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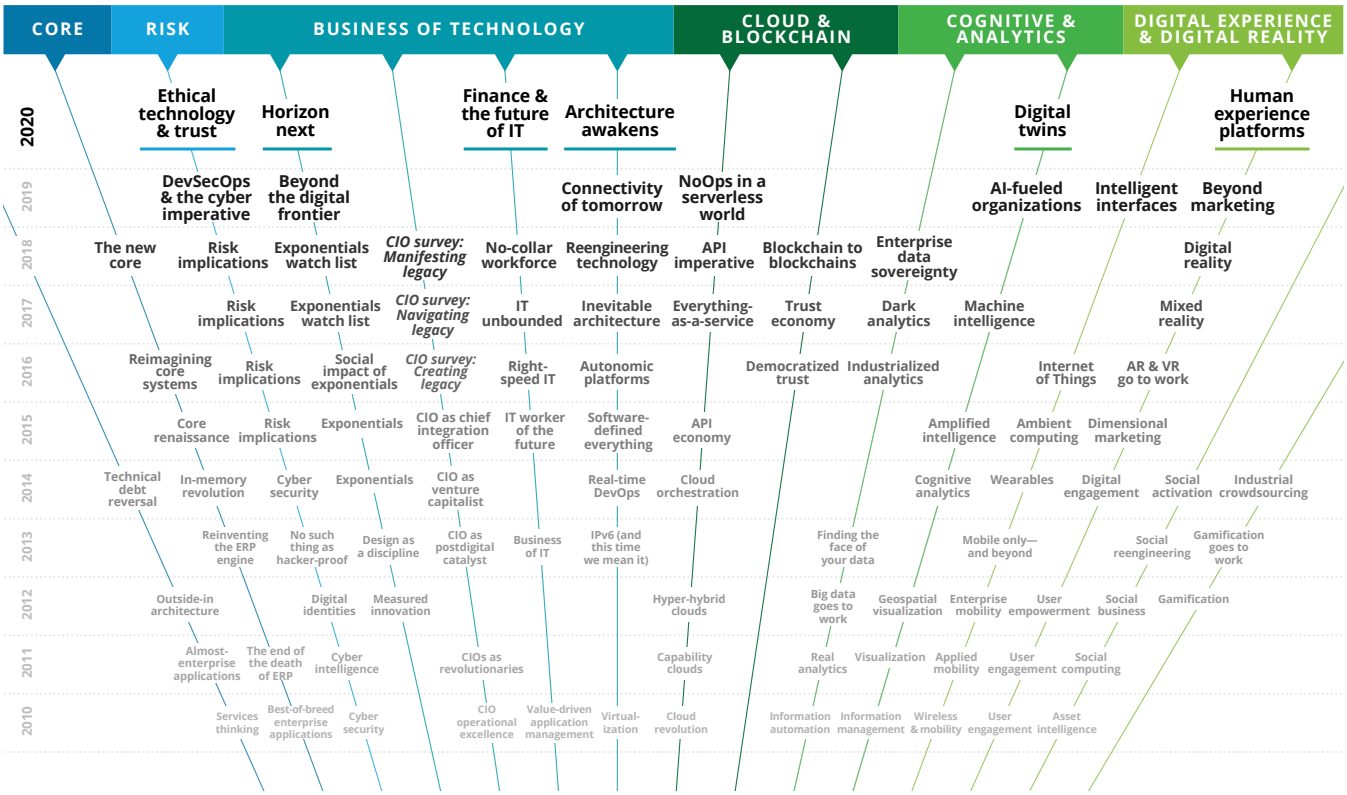
Insights

Tech Trends 2020

Contents

Trending the trends: Eleven years of research



Introduction

IN 2020, THE next stage of digital's evolution welcomes us with the promise of emotionally intelligent interfaces and hyperintuitive cognitive capabilities that will transform business in unpredictable ways. Yet as we prepare for the coming decade of disruptive change, we would be wise to remember an important point about yesteryear's leading-edge innovations: Architects of the 1980s designed mainframe systems that continue to run and generate business value today. Sure, they're outmoded by today's standards, but how many of us will build systems that run for decades? And how's that for a legacy?

Architecting for longevity and adaptability requires a deep understanding of both today's realities and tomorrow's possibilities. It requires an appreciation for the technology and market forces driving change. And finally, it requires a long-term commitment to focused and incremental progress.

Against this backdrop, we present *Tech Trends 2020*, Deloitte's 11th annual examination of the emerging technology trends that will affect your organization over the next 18 to 24 months. Several of this year's trends are responses to persistent IT challenges. Others represent technology-specific dimensions of larger enterprise opportunities. All are poised to drive significant change.

We begin *Tech Trends 2020* with a timely update on the nine *macro technology forces* we examined in last year's report. These forces—digital experience, analytics, cloud, core modernization, risk, the business of technology, digital reality, cognitive, and blockchain—form the technology foundation upon which organizations will build the future. This year's update takes a fresh look at enterprise adoption of these macro forces and how they're shaping the trends that we predict will disrupt businesses over the next 18 to 24 months. We also look at three technologies that will likely become macro forces in their own right: ambient experience, exponential intelligence, and quantum.

In subsequent chapters, we discuss trends that, though grounded in today's realities, will inform the way we work tomorrow. Our chapter on e*thical technology and trust* takes an in-depth look at how every aspect of an organization that is disrupted by technology becomes an opportunity to lose—or earn—the trust of customers, employees, and stakeholders. We follow with a discussion of *human experience platforms* that will enable tomorrow's systems to understand context and sense human emotion to respond appropriately. Pioneering organizations are already exploring ways in which these platforms can meet the very human need for connection.

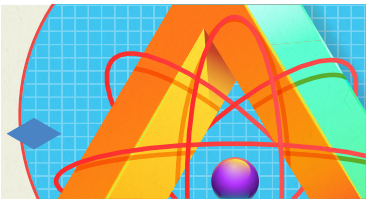
Trends evolve in unexpected ways. And often, the most interesting opportunities happen at the places where they intersect. Several of this year's trends represent fascinating combinations of macro forces and other technology advances. For instance, *digital twins* represents the culmination of modernized cores, advanced cognitive models, embedded sensors, and more—a recipe that is in itself a trend, even as it builds on evolving individual technologies.

We hope *Tech Trends 2020* offers the insights and inspiration you will need for the digital journey ahead. The road from today's realities to tomorrow's possibilities will be long and full of surprises, so dream big and architect accordingly.

Scott Buchholz
Emerging Technology research director and Government & Public Services chief technology officer
Deloitte Consulting LLP
sbuchholz@deloitte.com

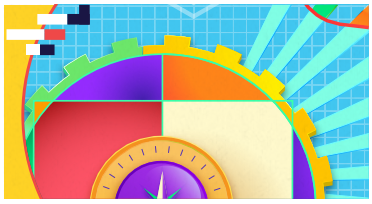
Bill Briggs
Global chief technology officer
Deloitte Consulting LLP
wbriggs@deloitte.com
Twitter: @wdbthree

Executive summary



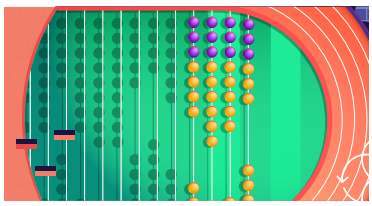
Macro technology forces

Last year's *Tech Trends* report explored nine macro technology forces that form the backbone of business innovation and transformation. For a decade, we've been tracking the emergence and eventual ascent of digital experience, analytics, cloud, digital reality, cognitive, blockchain, the business of IT, risk, and core modernization. This year's update takes a fresh look at enterprise adoption of these macro forces and explores how they're shaping the tech trends we predict will disrupt businesses over the next 18 to 24 months. To realize the full promise of these forces, organizations are exploring how they intersect to create more value as well as new ways to manage technology and the technology function. This necessary step is becoming increasingly important as businesses prepare to tackle emerging forces that appear farther out on the horizon: ambient experience, exponential intelligence, and quantum.



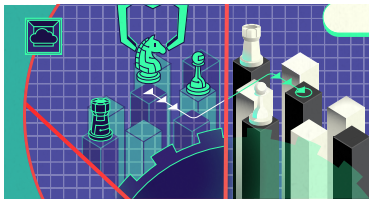
Ethical technology and trust

In a growing trend, leading companies are realizing that every aspect of their organization that is disrupted by technology represents an opportunity to gain or lose trust. They are approaching trust not as a compliance or public relations issue, but *as a business-critical goal* to be pursued. In this light, trust becomes a 360-degree undertaking to ensure that the many dimensions across an organization's technology, processes, and people are working in concert to maintain the high level of trust expected by their many stakeholders. Business leaders are reevaluating how their products, services, and the decisions they make—around managing data, building a partner ecosystem, and training employees, among others—build trust. CIOs are emphasizing "ethical technology" and creating a set of tools to help people recognize ethical dilemmas when making decisions on how to use disruptive technologies. Leaders who embed organizational values and tech ethics across their organization are demonstrating a commitment to "doing good" that can build a long-term foundation of trust with stakeholders.



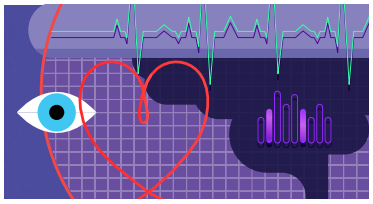
Finance and the future of IT

As technology strategy has increasingly become a core part of business strategy in organizations, the demand for improved outcomes has grown. To achieve this, we expect to see more IT and finance leaders working together to develop flexible approaches for innovating and operating at the speed of agile. Whether under the name of supporting innovation, defending against disruption, or enabling digital transformation, IT will need finance's support to effectively rethink governance of technology innovation, adapt to Agile methodologies, and secure creative capital. The work of transitioning to new finance, budgeting, and accounting processes that support innovation will not happen overnight. But there are strong incentives for both CIOs and CFOs to find ways to effectively fund innovation. Some companies are already embracing this trend and are exploring possibilities. They are at the leading edge and will likely be the first to enjoy the competitive advantages that come when finance funds innovation at the speed of agile.



Digital twins: Bridging the physical and digital

The idea of using virtual models to optimize processes, products, or services is not new. But organizations are finding that increasingly sophisticated simulation and modeling capabilities, power visualization, better interoperability and IoT sensors, and more widely available platforms and tools are making it possible to create simulations that are more detailed and dynamic than ever. Digital twins can increase efficiency in manufacturing, optimize supply chains, transform predictive field maintenance, aid in traffic congestion remediation, and much more. Organizations making the transition from selling products to selling bundled products and services, or selling as-a-service, are increasing use of digital twins. As capabilities and sophistication grow, expect to see more organizations use digital twins to optimize processes, make data-driven decisions in real time, and design new products, services, and business models. In the long term, realizing digital twins' full promise may require integrating systems and data across entire ecosystems.

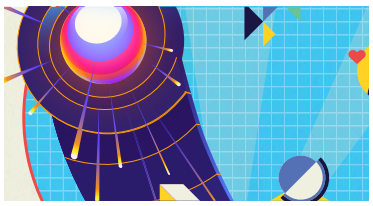


Human experience platforms

A growing class of AI-powered solutions—referred to as "affective computing" or "emotion AI"—are redefining the way we experience technology. In the coming months, more companies will ramp up their responses to a growing yet largely unmet demand for technology to better understand humans and to respond to us more appropriately. Historically, computers have been unable to correlate events with human emotions or emotional factors, but that's changing as innovators are adding an emotional quotient (EQ) to technology's IQ, at scale. Combining AI, human-centered design techniques, and technologies currently being used in neurological research to better understand human needs, human experience platforms will be able to recognize a user's emotional state and the context behind it, and then respond suitably. Indeed, the ability to leverage emotionally intelligent platforms to recognize and use emotional data at scale is one of the biggest, most important opportunities for companies going forward.

Architecture awakens

Growing numbers of technology and C-suite leaders are recognizing that the science of technology architecture is more strategically important than ever. Indeed, to remain competitive in markets being disrupted by technology innovation, established organizations will need to evolve their approaches to architecture—a process that can begin by transforming the role technology architects play in the enterprise. In the coming months, we expect to see more organizations move architects out of their traditional ivory towers and into the trenches. These talented, if underused, technologists will begin taking more responsibility for services and systems. Likewise, they will become involved in system operations. The goal of this shift is straightforward: move the most experienced architects where they are needed most—into software development teams that are designing complex technology. Investing in architects and architecture and promoting their strategic value enterprisewide can evolve this IT function into a competitive differentiator in the digital economy.



Horizon next: A future look at the trends

There's growing interest among enterprises in looking beyond *what's new* to *what's next*, and no wonder—an understanding of what's coming may inform early planning and enable relationships that could make reaping future rewards possible. Leading organizations have disciplined, measured innovation programs that align innovation with business strategy and a long-term technology landscape. They take a programmatic approach to sensing, scanning, vetting, experimenting, and incubating future macro technology forces—such as ambient experiences, exponential intelligence, and quantum—until the technology, the market, and the business applications are ready on an enterprisewide scale. Other organizations should consider following suit, using the knowledge gained to reimagine and transform their enterprises, agencies, and organizations before they themselves are disrupted. In a world of seemingly infinite unknowns, it is possible to focus attention on a meaningful collection of known technologies that, taken together, can help you chart a path to the next horizon.

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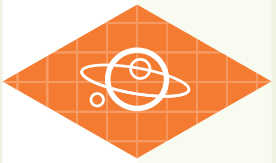
TREND SUMMARY

Exploring intersections of the macro technology forces can drive purposeful, transformational change.

ENABLERS	FOUNDATION	DISRUPTORS	HORIZON NEXT
			
DIGITAL EXPERIENCE	**BUSINESS OF TECHNOLOGY**	**DIGITAL REALITY**	**AMBIENT EXPERIENCE**
From channel to human-centered design	Reengineering "capital T" Technology	Reimagining engagement	Transparent, ubiquitous interfaces
			
ANALYTICS	**RISK**	**COGNITIVE**	**EXPONENTIAL INTELLIGENCE**
Data management, architecture, and insights	Cyber, regulatory, and ethics	Predict, prescribe, augment, and automate	Symbolic, deep, and broad reasoning
			
CLOUD	**CORE MODERNIZATION**	**BLOCKCHAIN**	**QUANTUM**
Flexibility and ubiquity	Reshaping the heart of the business	Distributed trust and assets	Exponential computation

Macro technology forces

A second look at the pillars of past, current, and future innovation

AS THE UNPRECEDENTED expansion of technology-driven innovation fuels a high-stakes game of competitive whack-a-mole, an organization's ability to exploit technology to its advantage will determine its survival. Leaders across sectors now routinely elevate technology to a strategic business priority.

Emerging technology trends stir competing emotions and narratives, often pushing us beyond our comfort zones. We're inseparable from our mobile devices, but they constantly interrupt us with an overwhelming flow of information. Cognitive assistants are helpful time-savers, but most of us find them a little creepy. Investors are bullish on flying taxis, but savvy consumers are distrustful of empty media hype and promises that exceed reality. And a painful tension exists between the possibilities of exciting novel technologies and the responsible exploration of technology domains at the forefront of an organization's 18-to-24-month investment road map.

Eleven years of research and deep engagement with global business and technology executives have helped bring clarity to this ongoing drama—and a simpler way to think about significant technology developments. Last year's *Tech Trends* report[1] explored nine macro technology forces that have been—and continue to be—the backbone of business innovation and transformation: digital experience, analytics, cloud, digital reality, cognitive technologies, blockchain, the business of technology, risk, and core modernization. For a decade, we've been tracking their emergence and eventual ascent, exploring how organizations are using them to innovate and drive purposeful, transformational change.

Digital experience, **analytics**, and **cloud** are enabling technologies that have proven their value—and then some—over the past decade. They are the basis of numerous successful corporate strategies and new business models.

This decade's disruptors are **digital reality**, **cognitive technologies**, and **blockchain**. Adoption is on the uptake, with business cases multiplying across industries. We expect these disruptors to spark surprises throughout the 2020s.

