize waste, while leveraging all goodness from AI, events, and agile orchestration. They not only drive cost savings and extreme agility but also keep businesses competitive in a dynamic market. The result is a seamless, uninterrupted flow of intelligent micro-processes that spark agility, cut through complexity, and keep businesses ahead of the curve. As businesses thus rewire their operations step by step, the magic is real: one flow, one goal, one pulse at a time.

Manuel Sevilla
Expert in Residence

What

- Every business process is triggered by an event or another process (has data in… has data out) and may generate a transaction or call for a process. Yes! A process is like a service and can be organized and implemented with as many microservices as needed. This is the process magic and the native link between business processes and architecture.
- Microservice orchestration platforms enable the decoupling of services, fostering modular and scalable software architecture. It happens while streamlining development, accelerating product launches, and enhancing coordination and reliability in microservices-based applications through efficient management and automation.
- Low-code platforms accelerate app development with visual interfaces and seamless integration, supporting scalability, flexibility, and adaptability, and empowering developers to enhance and expand applications in response to evolving business needs.
- Service mesh solutions enhance miniaturization by providing codeless observability, improving reliability and security for cloud-native apps—offering efficient, out-of-the-box configurations for high request volumes.

Use

- **NVIDIA** introduced three new NIM microservices to enhance the security and reliability of AI agents. These microservices help enterprises ensure ethical, focused, and tamper-resistant AI interactions. Early adopters like Amdocs, Cerence AI, and Lowe's are using them to improve customer service, in-car assistants, and retail operations.
- **Trend Micro** is leveraging NVIDIA's Universal LLM NIM microservices to deploy its Cybertron cybersecurity language models securely and efficiently across cloud, hybrid, and on-prem environments. This integration allows faster, back-end-agnostic deployment and supports sovereign AI-driven threat detection with enhanced control, observability, and zero-trust inference capabilities.
- **Atua AI**, a decentralized AI-driven productivity platform, expanded its microservices-based architecture. This upgrade enables modular development and intelligent orchestration of AI components—such as chat, writer, voiceover, and classifier—each operating as independent, containerized services.
- **VPBank**, a Vietnam-based commercial bank, adopted the latest Temenos core banking system built on a cloud-native, microservices architecture to modernize its core banking with greater agility, scalability, and rapid innovation. Deployed on Red Hat OpenShift, the system helps the bank reduce IT overheads and realise significant cost efficiencies.
- **The US Government** is modernizing its software delivery infrastructure by adopting secure, modular, and cloud-native architectures. This helps federal agencies to achieve FedRAMP compliance in just 90 days and adopt microservices architectures for mission-critical systems, reducing complexity and enhancing agility.

Impact

- Transforming a business process is already very difficult from the compliance, business, and human point of view. If it runs on top of a rigid IT solution, change becomes so difficult that it never happens. Using agile microservices makes the change possible.
- Microservices orchestration platforms automate container management, boost productivity, and support CI/ CD workflows. It also allows independent scalability, and enhances system resilience by isolating service failures, ensuring a robust and flexible software environment.
- Using microservices is an open door to finding the most efficient provider or solution targeting better cost, better scalability, quality, respect of new compliance rules, or better UI. By being able to easily improve each sub-part of the process, the whole process keeps improving continuously. Low-code platforms facilitate the development of streamlined, efficient, and nimble processes that can be rapidly created and deployed, often with minimized coding, resulting in cost savings and increased productivity.
- Reactive microservices enable miniaturization through efficient scalability, isolated failure impacts, improved developer productivity, resource efficiency, and reduced failure risks in application development and maintenance.

Tech

- **Microservices Orchestration Platform:** Temporal, Apache Airflow, Camunda, AosEdge, Orkes, dextcloud
- **Microservices Infrastructure:** Kubernetes, VMware Tanzu, communicating event streams such as AWS Kinesis, Google Cloud Dataflow, Confluent, Apache Spark, Kafka, AWS Lambda, KEDA
- **Service Mesh:** Kong, Tetrate Istio, Linkerd, Grey Matter
- **Serverless Computing/ Function-as-a Service:** AWS Lambda, Azure Functions, Google Run Cloud Functions
- **API Gateway and Management:** Kong, Amazon API Gateway, Apigee (Google Cloud)
- **Back-end Development Platform:** Platformatic, IBM company API Connect, Encore
- **Low-code Platform:** Outsystems, Appian, Microsoft Powerapps, Zoho Creator
- **Software-defined Networking:** VMware NSX, Azure Virtual network, Juniper Networks Contrail

CTRL-ALT-Human

Blending human intuition with AI to create hybrid workforces in which automation amplifies creativity, ethics guide intelligence, and the human touch drives meaningful outcomes.

It's time to reboot automation with a human-first mindset. By blending human intuition with agentic AI and empathetic design, organizations create hybrid workforces where people and intelligent systems collaborate to deliver ethical, creative, and high-impact outcomes. AI agents go beyond automating the obvious, identifying critical decision points and assembling human strike-teams to act with speed and purpose. This shift from automation to amplification unlocks new levels of innovation and adaptability. It is not just about efficiency, it is about empowering humans to do what only humans can. In a world of accelerating change, Ctrl-Alt-Human is the reset that matters.

Priya
Ganesh
Expert in Residence

What

- By strategically deploying AI to handle routine tasks, organizations can significantly enhance operational efficiency. This allows human workers to engage more deeply in problem-solving and innovation, propelling productivity and driving business growth.
- Leveraging AI for predictive analytics and automated forecasting transforms decision-making processes. By integrating real-time data analytics, organizations can anticipate market trends and customer needs with unprecedented accuracy, ensuring strategic agility.
- Combining AI with existing domain expertise bridges the gap between data-driven insights and experiential knowledge, ensuring a holistic approach to problem-solving. This integration not only preserves but enriches the organizational knowledge base, facilitating continuous learning and adaptation.
- By placing humans at the core of AI development and application, we ensure that technology complements rather than supplants human capabilities, leading to a more resilient and adaptive organizational model.

Use

- **Microsoft** Copilot Studio's agent Flows for enterprise workflow automation embeds human-in-the-loop (HITL) mechanisms directly into AI-first workflows. These actions include advanced multi-stage approval mechanisms and collaboration tools that integrate seamlessly with platforms like Outlook, Gmail, Teams, and Slack and keeps humans central to decision-making.
- **Klarna**, a Sweden-based Fintech, is shifting to a hybrid customer service model, combining AI efficiency with human empathy to improve user experience. After replacing 700 human agents with AI in 2022, Klarna is now reintroducing human support to enhance service quality and restore customer trust, while still leveraging AI for internal operations.
- **Almanak**, a DeFi AI platform, employs a hybrid model where AI agents handle tasks such as financial strategy creation and execution, while humans retain oversight and the ability to intervene in case of errors or inefficiencies. All actions performed by the AI agents are logged and verifiable, ensuring transparency and accountability.
- **Vecna Robotics** is advancing scalable warehouse automation by integrating human-in-the-loop support system. Through its 24/7 Pivotal Command Center, Vecna's remote 'pit crew' monitors and optimizes robot operations in real time, ensuring safety, adaptability, and reliability.
- **AMD** is developing a chain of AI assistants that span the entire software development lifecycle, with humans embedded throughout to guide, validate, and refine outputs. This model ensures that AI augments rather than replaces developers, especially in complex or high-stakes tasks.

Impact

- Advanced natural language processing has been instrumental in analyzing and interpreting commercial loan agreements. Automation of the labor-intensive process has reduced the cost and effort of manual reviews allowing employees to focus on higher-value activities and decision-making, leveraging the human insight where it is most needed.
- AI-driven chatbots have taken over routine customer inquiries and transactions. Human agents are now free to handle complex customer issues providing a personalized service. Additionally, AI helps in understanding customer behavior and preferences, which in turn allows human advisors to offer tailored financial advice and products.
- Enterprise performance is enhanced via real-time what if scenarios, for example, creating a budget aligned to the actuals to avoid variance analysis and focus on planning for market conditions.
- Integrated AI allows for human focus on scenario building, market understanding and business advisory. Adaptive insights and automation of budgeting process enables analysts to generate financial forecasts that adapt to changes in the business environment.
- For the new era of human and AI collaboration, the initial upskilling of resources and creating more domain expertise-led persona is important to achieve the right AI build.

Tech

- **Agent Builder Platforms:** Microsoft Copilot Studio, Google Agentspace, Amazon Bedrock Agents, Salesforce Agentforce, SAP Joule Agents, IBM AI Agents
- **Multi-agent Platforms and Frameworks:** CrewAI, IBM watsonx Orchestrate, Autogen, LangGraph, MetaGPT, Agno, Greymatter, Moveworks, Ema, Leena.ai, Talkdesk
- **Large Language Models (LLMs):** OpenAI, Google Gemini, Meta Llama, Anthropic Claude
- **Process Automation:** UiPath, Automation Anywhere, SAP Build Process Automation, IBM IT Automation Solutions, Scotty AI, HerculesAI
- **Autonomous Control Systems:** Honeywell

Autonomous Enterprise

Intelligent agents in adaptive processes continuously optimize operations, blending seamlessly into their environment to deliver performance, harmony, and innovation without human intervention.

Autonomy is no longer a vision, it is becoming the operating model. By harnessing AI and adaptive automation, the enterprise evolves into a self-optimizing system that senses, decides, and acts without human intervention. These intelligent agents continuously refine workflows, anticipate needs, and orchestrate resources remotely, even in the most complex or distributed environments. The result is a "lights-out" enterprise that blends performance with harmony, freeing humans to focus on purpose and innovation. As these systems learn and adapt over time, they unlock new levels of resilience, scalability, and strategic foresight. From agentification to orchestration, the Autonomous Enterprise hits all the right notes.

Lee Beardmore
Expert in Residence

What

- Autonomous business operations are powered by self-providing, self-managing, and self-optimizing systems that engender collaboration within and between business domains. These systems prioritize goal attainment, predictive actions, liberate decision-makers from labor-intensive tasks and provide them with crucial short, medium, and long-term intelligence to help them direct organizations. It also fosters agile product introduction, rapid capacity scaling, intelligent mass production, and environmental sustainability essential for modern supply chains.
- AI agents foster a collaborative, yet advanced automation and mechanization of repetitive and physically strenuous tasks, like machine tending, allowing factories to function with minimal human involvement.
- "Lights out" manufacturing allows for unattended, autonomous operations, complex customization, production of intricate designs with high precision, and a fully digital workflow.
- Automated production intelligence and processes utilize technologies such as AI/ML and real-time data analytics to achieve autonomous, predictive, and data-driven control over the manufacturing process and maintenance requirements.
- Super-agents, the next era of human and machine collaboration, orchestrate a symphony of AI processes in an ecosystem of autonomous operations, across physical and digital silos—masterfully collaborating with humans and machines to maximize revenue generation in a cost-optimized manner.

Use

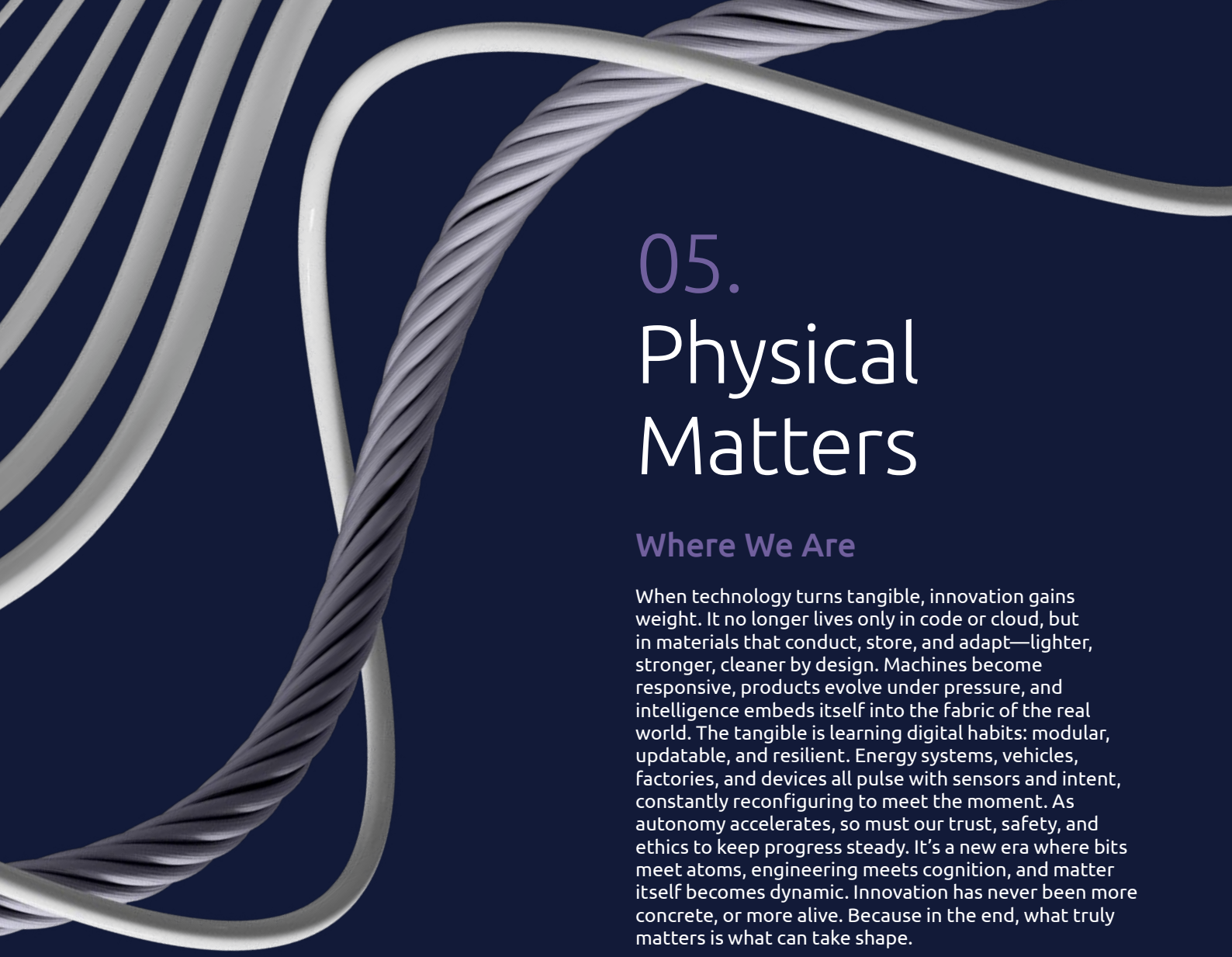
- **Midea** launched an AI-powered washing machine factory in China where human workers are no longer the primary operators. Humanoid robots handle physical tasks such as transporting components, autonomous mobile robots navigate through production zones in real time, and AI-enabled smart glasses assist inspectors with data and visuals. Central to this setup is a "factory brain" that coordinates all operations.
- **Tesla**, **Hyundai**, **BMW**, and **Mercedes-Benz**, etc., are testing advanced robots, including humanoids and autonomous mobile robots to move closer to dark factories, where production runs with minimal human involvement. These robots can navigate factory floors, collaborate with humans, and perform tasks like lifting, sorting, and transporting parts.
- **Siemens** introduced advanced AI agents for industrial automation. The new AI agent architecture features a sophisticated orchestrator. Like a craftsman, it deploys a toolbox of specialized agents to solve complex tasks across the entire industrial value chain.
- **Poonawalla Fincorp** introduced an agentic AI-driven Data Quality Index (DQI) to autonomously monitor and enhance data integrity across the organization. The system continuously evaluates the quality of data flowing through business processes, identifying inconsistencies, gaps, and anomalies in real time.
- **POSCO** implemented Oracle Autonomous Database to streamline data management, accelerate insights, and reduce operational costs. The autonomous database unifies data management across POSCO's global operations and eliminates the need for manual database management through self-tuning, autoscaling, self-patching, and self-encryption.

Impact

- Advanced robotics and automation enhance efficiency, improve productivity, reduce production costs over time, and decrease the risk of worker injury.
- Automated production intelligence contributes to heightened productivity, cost efficiency, and enhanced product quality, offering potential advantages such as reduced costs, elimination of human errors, and the ability to produce intricate, precise designs.
- AI-infused processes are unlocking novel possibilities, delivering unprecedented speed, and paving the way for the emergence of autonomous digital-only enterprises that can interact with humans independently and as required, gradually approaching the era of an autonomous enterprise.
- The evolution towards superagents will drive global productivity gains, break silos and reshape organizations to maximize outcomes through a new era of human-AI collaboration.

Tech

- **Agent Builder Platforms:** Microsoft Copilot Studio, Google Agentspace, Amazon Bedrock Agents, Salesforce Agentforce, SAP Joule Agents, AI Agents - ServiceNow, IBM AI Agents
- **Multi-Agent Platforms and Frameworks:** CrewAI, IBM watsonx Orchestrate, Autogen, LangGraph, MetaGPT, Agno, Greymatter, Moveworks, Ema, Leena.ai, Talkdesk, AI Agent Studio
- **Automation and Industrial Robotics:** ABB, Omron, Universal Robots, Fanuc, MiR, Boston Dynamics, Covariant
- **Production Intelligence:** Datanomix, MachineMetrics, Scytec, Tulip, BrainCube
- **Process Flow and Automation:** UiPath, Aera Technology, Appian, Workato, AirSlate, Alteryx
- **Enterprise AI Platforms:** IBM watsonx, Microsoft AI, DataRobot, Pega, 4Paradigm, H2O.ai, Boost.ai, RapidMiner, SoundHound, Beyond.ai, C3.ai



05. Physical Matters

Where We Are

When technology turns tangible, innovation gains weight. It no longer lives only in code or cloud, but in materials that conduct, store, and adapt—lighter, stronger, cleaner by design. Machines become responsive, products evolve under pressure, and intelligence embeds itself into the fabric of the real world. The tangible is learning digital habits: modular, updatable, and resilient. Energy systems, vehicles, factories, and devices all pulse with sensors and intent, constantly reconfiguring to meet the moment. As autonomy accelerates, so must our trust, safety, and ethics to keep progress steady. It's a new era where bits meet atoms, engineering meets cognition, and matter itself becomes dynamic. Innovation has never been more concrete, or more alive. Because in the end, what truly matters is what can take shape.

Balancing Acts

Digital technology is no longer deemed to stay virtual, it's pushing hard into the physical world. Here, energy and materials are reinvented for lighter, stronger, and more sustainable use, while products must adapt under pressure, evolving with modularity and agility rather than rigid planning. At the same time, autonomy accelerates into cars, drones, and robots, demanding that governance and ethics catch the same wind to prevent freefall. And intelligence itself slips past human boundaries, fusing with computation and engineering to open design spaces once unimaginable. Physical Matters captures this convergence, helping organizations steer between breakthrough and responsibility, resilience and speed. It's where technology gets real; quite literally.

Rodrigo Maia

Expert in Residence

The Trends

- **Material World:** Breakthroughs in energy and materials are reshaping industries, transforming how we build, power, and sustain the physical world.
- **Mission: Adaptable:** Physical products evolve under pressure—gaining resilience, agility, and adaptability through incremental design, modular systems, and model-driven development.
- **Terminal Velocity:** Technology is advancing in both capability and the degree of physical autonomy which we grant it. This velocity impacts our responsibilities, including safety, security, and ethics.
- **To Intelligence…and Beyond!:** Technology enables us to conceive and deliver products unachievable by the human imagination—what we will create next is beyond our current intelligence.