The **business of technology**, **risk**, and **core modernization** are foundational technologies. To carry the weight of technology-driven transformation and innovation initiatives, they need to be stable, strong, and sustainable.

These macro forces help drive meaningful conversations about emerging technologies not only with the CIO, CTO, and tech shop but with the CEO and the broader C-suite, board members, and line-of-business presidents. Discussing emerging technologies in the context of this framework can help simplify the tsunami of tech advances and ground in reality the investments and innovations coming from labs, startups, and R&D centers around the world. Smaller trends can be plotted on the evolutionary trajectory of these macro forces.

This year's update takes a fresh look at enterprise adoption of these macro forces and reviews how they're shaping the tech trends predicted to disrupt businesses over the next 18 to 24 months. We also peek beyond the horizon and unveil three macro forces—ambient experience, exponential intelligence, and quantum—that we expect to shape enterprise and technology strategies into the 2030s and beyond.

Enablers

When we first began exploring digital experience, analytics, and cloud a decade ago, we understood the possibilities but weren't quite sure how significant their impact would be. Since then, these now-familiar enabling forces have powered the disruption of businesses, operating models, and markets. They continue to evolve at an astounding pace.

Digital experience continues to be a critical driver of enterprise transformation—in fact, 64 percent of participants in Deloitte's 2018 global CIO survey say digital technologies will affect their businesses in the next three years.[2] Since we examined this trend last year in *Beyond marketing: Experience reimagined*,[3] organizations are dispensing with the traditional notion of customer acquisition-focused marketing, focusing instead on creating more human-centric interactions—including with their own employees and business partners.

This year, in *human experience platforms*, we discuss how leading organizations are creating customized, emotionally intelligent digital experiences based on individuals' behaviors, preferences, and emotions using an integrated array of AI capabilities such as voice stress analysis and microexpression detection tools. Consider, for example, the use of EEG- and machine learning-enabled headsets that shed light on situations that distract or create stress for employees, enabling businesses to design better workflows and work environments.

Analytics includes foundational capabilities and tools that generate powerful insights. Data management, data governance, and supporting architecture are age-old problems that not only are critical building blocks for AI programs but are tactical concerns as organizations work in a dynamic and complex regulatory environment with mandates on data residency, privacy, and usage.

CIOs understand what's at stake: 60 percent of them say that data and analytics will affect their businesses in the next three years.[4] But the issue is becoming only more challenging. The tried-and-true concepts of "data at rest" and "data in use" are joined by "data in motion," which is supported by tools for data streaming, ingestion, classification, storage, and access. The good news? Cloud, core modernization, cognitive, and other technologies are bringing fresh solutions to an exceptionally complicated challenge.

Developments in data analytics have helped advance many of this year's trends. For example, the ability to efficiently and cost-effectively process and integrate large amounts of data has spurred the creation of more advanced digital twin technology—but it has also created a deficit of trust, leading to our focus on *ethical technology and trust*.

Cloud's takeover of the enterprise is nearly complete. Ninety percent of organizations use cloud-based services[5] and they aren't putting on the brakes. In fact, cloud investments are expected to double as a percentage of IT budget over the next three years.[6] As we predicted in 2017, the use of cloud, extending beyond infrastructure, has given rise to everything-as-a-service, enabling any IT function to become a cloud-based service for enterprise consumption.[7] Hyperscalers—the handful of massive companies that dominate the public cloud and cloud services industries[8] —have shifted investments higher up the stack, providing platforms for advanced innovation in the other macro forces, including analytics, cloud, blockchain, digital reality, and in the future, quantum.

Cloud has also forced the reimagining of some tried-and-true roles. For example, as we discuss in *architecture awakens*, giving architects the ability to take full advantage of modern cloud-based offerings plays a critical role in developing complex IT systems and applications in a hybrid world.

Disruptors

Today's disruptors—digital reality, cognitive technologies, and blockchain—are the descendants of experience, analytics, and cloud. As the change agents of the coming decade, these newer trends may no longer be considered novel, but they're on the cusp of becoming as familiar and significant as their predecessors.

Digital reality

Digital reality technologies, including AR/VR, mixed reality, voice interfaces, speech recognition, ambient computing, 360° video, and immersive technologies, promote more natural user engagement by seamlessly extending a human-centric experience beyond the confines of keyboards and screens. The goal is natural, intuitive, and potentially imperceptible interactions with underlying technologies.

Commercial applications of digital reality are growing.[9] For example, as discussed in *human experience platforms*, many companies are using digital reality technologies to deepen emotional connections and empathy among customers and employees. And in *digital twins*, we see how digital reality can help bring the digital twin to life. Using AR, a manufacturer can provide its workers with a view into 3D content from a digital twin, improving worker productivity.[10]

Cognitive

Cognitive technologies, such as machine learning, neural networks, robotic process automation, bots, natural language processing, neural nets, and the broader domain of AI, have the potential to transform nearly every industry. These technologies personalize and contextualize the human-technology interaction, allowing businesses to provide tailored language- and image-based information and services, with minimal or no human involvement.

Demand for cognitive technologies is skyrocketing—IDC forecasts spending to reach US$77.6 billion in 2022[11]—although their potential benefits are accompanied by significant trust and tech ethics considerations. As we discuss in *ethical technology and trust*, a company can help build a reputation as a trusted global brand by being transparent about the use of cognitive technologies, evaluating the impact on customer trust, and proactively seeking to understand and mitigate the effects on customers and their data.

Blockchain

Blockchain is a critical technology priority for more than half of those who participated in Deloitte's 2019 Global Blockchain Survey, a 10-point increase from 2018. Eighty-three percent could identify compelling blockchain use cases, a 9-point increase from the previous year. Results suggest that in 2019, the topic of enterprise blockchain discussions shifted from, "Will blockchain work?" to, "How can we make blockchain work for us?"[12]

Financial services and fintech companies continue to lead blockchain development, but other sectors—notably, government, life sciences and health care, and technology, media, and telecommunications—are also advancing blockchain initiatives.[13] Similar to cloud, our *architecture awakens* trend discusses how blockchain provides architects with an opportunity to do bold new things, disrupting the status quo as they work on multidisciplinary teams to help achieve business outcomes.

Foundation

The business of technology, risk, and core modernization may seem prosaic and dull, but these forces are undeniably the heart of the business. And companies continue to make considerable investments and advances in these well-established domains. Combined, they provide a reliable, scalable foundation for digital transformation, innovation, and growth, and are a requirement for successful investments in analytics, cognitive, blockchain, and other disruptive technologies.

The business of technology

The business of technology—how IT operates—is evolving as technology and business strategies converge. As companies increasingly look to reengineer IT not only to deliver operational excellence but to partner with business functions to drive value creation, many IT teams are shifting their focus from project delivery to product and business outcomes and adopting collaboration-enabling development methodologies such as Agile and DevOps.

The supercharged technology function can then help enterprises become more agile in their response to technology-driven market and business changes. In *finance and the future of IT*, we take a closer look at how new approaches to technology finance are helping fuel business agility. And in *architecture awakens*, we examine how organizations are redefining the architect's role to cultivate responsiveness to overarching business needs and encourage collaboration with business and end customers.

Risk

Risks facing enterprises in an innovation-driven era extend far beyond traditional cyber, regulatory, operational, and financial threats. Participants in the *2019 CEO and board risk management survey*[14] said the top threats to their companies were those related to new disruptive technologies and innovations, ecosystem partners, brand and reputation, and organizational cultures—even as they acknowledged they hadn't prepared for or invested appropriately to manage these risks.

Beyond the essentials of compliance and security, organizations are approaching the broader issue of trust as a corporate strategy driven by the potential risks that emerging technologies could have on products, services, and business goals. *Ethical technology and trust* examines the broad implications of trust—including ethics and responsibility, privacy and control, transparency and accountability, and security and reliability—on an organization's people, processes, and technology.

Core modernization

Core modernization reflects the ongoing pressures that digital transformation, user expectations, and data-intensive algorithms put on core systems in the front, mid, and back office. Whether it's digital finance, a real-time supply chain, or a customer relationship management system, core systems support key business processes. Many CIOs recognize that their legacy systems lack the agility to innovate and scale, with 64 percent of CIO survey participants currently rolling out next-generation ERP or modernizing legacy platforms.[15]

In an era of instantaneous, always-on, tailored interactions, organizations need to lower their overall technical debt. Thoughtful approaches to modernizing the core—reengineering existing legacy systems, refreshing ERP systems, and rewriting systems—are more important than ever. *Architecture awakens* discusses how technology architects are building on future-forward architectures that leverage new platforms to get the benefits of agility, automation, security, and scalability.

Emerging forces on the horizon

As the three disruptor forces are gaining ground and are poised to make significant business contributions in the coming decade, three technology developments and innovations—the horizon next—are waiting in the wings. We will begin to feel their impact toward the end of the 2020s.

Ambient experience

Ambient experience envisions a future in which technology is simply part of the environment. Computing devices continue to increase in power and shrink in size. These ever-smaller devices are evolving our input from unnatural (pointing, clicking, and swiping) to natural (speaking, gesturing, and thinking) and their interactions from reactive (answering questions) to proactive (making unanticipated suggestions).

As devices become seamless and ubiquitous, they and we are becoming increasingly inseparable. Imagine a future world where tiny, connected, context-aware devices are embedded throughout the office, home, and beyond, functioning as part of the background. Or neurofeedback technology that today enables game-playing through brainwave analysis[16] could serve as the foundation for direct brain and neural interaction, allowing us to think a question or request and have an appropriate response or action delivered to our ambient experience. For example, thinking, "I need to leave for the airport in an hour" could trigger a cascade of background activity, including arrangements for automated flight check-in, a virtual boarding pass for biometric screening, a self-driving car programmed to activate at the correct terminal, setting your home smart system to "away," and halting deliveries for the duration of the trip.

Exponential intelligence

Exponential intelligence will build on today's cognitive capabilities. Today, machine intelligence can find patterns in data but can't interpret whether those patterns have inherent sense. It lacks the ability to recognize and respond to the nuances of human interaction and emotion. And it is also very narrow—it can defeat a human chess grandmaster but can't understand the need to flee from a room on fire.

The future promises more. With semantic and symbolic understanding, machines will be able to tease out actual causality from spurious correlation. With a combination of technologies from *human experience platforms*, our virtual assistants will increasingly be able to recognize—and adapt to—our moods. And as researchers make progress at creating broad, not just narrow, expertise, exponential intelligence will be able to move beyond the statistical and computational. It will ultimately lead to more capable AI with, dare we say, personality.

Quantum

Quantum harnesses the counterintuitive properties of subatomic particles to process information and perform new types of computation, communicate "unhackably," miniaturize tech, and more. For quantum computing, the special properties of these quantum bits, or qubits, have the potential to create exponential change. By manipulating individual particles, quantum computers will be able to solve certain highly complex problems that are too big and messy for current supercomputers—from data science to material science.

As researchers overcome current technical limitations, quantum computers will increasingly supplement classical computers. Data scientists will be able to scan ever larger volumes of data for correlations; material scientists can use qubits to simulate atoms in ways that are impracticable on classical computers; and fascinating possibilities exist in many other areas including communications, logistics, security and cryptography, energy, and more.

MY TAKE

JOHNSON & JOHNSON HELPS people live longer, healthier lives by creating innovative medicines, life-altering medical devices, and trusted consumer products. While there's no denying that technology touches every aspect of our business, what matters most to our patients and customers is how our products help improve their lives. Technology absolutely plays an important role in getting us there, but it is a means to achieving our greater purpose of improving human health.

JOAQUIN DUATO
VICE CHAIRMAN OF THE EXECUTIVE COMMITTEE, JOHNSON & JOHNSON

Within this context, technology's potential has always been front and center in some areas of our business, such as R&D. What has changed in the last few years is that now everyone appreciates that technology is an enabler, everywhere in the organization, across lines of business, functions, and our talent pool. Today, the convergence of multiple disruptive technologies is helping us generate more value for our stakeholders by making better decisions and working more productively.

First, we're making better business decisions thanks to data science. Given J&J's reach, there is tremendous potential in connecting our data and embedding higher-quality, more efficient, and increasingly predictive decision-making tools across the organization. To do this, we are working cross-functionally to build our data science foundation by understanding what types of data are available, cleaning and engineering it so it can be analyzed more easily, and defining our next-generation data standards and architecture. The results are already impressive. For example, supply chain leaders are using advanced analytics to plan and improve process controls. In addition, R&D depends on data science to advance clinical trials and screen new medicine candidates faster than ever before so we can deliver safe and effective new medicines to patients in need.

We're also using data science to help doctors make better patient health care decisions. For a hypertension study, J&J scientists collaborated with the Observational Health Data Sciences and Informatics network to perform research on hundreds of millions of patient records within the network's international database.[17] The study included insurance claims data and patient records from 4.9 million patients, making it the most comprehensive study ever on first-line drugs used to reduce hypertension. Rather than conducting single pairwise comparisons of two medicines for a given outcome, as most studies do, data science technologies enabled the team to evaluate 22,000 pairwise comparisons at once. By accelerating the research process, advanced analytics and cognitive technologies can help doctors deliver better patient care.

Second, we're using intelligent automation—automation technologies combined with artificial intelligence—to give our employees the gift of time. Intelligent automation reduces repetitive and routine work while generating insights that employees can use to improve compliance, quality, and speed. For example, our finance collections team automates routine tasks, giving members more time to engage with customers to resolve disputes. This has led to improved cash flow, increased productivity, greater efficiency, and enhanced job satisfaction.

Over the past 18 months, we've automated nearly 30 global processes affecting 300,000 transactions. We've improved business outcomes and quality, while giving back more than 15,000 hours to our teams. And we've merely scratched the surface of what's possible—we intend to scale these solutions across our enterprise.

These overarching initiatives are underpinned by investments in cloud, core modernization, comprehensive cyber risk strategies, and more. Our employees are just like consumers in that they want to have a frictionless experience with technology in their day-to-day lives, so we're focusing on improving their digital experience wherever we can. We're simplifying workflow, making processes less complicated, and shifting to modern user-centric designs powered by data science and intelligent automation.

All of this requires an evolved technology organization that works as a strategic partner and not just a service provider. Our technology team's role is to ensure we apply disruptive technologies in concert to help the organization deliver stronger outcomes, and we're introducing ways to measure the connection between the function's performance and the outcomes the business cares about. For example, how can we use metrics to show that R&D is making better decisions because our technology function is delivering cleaner data?

In the same way that the technology organization needs to understand the business outcomes it supports, our executives need to recognize how technology can help them achieve the outcomes they desire. We don't expect our executives to become programmers, but they should be able to identify how, when, and where technology can help them drive better results. And we want them to develop a dose of healthy skepticism so they can distinguish between hype and technologies likely to deliver lasting outcomes.

We look at technology as an enabler that helps our people progress in their careers, become proactive change agents, and deliver better outcomes. We take a simple view of new and emerging technologies: They are valuable because they help us achieve business results that are meaningful to our patients and customers—and because they help us create a better, healthier world.

MY TAKE

ROB CARTER
EVP AND CIO, FEDEX

FOR NEARLY HALF a century, technology has underpinned critical business and logistics operations on which FedEx customers depend. Almost a decade ago, we committed to an expansive technology renewal initiative based on an ongoing vision for cloud and everything-as-a-service. We began a journey to simplify and modernize our monolithic legacy systems by creating a collection of orchestrated microservices.

We're wrapping up the primary phase of the IT renewal initiative, and it's nothing less than a complete refactoring of legacy software applications that typically have long development, testing, and deployment cycles. Our new service-oriented, cloud-based model is more value-driven. The technology team orchestrates software functions as interoperable microservices that can be used across multiple platforms. They are smaller, incremental, and modular, with iterative delivery cycles that enable us to rapidly adapt to ever-changing business circumstances and help us remain in alignment with our customers as they adopt API- and service-driven architectures and workflows.