3 Steps to Take

1. **Embed intelligence into the physical world.** Leverage AI and generative technologies to design autonomous systems that go beyond human capability. As these systems interact with people and environments, clients must address safety, ethics, and regulatory assurance—ensuring trust and responsible innovation in real-world contexts.
2. **Accelerate adaptability through model-based engineering.** Adopt digital continuity and model-based systems to enable agile, evolutionary development of complex physical products—boosting resilience, reducing time-to-market, and improving collaboration across ecosystems.
3. **Treat sustainability as a systems imperative.** Engineer with the full lifecycle in mind. Integrate environmental, social, and ethical considerations into every phase, from material selection to operational impact, to ensure long-term viability and regulatory alignment.

Material World

Breakthroughs in energy and materials are reshaping industries, transforming how we build, power, and sustain the physical world.

Resources, energy, and materials are being reinvented. Renewables, hydrogen, advanced batteries, and modular nuclear designs are changing how power is produced, stored, and delivered. At the same time, nanotech, multifunctional compounds, and metamaterials are rewriting the rules of strength, flexibility, and efficiency across sectors from aerospace to healthcare. It's a true revolution: innovation that's lighter, stronger, and more sustainable by design, with new resources striking a pose for the future.

Ramon Antelo
Expert in Residence

What

- Changes in the fundamental use and transformation of materials, and the capture, transmission and storage of energy are now disrupting products, systems, and supply chains.
- The revolution in materials refers to a profound, ongoing shift in materials science. It is driven by breakthroughs in nanomaterials and metamaterials that deliver superior strength, flexibility, and lightweight design, transforming industries from electronics and medicine to construction and aerospace.
- The industrial energy mix is already changing, and there's more to come. Not only hydrogen and its derivatives, but also smaller nuclear reactors, have the potential to change the paradigm of sustainable energy resources.
- However, production challenges need to be overcome. Nothing will happen without rethinking the way energy resources are made available to end-users. As the world is moving from centralized energy production to a distributed network of intermittent producers, the current infrastructures are not ready to support the shift.

Use

- **ABB**, **B&R**, and **VTT** collaborated on modular solutions for hydrogen production and automated process plants in Finland. This partnership aims to enhance green hydrogen production through advanced modular automation systems, leveraging VTT's electrolyzer system technology and ABB's modular automation and MTP, utilizing OPC UA for information modeling and communication.
- **Asahi Kasei** along with **Furuya Metal**, **Nobian**, and **Mastermelt** launched a rare metal recycling initiative to recover iridium and ruthenium from used electrolyzer electrodes, enabling their reuse in manufacturing new ones. This supports sustainable production of electrolyzers for water electrolysis, crucial for green hydrogen generation.
- **Nanowear**'s nanotech-based SimpleSense platform integrates Dexcom G7 CGM data, enabling self-administered, real-time cardiometabolic diagnostics at home, merging glucose, ECG, and blood pressure tracking in one wearable system.
- **NanoHive Medical** is integrating piezoelectric sensor technology into its 3D-printed Hive Soft Titanium spinal implants, aiming to create smart implants that enable bone stimulation and real-time data monitoring for enhanced spinal fusion outcomes.
- **K&R Solutions Group** developed Bio Knit, a tension fabric powered by CiCLO technology. CiCLO embeds biodegradable pathways directly into polyester fibers. The product aims to reduce microplastic pollution without compromising on bold, high-performance visuals adopted across airports and major retail and corporate spaces.

Impact

- The resource revolution is reshaping industry through twin breakthroughs in energy and materials. As generations shift from fossil fuels to nuclear, solar, hydrogen and wind, environmental burdens fall sharply while economies gain from new jobs, local supply chains, and accelerated innovation.
- This transition demands bold investments like modernizing legacy grids, hardening resilience, and building decentralized microgrids that bring reliable, flexible power closer to demand.
- AI and Gen AI are revolutionizing materials science by rapidly designing and optimizing metamaterials and nanomaterials. This accelerates discovery, enhances functionality, and enables smarter, lighter, and more efficient substances, driving breakthroughs across industries from mobility to electronics in the renaissance of new materials.
- Together, these forces compress costs, reduce risk, and expand design freedom, allowing companies to decarbonize operations, open new markets, and raise productivity. The result is a more sustainable, competitive industrial base, capable of faster iteration and smarter use of resources, with benefits compounding over time for business, communities, the environment, and the society.

Tech

- **Energy Production and Transformation:** GE Vernova's Electrification Software, AVEVA Power Generation, Hitachi Energy Digitalization, Altair Energy, Siemens Power Utilities, X Energy, newcleo SMR, Radiant Kaleidos Portable Nuclear Microreactor, Terrestrial Energy
- **Process Electrification and Hydrogen:** Schneider Electric Green Hydrogen, Siemens Energy Green hydrogen Production, ABB Hydrogen, AVEVA Hydrogen Economy Software, Hysata, Electric Hydrogen, Ohmium, Modern Hydrogen, Sunfire
- **Nanomaterials:** Arkema block copolymers, Ten-Nine, Vee Technologies Nano Technology, Agilent Nanomaterials Characterization & Analysis, Chemspeed's Solutions for Nanomaterials, Carbonnova, Danubia NanoTech
- **ALM:** Siemens Additive manufacturing Solutions, EOS Additive Manufacturing, HP Industrial 3D Printers and Solutions, Dassault Systèmes Additive Manufacturing, Hexagon Additive Manufacturing, 3D Systems' 3D Bioprinting

Mission: Adaptable

Physical products evolve under pressure—gaining resilience, agility, and adaptability through incremental design, modular systems, and model-driven development.

Physical products are growing more complex while facing harder constraints: physics, manufacturability, sustainability, and hostile disruptions. The answer isn't rigid planning but agile evolution: modular design, adaptive ecosystems, and incremental improvements that build resilience over time. From modular fighter jets to AI-optimized UAVs (Unmanned Aerial Vehicles), tomorrow's products are designed to flex, shift, and endure. Consider it the Ethan Hunt of technology: always on the edge, always adapting to the future, always ready to cruise through the impossible.

David Jackson
Expert in Residence

What

- Physical products, even in mature industries, are becoming more technologically sophisticated and complex. This brings new and evolving challenges—whether in creation (complex integration) or operation (software updates and cybersecurity)—in addition to the VUCA (Volatility, Uncertainty, Complexity, and Ambiguity) environment. Our products, product lines and systems need to be resilient to changes and challenges, while still constrained by physicality—the laws of physics!
- Adapting to new challenges demands agility, not just in a software sense but in exploration, conceptualization, design and manufacture, even where some of the processes involved may be slow, expensive, or intractable. Lifecycles and methods that encourage agility, and technologies that enable it (e.g., digital V&V, ALM, programmable components, modularity, product lines), are needed.
- Agility alone is insufficient to meet challenges, we need direction. In a multifaceted environment, this can be evolutionary development and multidisciplinary optimization. Design spaces can be characterized, merit determined, and solutions evaluated, either by genetic approaches consolidating the results of small changes, or analytically, if the models and metrics allow.
- To enable these dynamic and optimizing development processes, there's an increasing use of models, in addition to linear documents and data. This extends from the detailed technical level (model-based definition, model-based systems engineering) to organizations and supply chains (model-based enterprises).

Use

- **P&C Global** partnered with Toyota, the Mayo Clinic, and JPMorgan Chase to build resilient supply chains by integrating antifragility frameworks, predictive AI, and collaborative ecosystems. This allows real-time risk management, diversified sourcing, and adaptive logistics, resulting in reduced costs, improved outcomes, and new revenue streams across automotive, healthcare, and finance sectors.
- **Armis Centrix**, a cyber exposure management platform integrated with NVIDIA BlueField-3 DPUs and Morpheus cybersecurity AI framework, to autonomously secure cyber-physical systems in critical infrastructure industries.
- **Aeralis** is developing a modular military jet, Phoenix, built around a Common Core Fuselage (CCF) to support interchangeable engines, wings, and mission-specific modules. Through its AERSYSTEM suite along with AERSIDE, AEROSA, and AERCORE, Aeralis will be using modularity to reduce lifecycle costs and accelerate innovation in military aviation.
- **Arcfield**'s STC launched Intelligent MBSE, an AI-powered model-based systems engineering tool tailored for defense and high-security sectors. It leverages LLMs and ML to automate system design, streamline requirements generation, and perform digital thread analysis across classified and unclassified environments.
- According to a research paper from **Federal University of Santa Maria, LUT University,** and others, genetic algorithms and neural networks have been leveraged for stiffness and weight optimization of an unmanned aerial vehicle (UAV) support arm. The hybrid optimization framework significantly improves the stiffness-to-weight ratio of UAV support arms.

Impact

- Legacy markets will become accessible to disruptors, even in conservative industries such as aerospace and defense.
- Technologies that enable rapid evolution (e.g., additive layer manufacturing, software-defined products) will gain adoption.
- Product lifetimes will decrease as optimization accelerates and customization and hyper-personalization will become more practical.
- Maintaining a digital thread and a single source of truth across the extended enterprise will gain focus—work will shift from exchanging documents and drawings to collaborating on models and data.

Tech

- **Resilience Engineering:** Blue Yonder's generative AI-led supply chain management, e2open Risk and Resilience Solutions, Dassault Systèmes Resilient Supply Chain, Siemens Supply Chain Resilience, Zurich Resilience Solutions, Supplier.io Supply Chain Resilience Software, Aravo Supply Chain Resilience, Craft, Prewave, Everstream analytics
- **Autonomous Cyberphysical Systems:** Fortinet OT Security Platform, TXOne Networks Cyber-Physical Systems Security, Flexxon X-PHY AI Autonomous Cybersecurity Solution, Darktrace Cyber AI, Tanium Autonomous Endpoint Management
- **Model-Based System Engineering:** Siemens MBSE, Dassault Systèmes Model Based Systems Engineering Solutions, Ansys ModelCenter, Sparx Systems MBSE
- **Agile/Evolutionary Product Development:** Autodesk Agile Product Development Software, Valispace agile hardware design solution, Siemens NX software, PTC PLM, ATS PLM, Dassault Systèmes PLM Software, Autodesk PLM

Terminal Velocity

Technology is advancing in both capability and the degree of physical autonomy which we grant it. This velocity impacts our responsibilities, including safety, security, and ethics.

Autonomous cars, drones, and humanoid robots are leaping into the real world, powered by agentic AI and new design principles. The challenge is not to stop the jump, but to steer it—aligning regulation, assurance, and ethics with the speed of innovation. With the right parachute, momentum turns from freefall into lift, carrying us toward safer mobility, smarter infrastructure, and more resilient societies.

Efi
Raili
Expert in Residence

What

- Critical physical systems, infrastructure, and products are increasingly getting dependent on digital technology including digital supply chains and digital assurance.
- Increasing system autonomy and the emergence of agentic AI capable of making decisions and taking actions independently amplifies both opportunities and risks. This shift demands revised governance frameworks to ensure such systems are deployed safely, responsibly, and effectively.
- The reactive social measures that govern technology—regulation and legislation—cannot keep pace with the speed of emergence of technologies such as AI and robotics, leading to an increasing misalignment and gaps in oversight and assurance.
- The emergence of humanoid robots and increasingly sophisticated AI agents and multi-agent systems introduces a new type of human-machine interaction, designed to operate in environments, roles, and social contexts that are familiar to people. Their human-like form, communication capabilities and adaptive behaviors enable them to collaborate, assist, and even make decisions alongside humans.

Use

- **Hexaware** and **Abluva** are enabling secure, compliant use of agentic AI in life sciences sector by protecting sensitive data during tasks like clinical trial automation and patient data handling. Their solution ensures adherence to HIPAA and GDPR standards.
- **IQVIA** has launched custom-built AI agents, developed in collaboration with NVIDIA, to streamline workflows and accelerate insights across life sciences and healthcare industries. They help in target identification, clinical and literature reviews, market assessment, and HCP engagement.
- **Figure AI** is launching a Center for Humanoid Safety to set industry-wide standards for humanoid robot safety. The initiative focuses on rigorous testing and third-party certification of batteries, control systems, and AI behavior, addressing the lack of specific OSHA regulations for robotics.
- **Square Robot** has developed its newest high temperature inspection robot, the SR-3HT, formally receiving the NEC/CEC Class I Division 2 (C1D2) certification. The C1D2 certification was issued by FM Approvals, a third-party US-recognized test lab, confirming the system is safe for use in hazardous locations.
- A recent **Cornell University** research paper, titled "Risk Model and Analysis Methods for the Psychological Safety of Human and Autonomous Vehicles Interaction" highlights trust and perceived risk as key to psychological safety in autonomous vehicles. It proposes a framework to assess these risks, supporting safer, user-centered AI mobility design.

Impact

- Existing means of assurance and governance are inadequate for autonomous physical systems including AI and agentic AI.
- However, we can expect regulations to change globally and new or different demands on organizations developing, deploying, or using autonomous and AI-based physical systems.
- Alongside their potential benefits, humanoid robots also pose psychological safety risks when it comes to trust, acceptance, and over-reliance. All of these require careful governance and assurance.
- Misalignment between regulation and technology, where existing rules fail to address new risks or provide a clear pathway to compliance, can slow innovation and adoption and create potential gaps in safety, trust, and compliance.
- The dependence of critical physical systems on digital technologies can result in smarter, more resilient, and efficient infrastructures. However, it can also expose them to cyber threats, supply chain vulnerabilities, and assurance gaps.

Tech

- **Autonomous Vehicles:** Waymo Driver, Tesla Full Self-Driving (FSD), Zoox Autonomous Robotaxi, Ford autonomous car, OTTO by Rockwell Automation, MiR (Mobile Industrial Robots), Aumovio Integrated AMRs, Geek+ Robotics, Atlas (Boston Dynamics), Robonaut 2 (NASA and GM), ABB Autonomous Mobile Robots AMR and AGV robots, Omron Autonomous Mobile Robots (AMR), Nuro AI, Wayve, Applied Intuition, PlusAI
- **Autonomous Humanoid Robots:** Unitree G1, Figure 02, Agility Robotics, Apptronik Apollo, Boston Dynamics Atlas, Fourier GR-1, Tesla, Sanctuary AI, 1X, UBTech Walker S2
- **New Modes of Human-machine Interaction:** InnoBrain BCI Platform, NXP HMI, Renesas Advanced HMI Solutions, In2tec Smart HMI, AVEVA InTouch HMI, Incon
- **Trustworthy AI:** IBM Responsible AI, Google Responsible AI, AWS Responsible AI, Autodesk Trusted AI, Azure Trustworthy AI, Salesforce Einstein Trust Layer, Alation
- **Verification and Validation Technologies for Physical Systems Dependent on Digital Technologies:** Dassault Systèmes Systems Validation, Cadence Verification, Synopsys Systems V&V, FullSpectrum V&V, Dessia's AI Design V&V

To Intelligence... and Beyond!

Technology enables us to conceive and deliver products unachievable by the human imagination—what we will create next is beyond our current intelligence.

The evolution of intelligence is no longer confined to people. Advances in scope, cognition, autonomy, and distribution embed it everywhere, reliably augmenting how we work, decide, and create. Hybrid solutions merge digital and physical, fluidly delivered across a continuum of compute. Specific problems are met with tailored classes of solutions, while human insight is amplified, rather than replaced. The result? A new chapter in the story of intelligence—one that already has a buzz.

Andy Vickers
Expert in Residence

What

- Multi-agent systems use AI-powered agents with varying degrees of authority, autonomy, and agency working together to proactively deliver value. They range from the hyper-automation of known processes to the transformation of whole departments, to mixed human-AI systems, and last but not least, enhanced problem-solving.
- Decentralized models entail the implementation of AI across a computing continuum ranging from the edge, through on-premises and cloud. It's a process of blending performance, agility, and specialism using increasingly smaller specialized models for more effective problem-solving. Here's AI becoming ubiquitous.
- Hybrid AI is the combination of AI with other scientific and engineering methods to introduce rigor, precision, and correctness to the use of AI.
- Multimodal models are the development of AI models that can support the management of design concepts rather than their underlying representation. They connect text, images, mathematical models, 3D representations, etc.
- Earlier, the use of generative AI focused on productivity. The first industrial applications of generative AI were mostly from the life sciences industry involving drug discovery. Now we will see increasing use of this technology for the design of new products.

Use

- **Toyota**'s O-Beya system, built on Azure OpenAI and GPT-4o, supports the automotive industry by enabling over 800 powertrain engineers to collaborate using nine AI agents. The agents are focused on battery, motor, regulations, and system control, and they collaborate asynchronously to assist in vehicle design.
- **Luminary Cloud**'s SHIFT-Wing AI model accelerates transonic wing design by replacing traditional simulations with instant, mesh-free predictions. Trained on high-fidelity data and powered by NVIDIA's PhysicsNeMo, it enables accurate, flexible design exploration while reducing computational cost and engineering bottlenecks in early-stage aircraft design, unlocking broader design possibilities and minimizing late-stage rework.
- **SEALSQ** has announced its advancement in post-quantum semiconductors. It's for edge and IoT applications using DeepSeek, a cost-effective LLM rivaling GPT-4. The open-source, decentralized AI powered by SEALSQ's chips can pave the way for a decentralized, secure, and energy-efficient AI future.
- **Stellantis** and **Mistral AI** use hybrid AI, combining LLMs and edge computing, for real-time anomaly detection in auto manufacturing, helping operators identify and correct defects before components are released. The key example is BOM Data Intelligence chatbot helping engineers analyze and optimize component selection.
- **SOPHiA GENETICS** is using its multimodal AI Factories, trained on diverse healthcare datasets, to help AstraZeneca assess the efficacy, value, and real-world impact of breast cancer therapies.

Impact

- A new reality is emerging. We are getting used to AI being everywhere. However, while we are still firmly surrounded by the AI hype, industries and organizations will slowly begin to discover what is possible and what is fiction. Once we are free from our own institutionalized biases and experiences, we will discover new productivity norms and application areas.
- As the productivity norms become re-baselined, we will discover new services and new products. AI is already helping us identify new design patterns or optimizations which, due to scale and complexity, are beyond the visibility of human design teams. They will become tractable and discoverable by the application of next-generation compute.
- We will see a new generation of technological disruption as we start to combine AI with other systems engineering and computer science disciplines. There will be new approaches to regulation and new multi-disciplinary research topics.

Tech

- **Multi-Agent Systems:** Google Vertex AI Agent Builder, CrewAI Multi-Agent Platform, Novuscode Multi-Agent AI Platform, AgentX Build Multi-Agent Workforce, Salesforce Agentforce, Langchain
- **Multimodal Models:** Appen AI Data Platform (ADAP), Zensar Multi-Modal Generative AI, Aimesoft Multimodal AI
- **Edge AI:** Siemens Industrial Edge for Process Industry, Liquid Edge AI Models, Dell's AI-enhanced Edge Solutions, Stmicroelectronics Industrial Edge AI Solutions, ADLINK Edge AI and IoT for Industrial Automation, fetch.ai Cortex, DEEPCRAFT Edge AI Solutions, Viso (Edge AI)
- **Hybrid AI:** Lenovo for Hybrid AI, Cognite Data Fusion, Orangemantra Hybrid AI Solutions, Fabric's Hybrid AI

06. Nature's Code

Where We Are

Billions of years of R&D have already been done, by nature. Every leaf, every cell, every ecosystem is the outcome of relentless iteration. *Nature's Code* dares us to peek at that source code: patterns of resilience, regeneration, and balance—and start copy-pasting wisely. This container blends biology, computer science, biotechnology, and engineering to explore what happens when technology runs nature's algorithms (and sometimes helps debug them). From biomimicry to bioengineering, from regenerative design to AI that behaves more like an ecosystem than a machine, the lessons are there for anyone willing to learn. The result is innovation that doesn't just imitate nature, but codes along with it: alive to context, adaptive by design, and sustainable by default. After all, nature is still the ultimate open-source platform.

Balancing Acts

From DNA sequencing to personalized medicine, and from Maxwell's equations to integrated photonics, we explore the space between scientific breakthroughs and the societal changes they enable. As we navigate this space, we ask: how do we harness the complexity of scientific discovery for a safe, sustainable future? In a world of constant noise, diverse opinions, and multiple pendulum swings, learning from nature's precision is more relevant than ever. Today's challenges in health, sustainability, technology (and more) demand solutions that balance innovation with responsibility. By making nature-inspired design a core focus, organizations can cut through the chaos, align with enduring principles, and create impact that is both lasting and ethical.

Monty Barlow

Expert in Residence

The Trends

- **My Chemical Advance:** Advances in solid-state chemistry are redefining batteries, delivering safer, denser, and more sustainable energy storage across mobility, healthcare, and personal tech.
- **Language of Life**: AI is accelerating biotechnology innovation, reshaping how discoveries are made, protected, and commercialized.
- **Paint it Light**: Programmable light is reshaping communication, computing, and sensing, positioning photonics as a foundation for the next technology revolution.
- **Mind over Machine**: By reading signals and context, neural interfaces let technology work the moment you think it.

3 Steps to Take

1. **Forge partnerships across academia, startups, and industry bodies** to stay at the forefront of scientific discovery, exposing your organization to breakthrough thinking and emerging technologies.
2. **Encourage a culture of scientific inquiry;** one that values curiosity, learning, and experimentation. Encourage teams to think like researchers—ask bold questions, test hypotheses, and navigate complexity with confidence.
3. **Position science at the core of your strategy,** treating scientific breakthroughs as a primary source of competitive differentiation rather than background noise. Make environmental, social, and ethical considerations integral to every decision, ensuring long-term value and stakeholder trust.

My Chemical Advance

Advances in solid-state chemistry are redefining batteries, delivering safer, denser, and more sustainable energy storage across mobility, healthcare, and personal tech.

Batteries power our world, but conventional lithium-ion chemistry is heavy, unstable, and increasingly constrained. But solid-state technology is coming, replacing volatile liquids with stable electrolytes, enabling lighter, safer, and longer-lasting energy storage. From EVs with true long-range to wearables and medical implants free of leaks, this chemical advance rewrites the playbook. Higher capacity, fewer rare materials, greater trust: energy innovation with a backbeat strong enough to move industries forward.

Steve Thomas
Expert in Residence

What

- EV companies and consumer electronics brands are developing a new type of battery. What makes them different? Not only can they store more energy than conventional batteries, they are also safer, free of unstable liquids that lead to fire and other safety risks.
- The liquids are being replaced with special materials called solid electrolytes, making the batteries more stable at high temperatures. This also means a lower risk of batteries bursting into flames if damaged or over-charged.
- Removing the liquid also makes it possible to use pure lithium metal as the anode. Instead of hiding a small number of lithium atoms inside a fragile graphite electrode, the lithium itself becomes the electrode. This process increases the capacity of the batteries and avoids many of the degradation mechanisms that cause them to fail.
- Other advances, like sulfur cathodes, increase the battery performance even further, promising higher capacities for batteries with the same weight and volume. This also avoids the need for rare and controversial materials like cobalt and nickel.
- No liquids means no leaks, making batteries safer to use in applications where leaks would be dangerous, for example, in medical devices and consumer electronics.

Use

- **BMW** and Solid Power, a US-based solid-state batteries manufacturer, tested all-solid-state batteries with sulfide-based electrolytes in a BMW I7 vehicle. These batteries offer higher energy density, enabling longer vehicle ranges without any increase in storage system weight.
- **QuantumScape** (QS), a US-based solid-state battery manufacturer, and PowerCo, a Volkswagen Group subsidiary, demonstrated QS solid-state lithium-metal batteries powering a Ducati motorcycle. The demonstration showcased the advantages of the batteries in terms of energy density, fast charging capability, safety, and lifecycle.
- **Factorial**, a US-based solid-state battery manufacturer, shipped its solid-state lithium-metal battery cells to Avidrone Aerospace, a Canada-based unmanned aerial systems (UAS) manufacturer, for use in cargo drones.
- **Baracoda**, a global health-tech company, has collaborated with ITEN. Baracoda's BHeart, a self-powered health tracker, uses ITEN's POWENCY, micro solid-state batteries. The device harnesses energy from body heat and ambient light, enabling continuous operation without the need for frequent recharging.
- **Ilika**, a UK-based solid-state battery manufacturer, partnered with Cirtec Medical, a US-based medical devices manufacturer, to produce Stereax M300 micro-battery for active medical implanted devices, small wearables, and industrial IoT sensors.

Impact

- Battery safety will increase significantly. Incidents like EVs bursting into flames during charging or house fires caused by charging scooters or electric bicycles will become a thing of the past.
- Higher-capacity batteries will allow EVs to travel longer distances on a single charge, easing range anxiety that prevents many people from adopting electric vehicles. Wider adoption of EVs will reduce fossil fuel emissions and dependence.
- Compact high-density batteries will make it possible to power medical devices like smart implants and contact lenses without the risk of leaks, opening a door to a new generation of medical devices, wearables, and consumer electronics.
- The price of electrical energy storage will plummet as rare and conflict-prone elements like cobalt are being replaced with common materials like sulfur. This will enable an acceleration of the energy transition, making electrification affordable and easily adoptable for cash-strapped consumers.

Tech

- **Solid-State Batteries:** Samsung SDI, TDK, Murata, Maxell, imec, Ilika, Solid Power

Language of Life

AI is accelerating biotechnology innovation, reshaping how discoveries are made, protected, and commercialized.

AI is learning to speak biology's native tongue, and it's not shy about improvising. Generative models design antibiotics that outsmart resistance, craft antibodies and proteins from scratch, and accelerate mRNA (Messenger RNA) therapies at a pace human researchers can't match. Whole new design spaces are opening up, with foundation models remixing DNA, RNA, and proteins into novel forms of treatment. This new fluency also rattles the old rules of biotech IP, where patents may no longer hold. The result: a biotechnology industry that doesn't just read the language of life: it's starting to write its own verses.

Matthew Armean-Jones
Expert in Residence

What

- Generative design of novel antibiotics gives hope for overcoming antimicrobial resistance. For example, a base structure can be provided and the AI can suggest chemical modifications that increase efficacy without negatively impacting safety.
- The Chai Discovery model shows de novo antibody design with a high success rate paving the way for accelerated biological drug discovery and development. Designing antibodies de novo enlarges the design space and removes the constraints associated with tweaking an existing antibody.
- Profluent AI developed OpenCRISPR-1, an open-source alternative to the patented CRISPR/Cas9 system that is off limits for many commercial companies without a license. Access to this means any commercial entity can potentially perform CRISPR research license-free, though this hasn't been tested in court.
- LLMs are positively impacting clinical practices with PathChat being specialized in reviewing digital pathology data and identifying diseases, saving doctors' time on paperwork.
- Biological foundational models are designing entire proteins from short prompts, functionally similar but highly divergent from natural sequences. They are making biological systems like antibody-based therapies, pollution-degrading enzymes, and biosensors easier, faster and more reliable to engineer.

Use

- **MIT** researchers used generative AI algorithms to design new antibiotics that can combat two hard-to-treat infections: drug-resistant Neisseria gonorrhoeae and multi-drug-resistant Staphylococcus aureus (MRSA). The team screened over 36 million compounds for antimicrobial potential.
- **Chai Discovery**, a US-based AI-driven biotech firm, released Chai-2. It's a multimodal generative model that achieves high success rate in de novo antibody design advancing rapid and precise atomic-level molecular engineering.
- **Raina Biosciences**, a US-based mRNA technology and therapeutics company, unveiled GEMORNA, a generative AI platform for mRNA design and optimization. GEMORNA designs optimized mRNA sequences, accelerating drug discovery by eliminating iterative sequence optimization.
- **Profluent Bio**, a US-based AI-first protein design company, reported that its Protein2PAM AI model achieved successful application of machine learning to customize Cas enzymes for alternative PAM recognition, which may contribute to future developments in personalized genome editing.
- **Arc Institute**, a US-based biomedical research organization, and Stanford University unveiled Evo 2, a genomic foundation model available via NVIDIA BioNeMo platform. Evo 2 is capable of generalist prediction and design tasks across DNA, RNA, and proteins. It enables biomolecular research such as protein structure prediction, novel molecule identification, and analysis of gene mutation effects.

Impact

- Generative antibiotic design is game-changing in the fight against anti-microbial resistance and treating diseases where existing treatments are becoming obsolete. However, we may see new bottlenecks. Advances in automation and manufacturing will be needed to fully realize the potential.
- Similarly, some AI antibody design experts have described designing binders for a known target as a solved problem. But binders alone aren't enough, manufacturing potential and clinical trial success are far harder to predict. We need AI for developability to achieve that.
- Gen AI is changing the landscape of biotechnology IP. Landmark cases will likely decide whether using AI to design around patents will be viable in the future.
- The exploitation of foundational models in medicine will help streamline healthcare with smart triaging, matching the right treatment to the right patients.

Tech

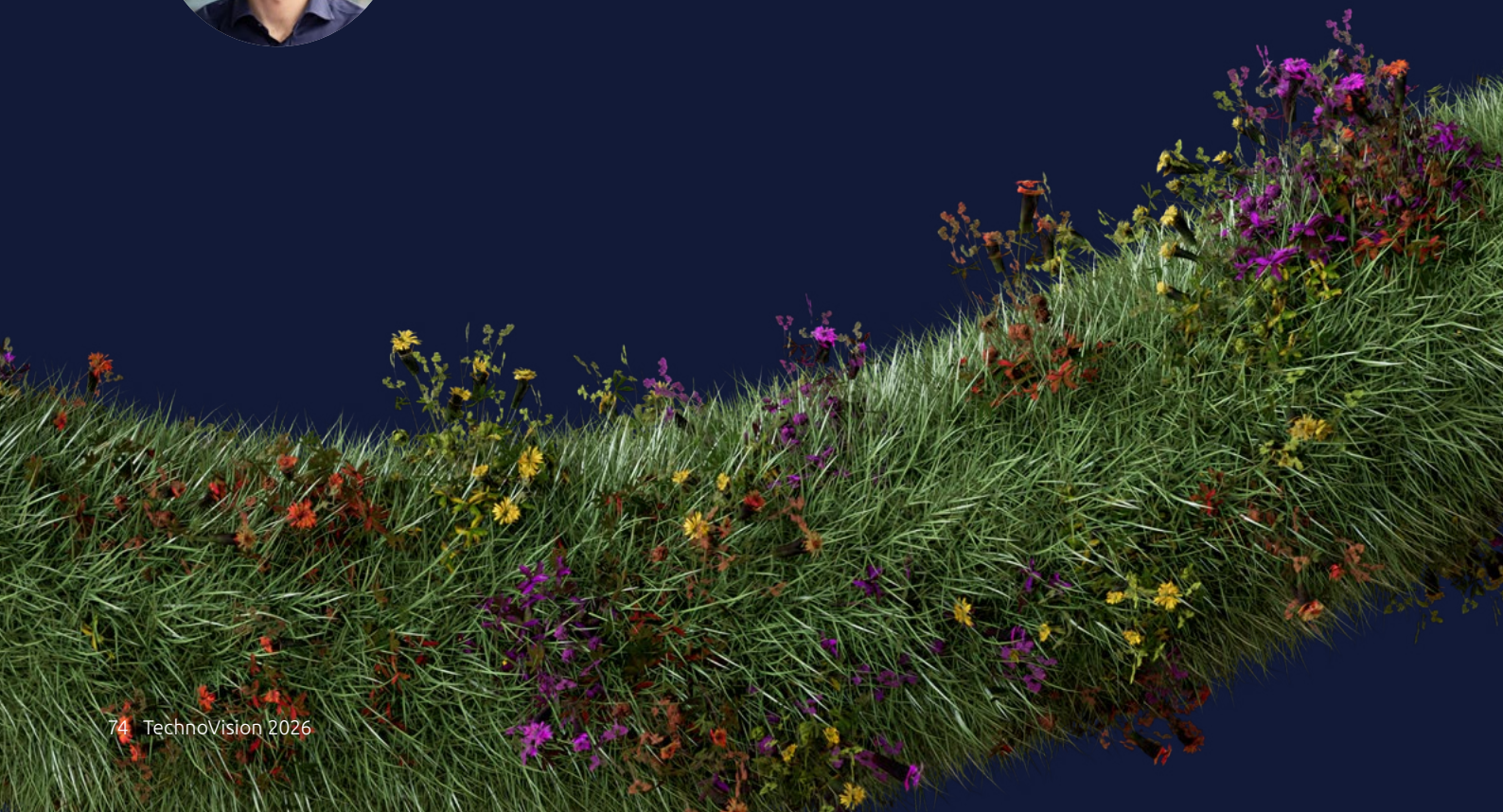
- **Generative AI Platform:** NVIDIA BioNeMo, Cradle Bio, GEMORNA, The Generate Platform, Iktos, Pharma.AI, Profluent Bio, WhiteLab Genomics
- **Bio Foundation Model:** AlphaFold 3, Chai-2, IBM Biomedical Foundation Models, Helix-mRNA-v0
- **Multimodal Foundation Model:** Tempus AI
- **AI Platform:** Numerion Labs, Antiverse, Recursion Operating System

Paint it Light

Programmable light is reshaping communication, computing, and sensing, positioning photonics as a foundation for the next technology revolution.

Photonics is stepping out of the shadows. By making light programmable, it drives breakthroughs in communication, computing, and sensing. Silicon photonics already cuts the power drain of AI data centers, while photonic processors promise ultra-fast, light-speed computation. Add quantum integration and advanced materials, and you get secure communication and precision sensing like never before. The satisfaction? The old order fades to black; the future gets painted in light.

Tom
Watson
Expert in Residence



What

- Photonics is the technology of controlling photons—light particles—in energy, time, and space to achieve practical functions like communication, sensing, and computing.
- Currently, silicon photonics is being commercially deployed by NVIDIA and TSMC among others, enabling energy-efficient optical interconnects connecting millions of AI processors. NVIDIA's Spectrum-X switches reduce power by 3.5x while TSMC's COUPE platform delivers multi-terabit throughput through co-packaged optics that integrate electronics and photonics on single chips.
- In the near future, programmable photonic processors, based on free space or photonic integrated circuits, will perform AI computations in picoseconds. These systems will enable dynamic light control for matrix operations while photonic sensors will advance toward ultra-sensitive environmental and biomedical detection.
- In the long term, photonic time crystals will modulate material properties at light speed, allowing the potential for all-optical control systems, while integrated quantum photonics will enable scalable quantum computing and ultra-secure communication using single photons as information carriers.

Use

- **Q.ANT**, a Germany-based photonic deep-tech company, for the first time, integrated its photonic AI processor into an operational HPC system through the deployment of its Native Processing Server at the Leibniz Supercomputing Centre.
- **NVIDIA** introduced NVIDIA Spectrum-X and NVIDIA Quantum-X silicon photonics networking switches offering 3.5x higher power efficiency, 63 times improved signal integrity, 10x better network resiliency at scale, and 1.3x faster deployment than traditional methods.
- **Lightmatter**, a US-based photonic computing company, launched Passage M1000, a 3D Photonic Superchip which delivers 114 Tbps total optical bandwidth for the most demanding AI infrastructure applications.
- **InnoPIC**, a Netherlands-based initiative, is working on a non-invasive continuous glucose monitor that merges photonic integrated circuits, Raman spectroscopy, advanced signal conditioning, and AI analytics to develop a wearable biosensor intended for healthcare and biomedical applications.
- **Meta4D's** research is developing cutting-edge materials that change their properties at the speed of light, enabling a completely new paradigm of light-matter interaction. This could disrupt anything from stealth technologies, biosensors, wireless networks and computing.

Impact

- Is a nuclear power station still necessary? Greater than 3.5-fold reductions in data center power consumption enable sustainable AI infrastructure growth, beginning with co-packaged optics and optical switching, and ultimately progressing to the use of optical processors.
- There's a rise in consumer health consciousness propelled by the integration of advanced photonic diagnostic sensors into accessible consumer electronic devices.
- Sovereignty and the security of critical infrastructure are increasingly being dependent on photonics, which plays a vital role in quantum computing and in safeguarding against quantum-enabled attacks on classical encryption.
- A new era of optical control is here, enabled by photonic temporal materials for the detection of minute particles, and biomarkers through exponential signal amplification, along with advancements in all-optical control systems, switching, and digital photonics.

Tech

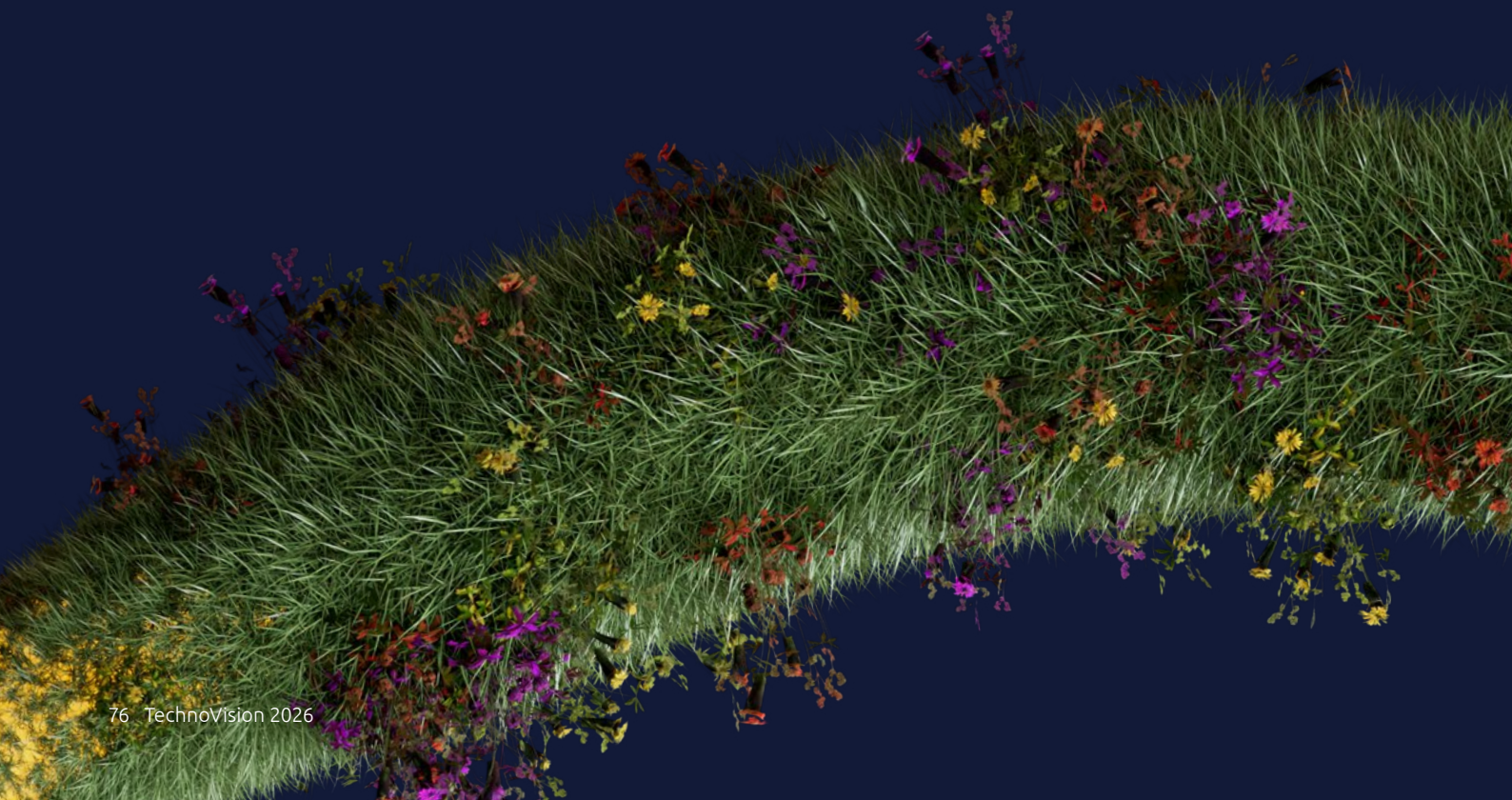
- **Photonic Computing:** Microsoft, Q.ANT, LightSolver, Optalysys, Salience Labs
- **Photonic Interconnect:** NVIDIA Spectrum-X, Intel, Lightmatter, Ayar Labs, Lightelligence, SmartPhotonics, Celestial AI
- **Photonic Sensing:** ams OSRAM, MantiSpectra, InnoPIC, VoxelSensor, Hamamatsu Photonics, SiPhox Health
- **Quantum Photonic Circuits:** PsiQuantum, Xanadu, Quandela
- **Photonic Temporal Material:** Meta4D, Aalto University, the University of Eastern Finland, Karlsruhe Institute of Technology, Harbin Engineering University

Mind over Machine

By reading signals and context, neural interfaces let technology work the moment you think it.