As the Internet of Things, advanced analytics, and blockchain emerged, we were able to leverage them to sustainably develop innovative new products and services for our customers. We've been able to position ourselves ahead of the curve on these and other emerging technologies. For example, we developed and are testing small, embeddable IoT sensors—each about the size of a pack of gum—that provide drop-in connectivity using Bluetooth Low Energy (BLE) wireless networks. This allows us to dramatically expand the amount of shipment data we collect beyond date, time, and location stamps to include temperature, speed, and a host of other measurements. The application of real-time analytics to the sensor-collected data improves visibility into the transportation network, automatically predicts the flow of shipments, and optimizes delivery routes by dynamically routing shipments to bypass network clog points.

When IoT and analytics are combined with blockchain, they have the potential to improve existing chain-of-custody systems and processes. Embedded IoT sensors can automatically transmit data to a blockchain ledger as a shipment moves from point of supply to point of demand, enabling carriers, regulators, and customers to track the provenance of goods, combat illegal and counterfeit products, and simplify the cross-border shipping process. Ultimately, we expect the impact of these technologies to extend beyond product shipments to the end-to-end life cycle of a product as it moves through the supply chain.

To stay ahead of the innovation curve, we must be responsive, which requires an agile framework that allows us to rapidly and iteratively adapt, deploy, and pivot when the market demands it. For instance, our experiments with sensor-based logistics stretch back more than a decade with the launch of our SenseAware device. Initially, we deployed sensors that relied on cell phone networks, migrating to BLE network technology when it proved more efficient. Large and expensive, the original sensors had to be reclaimed and reused. As IoT capabilities matured and became more cost-effective, we were able to roll out smaller, less expensive sensors at scale.

We also embrace risk-taking innovation when the potential reward outweighs the risk. For example, we calculated that the cost of experimenting with blockchain and potentially concluding that it wasn't useful would be a fraction of the cost of not making an early blockchain move at all. Our willingness to take an early risk paid off. As a charter member of the Blockchain Research Institute and current standards chair of the Blockchain in Transport Alliance, we have access to invaluable contacts and resources in the blockchain industry.

We know this is a continuous journey—we can't ever stop transforming. New competitors are agile and technologically savvy, so we plan to continue to evolve our analytics capabilities and to integrate artificial intelligence into the logistics network. And there are a few more legacy systems whose long tentacles haven't been fully pried out yet. But because we can't predict the next innovation or market force, we haven't locked ourselves into processes, investments, or technologies that aren't adaptable to future unknowns. I don't always know what's coming next, but with an adaptable set of services and the ability to be agile and iterative, I know we'll be much faster at delivering value.

EXECUTIVE PERSPECTIVES

STRATEGY

Many of the disruptive opportunities around which organizations are building their business and innovation strategies are grounded in the macro forces discussed in this chapter. To capitalize on changing technology forces and become undisruptable, CEOs need to become "masters of disruptive jujitsu."[18] They should identify potential disruptions, organize appropriate component responses, and hijack the trends for their own competitive advantage. To do so, CEOs can work with tech executives and their teams who are identifying emerging technology and operating on the front lines of the digital revolution. At the same time, it falls to the CEO—particularly those in incumbent organizations—to strike an ambidextrous balance between "protecting the fortress" and embracing disruptive technology. Stability is important, but given the pace of technology-driven disruption, few can afford to focus solely on the short term. The time to invest in the next generation of macro force innovations is now. As such, CEOs expect CIOs to become insightful strategists and futurists who can help their peers connect the realities of today with the possibilities of tomorrow.[19]

FINANCE

Which macro-level technology disruptions could upend one industry and cause value to migrate to another? As CFOs examine technology-driven innovations for opportunities, this question should be top of mind. In the last 20 years, for example, disruptive innovations have driven value away from established advertising and retail players, toward tech startups with dynamic new models, and onward to social media platforms attracting advertising and marketing dollars. It is finance's job to anticipate how emerging trends could alter where and how companies may make money in the future, and who will own the profit streams. As a result, CFOs and their teams should strive to become more fluent in enterprise technology. With a vision of the future in mind and a deeper understanding of disruptive technologies and their possibilities, CFOs and their teams can then develop strategies for competing in a brave new ecosystem.

RISK

The farther we gaze into the future of the macro forces and the disruption they enable, the more difficult it becomes to recognize, evaluate, and plan for consequent risks. Today's risk assumptions will quickly dissolve into a fog of ambiguities and unknowns that do not fit neatly into the chief risk officer's green, yellow, and red stoplight charts. How, then, can companies better understand the technology risks that lie ahead? First, by deploying advanced cognitive risk sensing and predictive risk intelligence tools that continuously scan the digitalized risk landscape for relevant information.[20] Similarly, by applying AI capabilities—including data mining, machine learning, and natural language processing—to unstructured data, they can identify risk indicators that humans and traditional analytics often miss.[21] But these steps alone are not enough to bring the future into focus. Going forward, CIOs should help risk and business leaders develop a more nuanced understanding of the role macro forces play in their company's future. This will help them think beyond traditional stoplight chart reporting and develop new approaches for identifying and managing only the most relevant risks ahead.

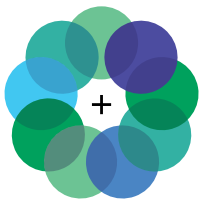
NINE SHIFTS HELP DELIVER ON THE PROMISE OF THE MACRO FORCES

Nine shifts can help businesses organize effectively and upgrade their innovation chops to realize the collective benefits of the macro forces.[22] Each of these interconnected shifts influences the others; applying them in concert can help businesses achieve the most effective outcomes.

- **Agility and speed.** Agile capabilities, organizational design, culture, work style, funding, governance, and sourcing can help companies innovate rapidly.
- **Future workforce.** As traditional IT tasks and capabilities disappear, businesses seek talent with new technical skill sets and soft skills.
- **Digital transition.** Every company's transition from digital experience to digital reality will have a different focus, type of leader, and structure.
- **Innovation and ecosystems.** A radar for disruptive technologies, an innovation ecosystem, and a pipeline of ideas can enable continual innovation.
- **Governance and funding.** Leaders can consider making governance and funding changes that support technology innovation and a product-centric focus.
- **Data organization.** Data-focused organizations extend the focus of analytics from operational efficiency and risk management to value creation.
- **Blurred internal boundaries.** Embedding technologists in business functions can extend technology funding and accountability deeper into the business.
- **Leadership and culture.** Leadership skills and a supportive culture can help companies recruit, develop, and inspire the technology workforce.
- **Cloud adoption.** Adopting the cloud typically shrinks the centralized IT organization and promotes value cocreation in addition to operational excellence.

Build wisely: The macro forces in concert

In and of themselves, none of the macro forces is sufficient. But like instruments in a symphony, the macro forces, working in concert, can lead to innovative new business models, new sources of business value, and transformed business operations.



In our exploration of these macro forces over the last decade, perhaps our most significant finding was that the most effective organizations are combining multiple trends. For each of our 2020 trends, we highlight how multiple macro forces come together to set the stage for a new disruption. Take, for example, digital twin technology. Over the course of the last decade, advances in cloud, analytics, cognitive technologies, and digital reality have combined with digital design and manufacturing system advancements to make it easier to integrate data from multiple systems, software platforms, applications and hardware. Now organizations across industries can use digital twins to optimize processes, make data-driven decisions in real time, and create new products, services, and business models.

Leading organizations are proactively engineering a controlled collision of these macro technology forces to create a solid foundation for innovation that can propel their business into the future.

ARE YOU READY?

1. How is your business integrating the adoption of emerging technologies with business strategy?
2. How many, and which, macro technology forces do you believe provide the strongest backbone for future innovation in your business?
3. Which time horizon does your organization's technology strategy currently address?

BOTTOM LINE

Nine macro forces will continue to shape future business and technology strategies, IT operations and investments, business models, and markets. Together, they're clearing a path for three new forces that could render our world unrecognizable by the next decade. Our challenge is to organize the enterprise to navigate the macro forces from experience to digital reality, analytics to cognitive, and cloud to blockchain to deliver on the combined promise that these forces hold.

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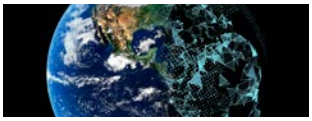

2019 FUTURE OF CYBER SURVEY

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Authors

BILL BRIGGS is a principal with Deloitte Consulting LLP and is the global chief technology officer. With more than 20 years of experience, he helps clients anticipate the impact that emerging technologies may have on their businesses in the future, and how to get there from the realities of today. He also helps define the vision and incubate the future of Deloitte Consulting LLP's evolving technology services and offerings. Briggs serves as executive sponsor of Deloitte's CIO Program, offering CIOs and other IT executives insights on how to navigate the complex challenges they face in business and technology.

SCOTT BUCHHOLZ is a managing director with Deloitte Consulting LLP and serves as the Government and Public Services chief technology officer and the national Emerging Tech Research director. A leader and visionary with more than 25 years' experience, he advises clients on how to navigate the future using existing and emerging technologies. Buchholz also leads Deloitte's efforts to incubate nascent technology offerings.

SANDEEP SHARMA is the deputy chief technology officer and managing director in the Strategy and Analytics practice with Deloitte Consulting LLP. He has a doctorate in real-time analytics and is a data scientist with more than 23 years of global experience, focusing on the future of analytics, artificial intelligence, digital workforce, and data modernization programs. Sharma works in a variety of industries, helping our clients to become AI-enabled, insight-driven organizations.

SENIOR CONTRIBUTORS

Andries van Dijk
Director
Deloitte Consulting B.V.

Hans van Grieken
Independent adviser
Deloitte MCS Limited

Nicholas Reed
Senior manager
Deloitte MCS Limited

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TREND SUMMARY

In a time of constant tech disruption, earning trust is a 360-degree challenge—and opportunity.

DEFINITION

e-thi-kəl / technology

An overarching set of values that direct an organization's approach to its use of technologies as a whole and the ways in which they are deployed to drive business.

BY THE NUMBERS

of respondents in a Deloitte study from high-growth companies are highly concerned about the ethical ramifications of technologies, compared to only 27% of low-growth companies.†

TREND BREAKDOWN

†Timothy Murphy et al., *Ethical technology use in the Fourth Industrial Revolution*, Deloitte Insights, July 15, 2019.

Ethical technology and trust

Applying your company's values to technology, people, and processes

A COMMON REFRAIN in Deloitte's *Tech Trends* reports is that every company is now a technology company. With the advent of digital technology, businesses have been asking customers to trust them in new and deeper ways, from asking for personal information to tracking online behavior through digital breadcrumbs. At the same time, headlines regularly chronicle technology-based issues such as security hacks, inappropriate or illegal surveillance, misuse of personal data, spread of misinformation, algorithmic bias, and lack of transparency. The distrust these incidents breed in stakeholders—whether customers, employees, partners, investors, or regulators—can significantly damage an organization's reputation.[1] Indeed, consumer trust in commercial enterprises is declining, citizens are becoming wary of public institutions, and workers are asking employers to explicitly state their core values.[2]

In what we recognize as an emerging trend, some companies are approaching trust not as a compliance or public relations issue but *as a business-critical goal* to be pursued—one that can differentiate them in an increasingly complex and overfilled market. As discussed in Deloitte's 2020 *Global Marketing Trends* report, brand trust is more important than ever for businesses—and it's all-encompassing. Customers, regulators, and the media expect brands to be open, honest, and consistent across all aspects of their business, from products and promotions to workforce culture and partner relationships.[3]

Every aspect of a company that is disrupted by technology represents an opportunity to gain or lose trust with customers, employees, partners, investors, and/or regulators. Leaders who embed organizational values and the principles of ethical technology across their organizations are demonstrating a

commitment to "doing good" that can build a long-term foundation of trust with stakeholders. In this light, trust becomes a 360-degree undertaking to help ensure that an organization's technology, processes, and people are working in concert to maintain that foundation.

As the adage reminds us, trust is hard to gain and easy to lose.

The ethical technology terrain

The term *ethical technology* refers to an overarching set of values that is not limited to or focused on any one technology, instead addressing the organization's approach to its use of technologies as a whole and the ways in which they are deployed to drive business strategy and operations.[4] Companies should consider proactively evaluating how they can use technology in ways that are aligned with their fundamental purpose and core values.

Ethical technology policies do not replace general compliance or business ethics, but they should all connect in some way. Just as your approach to cybersecurity hasn't taken the place of your company's more general privacy policies, your ethical technology approach should complement your overall approach to ethics and serve as its logical extension in the digital realm. Some companies are expanding the mission of existing ethics, learning, and inclusion to include ethical technology, while maintaining separate technology ethics programs. Doing so helps keep technology ethics top of mind across the organization and encourages executives to consider the distinctions between technology-related ethical issues and broader corporate and professional ethics concerns.

The fifth annual study of digital business by *MIT Sloan Management Review* and Deloitte found that just 35 percent of respondents believe their organization's leaders spend enough time thinking about and communicating the impact of digital initiatives on society. While respondents from digitally maturing companies are the most likely to say their leaders are doing enough, even then, the percentage barely breaks into a majority, at 57 percent.[5]

These findings suggest that organizations still have significant room to step into the lead. Those companies that develop an ethical technology mindset—demonstrating a commitment to ethical decision-making and promoting a culture that supports it—have an opportunity to earn the trust of their stakeholders.

In pursuit of trust

In the digital era, trust is a complex issue fraught with myriad existential threats to the enterprise. And while disruptive technologies are often viewed as vehicles for exponential growth, tech alone can't build long-term trust. For this reason, leading organizations are taking a 360-degree approach to maintain the high level of trust their stakeholders expect.

IN TECHNOLOGY WE TRUST

Artificial intelligence (AI), machine learning, blockchain, digital reality, and other emerging technologies are integrating into our everyday lives more quickly and deeply than ever. How can businesses create trust with the technologies their customers, partners, and employees are using?

- **Encode your company's values.** With technology ingrained in the business and machine learning driving business decisions and actions, an organization's values should be encoded and measured within its technology solutions. Digital systems can be designed to reduce bias and enable organizations to operate in line with their principles.[6] For instance, a city government worked with policy institutes

to develop an algorithm toolkit intended to identify ways to minimize unintended harm to constituents by limiting biases in the criminal justice system and other institutions.

Safeguards can promote stakeholder welfare by helping prevent users from engaging with technology in unhealthy or irresponsible ways. Examples include a company that imposes time and spending limits on habit-forming games, a content aggregator that prompts users to be skeptical about the veracity of crowdsourced information, and cloud computing providers that automatically issue alerts before customers go over budget.

Explainable AI technologies can clarify how AI-driven decisions are made. For instance, to enhance confidence in AI-supported medical diagnoses, health care companies are developing solutions that assign each diagnosis a confidence score that explains the probability and contribution of each patient symptom (vital signs, signals from medical reports, lifestyle traits, etc.) to that diagnosis. Clinical professionals can see why the conclusion was made and make a different one if required.[7]

- **Build a strong data foundation.** Without methodically and consistently tracking what data you have, where it lives, and who can access it, you cannot create an environment of trust. A strong data foundation unifies stakeholders around a single vision of data accountability and delivers on secure technology that supports effective data management.[8] Leaders should aim to give stakeholders some control over how their data will be used and delete data on demand unless it's necessary to keep it for legal or regulatory purposes.

- **Harden your defenses.** Deloitte's 2019 Future of Cyber Survey[9] reveals that executives are increasingly spending significant amounts of time focusing on cyber issues, and rightly so. Cyber defenses represent your commitment to protect your customers, employees, and business partners from those who do not share their values—or yours. Cyber risk strategy should be built and managed from the ground up, embedded in the business mindset, strategy, and policies, not only within IT. Business leaders can collaborate with IT to create a comprehensive cyber risk strategy—encompassing security, privacy, integrity, and confidentiality—to help build stakeholder trust and drive competitive advantage. This requires considering the organization's risk tolerance, identifying the most vulnerable gaps as well as the most valuable data and systems, then devising plans for mitigation and recovery.

WHAT'S IN A PROCESS

A strong foundation for ethical technology and trust will be shaped by the principles of an organization's leaders and realized in business processes.