The next wave of interfaces won't ask for clicks or swipes; they'll tune into us directly. Neural and physical sensing pick up intent, context, even emotion, enabling interactions that feel instinctive. From thought-driven implants to adaptive glasses, devices become extensions of ourselves. A future shaped not by machines controlling us, but by minds in command.

Josh de Gromoboy
Expert in Residence



What

- Across personal technology, ranging all the way from smart glasses to bionics, unintuitive interfaces remain the key hurdle preventing widespread adoption. Voice interfaces draw attention to the user, raise privacy concerns, and aren't suitable for use in public; pulling a device out of a pocket is clunky and slow. Making technologies adaptive for users with disabilities adds more complexity and creates even more barriers to use.
- Advances in contact and non-contact sensors for physiological and neurological signals help infer more information about user intent. By combining neurological, physiological, behavioral, task-specific, and context clues, devices can begin to understand both what the user is trying to do, and why they are doing it.
- Seamless interfaces that are always on, non-invasive, and can be accessed instantly and discreetly are key to enabling users to control their devices as second nature. This leads to new categories of technology in wearables and personal devices, shifting the focus from convenience and personal monitoring to unlocking new human capabilities.

Use

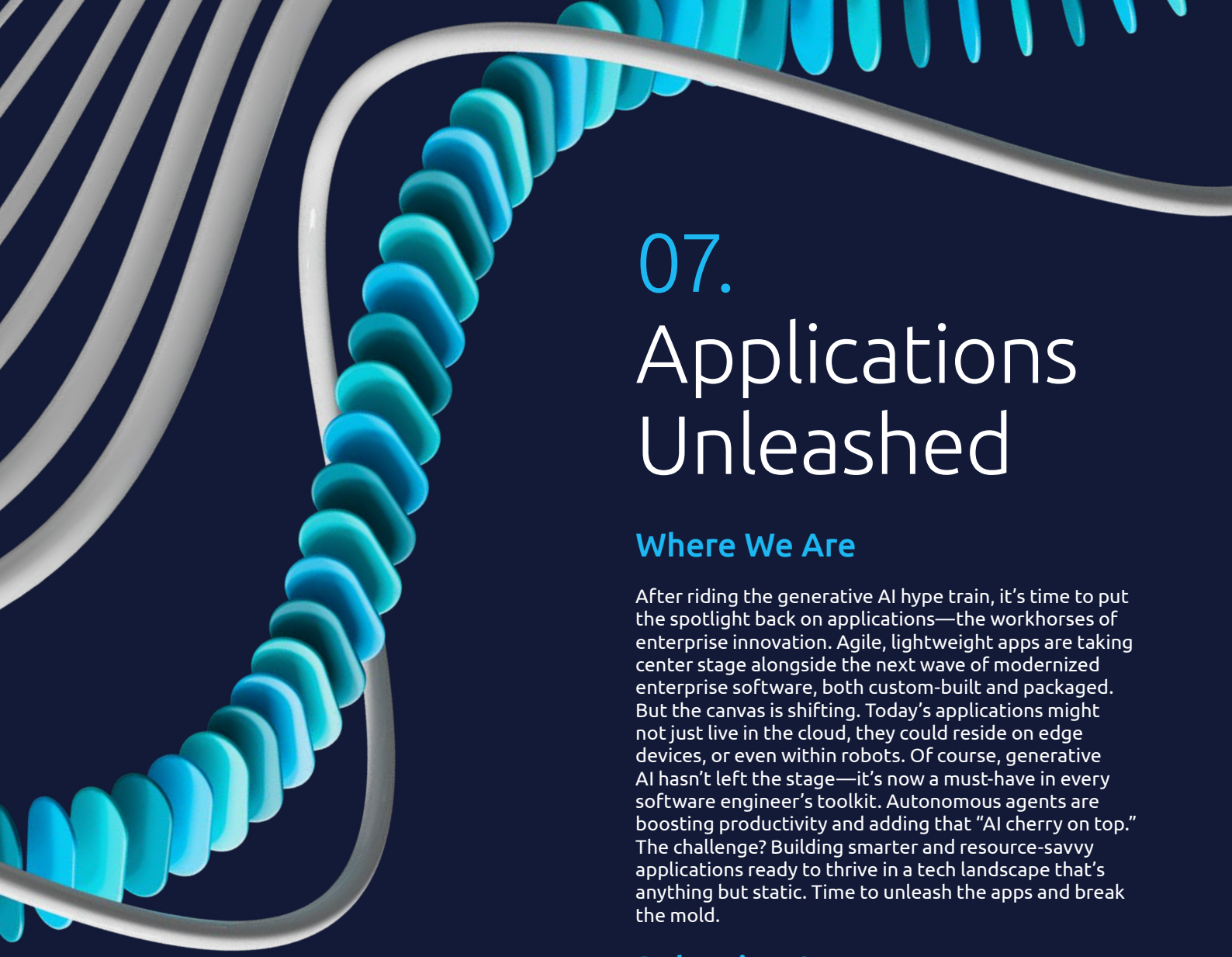
- Individuals with paralysis are receiving the **Neuralink** implant, a fully implantable, wireless brain-computer interface (BCI) that is invisible and designed to restore autonomy. It lets users control phones and computers using only their thoughts, a capability called telepathy.
- **Precision Neuroscience**, a US-based BCI technology company, received U.S. Food and Drug Administration (FDA) clearance for its Layer 7 Cortical Interface. It's a high-resolution cortical electrode array, for use in the recording, monitoring, and stimulation of electrical activity on the surface of the brain.
- **Bitbrain and Nissan** are working on BCI for brain-to-vehicle communication and have developed a wearable electroencephalogram (EEG) system designed for dynamic driving conditions. The device uses dry sensors to decode neural signals that anticipate the driver's intended actions before they are physically executed.
- **Toyota's** T-HR3 uses new physical interfaces to allow users to instinctively control a remote-controlled humanoid robot. This is a part of Toyota's broader research into technologies that can meet individuals' mobility needs, while also pushing towards greater co-existence of humans and machines.
- Aria Gen 2 by **Meta** is a set of smart glasses supported by a range of technologies, combining machine vision, eye and hand tracking, and contextual AI to understand user intent without the need for neural interfaces.

Impact

- Devices that better understand their user democratize the use of these technologies, making them usable by people who are not naturally tech-savvy.
- Seamless, adaptive interfaces will allow these technologies to cater to all users, while further advancements will open the door to truly game-changing assistive technology, or even extending human capability.
- However, unfettered use of this technology raises the risk of devices beginning to infringe on what it means to be human. Setting up assured frameworks to guide the use of all this new information is crucial for fostering trust, increasing mass adoption, and limiting misuse.
- The user must be at the center of decisions about how their data is used, setting contextual rules and limits. Devices must have the intelligence to balance long- and short-term needs. This must all be supported by regulations guided by societal input.

Tech

- **Invasive BCI:** Neuralink, Synchron, Paradromics, Precision Neuroscience, Blackrock Neurotech
- **Non-Invasive BCI:** Neuracle Neuroscience, Neurable, Bitbrain, Cognixion, OpenBCI, MindMaze
- **Neurological Activity Sensing:** Cortivision, Kernel, BioSerenity
- **Contextual AI:** Meta Aria Gen 2, Tobii



07. Applications Unleashed

Where We Are

After riding the generative AI hype train, it's time to put the spotlight back on applications—the workhorses of enterprise innovation. Agile, lightweight apps are taking center stage alongside the next wave of modernized enterprise software, both custom-built and packaged. But the canvas is shifting. Today's applications might not just live in the cloud, they could reside on edge devices, or even within robots. Of course, generative AI hasn't left the stage—it's now a must-have in every software engineer's toolkit. Autonomous agents are boosting productivity and adding that "AI cherry on top." The challenge? Building smarter and resource-savvy applications ready to thrive in a tech landscape that's anything but static. Time to unleash the apps and break the mold.

Balancing Acts

AI-powered apps dazzle, yet their energy demands challenge sustainability goals. Robotic agents will soon expand the application canvas but must work alongside humans, complementing rather than replacing them. The dream of "one app to rule them all" raises privacy stakes, requiring a balance of convenience and security. The goal? Smarter, greener, human-centered applications, unleashed for a dynamic future.

Thilo Hermann

Expert in Residence

The Trends

- **Honey, I Shrunk the Applications:** Next-generation agile applications, built on the concepts of microservices, API-first, cloud-native, and headless (MACH), make up an *applications portfolio* that is cradled by AI, and delivered via developer platforms.
- **When Code Goes Know:** Pair programming with an AI assistant doesn't just boost productivity and code quality, it also accelerates the learning curve, provided you know what you are doing.
- **Chat is the New Super App:** AI-augmented chatting and talking in plain, natural language becomes the new app to rule them all.
- **App = A Robot:** Robots are no longer just machines—they're programmable, intelligent agents, adding new dimensions and opportunities to the craft of software engineering.

3 Steps to Take

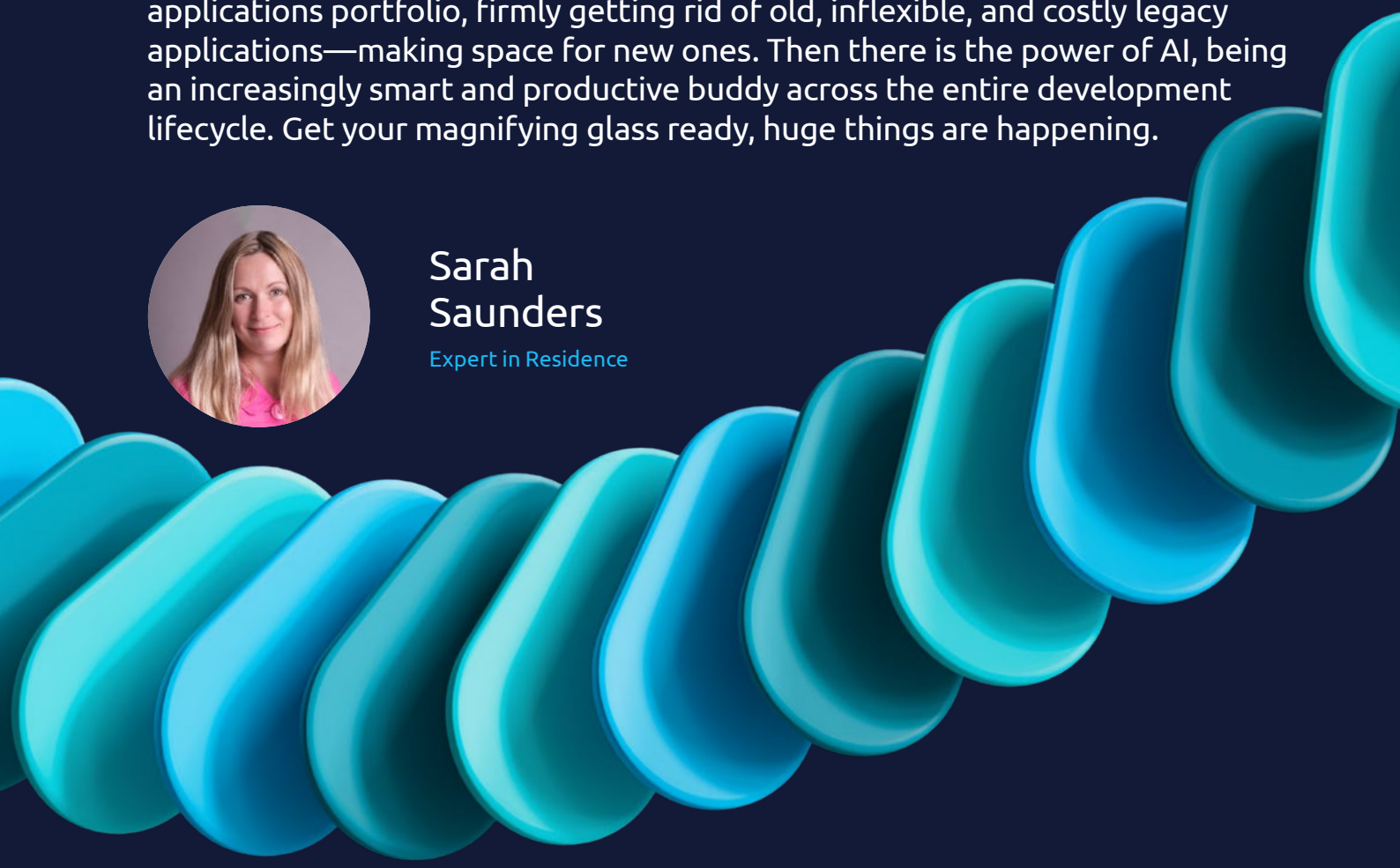
1. **Make AI and agents an integral part of applications.** Think AI at every stage, but don't lose sight of quality. Establish rigorous checks to avoid AI-generated errors or hallucinations. The pendulum swings between autonomous brilliance and human oversight, making it essential to strike the right balance for reliable, intelligent applications.
2. **Design applications with simplicity in mind.** Minimize complex user interactions by leveraging natural language instead. Create a highly integrated application that makes the most of the ecosystem in the simplest possible way. The pendulum swings between feature richness and simplicity in usage, so prioritize simple user interactions that keep applications usable and fit for purpose.
3. **Expand applications to embrace robotics.** Include robotics as part of your application strategy to unlock new opportunities. Flexible, adaptive systems can revolutionize business models but require careful control. The pendulum swings between groundbreaking innovation and operational risk. Build with foresight to keep your robotic applications in check.

Honey, I Shrunk the Applications

Next-generation agile applications, built on the concepts of microservices, API-first, cloud-native, and headless (MACH), make up an applications portfolio that is cradled by AI and delivered via developer platforms.

Applications used to be monoliths, cumbersome, bundled together with traditional user interfaces and hardcoded business logic. Now that the science of application miniaturization is here, application services are tiny, stateless, efficient, and scalable. They are flexible, adaptive, and responsive, morphing themselves seamlessly around new situations, needs, and use cases. The MACH concepts are best combined with a miniaturization approach to the entire applications portfolio, firmly getting rid of old, inflexible, and costly legacy applications—making space for new ones. Then there is the power of AI, being an increasingly smart and productive buddy across the entire development lifecycle. Get your magnifying glass ready, huge things are happening.

Sarah Saunders
Expert in Residence



What

- Apps are no longer tied to specific platforms. Developers' cognitive overload from managing app complexity is being eased by a dedicated developer platform, supported by customer-facing platform engineers. This lets developers focus on business functionality, with the added bonus of creating an abstraction between the application and its deployment, allowing apps to fly free in the clouds!
- We need fine-tuning deployment parameters to ensure maximum runtime efficiency. AI agents are taking the legwork out of writing code, freeing up developers to focus on finding the most efficient solutions to application problems. This means even smaller, lighter apps are created.
- Our code bases are often already too complex to understand. We rely on long-running teams and documentation to support and extend applications. AI is now assisting in summarizing the dependencies and interfaces of application architectures, as well as helping to identify and patch security issues.
- Quiet apps are becoming greener by reducing data transfers, logging, and looping, while leveraging application metrics to identify and optimize the least efficient code. Using programming languages such as Haskell and Rust can significantly reduce an application's energy footprint.
- Few organizations master the art of systematic application rationalization. An end-to-end approach is needed to make room for new application services, enabled by tools such as Capgemini's Clear Sight IT Decision Maker.

Use

- **B2 Impact** Poland, modernized its IT infrastructure with Red Hat OpenShift Virtualization. By upgrading two data centres and migrating operating environments, it achieved 4x faster ETL processes, 1-hour deployment for new business-ready environments, and seamless service transitions.
- **PepsiCo** is migrating workloads to AWS to accelerate innovation and integrate PepGenX platform with Amazon Bedrock for enhanced flexibility. AWS also powers real-time insights for ad performance, audience segmentation, hyper-personalized content, and targeted marketing across Amazon audiences.
- **Fifth Third Bank**, a US-based bank, modernized its IT infrastructure by adopting AWS cloud platform and refactoring key applications into microservices. Using agile DevOps, the bank launched "Jeanie," a cloud-native AI banking chatbot, enabling scalable services that adapt to usage surges.
- **Société Générale Maroc**, a Morocco-based financial institution, in partnership with IBM, modernized its core banking infrastructure by transitioning from monolithic systems to a microservices-based architecture, enhancing efficiency, security, and customer experience.
- **Uber** migrated its global compute platform from Apache Mesos to Kubernetes, across global data centers and cloud environments using a robust framework for gradual, backward-compatible transitions. These services will run on both platforms concurrently, reducing risk during the shift.

Impact

- Faster, scalable, and intent-driven application services that are modular, sustainable, and fit for current and future technology business purposes.
- Faster time-to-market for new business services and products, as the enabling application services can be rapidly selected and integrated.
- Less need for massive, troublesome upgrades of entire application suites, as minimized application services are autonomous and only loosely coupled to others.
- Lower cost of software development and maintenance combined with higher software quality and reduced time-to-market.
- Better reuse and upcycling of application services, as they can be used, integrated, and interfaced in many ways, wrapping old legacy systems in peripheral microservices—allowing faster adoption, and saving scarce human resources and energy.