- **Respect stakeholder privacy.** One of technology disruption's most overarching effects has been to accelerate the collection, analysis, and dissemination of information. Not so long ago, the transactional details of our lives were kept in physical file cabinets, pulled out and referenced for specific needs. Today, systems routinely collect these details and combine them with our purchase histories, posts on social media, online searches, and even the route we drive to work each day.[10] If consumers have reason to believe their data is being used in ways they don't approve of, reactions can include calls for boycotts, public inquiries, and even severe penalties under strict regulations, such as the European Union's General Data Protection Regulation and California's Consumer Privacy Act. Companies should create data privacy policies that build, rather than erode, public trust. A natural first step can be to ensure the data usage aligns

with the company mission.[11] For instance, JD Wetherspoon, a pub company servicing the United Kingdom and Ireland, recently deleted more than 656,000 customer email addresses, since it perceived the emails as an intrusive approach to customer interaction that provides little value.[12] This case highlights the importance of not only aligning data collection and usage to a company's values but, by extension, supporting the company's trust relationship with the customer.

- **Be transparent.** Companies can build trust with stakeholders by proactively and transparently demonstrating good behavior. "Transparency becomes vital and important," says AI Global executive director Ashley Casovan.[13] "Whether or not people are interested in seeing the resources and data behind it doesn't really matter. Simply knowing that companies have transparent policies provides more confidence that they are doing the right thing." Transparency extends beyond policies explaining data collection and usage practices. For instance, rather than masquerade as humans, intelligent agents or chatbots should identify themselves as such. Companies should disclose the use of automated decision systems that affect customers[14] and should stay focused on the customer when problems occur, providing both speed and quality in response. The fallout from negative incidents need not include customer loss or reputation-damaging headlines.[15]

- **Respect differing cultural norms.** An organization's overall approach to building trust is informed by interests, experiences, and professional standards as well as societal norms and government controls. It can be challenging to serve a global market in which expectations on government surveillance or law enforcement cooperation vary widely. For example, what is expected surveillance in some countries might seem outrageous elsewhere; cooperation with law enforcement is routine in many countries but perhaps unwise in places with rampant corruption or lack of protection for political or religious rights. Some countries have very specific regulations around gaining explicit customer consent to data usage; other municipalities are passing legislation, such as banning facial recognition technology, that can conflict with other rulings. Effective governance of emerging technologies requires all relevant stakeholders—industry, consumers, businesses, governments, academia, and society—to work together. Businesses can play a key role in helping governments as they develop laws and standards that increase the reliability of emerging technologies[16]—frank, candid discourse about new technologies, for example, could lead to new rules and guidance concerning matters of privacy, transparency, inclusivity, accessibility, inequality, and more.[17]

EMPOWER THE PEOPLE

Since technology is arguably used by most if not all individuals within an organization, ethical technology and trust is a topic that touches everyone.

- **Deploy the power of all.** Companies can waste time and money creating something that excludes a customer group or providing a service with undesirable side effects. Perhaps even worse, they may build solutions that undermine customer trust. Often, design dilemmas begin with a homogeneous group of people designing products, processes, or services without thinking through how other groups of people might be affected. Leading companies are changing this dynamic by creating teams and roles that reflect their diverse customer base and bringing in multiple viewpoints from different industries, economic backgrounds, educational experiences, genders, and ethnic backgrounds.[18] A 2013 Harvard survey revealed that organizations with leadership teams that have a combination of at least three inherent (ones you are born with)

and three acquired (ones you gain through experience) diversity traits out-innovate and outperform the others; these organizations are 45 percent more likely to report growth in market share and 70 percent more likely to report capturing a new market.[19]

- **Teach them to fish.** Training technologists to recognize their own biases, and to eliminate bias in the products they create is an important step toward creating a culture that emphasizes trust. But it is only one step. Building awareness of how technology affects stakeholder trust in those not directly involved or responsible for technology and creating associated decision-making frameworks are additional steps organizations should consider. This is especially important in non–digital native organizations, where the ripple effects of day-to-day uses of technology may be less obvious to leaders and teams. Companies should consider what resources may be needed to help their employees recognize ethical dilemmas, evaluate alternatives, and make (and test) ethical technology decisions.[20]

- **Give employees a reason to trust.** Much of the anxiety over AI and other advanced technologies stems from the fear of the displacement of labor. From an ethical perspective, this presents business leaders with a challenge: balancing the best interests of the business, the employees, and the wider community and society. It's a task made more complex by the fact that advanced technology systems are not self-sufficient. While AI can replace some jobs, for example, it creates others that often require specialized skills and training.[21] Companies can build trust with employees by advising them how technology may affect their jobs in the future. This could include retraining workers whose roles may evolve and who will likely work with automated systems.[22]

360 degrees of opportunity

Companies that don't consider technology to be their core business may assume that these considerations are largely irrelevant. In truth, no matter the industry or geography, most organizations are increasingly reliant on advanced digital and physical technologies to run their day-to-day operations.

While there is so much emphasis on the challenges disruptive technologies bring and the existential threats to an organization's reputation when technology isn't handled correctly—whether through misfeasance or malfeasance—these same disruptive technologies can be used to increase transparency, harden security, boost data privacy, and ultimately bolster an organization's position of trust.

For example, organizations can pivot personalization algorithms to provide relevant recommendations based on circumstance—for example, offer an umbrella on a rainy day rather than an umbrella after someone buys a raincoat. By focusing on relevance rather than personalization, AI recommendations are likely to seem more helpful than invasive.[23]

Deloitte surveys have found a positive correlation between organizations that strongly consider the ethics of Industry 4.0 technologies and company growth rates. For instance, in organizations that are witnessing low growth (up to 5 percent), only 27 percent of the respondents indicated that they are strongly considering the ethical ramifications of these technologies. By contrast, 55 percent of the respondents from companies growing at a rate of 10 percent or more are highly concerned about ethical considerations.[24]

After all, the pursuit of trust is not just a 360-degree challenge. It is also a 360-degree opportunity.

LESSONS FROM THE FRONT LINES

A healthy foundation for trust

DISRUPTIONS IN THE health care industry—including new care delivery models, consumer demand for digital experiences, declining reimbursements, and growing regulatory pressures—are driving many health care organizations to use technology to improve efficiency, cut costs, and improve patient care. And there could be an inadvertent benefit: Technology could help health care systems build trust with patients and providers.

Providence St. Joseph Health (PSJH) is leveraging technology to adhere to its mission of improving the health of underprivileged and underserved populations, says B.J. Moore, CIO of PSJH.[25] Technology is helping the Catholic not-for-profit health system simplify complex experiences to enhance caregiver and patient interactions, modernize the operating environment and business processes, and innovate with cloud, data analytics, AI, and other technologies to help improve patient care.

In the process, PSJH is building trust. For example, the organization is collaborating with technology partners to standardize cloud platforms and productivity and collaboration tools across its 51 hospitals and 1,085 clinics, a move that will improve provider and patient engagement and enable data-driven clinical and operational decision-making. It also aims to develop the first blockchain-powered integrated provider-payer claims processing system. Such technological breakthroughs can increase trust—but careless deployment and negligence can quickly erode it. That's why Moore has doubled down on establishing and maintaining a solid technology foundation for innovation and, by extension, trust. "Technology holds so much promise for helping patients at scale," he says. "But it also has the potential to cause damage at scale."

For example, data analytics, AI, and machine learning can help researchers and clinicians predict chronic disease risk and arrange early interventions, monitor patient symptoms and receive alerts if interventions are needed, estimate patient costs more accurately, reduce unnecessary care, and allocate personnel and resources more efficiently. When patients understand these benefits, they're generally willing to share their personal and health information with care providers. But their trust could diminish—or vanish—if weak data security or governance protocols were to result in a data breach or unauthorized use of private health information. This could cause patients to conceal information from care professionals, lose confidence in diagnoses, or ignore treatment recommendations.

Technological breakthroughs can increase trust—but careless deployment and negligence can quickly erode it.

A number of industry regulations help ensure patient privacy and safety, and PSJH has another effective governance and oversight mechanism: a council of sponsors, consisting of clergy and laypeople, that holds moral accountability for PSJH's actions in service of its mission. Sponsors help develop guidelines that ensure adherence to mission and values and advise the organization's

executive leadership and board of trustees on trust-related technology matters, such as the ethical use of data and the impact of technology on employees and caregivers.

"We're continuously working to raise awareness of technology's role in improving health," Moore says. "Educating and communicating with patients, care professionals, regulatory bodies, and other key stakeholders can help prevent potential barriers to rapid experimentation and innovation and allow us—and our patients—to fully experience the benefits of technology."

Do what's right: CIBC's strategic approach to building trust and engagement

CIBC IS USING technology to understand and anticipate individual client needs with the goal of delivering highly personalized experiences—an initiative they call Clientnomics™. Terry Hickey,[26] CIBC's chief analytics officer, recognized that AI-based algorithms could deliver the client insights required to drive Clientnomics but that to be successful, leaders needed to understand and share with employees how AI will complement and support the work they're doing, versus replacing their jobs. The bank also needed to maintain clients' trust by protecting their data and governing its use.

In early 2019, leaders from the bank's analytics, risk, and corporate strategy teams collaborated to develop an organizationwide AI strategy, which CIBC's senior executive committee and board of directors approved. At the heart of the strategy are guiding principles that address questions such as: *When will we use the technology? When will we* not *use it? How do we ensure that that we have our clients' permission?*

To reinforce employee trust, the strategic plan stated that a primary purpose of AI would be to augment employees' capabilities to achieve company goals. Leaders agreed to focus on funding AI use cases that support employees in their roles and improve practices that aren't currently optimized.

With the strategy in place, the next step was to build an AI governance process to ensure that new technology projects comply with the strategy and guiding principles. When a new project is proposed, stakeholders answer a series of questions that help them plan and document what they want to accomplish. These questions cover a broad range of ethical considerations, including project goals, possible inherent biases, and client permissions. Approved project documents are stored in a centralized library that regulators, internal auditors, and other reviewers can reference to explain the thought process behind the algorithm or model.

CIBC has also developed advanced analytic techniques to help govern its use of data—for instance, encoding client data in a way that it cannot be reverse-engineered to identify an individual. The analytics team also devised a way to assign a data veracity score—based on data quality and integrity, possible bias, ambiguity, timeliness, and relevance—to each piece of information that could be used by an algorithm. The algorithmic models are designed to recognize and treat the data veracity appropriately, supporting more reliable, trustworthy, and engaging interactions.

As the analytics team launches Clientnomics, members are focused on developing customized AI-supported client experiences rather than

large-scale technology projects. So far, they have accumulated 147 use cases, completing 40 in the first year.

For example, when a client calls CIBC's contact center, a predictive model dynamically configures the interactive voice response menu based on the client's recent transactions and offers the most relevant information at the top of the menu. The bank aims to cement client relationships over time with a continuous string of personalized interactions.

"In my previous role," Hickey says, "I spent a lot of time with organizations around the world. Everyone talked about the benefits and future potential of AI, and some completed proofs-of-concept, but few were able to implement them, especially in banking and finance. By proactively addressing how we will—and will not—use technology, CIBC has embraced the positive benefits it can deliver to employees and clients. All of this in less than a year."

Trust encoded in Abbott's DNA

IN THE HEALTH care industry, trust is a primary driver of patient behavior: Trusted organizations have an edge in influencing behaviors that can create more positive health outcomes. For 130-year-old global health care company Abbott, trust is top of mind as it evolves and expands its portfolio of diagnostic products, medical devices, nutritionals, and branded generic medicines, says CMO Melissa Brotz.[27]

With technology-driven products such as sensor-based glucose monitoring systems, smartphone-connected insertable cardiac monitors,and cloud-connected implantable defibrillators and pacemakers, Abbott takes a multifaceted approach to trust, adds CIO Mark Murphy.[28] Across the enterprise and its connected technologies, this includes comprehensive data protection policies, employee training programs, and an external ecosystem of trust-based partners, and other components.

For example, Abbott is exploring multiple data-enabled opportunities to improve health care, such as a machine learning solution that combines performance data from the company's diagnostics platforms with global clinical and patient demographic data to help health care providers diagnose heart attacks.[29] To safeguard patient data and privacy—a core facet of trust—Abbott has enacted a number of enterprisewide policies, procedures, and annual employee training and certification programs related to data handling and protection and compliance with national and global regulatory mandates. Leaders have also made significant investments in cybersecurity capabilities and controls embedded into product designs, which is increasingly critical for a company such as Abbott, with products and services that are heavily connected and integrated—often with other products, systems, and apps.

In addition, ensuring patient trust is a responsibility that falls to each of Abbott's 103,000 employees, from the board of directors and C-suite leadership to researchers, product designers, and engineers. Company leadership, for instance, is involved in data and product security oversight groups and board subcommittees, while employees participate in rigorous education programs on the implications of data privacy, security, and transparency. "Abbott is focused on helping people live better, healthier lives," Murphy notes. "Often, technology is the enabler to help us do that, but it always starts with the patient. We know that when we build technology, we are doing so on behalf of

the person who wears it, accesses it, or lives with it inside their body. And that means we must protect it—securely and responsibly."

Abbott also relies on a strong external ecosystem to maintain patient trust. Independent third parties and research groups test Abbott's products and services and assess their vulnerabilities on an ongoing basis. For example, the company is part of the #WeHeartHackers initiative, a collaboration between the medical device and security research communities that seeks to improve medical device security. At a recent event, Abbott teamed with university researchers to build a mock immersive hospital that enabled researchers to practice cybersecurity defense techniques.[30]

Rounding out Abbott's trust ecosystem are patients and care providers themselves. To learn what concepts such as trust, security, and privacy mean to the different users of its products and services, the company regularly holds focus groups with them and produces educational material to raise awareness of these issues.

Ultimately, Brotz says, data-enabled technologies that help people live better lives are an extension of the lifesaving products and services that patients and their care providers have trusted for 130 years. "Patients place the highest levels of trust in us, and we take it very seriously," she says. "It's part of our DNA. Our greatest responsibility is to keep them and their data safe and secure."

"We know that when we build technology, we are doing so on behalf of the person who wears it, accesses it, or lives with it inside their body. And that means we must protect it—securely and responsibly."

Rebuilding security from the ground up to maintain customer trust

BECAUSE A COMPANY'S approach to technology directly affects stakeholder trust in its brand, businesses that are leveraging advanced technologies can benefit from considering the technologies' impact on ecosystem partners, employees, customers, and other key stakeholders. Strong security controls and practices are foundational elements for building and maintaining stakeholder trust. Recognizing the impact of security breaches on customer trust, Google went beyond the expected table stakes by completely redesigning its security model to protect enterprise systems and data.

A decade ago, as Google moved internal applications and resources to the cloud, its security perimeter was constantly expanding and changing, complicating the defense of its network perimeter. At the same time, companies were seeing more sophisticated attacks by nation-state-sponsored hackers, testing the limits of the perimeter-based model of security. Hence, Google decided to completely overhaul its security approach and implement a new security model that turned the existing industry standard on its head, says Sampath Srinivas, Google product management director for information security.[31]

Google security experts could no longer assume that walling off the network would provide the security required to maintain system integrity and customer trust. They sought to reinvent the company's existing security architecture, since the traditional castle-and-moat model—based on a secure network perimeter with VPN-based employee access to internal applications—was no longer adequate. The goal: to ensure that employees could use any corporate application from any location on any device as easily as if they were using Gmail and as safely as if they were in a Google office.

Google embraced the zero-trust concept, an innovative security model that eliminates network-based trust, Srinivas says, instead applying access controls to applications based on user identity and the status of their devices, regardless of their network location.