Tech

- **Re-platforming:** AWS Transform, LzLabs Software Defined Mainframe, Capgemini Clear Sight IT Decision Maker, Capgemini Cloud for enterprise management, AWS Mainframe Modernization, Confluent, WhatNow
- **Agility:** SAFe, LESS (Large Scale Scrum), Scrum@Scale, Disciplined Agile
- **DevOps:** Headspin, OpenGitOps, Confluent Platform, Helm, GitLab, Azure DevOps Services, Capgemini DevOps accelerator - CREATE, GitHub Actions, Atlassian Bamboo, ReleaseOwl, Cycloid, OpenLegacy, Copado
- **Microservices Infrastructure:** Kubernetes, VMware Tanzu Platform, Kong, Cortex, AWS Kinesis, Google Cloud Dataflow, Confluent, Apache Spark, Kafka, AWS Lambda, KEDA, Datadog Kubernetes Autoscaling, Orkes, commercetools
- **Voice Assistant Platforms:** Apple Siri, Amazon Alexa, Alibaba's AliGenie, Bixby, Hound, Databot, Voice Qube, Screevo
- **Text Assistant Platforms:** WeChat Open Platform, Microsoft Bot Framework, Facebook Messenger Platform, Uipath Druid, Amazon Lex, Google Dialogflow CX, Salesforce Einstein Bots, Pega Chatbot, Aivo AgentBot, Haapie, Voxymore BOTIFUL

When Code Goes Know

Pair programming with an AI assistant doesn't just boost productivity and code quality, it also accelerates the learning curve, provided you know what you are doing.

Know what? Creating high-quality code was already easier than ever thanks to advanced low- and even no-code platforms. Now, with the compliments of AI, both professional developers and business users can leverage language models and agents that produce code with the finesse of the best engineers. This enhances productivity and also provides an incredible learning tool—all through dialogue in natural language. It's exactly what an ambitious technology-powered business needs. However, expert oversight is crucial before releasing AI-generated applications. After all, AI is a co-pilot, not the pilot. As the saying goes: you know it when you see it.

Ludovic Toinel
Expert in Residence

What

- Large Language Models trained on high-quality open-source code now support advanced autocompletion, automated testing, and in-depth reviews. However, senior expertise is still vital to review, validate, and secure the results.
- Generative AI takes low-code a step further by enabling natural-language-driven code generation, task automation, and process optimization. Complex workflows can be built and refined faster, empowering both technical developers and non-technical business experts.
- The future of development still relies on collaboration: sharing best practices, exchanging knowledge, and building upon each other's ideas. Active communities and an inner-source strategy will boost efficiency and quality.
- The MCP protocol offers a new standard for interactions between coding agents, but opens the question of cybersecurity and transparency of these AI agents.

Use

- **GitHub** launched customizable coding agents capable of performing complex development tasks with tailored behavior. Engineers can now configure their agents to generate code, specifications, and tests while choosing from multiple LLMs to best fit their needs.
- **Anthropic** open-sourced the Model Context Protocol (MCP), a new standard for connecting AI assistants to the systems where data lives. The protocol enables developers to build secure, two-way connections between their data sources and AI-powered tools.
- **OutSystems** released its AI Agent Builder which is embedded in the OutSystems Developer Cloud. This solution supports IT teams to design generative AI agents and integrate them into applications with full governance, all without requiring coding or AI expertise.
- **ServiceNow** released its Creator Studio as part of ServiceNow's App Engine. It offers an intuitive no-code environment that helps employees build apps and automation workflows. Combined with Now Assist's generative AI capabilities, it helps accelerate enterprise-wide digital transformation.
- **Salesforce** launched its MuleSoft Anypoint Code Builder, a generative AI-powered IDE that lets developers generate code, APIs, and integrations using natural language prompts, fully integrated with Visual Studio Code to streamline software development.

Impact

- There is increased application development productivity on both sides of the business and IT spectrum, if the best approach for the challenge at hand is chosen.
- There is also enhanced organizational agility through a significantly faster time-to-market for new business applications and a faster learning curve for junior software engineers.
- There's higher code quality due to Large Language Models trained on the knowledge of the huge open-source community.
- A cohesive alignment between IT and business functions through personally involved and committed citizen application developers, using open, digital platforms.
- More innovative and higher-quality, business-facing applications that demonstrate enterprise robustness combined with agile solutions.
- Dealing with a scarcity of specialized software developers by enabling more people in the organization to quickly develop high-quality solutions without the need for deep skills and experience.

Tech

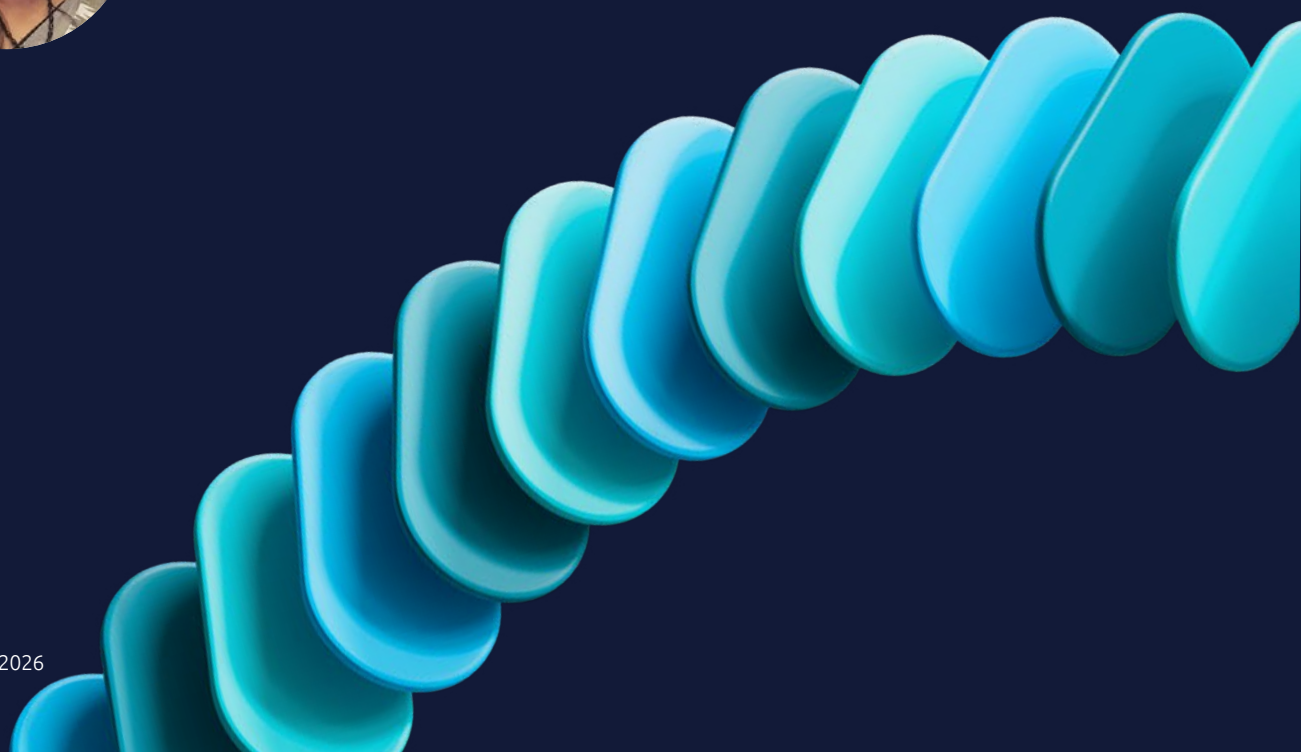
- **AI-based Tools for Pro Code Software :** GitHub Copilot, OpenAI Codex, Replit Agent, Bolt, Cursor, Amazon Q Developer, Google Code Assist, Tabnine, Qodo, Salesforce CodeGen, AlphaCode, H2O, Visual Blocks, MxNet, Harness AIDA, Code Llama, Llama 4, Claude 4, AlphaEvolve, Codestral, JetBrains AI, Gitlab Duo
- **High-productivity Development Platforms :** Mendix, OutSystems, Microsoft PowerPlatform, Salesforce Lightning Platform, Betty Blocks, Appian, SAP Build Apps, Thinkwise, Pega, Usoft, UiPath Apps, ServiceNow App Engine, Zoho Creator's low-code platform, Retool, AgilePoint, AuraQuantic, Decisions, Lansa Professional Low-Code, Quixy, Airtable

Chat is the New Super App

AI-augmented chatting and talking in plain, natural language becomes the new app to rule them all.

It has been the ambition of quite a few captains of the IT industry: creating one “super app” that can be used to manage and launch whatever application service one could possibly need. Yet, at its core, even a super app remains just that—an app, with an interface to be mastered and a logical flow to be followed. What if all that complexity disappeared, replaced by simple natural language dialogue? The rapid breakthrough of AI-augmented chat systems, combined with an infinity of multimodal, subject-matter-specific plug-in models, well-defined interfaces like MCP and A2A, is making this a reality. It will democratize access to applications, driven by a radically new design concept for software engineers. Supercalifragilisticexpialidocious!

Khambampati Sailu
Expert in Residence



What

- A super app is an application that provides many different application services through one integrated platform interface, eradicating the need for managing and launching multiple applications and managing several accounts.
- Many industry players have aspired to provide and own such a super app, as it secures a central place in a diverse application services ecosystem.
- With the rapid evolution of chat-based, natural language interfaces (triggered by OpenAI's ChatGPT), a new, preferred user interface has emerged, possibly further strengthened by voice capabilities.
- With most of these chat systems having an open, plug-in extension mechanism for application- and subject-matter-specific contents and actions, it becomes interesting to provide application services through the chat system. This renders a chat system into an unexpected, but undeniable super app.
- Standardized protocols such as MCP and A2A form the foundation for seamless integration, enabling vast ecosystems to serve as the backbone of the envisioned services.

Use

- **OpenAI** has introduced a new generation of apps for users to chat with, right inside ChatGPT. Developers can also start building them with the new Apps SDK, available in preview. The pilot partners include Booking.com, Canva, Coursera, Figma, Expedia, Spotify and Zillow, in markets where their services are offered in English.
- **BNY** adopted GitHub Copilot, with over 80% of its developer community now relying on it daily, increasing the speed of code development. BNY also uses Eliza, a virtual assistant. Eliza leverages advanced large language models including OpenAI's GPT-4 for employees to innovate, streamline workflows, and deliver enhanced value to clients.
- **Perplexity** has partnered with PayPal to let users make purchases directly in chat. Customers based in the United States will soon be able to book travel, buy products, and secure concert tickets without leaving the platform. Payments will be completed in the chat with PayPal or Venmo, and PayPal will handle processing, shipping, tracking, and invoicing. Purchases will be completed with one click, with the help of the payment company's passkey checkout.
- **ABN AMRO**, a Netherlands-based bank, partnered with Capgemini to transition to Microsoft Copilot to begin developing Gen AI solutions and created "Rikkie", a Gen AI-powered chatbot to provide a more natural one-on-one digital interaction.
- **Mercedes-Benz** partnered with Google Cloud to introduce new conversational capabilities to the MBUX Virtual Assistant, powered by Google Cloud's new Automotive AI Agent. Google Maps platform gives Mercedes-Benz owners access to 250 million global locations, with maps refreshed in near real-time with over 100 million updates daily.

Impact

- Leveraging the superior dialogue qualities and consumer reach of chat front ends will lead to better connect with the market and serving customers in a simpler and better way.
- There will no longer be a need to manage or own proprietary application user interfaces.
- Rapid integration of new services—whether standalone, with partners, or through an ecosystem—delivers new functionality and greater user value, all with a minimal learning curve for the actual users.
- We can aim for disruption on traditional businesses by combining different services to offer a much better and simpler user experience. It's empowering to have the first point of contact.
- Chat super apps can collect vast amounts of data on user behavior and preferences. It can be used to improve services, personalize user experiences, and provide valuable insights and data for business decisions and marketing.

Tech

- **AI-based Tools:** IBM Watson Studio, H2O, TensorFlow, Microsoft Copilot, Harness AI, Agentforce, Clarifai, C3 AI Platform, Altair RapidMiner, DataRobot
- **Super Apps:** Alipay, OMNi, Rappi, Grab, Troop Messenger, Gojek
- **AI-based Chatbots:** ChatGPT 5, Google Gemini, HuggingChat, Zapier- AI Chatbot, ChatSpot, Poe, DeepAI Chat, Claude, Zoho Zia, IBM Watsonx Assistant, Zendesk Messaging, Replika, Chatfuel, HubSpot Chatbot, SnatchBot, Ada CX, Perplexity
- **For Searching the Web:** Microsoft Bing AI, YouChat, KoalaChat
- **Content Writing:** Jasper Chat, Chat by Copy.ai, ChatSonic, ZenoChat, Writesonic, ContentBot, Rytr, Wordtune, Anyword, Grammarly, Quillbot, Neural Text, Scribe
- **For Coding:** GitHub Copilot, Amazon Q Developer, Salesforce CodeGen, DeepCode (by Snyk), Qodo, Windsurf Cascade, CodeGPT, Codex by OpenAI, Sourcegraph, Visual Studio IntelliCode, BuildAI, Augment Code, Cognition, JetBrains AI Assistant

App = A Robot

Robots are no longer just machines—they're programmable, intelligent agents, adding new dimensions and opportunities to the craft of software engineering.

For engineers, the canvas is shifting from screens to embodied machines. Robots, equipped with cameras, LiDAR, advanced sensors, and AI, don't just execute commands; they perceive, adapt, and collaborate in dynamic environments. Building them means aligning hardware, electronics, and software: fusing real-time data, synchronizing actuators with control systems, and designing adaptive algorithms for unpredictable conditions. Just as vital is communication—not only between robots and people, but also robot-to-robot, enabling coordinated teamwork. Advanced frameworks now make it possible to reprogram and customize robotic behavior on the fly. It's a new frontier where engineers don't just build apps—they create intelligence that moves, senses, and innovates. Or to paraphrase, we're doing robotics harder, better, faster, stronger.

Marc Blanchon
Expert in Residence

What

- The transition from rigid robotics to robotic agents represents a significant step forward in the field of robotics, enabling the development of more intelligent, adaptable, and collaborative systems—both with humans and with other robots.
- Robotic agents, equipped with an array of sensors such as cameras, LiDAR, infrared, and ultrasonic sensors, are capable of perceiving their environment, making decisions, and taking actions to achieve specific goals or tasks.
- Their designs often include various safety features, such as sensors, emergency stops, and protective barriers, to ensure safe operation and minimize the risk of accidents. Advanced software frameworks and programming interfaces enable the customization and reprogramming of robotic agents to meet changing requirements.
- Robots can possess varying levels of intelligence, from basic rule-based systems to sophisticated AI and machine learning algorithms, empowering them to make decisions, adapt to dynamic conditions, and autonomously solve complex problems.
- By using Wi-Fi, Bluetooth, or specialized industrial standards for seamless data exchange and coordination, these robotic agents can communicate not only with central control systems, but also directly with each other and with human operators, leading to a true collaborative multi-agent ecosystem.

Use

- **Foxconn**, a Taiwan-based manufacturing company, partnered with NVIDIA to deploy solutions like Nurabot, a collaborative nursing robot for medication and sample transport, across major hospitals like Taichung Veterans General Hospital, Baishatun Tung Hospital, Mazu Hospital, and Cardinal Tien Hospital in Taiwan.
- **Hyundai Motor Group** plans to deploy thousands of Boston Dynamics robots, including Atlas, a humanoid robot,and build a physical AI ecosystem across global manufacturing and logistics sites. Spot robots are already in use for industrial inspection and predictive maintenance at Hyundai facilities.
- **Luminous**, a US-based robotics company, has partnered with Equans, a global engineering and construction firm, to deploy LUMI, an AI-powered pick and place technology at two Australian solar farms, the 440MW Neoen Culcairn Solar Farm in New South Wales and the 250MW Engie Goorambat East Solar Farm in Victoria.
- **Foxconn** and NVIDIA plan to deploy humanoid robots at Foxconn's Houston plant for assembling GB300 AI servers marking the first NVIDIA product built with humanoid assistance and Foxconn's first AI server factory using robots on the production line.
- **Figure AI** raised $1 billion at a $39 billion valuation to scale production, launch its BotQ facility, and broaden humanoid deployments beyond automotive into commercial and household tasks.

Impact

- AI-powered robots can adapt to changing environments, tasks, and conditions more effectively than traditional, rule-based robots, enabling them to manage a broader scope of applications and respond dynamically to evolving situations.
- They can learn from experience, continually refining and enhancing their performance, leading to greater efficiency and effectiveness over time.
- Using AI, these robotic agents can adapt their behavior and interactions to meet the preferences of individual users and to collaborate naturally with human teams or with other robots. All of this can be achieved while operating with a higher degree of autonomy, reducing the need for constant human supervision and intervention.
- They can monitor their own performance and predict when maintenance or repairs will be needed, reducing downtime and maintenance costs.

Tech

- **Sensors:** Quanergy LiDAR, SICK Ultrasonic distance sensors, Sony Depthsensing Solutions, Garmin LIDAR-Lite v3, OMRON FQ2 vision sensor, Texas Instrument mmWave radar sensors, Teledyne
- **Actuators:** ABB Servo system, Mitsubishi servo motor, Imsystems archimedes, ESTAT Actuation, Artimus Robotics, HEBI Robotics
- **Communication and Networking:** Thales Secure Communications, Keysight Nemo Wireless Network Solutions, Intel Edge Computing, Qualcomm Robotics, NVIDIA Edge AI Solutions
- **Artificial intelligence and Machine Learning:** NVIDIA Jetson, NVIDIA Deep learning, Tensorflow, Azure AI, IBM Watsonx.ai, Qualcomm Snapdragon, Unity ML Agents
- **Industrial Robotics:** Fanuc, ABB Robotics, Yaskawa Motoman, Universal Robots, Boston Dynamics' Stretch, Vecna Robotics, Fox Robotics, Cartken, Dexterity Industrial Mechs, Unitree, Figure, Ubtech
- **Service Robotics:** SoftBank Pepper, Relay Delivery Robots, Aethon T3, Keenon Robotics, Blue Ocean Robotics UVD Robot, Apptronik Apollo, 1X Neo, Ubtech healthcare robotics
- **Medical and Surgical Robotics:** Intuitive Surgical's da Vinci, Mako by Stryker, Medtronic's Hugo RAS, Vicarious Surgical, Ekso Bionics, Saroa Surgical System

08. Invisible Infostructure

Where We Are

The era of *Invisible Infostructure* is becoming real: a digital foundation that's both virtual and indispensable. Autonomous, self-learning, self-healing and AI-powered, it quietly empowers the modern enterprise, connecting everything, including "things" and edge devices.
But don't let subtly fool you. With quantum and neuromorphic computing, and next-gen connectivity stretching to non-terrestrial networks, it's reshaping what infrastructure can do. As specialized high-performance computing evolves to meet AI's relentless demands, delivering leaps in capability, it's a backbone that must scale effortlessly while staying energy conscious. This isn't just IT infrastructure—it's the force that's keeping businesses adaptive, innovative, and ready for whatever comes next. Quiet, yes. Invisible, maybe. Essential? Absolutely.

Balancing Acts

Infrastructure certainly drives a perpetual balancing act, juggling competing forces. AI may dazzle with autonomy, but humans remain essential for judgment and control. Industry-focused solutions promise tailored precision, yet ubiquitous platforms bring unmatched scalability and versatility. Compute power races ahead, but sustainability pulls the reins on energy demands. Sovereign control ensures local compliance, while global networks foster cross-border collaboration. Ambient edge computing pushes intelligence closer to users, even as centralized systems ensure consistency and scale. Meanwhile, terrestrial networks vie with satellite communications for the future of connectivity. Each swing forces organizations to rethink priorities, chasing the harmony of the moment in an ever-shifting landscape.