Google's zero-trust security strategy treats every single network request as if it came from the internet. It applies context-aware access policies to clues such as user identity, device attributes, session information, IP address, and context of the access request itself, collected in real time by a device inventory service. A globally distributed reverse proxy server protects the target server, encrypts traffic to protect data in transmission, and acts as a sophisticated rules engine that determines access rights based on the user and device's context, such as whether it is fully patched. Every access request is subject to authentication, authorization, and encryption. To protect against phishing, the company—working with the industry in the FIDO Alliance standards organization—developed and deployed a new form of cryptographic hardware two-factor authentication called Security Keys.[32]

Today, Google's user- and device-centric security workflow allows authorized users to securely work from an untrusted network without the use of a VPN. The user experiences internal applications as if they were directly on the internet. Employees, contractors, and other users can have a seamless user-access experience from any location by simply typing in a web address—a process that dramatically reduces support burden. "To deliver on our goal of maintaining customer privacy and trust, we had to look beyond the status quo solutions, innovate, and take risks," Srinivas says. "When we broke with tradition and changed the way we thought about our security infrastructure, it allowed us to develop a more effective way to protect data and systems."

MY TAKE

WHEN I SPEAK with leaders in the corporate world, they often ask for advice on how to build a brand that customers and employees trust. As we talk, I find that some haven't carefully thought about what they mean by "trust." Some define it subjectively, like a warm fuzzy feeling. At the other end of the spectrum, others assume that if a customer is willing to use a service or product, that action alone implies trust. I believe that neither of these definitions is complete nor accurate.

DAVID DANKS, PH.D.
PROFESSOR OF PHILOSOPHY AND PSYCHOLOGY, CARNEGIE MELLON UNIVERSITY

To me, trust is a willingness to make yourself vulnerable because you expect the broader system to act in ways that support your values and interests. That doesn't mean that you expect the company will never make a mistake or experience an unintended outcome. Instead, what's important is that if something goes wrong, you're confident that the company will take care of it.

This definition applies even if a company's product isn't 100 percent reliable. For example, I'm more likely to buy from a company I trust, even if its product is occasionally unreliable, because I'm confident that if something goes wrong, the company will take care of me and my interests. I'm less likely to buy from a company offering a highly reliable product if I'm concerned that if the unexpected happens, I'll be left to deal with the consequences on my own.

So how should corporate leaders approach trust? The first step is to think through the relevant values and interests of both the company and its stakeholders. What are the things that matter to customers, users, employees, and shareholders? This question supports a discussion about how the product or service could advance, protect, or impair those stakeholder groups.

The second step is related to design. How can the organization design a product or service that supports or endorses those relevant values? This is where ethics comes in. From my perspective, ethics is about asking two questions: What values should we have? Then, given these values, what shall we do to advance them? Of course, sometimes values conflict, which pushes organizations to think about the problem differently. Can we design the product in such a way that we don't have to choose? This design approach can generate innovative and trusted products.

It's impossible to totally avoid unexpected consequences, but leaders who bring together multidisciplinary product teams can improve the odds in their favor. A team made up of people from a variety of backgrounds and cultures—who feel free to openly share their experiences and opinions—can often uncover creative design solutions or potential design issues. But when a conflict in values is unavoidable, leaders must make intelligent, self-aware, deliberate choices. A leader should decide what's most important to the company—and own it.

Most leaders already know the right action to take if the ultimate goal is to build trust. But some care more about cost reduction. Or increased efficiency. Or speed to market. The list goes on. And that's fine. Leaders can choose to build things that don't increase user trust, if they understand *why* they are making that choice

and are willing to accept the consequences—expected or unexpected. Problems occur when leaders make choices that damage trust without realizing what they are doing.

Another misconception that leaders often have is that being ethical conflicts with being profitable. This is a false dichotomy. Companies have proven that they can produce reliable, powerful, user-friendly—and profitable—products. And while the products may not perform perfectly all the time, trusted companies have ways to monitor and detect problems, as well as methods for addressing issues quickly and effectively.

My dream is that within 20 years, corporate leaders won't need to ask ethicists or other advisers about human or societal impacts that could result from product design decisions. I hope the answers will be internalized into corporate cultures so that asking questions such as "Are we sure this is a good idea?" is just part of what organizations consistently do.

EXECUTIVE PERSPECTIVES

STRATEGY

A company's brand is, by definition, a contract of trust. Yet in business, brand trust can erode overnight. CEOs and C-suite leaders across the organization can communicate the importance of trust to their company's mission and establish clear ethics guardrails. Indeed, establishing clear policies for ethical usage of technology—an important first step in earning trust—could benefit their businesses. Ultimately, individual employees are acting based on their best understanding and awareness of an organization's policies and values. This is no small matter. They will be making deliberate decisions about trust that will manifest in their company's strategy, purpose, and market performance. Moreover, if leaders don't own the trust and ethics agenda, decisions will be made in a diffuse way. CEOs have an opportunity to provide clarity, education, and ongoing communication. With the entire enterprise aligned behind the C-suite's guidelines on ethical technology and trust, CIOs can help ensure that tech strategies, development efforts, and cyber approaches support those guidelines.

FINANCE

One of the finance function's primary responsibilities is to build and maintain trust among customers, business partners, and investors. Yet rising expectations of transparency are making it more difficult for finance to meet this responsibility. Consider this scenario: Using drone-based cameras, analysts identify a potential issue in your company's manufacturing or distribution facilities that your operations team missed. Analysts unexpectedly bring up the issue on an earnings call. Markets now expect companies to respond to situations such as this in near real time. Failure to do so raises doubts, which in turn can erode market trust. To meet this challenge, finance organizations will likely need to collect more data from across the enterprise and deploy advanced analytics that enable real-time reporting. They can also collaborate with peers to educate employees on the value that ethics and trust help create. Finally, CFOs will be able to help their companies deliver the kind of detailed, accurate, and timely responses that markets—and the analysts and investors who watch them—demand.

RISK

Cyber risk threat vectors have evolved rapidly, and attacks have become increasingly sophisticated, deliberate, and unrelenting in nature. Fifty-seven percent of companies participating in Deloitte's 2019 Future of Cyber Survey experienced their most recent cyber incidents within the past two years.[33] And the risk isn't just that cyber incidents will destroy trust in the classical sense. The opportunity cost of what cyber vulnerabilities can prevent organizations from doing can be far greater: The specter of cybercrime and its fallout can cast a shadow over an organization's efforts to turn technology to better use, strangling innovation and slowing digital transformation efforts to a crawl. It can also affect the bottom line, quickly and dramatically. One survey found that 48 percent of respondents had stopped using online services that reported data breaches.[34] The issues of ethical technology and trust will steadily capture CXO mindshare. CIOs have a responsibility to help other enterprise leaders become more tech-savvy and understand the impact their digital strategies can have on the organization's trust brand.

ARE YOU READY?

1. What is your current position of trust with your employees, customers, partners, shareholders, and community?
2. On a scale of "What's ethical technology?" to "We understand the ethical ramifications of our tech initiatives" to "We have ethical technology policies in place," where does your leadership team rank?
3. How do you measure each new digital initiative against its alignment to organizational values and impact on stakeholder trust?

BOTTOM LINE

Companies who have yet to recognize that disruptive technology can measurably affect—positively or negatively—every facet of a business risk being overshadowed by those competitors that make trust a business-critical mission. Leaders should be thinking about the potential consequences of employing disruptive technologies throughout their organization. To master the trust equation, what is needed is a cohesive effort that starts from the very top of an organization: align the use of technology with organizational values, clearly articulate the policies and guidelines everyone should follow, and embed those policies into the very fabric of an organization.

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Authors

CATHERINE BANNISTER is a managing director in Deloitte Services LP and leads performance and development for Deloitte's professionals. She is also the architect of Deloitte's Tech Fluency program, which originated in Deloitte Consulting LLP's Technology practice to develop and cultivate breadth and depth of technical capabilities, as well as Deloitte's Tech Savvy program, enabling Deloitte professionals to be conversant in disruptive technologies.

DEBORAH GOLDEN is a principal with Deloitte & Touche LLP and the US Deloitte's US Cyber Risk Services leader. She brings more than 25 years of information technology experience in industries that include government and public services (GPS), life sciences and health care, and financial services to the role, and previously served as Deloitte's GPS cyber leader, as well as GPS Advisory market offering leader. Golden also serves on Virginia Tech's Business Information Technology and Masters in Information Technology advisory boards.

SENIOR CONTRIBUTORS

Dan Frank
Principal
Deloitte & Touche LLP

Kirsty Hosea
Partner
Deloitte Touche Tohmatsu

Dalibor Petrovic
Partner
Deloitte LLP

Yang Chu
Senior manager
Deloitte & Touche LLP

Anand Ananthapadmanabhan
Manager
Deloitte & Touche LLP

Anu Widyalankara
Manager
Deloitte MCS Limited

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TREND SUMMARY

IT and finance leaders work together to develop flexible approaches for funding innovation.

FUNDING INNOVATION AT THE SPEED OF AGILE

Move the IT organization to a product-focused operating model and create a road map for tech investments.

CHANGE WITHIN IT

CREATIVE FINANCE

Explore opportunities for strategic co-investment, ecosystem subsidies, carveout leasebacks, and other models.

Tailor budgeting, funding, and reporting processes to meet the evolving technology needs of the business.

CHANGE WITHIN FINANCE

IT NEEDS	FINANCE NEEDS
Cross-functional teams	Value calculation
Flexible timelines	Measurable ROI
Product focus	Fiscal control

DEFINITIONS

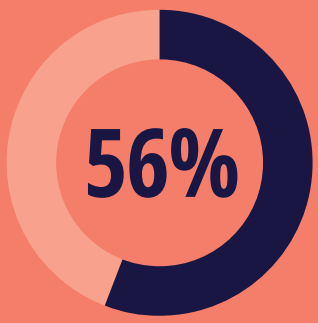
'a-jəl

A synonym for "nimble"; the ability to respond gracefully to a need to change and adapt.

'A-jəl

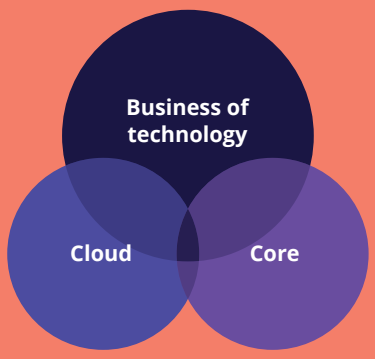
An iterative, incremental software delivery methodology.

BY THE NUMBERS



of CIOs expect to implement Agile, DevOps, or a similar flexible IT delivery model to increase IT responsiveness and help spur broader innovation ambitions.[†]

TREND BREAKDOWN



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Finance and the future of IT

Funding innovation at the speed of agile

FLEXIBLE DELIVERY OF emerging technologies to drive business outcomes is fast becoming today's competitive battleground. Deloitte research found that 56 percent of CIOs expect to implement Agile software development, DevOps, or a similar flexible IT delivery model to increase IT responsiveness[1] and help spur broader innovation ambitions.

But there is an obstacle currently slowing these efforts, and it is formidable: the sourcing and distribution of funds. IT's operations and development processes are becoming nimbler and product-focused while the finance function continues to budget, fund, and report the same way it has for decades. The result: tension between IT's needs and finance's procedures. If left unaddressed, this issue could impair the CIO's innovation agenda and undermine an organization's strategic goals.

Nowhere is this tension felt more acutely than in funding strategic innovation and transformation agendas, which currently account for a small percentage of IT's overall budget. (The average IT department spends 56 percent of its technology budget on maintaining business operations and only 18 percent on building new business capabilities.[2]) This is especially true for development initiatives that emphasize agility and speed. Finance processes are typically still tied to a project mentality, where the fallacy of predicting the future for unique product development (with unknown unknowns) is locked into a project plan with associated fixed project funding. Instead an "agile" approach—referring in this context to a state of being nimble or flexible rather than to Agile software development methodology—is capacity funded with a focus on maximizing outcomes.

Moreover, agile initiatives typically feature cross-functional teams working in iterative sprints. In many companies, this clashes with the finance organization's traditional funding processes, which are optimized for functionally compartmentalized teams. The cross-functional teams model hails from an era that emphasized repetition and scale of known and knowable assets, unlike today's innovation-focused digital age.

Building distinctive, disciplined approaches now can lead to sustained competitive edges. The time for CIO-CFO collaboration on this issue is now.

Over the next 18 to 24 months, we expect to see more IT and finance leaders working together to develop flexible approaches for funding innovation at the speed of agile. This does not mean they will replace annual budgeting cycles with a shiny, unproven alternative. Indeed, balancing fiscal control and appropriate spending with value creation and financial results is a nonnegotiable requirement. There are multiple approaches that can help maintain the balance:

- **Change within finance.** Finance should explore opportunities to tailor budgeting, funding, and reporting processes to better meet the business's evolving needs for its portfolio of technology investments. This will likely include developing new methods for investing across time horizons, accurately measuring the somewhat unpredictable long-term value that products built with agility can generate, and accounting for value in ways that meet accounting and reporting standards.
- **Change within IT.** The future of the IT organization includes structural changes such as organizing resources around products and outcomes, creating a clear road map for foundational tech investments, and evolving traditional roles in procurement and vendor management.
- **Creative funding.** Creative funding sources can amplify and accelerate change. CIOs and CFOs can explore opportunities for funding innovation such as co-investing within and across their industry, ecosystem subsidies, carveout leasebacks, and other models.

Unlikely, you say? Convincing your CFO to alter long-standing financial processes may be a hard sell, at least initially. What's more, external funding opportunities may sound promising but could introduce risks that give CFOs pause.

Yet there are strong incentives for both CIOs and CFOs to find ways to reimagine finance to bolster technology's potential. As more large organizations demonstrate agile's positive impact on speed to value, flexibility, and responsiveness to market needs, their competitors will likely launch their own agile initiatives at speed and scale.[3] Building distinctive, disciplined approaches now can lead to sustained competitive edges. The time for CIO-CFO collaboration on this issue is now.

Money matters

The tension between IT's funding needs and finance's long-held processes did not appear overnight. It has been building slowly over the last decade as cloud and platform technologies steadily disrupted operating models in ways that cause the finance function to reevaluate its methods.

As CIOs and CFOs look for ways to better meet their respective needs in the coming years, there

are three central problems to consider—all of which trace their roots to the early days of the digital revolution.

- **Shifting from capex to opex.** Transitioning from on-site to cloud-based systems involves shifting a significant amount of spending from capital expenses (capex) to operating expenses (opex). In fact, teams will be doing a little bit of capex and opex all the time. The new mantra is "you build it, you run it." From an accounting perspective, short-term opex growth can affect quarterly results, which CFOs must explain to investors and financial analysts.[4]

- **Measuring elusive ROI.** Technology innovation initiatives are often experiments that fall short of internal rate-of-return expectations and may or may not deliver positive returns. Investments in innovation don't typically offer traditional IT projects' level of confidence, financially or temporally, so they are often hard to confidently champion through standard governance processes. In some instances, this leaves the finance function struggling to develop an accurate process for tracking ROI long-term. This challenge becomes more complicated in tracking fixed budget investments in things such as platforms that can be reused over an indefinite period.

- **Calculating value delivered.** CFOs rigorously track returns on capital and associated risk models across areas of investment. But for technology investments, few organizations show similar discipline in tracking and measuring the magnitude and timing of solution value—when CIOs make their own calculations, they may use assumptions that differ from those typically used by business or finance. In Deloitte's 2018 Global CIO Survey, 65 percent of respondents said they measured the impact of IT investments on a case-by-case basis, rather than as part of a regular reporting process.[5] Clearly, CIOs and CFOs are not on the same page when it comes to assessing the value IT delivers.

As part of the *finance and the future of IT* trend, we expect to see more CIOs, CFOs, and their respective teams explore ways to address these and other funding, accounting, and reporting challenges.

Finance transforms capital deployment

CFOs and their organizations can be the arbiters of rapid change, balancing necessary controls and risk management with modernized techniques for budgeting, deploying funds, and working with technology and business leaders to continuously monitor and optimize impacts. Some techniques include:

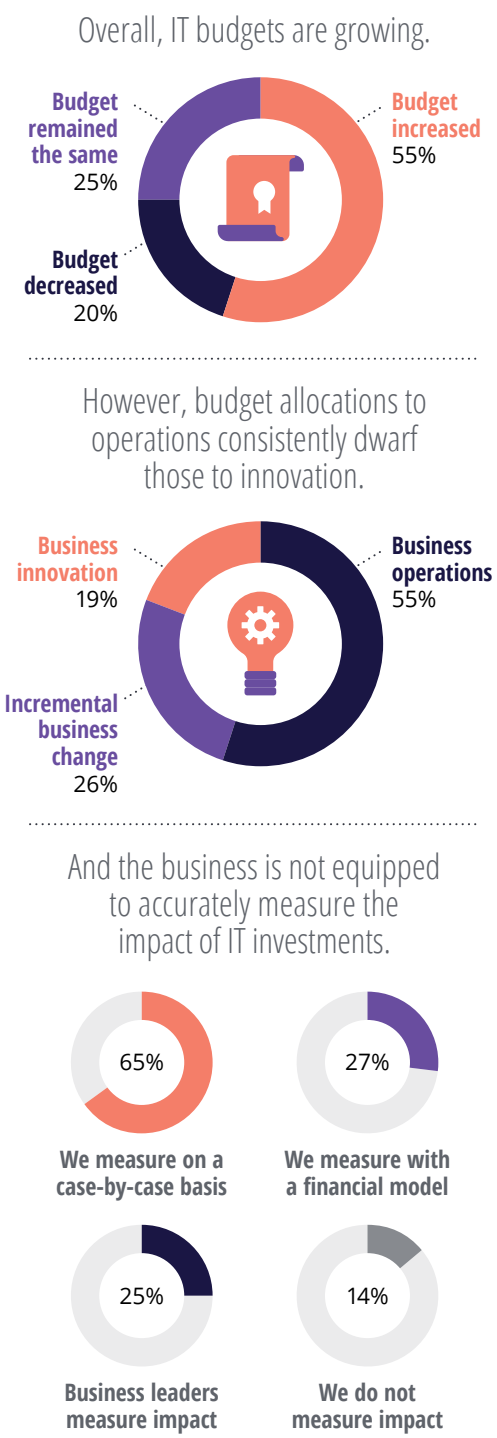
- **Risk-based portfolio mindset.** Many organizations struggle to justify significant funds for innovation and disruptive technologies—the likelihood of failure can be high, and the upside of success isn't always straightforward to quantify. Treating investments as a portfolio is important; thoughtfully developing the governance and attributes of the portfolio is more so. Shoehorning prototypes of disruptive technologies into classical five-year ROI calculations is likely to generate either wildly optimistic valuations or widespread risk aversion. Treat investing in emerging tech as you would buying call options: The CFO and management team can make measured bets while getting information to more confidently guide future investment and mitigate future risk.[6]

- **Capex versus opex strategy.** Every technology investment has risks, and those made in cloud are no different. Because cloud

FIGURE 1

Following the money

Deloitte asked more than 1,400 global CIOs about the challenges of funding innovation. Here is what they said:



Source: 2018 Deloitte global CIO survey.

shifts technology investments from the *capital expense* to the *operating expense* column, moving to cloud too quickly can affect company financials. CIOs and CFOs can work together to classify these costs appropriately and assess and optimize the impact of cloud investments. They can also develop strategies for depreciation and capital allocation to offset any impact.[7] The good news is that the capex-versus-opex issue may not rattle Wall Street much longer. Deloitte studied how a set of public companies communicated their cloud investments to Wall Street and how analysts responded. The capex/opex issue did not appear to be a significant consideration in filings, commentary, and analyst discussions. In fact, companies may be underselling and underutilizing their cloud investments. Analysts appear to be more interested in how cloud adoption can lead to potential new revenue streams or revenue enhancement than in its potential for cost-reduction.[8]

- **Capacity-based funding.** The idea of fixing IT budgets around explicit capacity, tweaked annually, is not new. But as technology organizations move from project to product orientation, those teams increasingly represent dedicated multidisciplinary staff from across the business and IT. Now, "capacity" is tied directly to customer, market, or supporting value streams. Road maps of growth objectives and investment needs define existing and future funding, measured not in IT-speak SLAs but in outcomes and results aligned directly to business metrics. Instead of annually framing projects to earmark access to tech resources, the product team is responsible for continuously assessing and refreshing its performance and priorities, with the ability to scale up or down based on justified changes to nested outcomes and expected key results. Everything will become more fluid, so finance should start putting processes and governance in place now to accommodate this volatility.[9]

- **Digital foundations.** Many of the investments that companies make in cloud migration, core modernization, data platforms, and other technologies form a digital foundation that benefits the entire organization. Given the business-critical nature of these investments, CIOs and CFOs should consider funding them separately from the larger IT budget. More important, they should consider not allocating costs to the business and instead providing subsidies for lines of business or departments participating in executing the vision. This can protect these funding streams from indiscriminate budget cuts or belt-tightening—and distinguish them from spending on core revitalization efforts that, while also foundational, will eventually wind down.[10]

IT's call to arms

Big changes need to happen with the IT organization as well—ideally in the spirit of, if not the structure of, drastically improved alignment and collaboration with the finance organization. Areas to consider include:

- **Product-focused operating model.** As described above, IT organizations are moving from plan-build-run structures with associated capabilities to teams oriented around market-facing products, capabilities, and internal-facing, shared service value streams. These teams bring together disciplines across tech and business silos, typically use Agile methods and tools, and tend to inspire different mindsets while requiring different skill sets. Without trivializing the challenge in reorienting every part of IT's portfolio along these lines, the talent realities are often the biggest hurdle. Having a vision for the future of work within the organization is needed: identifying the required skill sets, how they can be sourced (for example, reskilling existing resources or tapping new talent pools), and defining new expectations and incentives.

- **Foundational "tech for tech" road map.** CIOs typically have a piece of their budget earmarked for IT's own investment in the department. Being deliberate about quantifying and explaining the nature of those investments in business terms can win over skeptics. Examples include sharing the rationale behind core modernization initiatives and showing year-to-year efficiency gains as a result of simplifying, automating, and re-platforming systems. Coupled with developing and maintaining a road map of foundational strategic tech investments, CIOs can set the stage for a much different conversation about IT investment with the CFO, CEO, and board.

- **Enablement empowered.** Some traditional IT roles can be bastions of change, but only with a mindset shift in purpose and remit. Procurement officers and vendor managers should move from tactical short-term measures to becoming architects of creative contracts and ecosystem partnership vehicles.

Outside-in

The digital transformation underway at many organizations requires additional sources of funding to enable the kinds of changes needed to keep disruptive competitors at bay. As part of the *finance and the future of IT* trend, we expect to see more CIOs, CFOs, and their respective teams explore the following:

- **Vendor subsidy programs.** A growing number of cloud and platform-as-a-service vendors are creating subsidy programs that offer credits, free trials, and "always free" limited usage on select products to new customers that commit to fixed-term subscriptions (usually 12 months). Though

many of these programs target smaller companies, vendors are beginning to offer large enterprise-level subsidy programs with negotiable terms.

- **Co-investment and industry consortia.** CIOs and CFOs can explore opportunities to co-invest within industry consortia or even with competitors to develop and share the benefits of a needed technology. Companies are entering into multiparty participation contracts with fine print for who has decision rights over functionality and design, and under what circumstances ownership of the IP can be transferred, among other considerations needed for productive collaboration.

- **Ecosystem investments with universities.** Some organizations are working with university innovation hubs to perform research and to keep their fingers on the pulse of technology innovation. Taken a step further, CIOs could set up a co-creation deal with a university in which the CIO provides funding for university research to work on a problem set. In return, the CIO and the university will co-own the resulting IP and can sell it to other organizations.

- **Carveout leasebacks.** In cases where an immediate capital infusion is required, one option is to identify a set of systems or infrastructure that can be sold to a third party. The third party, in return, leases back the capabilities to the seller under a predetermined set of conditions. In this fashion, CIOs and CFOs can generate immediate capital funds to spend, while accepting ongoing opex costs for the systems, services, and infrastructure. In some cases, the realized savings can be used to jointly fund new innovation agendas and activities.

Let the funding begin

In its simplest form, the Agile software development boom is a decades-old, IT-centric construct that, after years of evolving, now offers the business and IT an opportunity to work together more effectively and efficiently. The move to DevOps has amplified the opportunity by making sure the business and the "run" and "build" houses within IT come together. Likewise, DevSecOps[11] enables tighter integration of yet another function. Funding the pursuit of agile opportunities has been both complex and challenging; it's now time to bring finance squarely in the fold of tomorrow's technology engine.

The *why* is simple. Funding at the speed of agile optimizes for the fast flow of safe value. In order to survive and thrive, organizations should adopt new ways of working to sense, explore, invent, and innovate. Beyond strategic positioning, it can drive material impact in the market and ultimately affect the valuation of the organization. On average, product companies have valuations that are 1x their revenue. For service companies, the average valuation is 2x their revenue. For platform companies, the average valuation is 8x the revenue they generate.[12]

Transitioning fully to a new funding model won't happen quickly. For at least the near future, you can run both old and new funding approaches in parallel as you further refine your processes and establish governance guardrails. But ultimately, the journey can be worth it. The more you embrace tech futures, the bigger the impact your efforts can have on the way investors, customers, and your people view your organization and its future promise.

LESSONS FROM THE FRONT LINES

Constructing an agile enterprise: Nationwide Building Society takes the long view

FROM ONLINE BANKING to cashless commerce, traditional financial institutions are embracing change to survive—and Nationwide, the United Kingdom's 130-year-old building society, is no different. Leaders wanted to deliver more value and services to Nationwide's 15 million members to excel in an environment of digital disruption and increased regulation. In late 2018, the Society hired Patrick Eltridge[13] as its COO, aiming to transform the way the organization works.

Before Eltridge's arrival, IT and the digital business group had launched several Agile initiatives, and Nationwide now looked to create a more cohesive, enterprise-level approach. Eltridge set out to shift the organization's legacy systems away from waterfall methods, which he views as promoting "the illusion that you can fix the time, scope, and cost of work and hold people accountable for immovable milestones."

Eltridge's charter was to introduce the agile mindset across the enterprise. He approached finance leaders soon after his arrival, looking to partner with them to evolve their traditional accounting and investment funding processes to better align with IT's Agile approach.

Instead of trying to explain—and win buy-in for—abstract agile processes, Eltridge engaged finance leaders with three commitments: 1) The monthly expenditure rate of IT change would be known and not exceeded, 2) change priorities could be revised in less than 30 days with minimal disruption, and 3) there would be no more unplanned software write-offs—all music to any CFO's ears. Convinced of the benefits and validated by IT's reputation for safe and reliable delivery, finance agreed to enable Agile methods and continuous funding in the coming year.

Eltridge introduced the "weighted shortest job first" (WSJF) prioritization method to help the team prioritize changes ... WSJF is not a one-and-done process—the backlog of initiatives is regularly reviewed and reprioritized.

During the funding transition, the portfolio management office—renamed the Value Realization Office—continued to use waterfall or Agile methods, depending on the project type. But when the office needed to shift investment priorities, Nationwide had not yet defined a way to objectively evaluate the relative value of inflight changes across the entire portfolio. To resolve this, Eltridge introduced the "weighted shortest job first" (WSJF) prioritization method to help the team prioritize changes based on their projected economic benefit, which is estimated by dividing "cost of delay" by job size. WSJF is not a one-and-done process—the backlog of initiatives is regularly reviewed and reprioritized.

The Value Realization Office led the exercise, inviting product owners, architects, delivery leaders, and finance to discuss and vote on

change priorities across the entire portfolio. The WSJF exercise accomplished the team's goal of rationalizing budget and investment decisions—and generated an unexpected benefit. "Senior leaders left with a deeper understanding of the portfolio and interdependencies of the work," Eltridge says. "Prioritization was a happy byproduct."

According to Eltridge, "I've seen many organizations with a bottom-up, grassroots push toward enterprise agility, but that alone is seldom sustainable. This sort of change requires senior leadership understanding, trust, and sponsorship to last over the long haul. Leaders need to experience this way of working before they can internalize and understand it." Patience and persistence are required.

Barclays banks on agile

SIZE AND HISTORY don't make an organization safe from rapidly evolving competitive pressure, and banking giant Barclays is adapting by leveraging agile ways of working. Nimble fintech startups, business model-changing emerging technologies, new consumer data protection regulations, and other industry challenges led Barclays to launch an enterprisewide agile adoption initiative in 2015. Since then, more than 800 teams—including the bank's Trade and Working Capital (T&WC) business—have adopted agile principles, values, and practices.

To better support iterative releases, continually changing requirements, cross-functional collaboration, and other hallmarks of Agile software development, Barclays retooled many planning, budgeting, and finance processes. The agile transformation changed the way business, finance, and technology functions interact, says Brijesh Ammanath, global CIO for T&WC.[14]

For example, Ammanath's technology team was challenged to reconcile iterative delivery with its traditional budgeting exercise, typically conducted 18 months in advance of project delivery. Instead, the team established a rolling wave planning cycle. Technology and business functions meet quarterly to discuss and prioritize the product outcome road map and feature deliveries; technical debt also goes in the queue so that it doesn't bog down development and testing. Other business priorities may bubble up depending on competitive pressures, regulatory changes, the emergence of new technologies, evolving operational goals, and other market trends and performance indicators.

Outcomes that aren't driving value for the business are de-emphasized, with funding rerouted to key revenue drivers. Conversely, if a feature is increasing revenue, teams could decide to enhance it and align more of the capacity-based funding to it. Business and technology leaders are equally empowered to prioritize projects.

Finance and technology teams then meet monthly to review costs and outcomes. Instead of providing imprecise long-horizon estimates, the technology team maps investments to key business revenue drivers. The move to agile allowed T&WC to increase production delivery frequency twelve-fold, from quarterly to weekly, allowing the technology team to demonstrate tangible outcomes even if revenue is not immediately projected.

Barclays' enterprise operating model—and the organization's mindset—are now fully adapted to the agile life cycle. One critical success factor was intentional communication with business partners—for example, educating the finance team about one project's cone of uncertainty helped team members understand why agile was needed and

how the new delivery model worked. Radical cost transparency has helped establish trust. Finally, improving visibility into the delivery process, taking the time to understand business priorities, and consistently meeting delivery commitments have helped improve cross-functional collaboration and build trust with business stakeholders. As a result, the T&WC technology team enjoys a high level of confidence from its business and finance partners when it comes to prioritizing, delivering, and funding features and products.

"Agile has changed everything from the way we're structured and how we hire people to the tools we use for collaboration," Ammanath says. "It's a continuous improvement journey, so the transformation will be ongoing. The whole purpose is to be better this week than we were last month."

Big bang: Rolls-Royce's bold approach to agile

FOR OVER A century, Rolls-Royce has pioneered some of the world's most powerful and efficient engines. From its beginnings as an internal combustion engine manufacturer, the company has evolved into a leading global industrial technology-based innovator of intelligent and electrical engines, pioneering cutting-edge technologies to help the planet's vital power needs. To facilitate continual improvement, Rolls-Royce is embracing digitalization across the enterprise to create entirely new ways of engineering, manufacturing, and serving customers.[15]

The transformative journey began in March 2018, when leadership restructured the company to drive more business value and improve cash flow. Rolls-Royce established several restructuring programs covering areas from culture and organizational health advancement to financial improvement and technology transformation.[16] Anthony Allcock, director of IT business management and transformation,[17] was charged with enabling the technology transformation by erecting a foundation to support agile ways of working across the enterprise.

Allcock realized that IT needed to lead the change to agile methods. A significant change in the IT operating model became critical to establish a foundation for transformation. By using a modern, product-oriented delivery model, they focused on delivering value more quickly across the company. If the organization tried to build a digital technology foundation using their traditional IT operating model, it would be too slow—IT would not be able to keep up with the pace of change in the business.

In the new model, IT and the business work as a team to achieve business outcomes. There's more energy and empowerment in the organization and shared ownership of the corporate strategy. They have also been able to generate more value and improve efficiencies through simplifying and automating key processes. While there is still work to be done, the organization has achieved a 40 percent reduction in governance forms and a 60 percent reduction in management control gates.