Patrice Duboe

Expert in Residence

The Trends

- **Cloud Encounters of the Third Kind:** With the cloud evolving and maturing, it's time to create a new, secure, smart mix of sovereignty, sustainability, agility, deployment options, and specialized capabilities where AI is everywhere.
- **Everything, Everywhere, All At Once Connected:** Connectivity has become the foundation of a hyper-connected world, seamlessly linking devices, industries, and ecosystems to drive unprecedented innovation.
- **Simply the Edge:** Core edge technologies like 5G and upcoming 6G, system-on-a-chip, and embedded AI have moved the boundaries, bringing the power of IT infrastructure close to real-world operations and people while decreasing energy consumption.
- **Ok Qompute:** New computing architectures are emerging, such as in quantum, AI and neuromorphic chips, rewriting the rules and possibilities of innovation.

3 Steps to Take

1. **Leverage AI for autonomous operations.** Implement AI to drive self-learning and self-healing capabilities across your infrastructure, from architecture to operations. Ensure these autonomous systems enhance optimization and resilience across all environments—whether in the cloud, on-premises, or at the edge.
2. **Build seamless interconnectivity everywhere.** Prioritize rapid, cost-effective data transfer across corporate domains, factories, storefronts, and remote locations. Leverage emerging terrestrial and non-terrestrial connectivity solutions to ensure seamless access to insights and decision-making in an increasingly interconnected world.
3. **Embrace the compute evolution responsibly.** Capitalize on advancements in neuromorphic, quantum, and AI-driven high-performance computing to stay ahead. Address post-quantum threats with robust sovereign defenses while balancing sustainability impacts (energy, water) with strategic goals, ensuring compute power delivers value without compromising long-term responsibility.

Cloud Encounters of the Third Kind

With the cloud evolving and maturing, it's time to create a new, secure, smart mix of sovereignty, sustainability, agility, deployment options, and specialized capabilities where AI is everywhere.

As the cloud frontier expands, businesses are having their own close encounters with a whole new kind of IT. It's driven by multi-cloud, industry cloud, AI, and a galaxy of embedded tools. The new cloud isn't just about storage and compute; it's about sovereignty, sustainability, and an increasingly diverse mix of deployment options. With a focus on net-zero operations and dynamically optimized workloads, this wave not only enhances operational efficiency but also reduces carbon footprints. The new kind of cloud brings speed, agility, laser-focused compliance, and unleashes the power of AI. It's time to answer the call, adapt smart, and make your own cloud encounter a transformational journey, not just an alien blip.

Jean-Georges Saury
Expert in Residence

What

- Cloud is dominating IT budgets, with top talent seeking out work that provides access to cutting-edge technology within high value-creating teams, confirming cloud as the foundation of modern IT and a strategic necessity for competitiveness.
- Cloud enables scalable deployment of AI and advanced analytics, making it a key innovation enabler across industries. Developers expect environments that leverage AI-assisted coding, tight cloud API integration, and guardrails with organizational standards embedded.
- Industry-specific cloud platforms are rising to meet regulatory and market demands, blending AI, secure infrastructure, and specialized analytics to drive innovation. Multi-cloud and hybrid setups are now the norm, offering flexibility and resilience making multi-cloud mastery a key strategic advantage.
- Cloud security is shifting to zero-trust architectures. Strong identity controls, end-to-end encryption and continuous monitoring are now standard. Meanwhile, data sovereignty is rising and global enterprises may adopt sovereign cloud strategies to retain legal control over sensitive data.
- Cloud cost optimization is a top priority. FinOps is widely adopted to reduce waste (often 20–30% of spend), improve resource efficiency, and maximize ROI. Executive teams are increasingly tracking these metrics to ensure cloud investments deliver value.

Use

- **CommBank**, an Australia-based bank, has signed a five-year deal with AWS to remain its preferred cloud provider. The bank will shift more workloads to AWS using cloud-native designs to simplify systems, strengthen security, and accelerate AI adoption for better customer experiences.
- **The New York State Office of Information Technology Services** (ITS) has partnered with Google Public Sector to provide state employees with secure cloud-based technology tools. Participating agencies will gain access to Google Cloud services and will streamline integration, boost efficiency, cut costs, and provide enhanced training and dedicated support for state employees.
- **Rolls-Royce** used Microsoft Cloud for Manufacturing with generative AI and machine learning to optimize engine design, turbine production, and health monitoring. This boosted machine utilization by 30%, cut scrap, and prevented around 400 unplanned maintenance events annually saving millions in repairs.
- **Epic Games** migrated fully to AWS to support its game Fortnite. On AWS, Epic can auto-scale to accommodate 30× peak player traffic without service degradation. This scaling is paired with lower operational costs with the help of AWS cost optimization.
- **BMW Group** built an Azure-based IoT and analytics pipeline for R&D vehicles. Using Azure AI Foundry and Azure OpenAI Service, they launched an MDR copilot powered by GPT-4o, accessible via web app. This enables 10× faster data access and analysis, accelerating prototype development.

Impact

- Leveraging platforms that provision foundational cloud infrastructure and developer tooling, with observability and security tightly integrated, can accelerate cloud adoption and modernization and are expected "table stakes" for high-performing teams.
- Industry cloud solutions that automate compliance, sales, marketing, customer service, financial management, and align the supply chain to customer demand, will drive human interactions delivering significant impact.
- Innovation, through research and engineering, is unlocked by ready access to globally distributed AI/ML capabilities incorporated into the latest cloud environments.
- Cloud providers will accelerate organizations reaching their sustainability targets by leveraging net-zero plants and dynamically distributing compute workloads to the optimum location for cost and sustainability.

Tech

- **Platforms:** Fly.io, Accelario, Red Hat OpenShift on IBM Cloud, Koyeb, Cloudflare, Salesforce, Veeva, RunPod, CoreWeave, Rafay, Rescale, Cirrascale, Fermyon, Docker, Transition Manager, Snowflake, Databricks, Matillion, Teradata, Devo, Opensee
- **Observability:** Cisco-AppDynamics, chronosphere.io, Coralogix, Dynatrace, Datadog, Grafana Labs, Sentry, honeycomb, Watermelon, Fiddler
- **Sustainability Tools:** Microsoft Emissions Impact Dashboard, Google Cloud Sustainability, AWS Sustainability Tools, Google Environment APIs, Aguaro, Green Eagle Solutions
- **Hybrid, Multi-cloud Tools:** Google Kubernetes Engine (GKE), Azure Arc, Backstage, Crossplane, Port, OpsRamp, Mist.io, Alkira
- **Sovereign Cloud:** GAIA-X, Oracle EU Sovereign Cloud, StackIt, Nebul, SAP Sovereign Cloud, AWS European Sovereign Cloud, Microsoft Sovereign Cloud
- **Cost Management ('FinOps'):** Microsoft Cost Management, AWS Cost Explorer, IBM Kubecost, IBM Apptio, Flexera Spot, firefly.ai, ProsperOps, Cycloid, Finout, Openops, Zylo
- **Cloud Infrastructures for LLMs:** Lambda Labs, Paperspace by Digital Ocean, NVIDIA DGX, Jarvis Labs, CoreWeave, Vast AI, Latitude.sh, Seeweb, FluidStack, Skyflow, Deepset, Vercel

Everything, Everywhere, All At Once Connected

Connectivity has become the foundation of a hyper-connected world, seamlessly linking devices, industries, and ecosystems to drive unprecedented innovation.

Connectivity has stolen the spotlight, evolving from backstage enabler to leading role in the digital age. From 5G to satellite links, from intelligent edge computing to the coming waves of 6G and quantum networking, it's the invisible infrastructure binding everything, everywhere, all at once. Decentralized networks now stretch from handhelds to factories, from vehicles to orbit—forming a seamless web connecting industries, ecosystems, and people. High-speed technologies like Infiniband and NVLink keep data flowing with near-zero latency, while AI turns infrastructure into a cognitive network. Even space is joining the cast, extending digital services beyond Earth's surface. Think of it as connectivity's multiversal moment—breaking the old rules, reducing delay to near nothing, and securing every interaction. Move over, movie magic: this is connectivity's Oscar-winning performance, and it's playing in real time.

Adrien Calvayrac
Expert in Residence

What

- The expansion of mobile and satellite networks has created a global digital fabric, enabling near real-time connectivity almost everywhere. The convergence of terrestrial (TN) and non-terrestrial networks (NTN) is now essential for delivering a seamless hyper-connected experience.
- Internet of everything (IoE) is driving wireless connectivity into everyday objects, enabling automation, remote monitoring, and smart functionalities, building a connected world. Connectivity is vital for critical services such as healthcare and emergency response making them accessible anywhere, anytime.
- Smart cities need connectivity to manage resources, transportation, energy, and public services efficiently, while adapting to the needs of their populations in real time. 5G wireless connectivity, low-bandwidth NTN IoT along with edge AI power the transformation.
- Applications depend on high-speed, reliable data flows to personalize services and enhance experience. The expectations for more intelligent and immersive experiences have led to the convergence of AI, digital infrastructure and connectivity to enable business and people to run better.
- As AI adoption grows, the efficiency-to-cost curve for compute is flattening, driving the need for advanced, low-latency networking to support high-performance systems. Emerging technologies like UltraEthernet, RDMA over converged Ethernet, Infiniband, and NVLink are redefining transport and Ethernet protocols to ensure scalability, stability, and reliability.

Use

- **Lockheed Martin**, **Nokia**, and **Verizon** integrated military-grade 5G into Lockheed's 5G.MIL Hybrid Base Station (HBS), enabling secure, interoperable communications. It delivers unified networking, edge processing, and advanced capabilities for resilient, secure connectivity and data flow.
- **Itron** has partnered with NVIDIA to bring AI to the grid edge by integrating Jetson Orin Nano and AI Enterprise into Itron's Grid Edge Intelligence. This enables utilities to transform daily data into real-time insights, improving performance, disaster response, and decision-making.
- **Partisia**, a multiparty computation company, **Squareroot8**, a quantum-safe communication solutions provider and **NuSpace**, an IoT company, signed an MoU to advance quantum-safe satellite communications. They aim to deliver encrypted correlated randomness via a satellite-based Quantum Random Number Generator for secure Multi-Party Computation using advanced cryptography for quantum-proof data exchange.
- **Nokia** and Intuitive Machines integrated Nokia's Lunar Surface Communication System (LSCS) into the IM-2 mission lander, Athena. Using 4G/LTE, the system will deploy the Moon's first cellular network, enabling HD video, communications, and telemetry for reliable lunar exploration.
- **The European Space Agency (ESA)** partnered with UniVirtua to demo dashAlpha, a platform ensuring uninterrupted connectivity for disaster relief and autonomous vehicles. By bonding satellite, 5G, 4G, and Wi-Fi in a software-defined setup, it enables secure, high-bandwidth links with lower hardware costs.

Impact

- Seamless and secure connectivity across home, community, workplace, remote areas, and enterprises for diverse devices enables a connected ecosystem that unlocks new business opportunities.
- The convergence of connectivity, cloud, and AI is enabling machine-to-machine and machine-to-human communication. By combining a digital fabric for diverse device data with scalable edge and cloud computing, organizations can achieve hyper-automation and predictive operations at scale.
- Enterprises are being able to provide safe work environments. Predictive insights on network and equipment health can forecast potential failures before they occur, which helps prevent accidents due to equipment breakdowns. Integrated TN/NTN coverage ensures continuity in remote and mission-critical contexts.
- With Moore's Law constraints, high-performance computing is re-architected as network-powered cluster computing. Reliable, low-latency fabrics become the backbone for training and serving advanced AI systems, sustaining near-zero-latency experiences and data-intensive workloads.

Tech

- **Satellite Communication and Non-Terrestrial Networks, Low-Earth Orbit and High Altitude Platforms:** Non Terrestrial Networks, Starlink Satellite technology, High-Altitude Platforms, Amazon's Project Kuiper, Iridium's NTN service, Boeing Satellites, Airmo, Blackshark.ai, E-Space, Sateliot, Globalstar, Airbus Zephyr (HAPS), SoftBank HAPS, Eutelsat
- **5G/IoT for Industries:** 5G for maritime, 5G in railways, 5G in manufacturing for Airbus, Ericsson 5G RedCap, Qualcomm 5G IoT, Nokia 5G Industrial devices, GitSat, Galileo Satellite Network
- **Smart Digital Infrastructure:** Omnispace, ABB Smart Robotics, Lilygo, Myriota, Latent AI, SimpliSafe, Elevat, OQ Satellite 5G IoT, Xcel Smart Meters
- **Connectivity-Powered Distributed Intelligence:** AI for sustainable networks, EdgeConneX, Qualcomm IoT AI, Itron Distributed Intelligence, Ericsson smart power grid, Landis+Gyr Distribution Automation
- **Connectivity to Break Compute Limitations of AI:** UltraEthernet, RoCE

Simply the Edge

Core edge technologies like 5G and upcoming 6G, system-on-a-chip, and embedded AI have moved the boundaries, bringing the power of IT infrastructure close to real-world operations and people while decreasing energy consumption.

It's quite the page-turner. We move beyond limits and reach the edges at higher amplitudes. Edge core technologies, such as 5G, system-on-a-chip, and embedded AI, have matured, pushing the boundaries of central IT infrastructure closer to the real world of business operations, and real people. Technology has hit the ground, embedded in our surroundings. And the tipping point is right here; where compute, storage, and processing power join at the source of data collectors, sensors, and actors—that's where innovation ignites. It's where the cloud meets its edge cousins of "mist" and "fog". Simply put, with IT infrastructure now finally turned into a genuine "infostructure," it's so much better than all the rest.

Anne-Flore Agard
Expert in Residence

What

- The edge is an enabler of telecom, cloud, and AI convergence, processing data closer to where it's generated (devices, sensors, networks). It reduces latency, saves bandwidth and improves security.
- The edge evolves to a ubiquitous infrastructure everywhere, powered by new distributed hardware components. Combining low-power CPUs, GPUs, everything on a chip (SoC), embedded AI and battery improvements, makes the infrastructure more powerful.
- Use cases like AR/VR, ambient computing, autonomous driving, space tech, and connected health demand fast edge processing. A robust edge infrastructure powered by 5G or satellite networks and secure IT/OT integration enables real-time connectivity and embedded AI across devices, from robots to industrial components.
- EdgeOps will evolve to guarantee secure, continuous delivery of up-to-date software releases and device firmware upgrades, up to and beyond the edges of the existing IT infrastructure to support AI, sensor-based applications, or control data.
- Pervasive computing needs new talent across all industries: unified experts in core IT technologies like cloud, edge integration and operations, networking, embedded software deployment while bridging across IT and OT domains.

Use

- **T-Mobile** adopted Red Hat OpenShift Platform Plus to unify its telco cloud across core and edge environments. The platform boosts automation, streamlines operations, cuts costs, and accelerates app deployment while ensuring compliance, security, and simplified telecom workload management.
- **Siemens** and **Microsoft** expanded their partnership to integrate IT and OT via Siemens Industrial Edge and Azure IoT Operations. This enables seamless edge-to-cloud data integration, improving machine performance, product quality, and reducing maintenance through AI and digital twin solutions.
- **Audi** is advancing smart manufacturing at its Böllinger Höfe plant with the Edge Cloud 4 Production (EC4P) initiative. By deploying VMware Cloud Foundation to centralize non-real-time workloads across IPCs, and partnering with Broadcom, Siemens, Codesys, and Cisco, Audi is merging IT and OT to build a software-defined factory.
- **Aramco Digital** partnered with Qualcomm Technologies to develop edge AI devices and industrial solutions for efficiency, safety, and sustainability. Its 450 MHz 5G network will connect intelligent devices like robots, drones, cameras, sensors, and rugged industrial equipment.
- **Verizon Business** introduced Edge Transportation Exchange, a V2X platform for real-time data sharing among vehicles, pedestrians, and infrastructure. After a successful 5GAA demo, Volkswagen is exploring it for pedestrian safety and automated tolling to enhance safety and streamline operations.

Impact

- Ubiquitous compute with a strong edge-powered backbone is at the tipping point of breakthroughs across industries. Space tech's new telematic solutions are reducing traffic and emissions, or biotech with connected health is allowing personalized medicine and treatments.
- The edge is evolving as an enabler and accelerator for AI, with the ability to locally process and apply embedded AI technologies—machine-to-machine interaction or directly use in human-machine interaction with smart devices.
- Decentralized processing and storing (raw) data only once on low-power edge devices will reduce IT-caused emissions in all scopes.
- Sovereign edge is meeting new regulatory demands. Autonomous, independent systems and the processing of confidential workloads are working seamlessly with a sovereign cloud/EdgeOps operating model.
- Ambient computing is emerging as a new standard for human-machine interaction. Intelligent edge-powered devices like wearables integrated into factories, cars, and homes will create a ubiquitous, connected ecosystem, evolving into an intelligent live companion.

Tech

- **Building the Edge:** Fastly Edge Cloud, Intel Edge Cloud, Siemens Industrial Edge, Cloudera Edge Management, Edge Impulse Edge AI Platform, FOG Project, Azure Stack Edge, AWS for the Edge, Google Edge, NVIDIA Edge Computing
- **Management and Connectivity:** thin-edge.io, Belden Horizon, MQTT Sparkplug, txOne EdgeIPS, ServiceNow OT Management, Airbus OneSat
- **Autonomous Devices:** OTTO by Rockwell Automation, MiR (Mobile Industrial Robots), Aumovio Integrated AMRs, Geek+ Robotics, Atlas (Boston Dynamics), Robonaut 2 (NASA and GM)
- **Embedded AI:** NVIDIA Jetson Platform, Intel Movidius Myriad X VPU, Qualcomm Snapdragon Platforms, Siemens Industrial Edge, Arm Cortex-M55 processor, Edge Impulse
- **Standardizing the New:** The Metaverse Standards Forum, CDISC, Open Geospatial Consortium

Ok Qompute

New computing architectures are emerging, such as in quantum, AI, and neuromorphic chips, rewriting the rules and possibilities of innovation.

In the world of more Moore and more than Moore, computing evolves by embracing entirely new architectures. Quantum, AI, and neuromorphic processors are shattering limits, with quantum supercomputers handling complex tasks, GPUs crunching AI equations, and CPUs conducting the flow. It's beyond raw power. This tech renaissance is reshaping infrastructure, challenging cryptography, and sparking breakthroughs in materials science. As post-quantum cryptography emerges to secure the future, the convergence of bits, neurons, and qubits takes us beyond the familiar. It's computing reimagined. Quite OK.

Julian van Velzen
Expert in Residence

What

- As bits, neurons, and qubits continue to develop at their own pace, we can expect silicon innovation to continue. The end of Moore's Law, the law that describes the exponential growth in number of transistors in a chip, isn't here just yet.
- Platforms, beyond Von Neumann architectures and silicon, are making their way to the market. Neuromorphic computing is designed to mimic the brain, while quantum computing promises computation heavy lifting. Indeed, there's more of Moore's Law and more than Moore's.
- Say goodbye to homogeneous computing systems and embrace the future with heterogeneous computing. There won't be one chip to rule them all. Instead, it's horses for courses.
- Currently, 40% of all supercomputing time goes to understanding atomic behavior. Improved capabilities go beyond reducing wait times. Instead, it will enable new materials, applications, and business models.
- On the flip side, within a decade, quantum computers may break asymmetric encryption, the foundation of the internet. Quantum-safe cryptography is available, but implementation won't be so easy.

Use

- **Google** announced quantum-safe digital signatures in Google Cloud Key Management Service for software-based keys, available in preview. The roadmap includes support for the NIST post-quantum cryptography standards (FIPS 203, FIPS 204, FIPS 205, and future standards), in both software and hardware.
- **IBM Quantum** and **Moderna** demonstrated the use of quantum simulation to predict the secondary protein structure of a 60 nucleotide-long mRNA sequence, the longest nucleotide folding pattern ever simulated on a quantum computer. Understanding how proteins fold from a given nucleotide sequence is crucial for creating effective mRNA vaccines.
- **Capgemini's Quantum Lab** partnered with **Airbus** to develop and demonstrate a hybrid quantum-classical workflow tailored for atomistic simulations of corrosion processes. It's developed with a specific focus on the initial step of the oxygen reduction reaction—a critical trigger for the corrosion of aluminium alloys widely used in modern aircraft.
- **Q-CTRL's** Ironstone Opal quantum navigation system achieved a breakthrough in magnetic anomaly navigation. In field trials, it delivered up to 46× better accuracy than strategic-grade INS, with best results showing 22m positioning error, just 0.01% of flight distance.
- **Microsoft** launched Microsoft Discovery, an enterprise agentic platform designed to accelerate R&D by empowering scientists and engineers with AI. Scientists at the Pacific Northwest National Laboratory are using its advanced Gen AI and HPC capabilities to further develop machine learning models that predict and optimize complex chemical separations.

Impact

- Do you think your business is not in the material business? Think again. Innovations in chemistry and material science are estimated to have an impact on 96% of all manufactured goods, which impact 100% of humanity (Microsoft Quantum).
- Using today's technologies, R&D organizations already report significant improvements. Exascale computing systems in use already host a variety of chips, including a variety of CPUs and GPUs.
- Future systems will incorporate quantum processor units, QPUs, while neuromorphic processor units, NPUs, finding their niche in energy-efficient edge applications. Advanced networking capabilities such as InfiniBand stitch it all together.
- Enterprises can no longer postpone the transition to quantum-safe technology. It's a necessity, as new regulations are here and bad actors are aiming for the store-now-decrypt-later method.

Tech

- **Quantum Hardware and Software:** IBM, QCI, Rigetti Computing, PASQAL, Quantinuum System Model H2, IQM, IonQ, Xanadu QuERA, Q-CTRL, Classiq, D-Wave Quantum Ocean, Xanadu Pennylane, QC Ware Promethium, Quantum Machines
- **Neuromorphic Hardware and Software:** IBM, Intel Loihi 2 and Lava, Brain chip Akida, SynSense, Innatera Nanosystems, Prophesee, General Vision NeuroMem
- **High Performance Compute and Networking:** Supermicro HPC, AWS ParallelCluster, Azure HPC, HPE Cray Supercomputing, IBM Spectrum Computing Suite, Penguin OCP Servers, ThinkParQ, Rescale Cloud HPC Platform, Altair HPC and Cloud, Quantum Machines Quantum for HPC
- **Scientific Research Software:** QC Ware Promethium, Microsoft Discovery, Qsimulate, ProteinQure, QC Ware Forge, SandboxAQ AQChemSim, IBM Qiskit Runtime, QpiAI
- **Post-quantum Cryptography:** IBM Quantum Safe, Thales, PQShield, CryptoNext Security, PQ Solution, Arqit, Qusecure, QuintessenceLabs
- **Hyperscalers:** Azure Quantum cloud service, Amazon Braket, AWS High Performance Computing, Google Quantum AI, Google Quantum Virtual Machine
- **Quantum Cloud Services:** IonQ Quantum Cloud Service, Xanadu Quantum Cloud, Forest/Quantum Cloud Services (QCS), QANplatform cloud service, Q-CTRL Quantum, Dwave-Leap, Strangeworks

09. Balance by Design

Breakthrough technologies are rewriting the playbook, turning once-impossible goals into today's ambitions. Artificial intelligence, edge computing, and ambient automation are no longer future concepts—they are the living infrastructure of enterprise reinvention. Yet this abundance of capability brings its own paradox: more power means more responsibility, and more autonomy demands more judgment. Navigating this new landscape is not a straight path; it's more like walking a tightrope—balancing competing forces at every step.

Short-term results must align with long-term vision. Efficiency must coexist with creativity. Control must give way to empowerment, yet never to chaos. Get the balances right, and the tightrope becomes a runway, propelling organizations toward their boldest aspirations.

As introduced in this year's TechnoVision, many pendulums remain in constant motion, but the challenges have evolved. We do not seek the illusion of an equilibrium; we pursue dynamic balances—the art of navigating stability while in motion. Just as the human body coordinates its senses and muscles to stay upright while running, so must the organizations too continuously rebalance as technology, markets, and expectations shift around them.

Michiel Boreel
Expert in Residence

This is the essence of *Balance by Design*: an architectural mindset for continuous motion, seeking resonance. It transforms tension into propulsion, opposing forces into complementary strengths. It's not about picking sides, but about designing systems, cultures, and technologies that thrive in oscillation.

In this year's edition, five design principles form the core of that balancing act—fewer in number, deeper in scope. Each principle captures a vital dimension of how organizations must evolve in an age of generative and agentic AI:

- **Technology ∈∋ Business** aims for the complete fusion of business and IT into one seamless flow of value creation: strategy and operations intertwined, acting as one organism.
- **WE augment!** balances automation and human intelligence: delegating action and agency to AI while carefully ensuring proper judgment, creativity, and purpose.
- **Do Good, Do Less, Do Well** keeps insisting that sustainability is not a constraint but built-in from the start, doing less harm, doing more good, and doing it better in a smarter way.
- **Be Like Water** embodies agility and adaptability as a permanent flow: fluid architectures and flexible mindsets for a world in permanent beta.
- **Trust Thrust** builds the architecture of trust—external, internal, digital, and algorithmic—across people, data, and artificially intelligent systems.

Together, they create the blueprint for resilience and relevance in a world where motion is the new stability. Each "Principle" is paired with its "Antiprinciple"—a familiar but cautionary mirror that exposes our biases and blind spots. "The Context" situates the idea in today's environment; "Live the Principle" turns insight into concrete action; and "The Openings" mark the first strategic moves, like a well-considered chess opening.

In the end, *Balance by Design* is not just about managing technology, it's about engineering confidence in a world of uncertainty. It is the discipline of designing organizations that can think and act at the speed of change, purposeful yet adaptive, intelligent yet human.

Technology ∈∋ Business

The Principle

Move from alignment to unity of business and IT, creating a seamless technology business of strategy and operations, delivering a continuous flow of value.

Every business is a technology business. Once a brand new TechnoVision slogan, this is now a structural fact. Business and IT no longer live in separate worlds of requirements and releases. They move in resonance: one shared rhythm of data, design, and delivery. The “All Ops” movement—from DevOps to FinOps, DataOps, and StratOps—removes friction and middle layers, creating a continuous flow of value in the business. The stronger the coupling strength (K) between business and technology, the greater the coherence: strategy and execution adjusting in real time, guided by shared signals and purpose. AI amplifies this connection even further, embedding intelligence into every motion. The result is not alignment but unity in motion, a living system where business and technology oscillate together, continuously turning insight into impact.

Aliasgar Muchhala
Expert in Residence

The Antiprinciple

Keep business and IT apart. Communicate through documents, deadlines, and product owners shouting across the gap. Deliver in jolts—big bangs or an endless bumpy ride of sprints. Keep (K) low, and wonder why synchrony never appears.

The Context

The responsiveness, speed, and adaptability needed to thrive in today's technology business context does not allow any obstruction, delay, or noise between the stakeholders involved. Any technology business strategy should be deployed fluidly and rapidly across business and IT operations, connected as one, as it evolves and iterates repeatedly and continuously.

This "All Ops" approach, continuously adjusting and delivering on strategy, cannot afford any loss in translation along the way. Cross-disciplinary teams work jointly on products, rather than on projects that think of creating experience and outcomes, with a potentially unlimited lifecycle, guided by shared budgets and tangible business value streams. Technology becomes more democratized, and internalized as all involved learn from each other's roles, perspectives, and skills. Because after all, the whole organization should move as one.

Live the Principle

1. **Empower the business**. Shift ownership of and responsibility for technology business solutions, products, and change towards the actual business domains.
2. **Empower IT (CIOs and CTOs)** by offering a permanent seat at the table where business priorities are determined.
3. **Create technology business product "All Ops" teams** that cut across the organization and have autonomous ability (budgets) to make tech decisions.
4. **Democratize technology**. Make self-service availability of IT capabilities to be freely leveraged by the business.
5. **Go beyond conventional governance**. Enable technology business product teams to act quickly and autonomously on top of predefined policies and authority levels.
6. **Think platforms**. To enable an organization to innovate at the speed of technological change in a business environment requires resilience to deliver results, no matter the crisis. It also needs adaptiveness—changing to meet constantly shifting demand. And last but not the least, creativity, to re-invent continuously. To achieve these, a robust, unified integration platform that can allow the enterprise to handshake with APIs and systems enabling seamless flow of data are required. On top of this, fast and effective practices can be developed that deal with today's time compression.

The Openings

- Build generic, enabling platform services but make absolutely sure one or more business domains sponsor, adopt, and apply each service right away.
- Transition incrementally, introducing technology business product teams one at a time, considering the availability of relevant platform services.
- Make technology business product teams the default for new corporate products and services, especially when innovative technology enables them.

WE augment!

The Principle

Design every process with the ambition of full, hands-free automation, yet never lose sight of the ultimate goal: to amplify human intelligence. Let AI handle the routine, repetitive, and resource-hungry tasks, so people can focus on creativity, judgment, and purpose.

The art lies in knowing when to let go and when to lean in. As autonomy grows (multi-agent systems, self-learning loops, and adaptive automation), oversight must evolve from micro-control to mindful stewardship. Threat explainability, human-in-the-loop, and approvals as dials, not switches, tuned by risk and value. The future belongs to organizations that trust machines to act while ensuring humans still decide why.

Thordur Arnason
Expert in Residence

The Antiprinciple

Pick an extreme and lose the plot:

- Cling to manual control: insist on total transparency and human approval everywhere, turning leaders into bottlenecks and stalling innovation.
- Surrender to black-box autonomy: remove context, ethics, and purpose as human judgment fades from consequential decisions.

The Context

For years, enterprises bolted snippets of automation onto human-first workflows, resulting in incremental gains at best. Today, intelligent process automation and agentic AI promise systems that sense, decide, and act. But autonomy without wisdom is noise at scale. AI's knowledge is often probabilistic, unverifiable, or simply too vast to inspect; so any model is an approximation.

The breakthrough isn't replacing people, it's enabling co-intelligence: humans and machines raising each other's game. That demands a new balance between trust and control and a clear grasp of unknown vs unknowable. With scarce skills and rising expectations, think of it this way: hire AI as your doer; develop people as the deciders. Judgment shifts from micro approving every action to setting intent, boundaries, ethics, and outcomes. And none of this works without cultural readiness alongside technical capability.

Live the Principle

1. **Build in trust and responsibility.** Establish a practical code of ethics (fair, safe, unbiased, and sustainable). Prevent harmful or obviously inaccurate outputs; allow controlled exploration where appropriate (e.g., R&D, brainstorming).
2. **Automate by default.** Assume a process can be autonomous until proven otherwise, then prove what level is safe and valuable.
3. **Mine before you design.** Use process and task mining to find high-leverage, high friction candidates: don't just automate legacy steps.
4. **Think in autonomy levels.** Calibrate ambition (e.g., LO manual → L1 assist → L2 recommend → L3 human approve execute → L4 auto execute with audit → L5 closed loop optimize).
5. **Keep purpose human.** Align AI actions to values, customer outcomes, risk appetite, and long-term goals. Make trade-offs explicit.
6. **Evolve leadership.** Move from micro-management to context-setting and empowerment. Measure outcomes, not keystrokes.
7. **Distinguish unknown vs unknowable.** For the unknown, pursue new evidence (deterministic data and probabilistic synthesis). For the unknowable, rely on performance evidence and controls rather than perfect explanation (e.g., A/B Testing).
8. **Guard the loop, instrument for trust.** Use humans to validate intent, detect bias and steer direction. Add observability (decision logs, inputs/outputs, overrides), guardrails, and kill-switches instead of case-by-case approvals.
9. **Learn symbiotically.** Treat every interaction as mutual learning: update models, guardrails, and playbooks on a cadence. Upskill people in judgment, prompting and escalation.

The Openings

- Refresh (or create) your AI Code of Practice to remove unnecessary business-preventing boilerplates, preserve non-negotiable ethics foundations, and explicitly favor augmentation over control-by-default.
- Map regulations to risk tiers (e.g., EU AI Act): categorize uses by risk, with minimal-risk fast lanes and proportionate oversight.
- Target twin opportunities: pair friction-heavy processes (ideal for high autonomy) with judgment-intensive moments (where human intuition adds irreplaceable value).
- Take a whole process view (spanning apps, data, and teams) and link automation bets to clear business metrics (time to resolution, error rate, energy use, NPS, cash cycle).
- Pilot multi-agent and human-in-the-loop designs with auditability and manageability (even if internal model mechanics are too big to know).
- Stand up decision observability: capture prompts/contexts, confidence, outcomes, overrides; review monthly with product, risk, and ops.
- Train leaders and teams for co-creation: leaders practice intent setting and boundary design; teams practice prompt framing, escalation paths, and bias spotting.

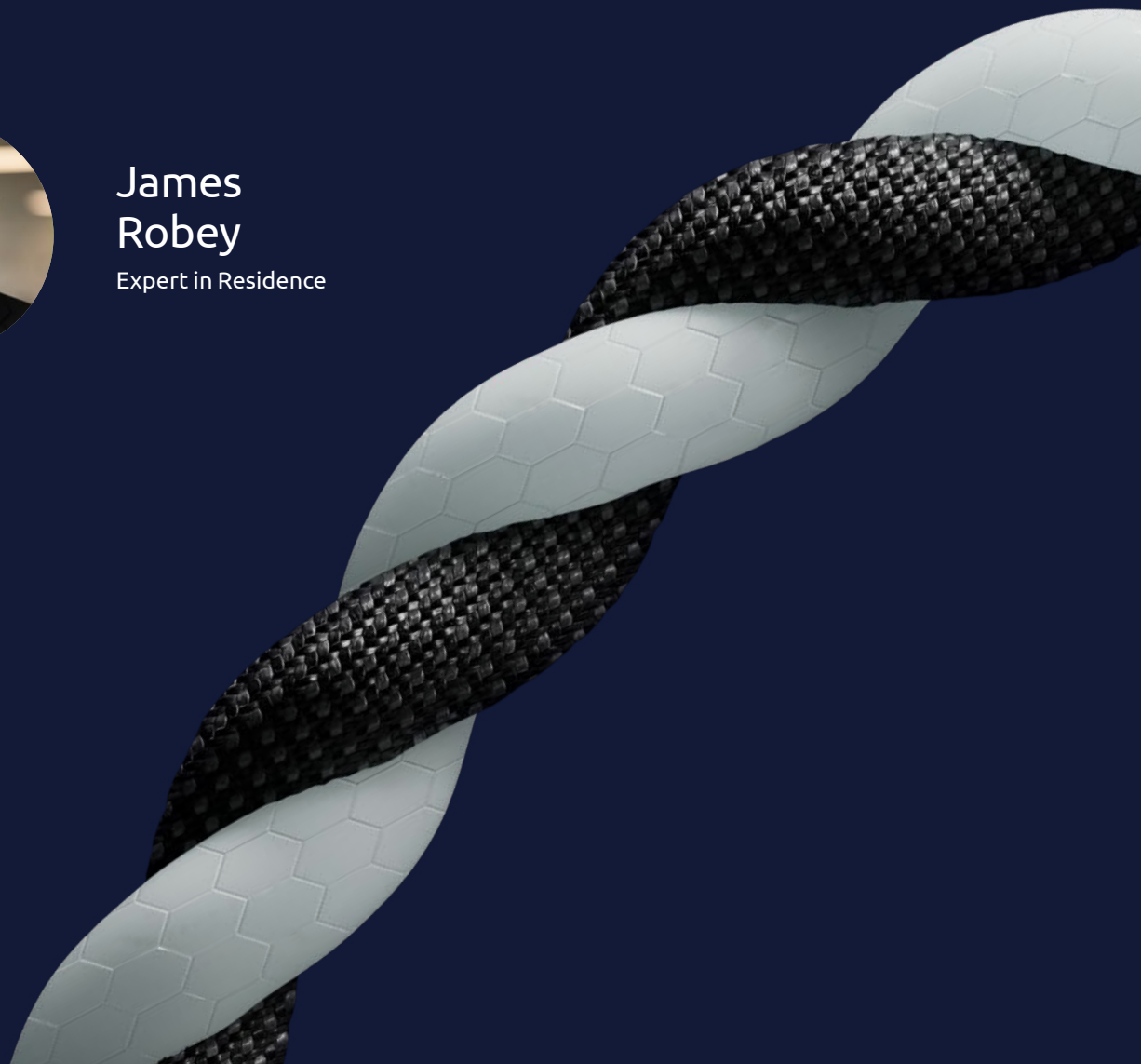
Do Good, Do Less, Do Well

The Principle

Make your organization thrive by embracing initiatives that create positive social and environmental value alongside economic value, while rejecting activities that damage the biosphere or destabilize society and compromise humanity.

Technology is a remarkable thing. Without the innovation we've seen over the past 200 years, we would be living very differently, if indeed we'd be living at all. Certainly, there wouldn't be nearly 8.5 billion of us on planet Earth! However, modern technology operates at such a staggering scale that for the first time humanity is altering the very planetary ecosystems critical to our well-being. So large is this scale that scientists have defined our era as the Anthropocene — humanity's impact on the planet is the dominant. Now is the time to apply the remarkable capabilities of technology to create a future for the benefit of every human being.

James Robey
Expert in Residence



The Antiprinciple

Unleash technology to maximize economic growth, whatever the social and environmental costs. Businesses should focus only on profit. Social and environmental concerns should only be considered if they enhance short-term profit.

The Context

Our biosphere is sick. Of the nine planetary boundaries critical for humanity's survival on planet Earth, seven have been broken and two are almost broken! Furthermore, of the 17 Sustainable Development Goals (SDGs) set by the United Nations which cover both social and economic outcomes, only 17% are on track to be met by 2030.

In this context, IT has immense potential. GESI (Global Enabling Sustainability Initiative) has identified that technology can positively impact all 17 of the goals and over 50% of the 169 specific targets sitting under the goals. Technology can improve crop yields, design medicines faster, improve the efficiency of almost every process, make supply chains more resilient, and simultaneously less carbon-intensive. At the same time, technology is also enabling individuals to learn and families to connect instantly across the globe.

While this is positive, it must be acknowledged that IT also has its own impact consuming energy, natural resources, and creating carbon emissions. Current estimates suggest up to 4% of global CO_2 emissions are associated with IT and the rapidly growing use of AI that requires an increasing amount of energy to train the sophisticated models. Indeed, if the IT industry were a country, it would be the third largest electricity consumer in the world. Clearly, IT itself must be delivered in an optimized way alongside making its societal and environmental contribution.