In only eight months, Allcock and the team have made significant progress, with the organization meeting goals for releasing more value to the enterprise through agile processes. And the journey continues: The team has developed a plan for how it can shift to funding agile teams and managing investments in a way that supports Rolls-Royce's digital transformation journey and long-term ambitions to deliver clean, safe, and competitive power solutions, while meeting financial goals.

MY TAKE

BEING AGILE IS about developing a flexible—yet structured—approach to how the entire enterprise works together to create stakeholder value. Instead of completing predefined one-and-done projects, an organization builds and delivers products and portfolios of products to meet customer needs. It's a cycle of continual improvement that supports learning as you go and adjusting direction as issues and opportunities arise.

NARAYANAN (KK) KRISHNAKUMAR,
VP AND CTO, DELTA AIR LINES

Delta's business is built on flight—one of technology's greatest achievements. We work to provide an exceptional experience for travelers who trust us to comfortably and safely carry them on their journeys around the world. As technology continually evolves and accelerates, we are evolving with it to deliver more value to our stakeholders.

To accomplish this, we're on a journey of our own to become more agile in everything we do. We started in IT, changing our applications and infrastructure to be more aligned with the business to enable new and better customer offerings. We jumped in, learning the mechanics of Agile, training our people, and running sprints and automated builds. Looking back, we were "doing agile," but we weren't yet "being agile." Being agile extends far beyond software development—it creates more flexibility and responsiveness across the enterprise and delivers tangible value as outcome.

So we pivoted. We're working with the business to shift our focus from projects to portfolios of products. For example, the account management portfolio includes products that enhance customer loyalty, including Delta Sky Club and Medallion status levels. And the catering operations portfolio includes new customer-focused products, such as enabling passengers to preselect their meals.

Our business team members are actively engaged in defining products within the portfolios and setting IT priorities. And in the spirit of being agile, we'll refine these as we learn. We're also changing how IT is funded—moving from project-based to product-based funding, with ongoing teams working in sprints to deliver a continuous stream of new and improved product features and value.

I've found that as companies shift from a project to a product lens, the agile mindset begins to ripple across the enterprise. At Delta, as IT becomes more agile, the business is changing too, creating new roles for product owners and managers while adapting their ways of working. Sustainable change takes time, and we're beginning to see a shift to more agile practices across the company.

My advice to other technology executives embarking on this journey is to recognize that building an agile enterprise is more than changing software development processes—being agile requires a cultural shift, beginning at the top. We've been on this journey for two years, and we're seeing results by engaging people at all levels across the organization. Patience is required. The agile journey is one that never ends—there will always be opportunities for improvement ahead.

EXECUTIVE PERSPECTIVES

STRATEGY

As the pressure to do more with technology increases, the business and IT can no longer remain separate operating entities. By aligning both to products or value streams, organizations can develop greater confidence in their technology investments. They can create joint outcome road maps and measure key results along the way with greater precision and accuracy. Moreover, as traditional boundaries separating the business from IT disappear, leaders are making increasingly complex technical innovation decisions. As such, organizations should work to find the right combination of CFO, CIO, or other CXOs to govern decisions. Even in organizations actively exploring new ways to fund innovation, decision rights are likely not on anyone's agenda at present. This will change: Left unaddressed, this issue could easily become an insurmountable barrier to change.

FINANCE

Funding IT has often felt like more art than science, from estimating costs and timelines to measuring results. And it's becoming more complex—whether dealing with the impacts of adopting enterprise agility or understanding the funding investment options from the hyperscale cloud providers. For example, responding to the pace of external disruption requires more than just a matter of transitioning from an annual to a rolling funding model. Agile requires changes to internal controls, financing mechanisms, and to established accounting and auditing processes. And notably, financial planning and analysis (FP&A) teams may need to develop more flexible approaches to forecasting profit and loss for income statements and to calculating operating performance. Further, depending on the magnitude of investments made in digital transformation, CFOs may have to renegotiate the way they report earnings to accommodate new FP&A approaches and open-ended investments that offer uncertain outcomes.

RISK

The same pressing need for greater enterprise agility that drives the *finance and the future of IT* trend also challenges chief risk officers and other leaders to reevaluate the way they understand and manage risk. Going forward, risk—like finance and other enterprise functions—should become *enablers* of innovation rather than *impediments* to it. One approach involves thinking about potential risks that could arise in a future that is largely unknown, rather than basing risk assessments on current or past activities. Consider the kinds of cyber risks that companies currently associate with technologies such as cloud, blockchain, or next-generation customer experience solutions. They often include factors like limitations on liability and identification of third-party risks. While certainly relevant, these factors apply to yesterday and today, not tomorrow. Viewing innovation through a backward-facing lens—whether for purposes of funding or assessing risk—not only places limitations on innovation's potential but may ultimately undermine competitiveness at a time when speed-to-market is more important than ever.

ARE YOU READY?

1. How effective is your organization's drive toward agility? Which parts of the organization have adopted a product-focused operating model?
2. Have you moved to capacity-based funding models? With a mindset of maximizing enterprise value?
3. Which flexible approaches for funding innovation are IT and finance jointly exploring? Which creative sources of capital from outside your organization are you taking advantage of to fund key initiatives?

BOTTOM LINE

The work of transitioning to new finance, budgeting, and accounting processes that support agile innovation will not happen overnight. This is a tough nut to crack. But some companies are already embracing this trend, shifting from time-based projects to long-lived products and taking a portfolio view of their innovation investments. In general, these are companies with strong approaches to horizon investments and maturing Agile development capabilities. They are already living with the challenges that are driving this trend and will likely be the first to enjoy the competitive advantages that come when finance funds innovation at the speed of agile.

LEARN MORE

REINVENTING TECH FINANCE

Explore the impact of IT operating model changes on technology funding and budgeting.

REIMAGINING THE ROLE OF TECHNOLOGY

See how companies are creating long-term value by unifying their business and technology strategies.

FINANCE 2025

Read how CFOs are preparing the finance function—and themselves—for the digital future.

Authors

JOHN CELI is a principal at Deloitte Consulting LLP with more than 30 years of experience in systems integration and architecture, helping clients realize significant value from large, complex enterprise transformations. Leading the Business Agility practice (Agile & DevOps), he helps clients transform their business and IT organizations to an agile/lean mindset. As a leader in the Life Sciences sector, Celi helps clients achieve results through pragmatic technology implementation, from strategy to deployment.

AJIT KAMBIL is the global research director of Deloitte LLP's Chief Financial Officer Program. He oversees research in areas such as leadership, capital markets, and risk. Kambil created CFO Insights, a biweekly publication serving more than 38,000 subscribers, and developed Deloitte's Executive Transition Lab, which helps CXOs make an efficient and effective transition into their new role. He is widely published in leading business and technology journals.

KHALID KARK is a managing director with Deloitte Consulting LLP, leading the development of research and insights for the CIO Program. He has served as a trusted adviser to large, multinational clients and has decades of experience helping technology leaders anticipate and plan for the impacts of new technology. Previously, Kark led the CIO Research practice at Forrester Research. His research has been widely featured in media outlets such as MSNBC, the *Boston Globe,* and *CIO* magazine.

JON SMART is a partner with Deloitte MCS Limited in the United Kingdom. With over 25 years of experience, he leads Deloitte UK's Business Agility practice, helping organizations deliver "Better Value Sooner, Safer, Happier" through the application of agile, lean, and DevOps principles and practices. Smart is the founder of the "Enterprise Agility Leaders Network."

ZSOLT BEREND is a senior manager in the Business Agility practice within Deloitte MCS Limited. He has 15 years of hands-on experience in applying agile/lean ways of working principles and practices as practitioner, coach, and trainer in a diverse portfolio of industry sectors, predominantly health care, telecom, and financial services. Berend helps clients to enable "Better Value Sooner, Safer, Happier."

SENIOR CONTRIBUTORS

Tony Caink
Director
Deloitte MCS Limited

Jacques de Villiers
Managing director
Deloitte Consulting LLP

Richard Walker
Principal
Deloitte Consulting LLP

Stephan Kahl
Senior manager
Deloitte Consulting GmbH

Kelly Gaertner
Manager
Deloitte Consulting LLP

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TREND SUMMARY

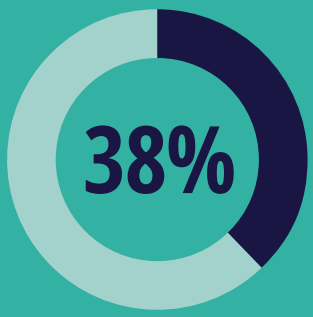
Leveraging next-generation digital twin capabilities to design, optimize, and transform the enterprise.

DEFINITION

di-jə-tᵊl / twin

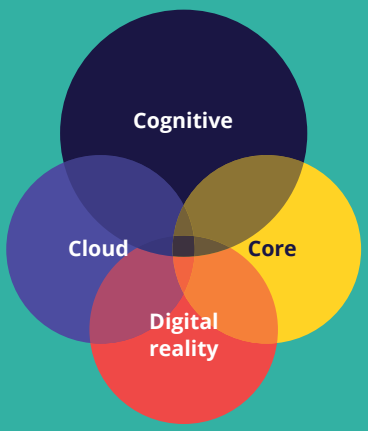
A digital simulation of physical systems, assets, or processes. Often paired with IoT technology to instrument simulated systems. Twins are supported by data science and machine learning, and supply optimizations and insights for physical world action.

BY THE NUMBERS



Projected compound annual growth rate of the digital twins market, from US$3.8 billion in 2019 to US$35.8 billion by 2025.[†]

TREND BREAKDOWN



[†]"Digital twin market worth $35.8 billion by 2025," (press release), Market and Markets, July 2019.

Digital twins

Bridging the physical and digital

IMAGINE THAT YOU had a perfect digital copy of the physical world: a digital twin. This twin would enable you to collaborate virtually, intake sensor data and simulate conditions quickly, understand what-if scenarios clearly, predict results more accurately, and output instructions to manipulate the physical world.

Today, companies are using digital twin capabilities in a variety of ways. In the automotive[1] and aircraft[2] sectors, they are becoming essential tools for optimizing entire manufacturing value chains and innovating new products. In the energy sector, oil field service operators are capturing and analyzing massive amounts of in-hole data that they use to build digital models that guide drilling efforts in real time.[3] In health care, cardiovascular researchers are creating highly accurate digital twins of the human heart for clinical diagnoses, education, and training.[4] And in a remarkable feat of smart-city management, Singapore uses a detailed virtual model of itself in urban planning, maintenance, and disaster readiness projects.[5]

Digital twins can simulate any aspect of a physical object or process. They can represent a new product's engineering drawings and dimensions, or represent all the subcomponents and corresponding lineage in the broader supply chain from the design table all the way to the consumer—the "as built" digital twin. They may also take an "as maintained" form—a physical representation of equipment on the production floor. The simulation captures how the equipment operates, how engineers maintain it, or even how the goods this equipment manufactures relates to customers.

Digital twins may take many forms, but they all capture and utilize data that represents the physical world.

Recent MarketsandMarkets research suggests that such efforts are already underway: The digital twins market—worth US$3.8 billion in 2019—is projected to reach US$35.8 billion in value by 2025.[6]

What accounts for this kind of growth? And why now? After all, digital twin capabilities are not new. Since the early 2000s, pioneering companies have explored ways to use digital models to improve their products and processes.[7] While digital twins' potential was clear even then, many other companies found that the connectivity, computing, data storage, and bandwidth required to process massive volumes of data involved in creating digital twins were cost-prohibitive.[8]

Digital twins are poised to transform the way companies perform predictive maintenance of products and machinery in the field.

The *digital twins* trend is gaining momentum thanks to rapidly evolving simulation and modeling capabilities, better interoperability and IoT sensors, and more availability of tools and computing infrastructure. As a result, digital twins' capabilities are more accessible to organizations large and small, across industries. IDC projects that by 2022, 40 percent of IoT platform vendors will integrate simulation platforms, systems, and capabilities to create digital twins, with 70 percent of manufacturers using the technology to conduct process simulations and scenario evaluations.[9]

At the same time, access to larger volumes of data is making it possible to create simulations that are more detailed and dynamic than ever.[10] For longtime digital twins users, it is like moving from fuzzy, black-and-white snapshots to colorful, high-definition digital pictures. The more information they add from digital sources, the more vivid—and revealing—the pictures become.

Models + data = insights and real value

Digital twin capabilities began as a tool of choice in the engineer's toolbox because they can streamline the design process and eliminate many aspects of prototype testing. Using 3D simulations and human-computer interfaces such as augmented reality and virtual reality,[11] engineers can determine a product's specifications, how it will be built and with what materials, and how the design measures against relevant policies, standards, and regulations. It helps engineers identify potential manufacturability, quality, and durability issues—all before the designs are finalized. Thus, traditional prototyping accelerates, with products moving into production more efficiently and at a lower cost.

Beyond design, digital twins are poised to transform the way companies perform predictive maintenance of products and machinery in the field. Sensors embedded in the machines feed performance data into a digital twin in real time, making it possible not only to identify and address malfunctions before they happen but to tailor service and maintenance plans to better meet unique customer needs. Recently, Royal Dutch Shell launched a two-year digital twin initiative to help oil and gas operators manage offshore assets more effectively, increase worker safety, and explore predictive maintenance opportunities.[12]

Digital twins can help optimize supply chains, distribution and fulfillment operations, and even the individual performance of the workers involved in each. As an example of this in action, global consumer products manufacturer Unilever has

launched a digital twin project that aims to create virtual models of dozens of its factories. At each location, IoT sensors embedded in factory machines feed performance data into AI and machine learning applications for analysis. The analyzed operational information is to be fed into the digital twin simulations, which can identify opportunities for workers to perform predictive maintenance, optimize output, and limit waste from substandard products.[13]

Smart city initiatives are also using digital twins for applications addressing traffic congestion remediation, urban planning, and much more. Singapore's ambitious Virtual Singapore initiative enables everything from planning for cell towers and solar cells to simulating traffic patterns and foot traffic. One potential use may be to enable emergency evacuation planning and routing during the city's annual street closures for Formula 1 racing.[14]

What's new?

Over the course of the last decade, deployment of digital twin capabilities has accelerated due to a number of factors:

- **Simulation.** The tools for building digital twins are growing in power and sophistication. It is now possible to design complex what-if simulations, backtrack from detected real-world conditions, and perform millions of simulation processes without overwhelming systems. Further, with the number of vendors increasing, the range of options continues to grow and expand. Finally, machine learning functionality is enhancing the depth and usefulness of insights.

- **New sources of data.** Data from real-time asset monitoring technologies such as LIDAR (light detection and ranging) and FLIR (forward-looking infrared) can now be incorporated into digital twin simulations. Likewise, IoT sensors embedded in machinery or throughout supply chains can feed operational data directly into simulations, enabling continuous real-time monitoring.

- **Interoperability.** Over the past decade, the ability to integrate digital technology with the real world has improved dramatically. Much of this improvement can be attributed to enhanced industry standards for communications between IoT sensors, operational technology hardware, and vendor efforts to integrate with diverse platforms.

- **Visualization.** The sheer volume of data required to create digital twin simulations can complicate analysis and make efforts to gain meaningful insights challenging. Advanced data visualization can help meet this challenge by filtering and distilling information in real time. The latest data visualization tools go far beyond basic dashboards and standard visualization capabilities to include interactive 3D, VR and AR-based visualizations, AI-enabled visualizations, and real-time streaming.

- **Instrumentation.** IoT sensors, both embedded and external, are becoming smaller, more accurate, cheaper, and more powerful. With improvements in networking technology and security, traditional control systems can be leveraged to have more granular, timely, and accurate information on real-world conditions to integrate with the virtual models.

- **Platform.** Increased availability of and access to powerful and inexpensive computing power, network, and storage are key enablers of digital twins. Some software companies are making significant investments in cloud-based platforms, IoT, and analytics capabilities that will enable them to capitalize on the *digital twins* trend. Some of these investments are part of an ongoing effort to streamline the

development of industry-specific digital twin use cases.