Live the Principle

1. **Understand your current position by assessing your sustainability footprint**. Where are you making negative environmental or social impacts and can you eliminate these while maximizing the positive impacts of your business?
2. **Identify areas where IT can contribute to reducing environmental impacts** (ideally against all nine planetary boundaries):
   - Firstly, how you can optimize your IT estate to minimize its operational impacts—e.g., consolidating your application portfolio or migrating to new technology to reduce environmental impacts.
   - Secondly, consider how IT can reduce the impact of your wider business—e.g., leveraging digital twins to identify efficiencies or applying intelligent routing to your logistics.
   - Thirdly, investigate how your application of technology can help your customers reduce their impacts—e.g., providing smart meters to help domestic energy consumers reduce their consumption.
   - Finally, remember the potentially hidden impacts of data-centers. Make sure your virtual compute power is running in the most efficient data-centers drawing only renewable electricity.
3. **When designing new products and services, assess their benefits** against the 17 Sustainable Development Goals. If it's not going to make a positive contribution across the goals, consider redesigning.
4. **Ultimately, reject non-sustainable business ideas and technology**. Align your business initiatives so that they create positive social and environmental value alongside economic value.

The Openings

- Educate your teams on the SDGs and encourage active debate about how your products and services are making a positive contribution.
- Undertake a systems audit to identify marginal or obsolete applications.
- Be critical when considering new applications, especially concerning AI, if the intended results justify the use of resources. If not, then do less with less.
- Focus on creating positive social and environmental value alongside economic value.

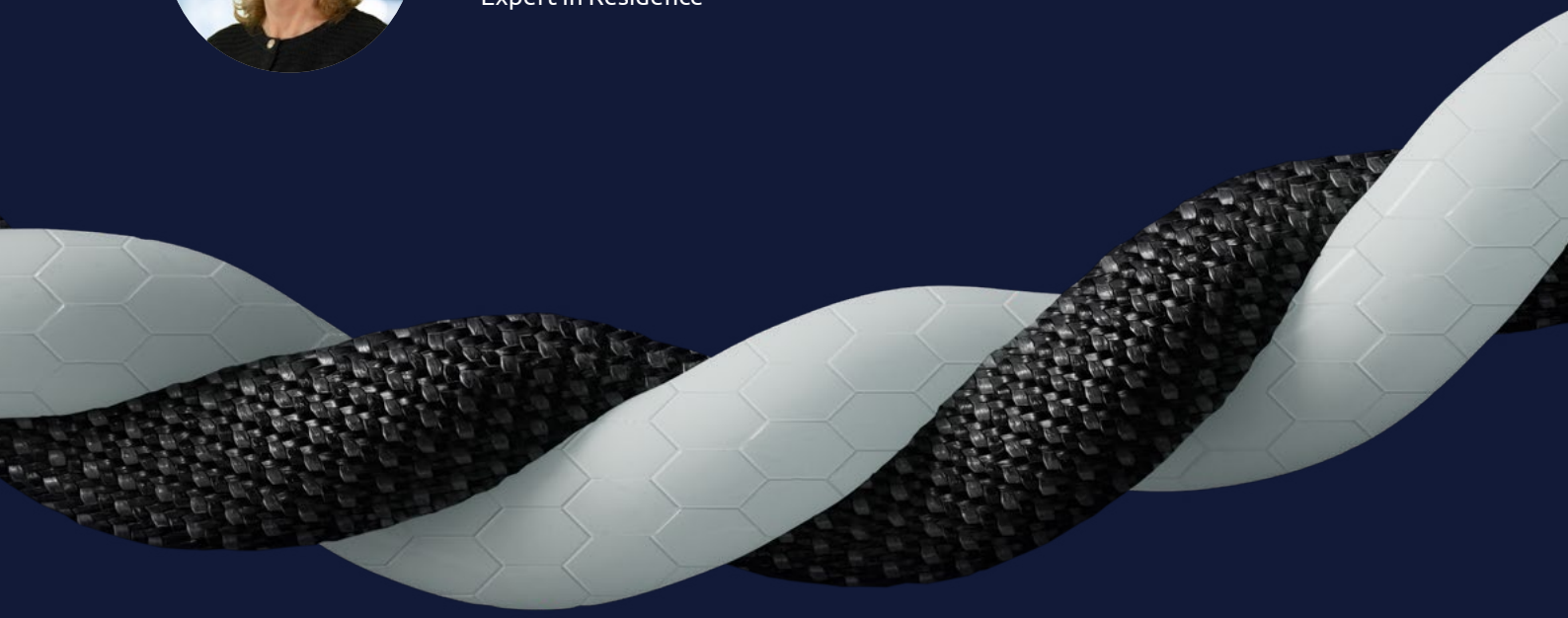
Be Like Water

The Principle

Ensure the built-in water-like capabilities of agility, flexibility, responsiveness, resilience, and openness.

The idea of being adaptable and flowing, like water, is a powerful metaphor in today's uncertain times of permacrisis. A technology business must embrace continuous, unexpected change. It involves rapid adaptation and ongoing experimentation by design. The technology infrastructure and applications landscape need to be upgraded to a flexible digital platform, ready to adapt to whatever requirement, opportunity, or challenge that arises. The organization must live and breathe agile principles, not only as the forte of the IT department and a few business representatives but also as the overall enterprise mindset. Agility and agile principles require a balance between rigid structure as guardrails to prevent chaos and creative freedom. Furthermore, adopting open standards allows the organization to harness external innovation effectively, offering an array of attractive services that invite collaboration, both internally and externally. To innovate at the speed of technological change and behavioural change of your customer, you'll need a fluid and porous organization.

Janet
Barr
Expert in Residence



The Antiprinciple

Continue to invest in the monolithic, unruly, intractable, rigid applications that limit the strategic maneuverability of the enterprise and refuse to solve the technical debt.

The Context

The near future will be marked by a series of crises and opportunities. Whether it's environmental issues, energy crises, disrupted supply chains, geopolitical turmoil, or technology breakthroughs, the world keeps defying predictions.

In this landscape, traditional prediction becomes futile, giving way to the importance of experimentation and swift adaptation. Organizations must be resilient, adaptive, and creative. Agility hinges on technology adaptability and seamless connections with internal and external stakeholders. Providing a unified experience for customers, partners, and employees necessitates effortless connectivity across industries. Applications should be designed to deal with disruption and change, featuring open connectivity as a standard. Various technologies enable this adaptability, including mesh API-first application services, self-improving IT operations, cloud-native infrastructure, open data-sharing capabilities, distributed networking, AI augmentation, and autonomous systems.

This approach allows continuous enterprise-wide reinvention, enabled by technology. But transformation will not come through technology only; neither will it come from implementing agile methodologies, tools and having passionate gurus to drive it. What's needed is a corporate mindset that embraces and expects change, rather than demonizing it.

Live the Principle

1. **Consider your IT infrastructure as digital assets.** Manage them just as carefully as you manage your physical assets.
2. **Go for enterprise-wide adoption of agile principles.** An agile IT-function within a conventional organization will not be enough to create the required maneuverability. Agility, resilience and creativity need to become the essential mindset of the total organization.
3. **Architect to adapt**. Follow architectural patterns that enable an agile, distributed mesh, such as microservices; look for AI to improve responsiveness. Re-architect your platform to evolve easily and integrate new partners, outside resources, providers, clients, and new services in the shortest time possible.
4. **Constantly evolve practices** like agile solution delivery, advanced analytics and AI, and hyper-automation drive on top of the unified digital platform as part of the overall enterprise mindset.
5. **Systematically adopt open standards** and state-of-the-art technologies—as a standing invitation card.
6. **Augment the business value of your APIs and data-sharing services**, evolving from technology-coupling systems into business-partnering vehicles.
7. **Assume processes and systems will be disturbed** and may even break. Build in measures to deal with failures and learn from them to improve resilience.
8. **Search the sweet and sour spots**. Maintain a heatmap of potential changes, for example, due to legislation, future products and services, or new partners.
9. **Prepare your change A-Teams**. Set up unified, cross-organizational teams that can absorb continuous change and act right away, especially when it's not planned.

The Openings

- Move from project to product thinking. Realizing that operations and applications always evolve, rather than end up in a final state, trains the adaptability muscles.
- Move from solution to platform thinking. A solution becomes only a temporary aggregate, built on a catalog of agile platform services and capabilities.
- Promote your technology business platform's capabilities and attractions as you would when promoting the glamor of a new product.
- Introduce objectives and key results that speak the language of open connection: business value, time-to-react, fluid workforce, and environmental contribution.
- Become irresistible to the scarce human resources out there, not just by providing security and comfort, but by offering a great work-life balance.
- Bridge strategy and operations. Apply an integrated, DevOps-style mindset to continuously operationalizing strategy in business and IT systems.

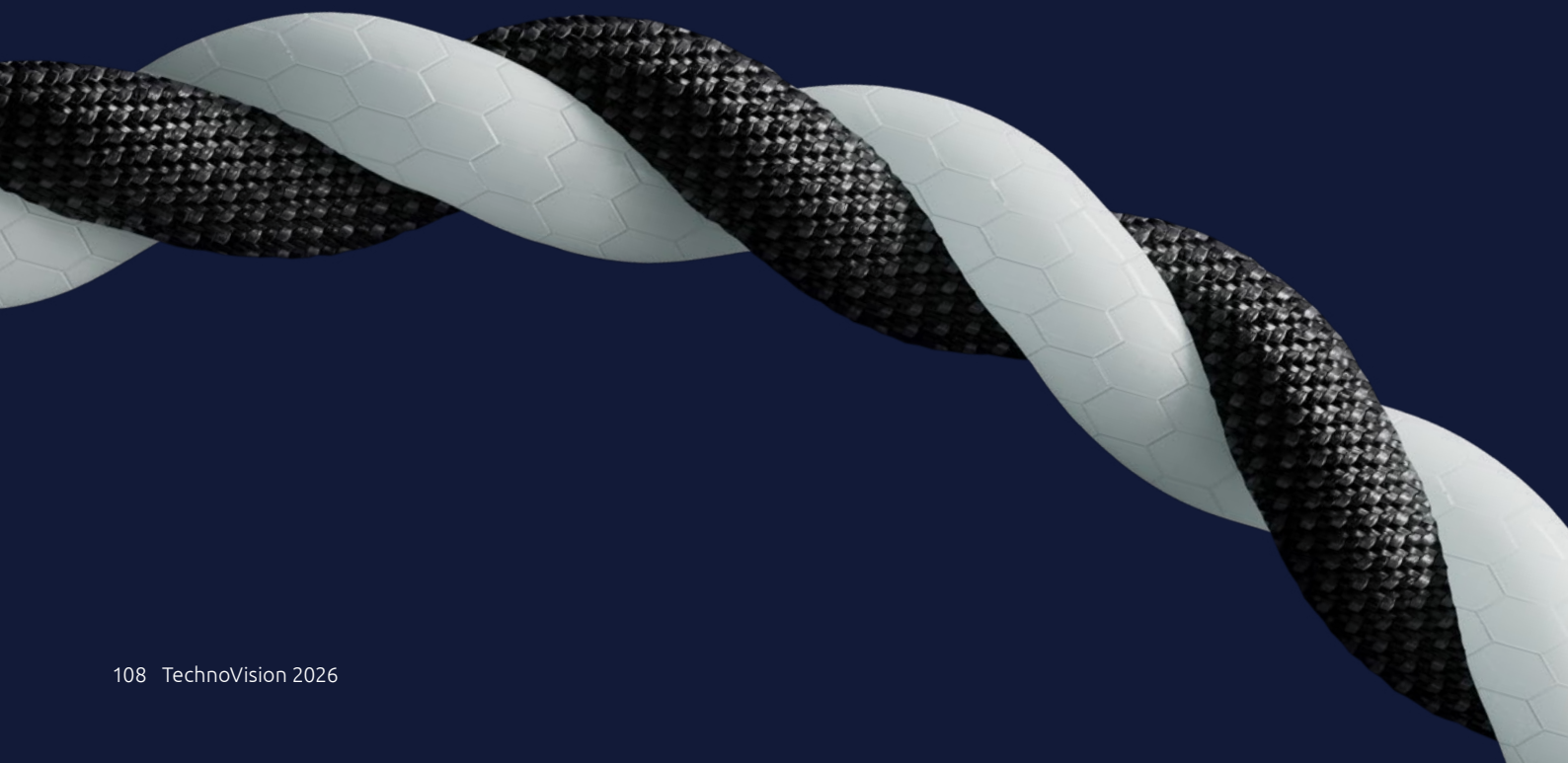
Trust Thrust

The Principle

Power up the entire trust ecosystem—from people to platforms, from the edge to the core.

Build an organization where trust isn't assumed—it's architected. Trust in customers, in colleagues, in data, and in the intelligent systems that increasingly act on our behalf. When every interaction, decision, and algorithm earns the right to be trusted, business confidence scales naturally. External trust becomes brand capital. Internal trust fuels performance and innovation. Trust in data and AI powers better, faster, more human decisions. The real thrust comes from balancing openness with assurance, empowerment with verification—designing systems where trust isn't a policy but a property. Trust everywhere. By design.

Dapo Adekola
Expert in Residence



The Antiprinciple

Treat trust as a compliance checkbox, something to prove once a year to auditors, not something to live by every day. Build a fortress of zero trust so impenetrable that collaboration, creativity, and customers are left standing outside the gate. React only when regulation demands it, then overreact by locking everything down. Confuse control with confidence. Slow innovation in the name of safety until nobody remembers what progress looked like. In the end, you'll be perfectly secure—and perfectly still.

The Context

In the age of generative AI, cyber volatility, and regulatory scrutiny, trust has become the currency of digital business.

- External trust defines how customers, consumers, and partners see the brand: shaped by transparency, reliability, and ethical use of technology.
- Internal trust governs how employees perform and collaborate, built on psychological safety and shared purpose.
- Trust in data ensures agility and confident decision-making, where insights are as reliable as the sources behind them.
- Trust in AI extends that belief system into the realm of autonomy, where algorithms execute on our behalf, responsibly and in an explainable manner.
- Data in trust means privacy, compliance, and sovereignty are non-negotiable foundations for innovation.
- Zero trust in cybersecurity reminds us that vigilance must be constant: trust nothing, verify everything—across IT, OT, and IoT.

These dimensions are not competing, but complementary. True trust leadership lies in orchestrating all six in harmony, so that innovation moves forward without fear and security never stifles creativity.

Live the Principle

1. **Embed trust end-to-end.** Make it a design parameter in every business initiative, not a checkbox at the end.
2. **Make trust measurable.** Track sentiment, reliability, privacy compliance, and ethical AI indicators as performance metrics.
3. **Build the trust fabric.** Link cybersecurity, data governance, AI ethics, and employee culture into one connected trust model.
4. **Empower responsibly.** Give teams and AI systems autonomy, but within clearly defined boundaries of purpose and ethics.
5. **Celebrate transparency.** Openness about how data and AI are used builds credibility both inside and outside the organization.
6. **Manage trust and distrust at the same time and be vigilant.** Previously, we believed that trust and distrust are the opposite endpoints at one continuum. Neuroscience has taught us that these two very different emotions occur at the same time and need specific targeted measures in parallel.

The Openings

- Run a Trust Maturity Assessment to benchmark your six dimensions of trust: external, internal, data, AI, privacy, and zero-trust security.
- Pilot multi-layer trust architectures, combining data lineage tools, ethical AI frameworks, and zero-trust cybersecurity.
- Train leaders in trust literacy, blending behavioral science, digital ethics, and cybersecurity awareness.
- Turn trust into brand equity. Communicate how your organization earns and maintains trust, not just how it secures it.

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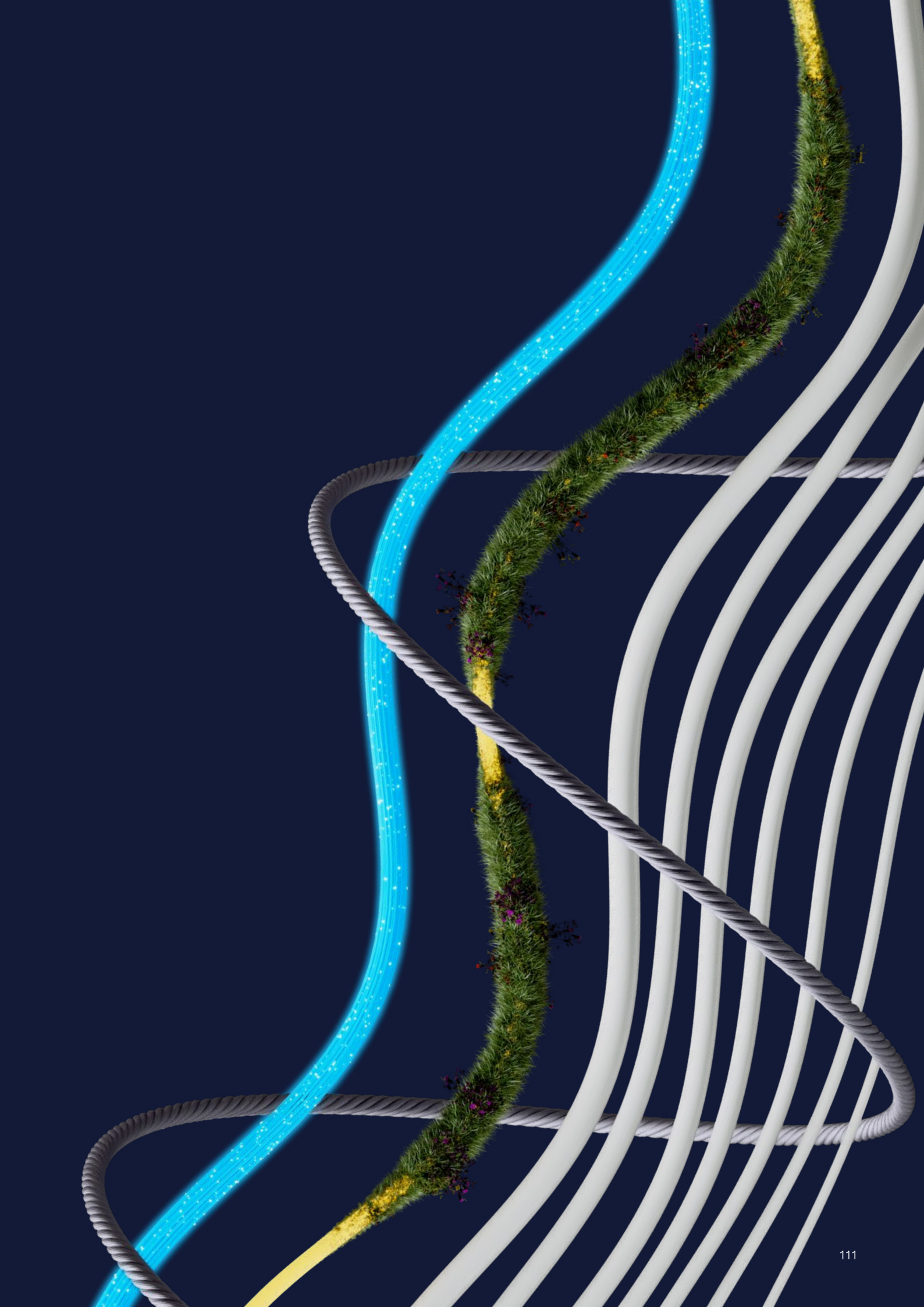

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