Costs versus benefits

The AI and machine learning algorithms that power digital twins require large volumes of data, and in many cases, data from the sensors on the production floor may have been corrupted, lost, or simply not collected consistently in the first place. So teams should begin collecting data now, particularly in areas with the largest number of issues and the highest outage costs. Taking steps to develop the necessary infrastructure and data management approach now can help shorten your time to benefit.

Balancing the cost/benefit analysis is critical. Modern aircraft engines can have thousands or tens of thousands of sensors, generating terabytes of data every second.

Even in cases where digital twin simulations are being created for new processes, systems, and devices, it's not always possible to perfectly instrument the process. For chemical and biological reactions or extreme conditions, it may not be possible to directly measure the process itself; in some cases, it may not be cost-effective or practical to instrument the physical objects. As a result, organizations need to look to proxies (for example, relying on the instrumentation and sensors in a vehicle rather than putting sensors into tires) or things that are possible to detect (for example, heat or light coming from chemical or biological reactions).

And with the cost of sensors dropping, how many sensors is enough? Balancing the cost/benefit analysis is critical. Modern aircraft engines can have thousands or tens of thousands of sensors, generating terabytes of data every second. Combined with digital twins, machine learning, and predictive models, manufacturers are providing recommendations to help pilots optimize fuel consumption, help maintenance be proactive, and help fleets manage costs.[15] Most use cases, however, require only a modest number of strategically placed sensors to detect key inputs, outputs, and stages within the process.

Models beyond

In the coming years, we expect to see digital twins deployed broadly across industries for multiple use cases. For logistics, manufacturing, and supply chains, digital twins combined with machine learning and advanced network connectivity such as 5G will increasingly track, monitor, route, and optimize the flow of goods throughout factories and around the world. Real-time visibility into locations and conditions (temperature, humidity, etc.) will be taken for granted. And without human intervention, the "control towers" will be able to take corrective actions by directing inventory transfers, adjusting process steps on an assembly line, or rerouting containers.

Organizations making the transition from selling products to selling bundled products and services, or selling as-a-service, are pioneering new digital twin use cases. Connecting a digital twin to embedded sensors and using it for financial analysis and projections enables better refinement and optimization of projections, pricing, and upsell opportunities.

For example, companies could monitor for higher wear-and-tear usage and offer additional warranty or maintenance options. Or organizations could sell output or throughput as-a-service in industries

as varied as farming, transportation, and smart buildings. As capabilities and sophistication grow, expect to see more companies seeking new monetization strategies for products and services, modeled on digital twins.

Modeling the digital future

As the *digital twins* trend accelerates in the coming years, more organizations may explore opportunities to use digital twins to optimize processes, make data-driven decision in real time, and design new products, services, and business models. Sectors that have capital-intensive assets and processes like manufacturing, utilities, and energy are pioneering digital twin use cases already. Others will follow as early adopters demonstrate first-mover advantage in their respective sectors.

Longer term, realizing digital twins' full promise may require integrating systems and data across entire ecosystems. Creating a digital simulation of the complete customer life cycle or of a supply chain that includes not only first-tier suppliers but their suppliers, may provide an insight-rich macro view of operations, but it would also require incorporating external entities into internal digital ecosystems. Today, few organizations seem comfortable with external integration beyond point-to-point connections. Overcoming this hesitation could be an ongoing challenge but, ultimately, one that is worth the effort. In the future, expect to see companies use blockchain to break down information silos, and then validate and feed that information into digital twin simulations. This could free up previously inaccessible data in volumes sufficient to make simulations more detailed, dynamic, and potentially valuable than ever.

It's time to transition your digital organization from black-and-white to color. Are you ready?

LESSONS FROM THE FRONT LINES

Prepare for takeoff: Airservices Australia enters the future of aviation

AIRSERVICES AUSTRALIA IS preparing for the aviation industry's next evolution. As the continent's provider of air navigation services, it expects the volume of conventional flights in its airspace to double over the next two decades. Meanwhile, the emergence of unmanned aerial vehicles in low altitude airspace—from aerial taxis to delivery drones—is accelerating the need for new intelligent systems, compounding an already difficult job.

Airservices is addressing these challenges by launching initiatives that will enable it to shift to leveraging the value of data and providing the information management services of the future. One of these initiatives is to explore how a digital twin, combined with IoT and machine learning capabilities, could enhance Airservices' ability to manage air traffic today and in the years to come.

The Service Strategy team, led by Mick Snell,[16] kicked off its digital twin development project in early 2019 with a practical objective: determine whether a digital twin can enhance Airservices' ability to manage its current air traffic network. For example, could it be used to enhance flight routes, optimize takeoff times, and reduce delays?

The team began by developing a digital twin of Airservices' air traffic network using historic air traffic data. The team has completed four proofs of concept proving out the original objective and is looking forward to piloting them in parallel with existing air traffic control systems. The proofs of concept were able to optimize flight routes based on real-time conditions to provide better traffic flow management.

While still in development, the digital twin project is also serving as a proving ground for enhancing Airservices' traditional ways of working. The company's heritage is built on safely delivering navigation services 24 hours a day, 365 days a year. With an unwavering focus on safe, efficient, and reliable service delivery, the increasing airspace complexity is driving Airservices to explore new solutions.

The digital twin project is helping change Airservices' view of what's possible. The team piloted an Agile development approach to improve time to market while preserving the focus on safety. The teams are delivering working software at a faster pace—iterating, testing, and learning in short sprints—and continuing to provide safe, accurate predictions. And while Airservices people have deep aeronautical expertise, the company also needed specialized technical knowledge to build and implement advanced analytic capabilities. The team filled that gap with vendors and advisers who offer highly relevant experience and off-the-shelf technology.

Meanwhile, the team continues to uncover relevant use cases for the digital twin. For example, air traffic controllers currently work in an assigned airspace regardless of traffic volume. To optimize the controllers' workload, the team plans to use the digital twin to assign airspace to controllers based on predicted customer demand rather than fixed geographic locations.

Optimization is an extraordinarily complex issue that requires volumes of real-time data to support what-if scenarios on the fly to help air traffic controllers to make faster, smarter decisions. The digital twin can also enable Airservices customers

(pilots) to optimize flights based on what's most important in the moment. For example, optimizing airspace and routing helps increase on-time arrivals and saves fuel, but a pilot may decide to trade fuel for additional speed to avoid passengers missing their connections.

Eventually, Airservices plans to use digital twins to develop and test strategies for dealing with disruptive innovations likely to affect its airspace. Strategists will be able to quickly test a wide range of scenarios for managing the multidimensional airspace of the future.

With the proof-of-concept phase complete, the team is moving into preproduction. Members will be running trials with current data for several more months and then move into full-scale production, planned for 2020. Snell reports, "We've been able to accelerate to an outcome far faster—we've come further in the last eight months than in the last eight years."

Gaining traction: Bridgestone's digital twin drives an innovative business model

BRIDGESTONE, THE WORLD'S largest tire and rubber manufacturer, is transforming to become a leader in mobility solutions. The company is reimagining its core business by developing digital capabilities that will enable it to revolutionize tire management services to its portfolio of offerings addressing vehicle manufacturers, fleet operators, and individual drivers.

While the business model is simple, setting the appropriate price per kilometer is anything but.

Digital twin technology is at the heart of Bridgestone's transformational journey. The company has used digital twin simulations augmented by sensor data as an R&D tool for several years to improve tire life and performance, but that's just the beginning. Jerome Boulet, digital strategy director, and Hans Dorfi, director of digital engineering,[17] together with their teams, are developing sophisticated digital twins to eventually deliver insights across Bridgestone's entire value chain, with the goal of enhancing profitability, sustaining competitive advantage, reducing time-to-market, and delivering leading-edge tire-as-a-service offerings.

European fleets are gradually shifting to a price-per-kilometer (PPK) subscription model, a way for fleet operators to optimize cash flow and reduce total cost of ownership. But while the business model is simple, setting the appropriate price per kilometer is anything but. A tire's lifespan is heavily influenced by a myriad of factors, including load, speed, road conditions, and driving behavior. A digital twin can provide insight into how these interrelated conditions affect tire performance by simulating various driving conditions. But without real-world data inputs for the digital twin, setting a price that hits the sweet spot at which the PPK is competitive—and sustainably profitable—is difficult if not impossible.

Bridgestone took a strategic leap by entering the PPK market with a product priced to win business from large fleets. The company used this initial install base to collect performance data that was then fed into advanced analytics algorithms.

According to Dorfi, "Some people ask, 'Why do you need a digital twin if you have big data—why not just run analytics?' I explain that while analytics plays a major role, it only augments the digital twin. The digital twin is able to capture the multidimensional performance envelope of tires and can also be applied to product in development, where no data is yet available." He sees the digital twin as a key component of Bridgestone's digital infrastructure. Incoming sensor data is augmented, cleaned, and processed; then digital simulations and analytics are applied to derive insights that inform decisions around maintenance, rotations, and other factors that can deliver more value for Bridgestone and its customers.

Bridgestone continues to enhance the digital twins. The 2019 acquisition of WebFleet Solutions[18] and the development of next-generation sensors will enable Bridgestone to learn how vehicles and tires are being used in real time, enabling the company to help fleets select the appropriate tires for their specific driving conditions and provide customized insights into how they can reduce tire wear or avoid breakdowns. As the digital model becomes more and more accurate, Bridgestone will address increasingly advanced use cases for its PPK business model.

Today, Bridgestone is using digital technologies to add more value for its fleet customers. Over time, the company intends to expand its use of digital twin technology to connect its entire value chain, from drivers and fleet managers to retailers, distributors, and manufacturers. Looking ahead, leaders see opportunities to inform safety protocols in a world that includes self-driving vehicles. "We're making sure we have the enablers in place that will take us into the future," Dorfi says. "And that's where digital twin technology comes in."

Takeda pursues end-to-end manufacturing automation with digital twins

TAKEDA PHARMACEUTICALS IS constantly seeking scientific breakthroughs to deliver transformative therapies to patients worldwide. Christoph Pistek[19] leads innovation during the company's development life cycle, translating promising research ideas into tangible medical products. His team also develops processes for how commercial manufacturing partners will actually make the products.

Because the industry is tightly regulated with strict quality control mandates, any process innovation must be thoroughly tested in the development lab for compliance before being introduced to the manufacturing floor. It can take up to 15 years to bring a new medicine to patients, so Pistek is always looking for ways to accelerate experimentation and business processes.

Even in the digital age, pharmaceutical manufacturing processes may contain manual steps. For example, making biologics, vaccines, and other pharma products derived from living organisms involve biochemical reactions, which can be variable and difficult to measure, making automation challenging. And no one has yet perfected a method for automatically progressing from one manufacturing step to the next. True end-to-end manufacturing automation has become the industry's "holy grail," Pistek says.

This is where digital twins come in. They help his team accelerate experimentation, develop new

manufacturing approaches, and generate data to enable more informed decisions and predictions that could help automate complex chemical and biochemical processes.

To that end, Pistek and his development team build sophisticated virtual representations of the manufacturing processes in their development labs. The team builds a digital twin for each process step and then links all parts via an overall digital twin that controls and automates the flow from one step to another, forming an end-to-end simulation of the manufacturing process.

While modeling chemical processes is complicated, modeling biochemical reactions can be far more complex and irregular. In many cases, real-time sensors cannot monitor the desired outputs, and the output quality remains unknown for hours or days. Instead, the development team uses "soft sensors" or proxy measurements to attempt to predict the time required to complete the biochemical reaction, which is fed into a digital twin that incorporates AI and machine learning. "The important aspect is that the architecture of digital twins allows the system to evolve on its own," Pistek says. "Every time we do an additional run and compare the soft sensor results against a true measurement that comes back from the quality control lab, we're able to make the predictions more accurate."

Some pharma companies think the key to automation is a matter of better equipment, sensors, or technology. But Pistek has a different opinion: "The true enabler for pharma is the control architecture across and around the process—and the foundation of that is a sophisticated digital twin that can mature itself over time while still in development." The end goal is a digital twin that can control and steer the automation process without human intervention.

In Takeda's development labs, the ecosystem for this integrated approach is up and running for one modality: biologics, which is the company's fastest-growing category and involves one of pharma's most complex manufacturing processes. The foundational work is complete—the twins are operational, the architecture is built, and the method is in place.

While modeling chemical processes is complicated, modeling biochemical reactions can be far more complex and irregular.

Now the team is refining the process to make it more robust. Pistek expects to expand this automation approach within the development lab across all modalities in the next year. And in two to three years, he expects to see sophisticated examples of this automation approach in use on the commercial manufacturing floor.

Modeling biology and chemical reactions in a digital twin is not straightforward and is difficult to recreate. Pistek's advice to others considering building digital twins: "Don't wait, don't be intimidated, just do it. It's a learning process that takes time. At Takeda, it's a critical capability for the job we have to do—find cures for diseases and provide aid to those who suffer."

MY TAKE

PEOPLE RELATE TO the frustration that traffic congestion creates—and are dissatisfied that it often takes decades to build infrastructure improvements. Our mission is to plan and develop transportation systems that accommodate San Diego's growing population and healthy economy, while meeting government requirements for improving traffic flow, air quality, and greenhouse gas emissions. And of course, we are working with our various communities to build public support for our anticipated recommendations. Anything we can do to get projects underway quickly can shave months or even years off the timeline.

RAY TRAYNOR
CHIEF PLANNING AND INNOVATION OFFICER, SAN DIEGO ASSOCIATION OF GOVERNMENTS (SANDAG)

These are the reasons SANDAG planners and data modelers are developing a nimble digital twin—or "sketch planning" tool—based on FutureScape™, a modeling and simulation platform that creates digital replicas of large systems, like those in a city or an entire region. We're using FutureScape to complement our government-mandated travel demand model, a macro simulation tool we refer to as an Activity-Based Model.

Regulators require that we run our proposals through the model to certify that the proposals meet federal and state government criteria. It's a deliberate, arduous process that requires months of calibration and testing and processing times that can take weeks to complete. The new sketch tool will enable us to quickly evaluate a wider range of traditional and innovative transportation options. The Activity-Based Model will process the most promising solutions to certify that the proposed transportation solutions meet regulatory requirements.

For example, one of our goals is to relieve rush-hour congestion between San Diego's most populated residential areas and the region's largest employment center. Widening roads is the traditional go-to solution in our car-oriented region, but we believe the sketch tool will enable us to compare road-widening with other options. These options include fast rail lines or light rail systems. Results from the tool should arrive within hours or days, not weeks.

Clearing the regulatory bar is only one factor, of course. Transportation planners must also wonder, "If we build it, will they come?" Evaluating different scenarios is key to answering that question. Using the Activity-Based Model's historical data, which is largely based on dated commuter surveys and travel diaries, limits our ability to be dynamic and current in how we measure future utilization and demand. We are working to incorporate near-time digital data and, eventually, artificial intelligence into the sketch tool to help us better reflect behavior in response to new transportation options. We also want to consider proposals that include on-demand transportation options and new trends in mobility, such as ridesharing, electric scooters, and bikes, with an eye to incorporating driverless vehicles when they become a viable option.

We also use a digital twin to support real-time traffic management. Here, I envision that adding AI enhancements to the tool will enable proactive decision-making for reducing day-to-day traffic congestion. The current system works well for reacting to traffic backups, using a microsimulation tool that evaluates current traffic flows every three minutes. When an incident disrupts normal traffic patterns, the tool can generate a set of solutions, such as temporarily diverting traffic to another road, which is deployed through

changeable highway messages. We're developing an AI-based strategy aimed to sense potential traffic disruptors in real time. When you're directing tens of thousands of rush-hour commuters, minutes matter.

By enabling fast, interactive feedback, our sketch planning digital twin will help us quickly develop innovative solutions to complex transportation problems. At SANDAG, we see data-based tools such as FutureScape playing key roles in helping us offer appealing—and environmentally beneficial—mass-transit options to many of our residents accustomed to our car-oriented culture.

OUR TAKE

WHILE A COMPLETE digital twin of the human body is years or even decades away, researchers are chipping away at understanding the biological processes that transform us from DNA into human beings. Today's research is enabled by advances in genetic sequencing and functional genomics, growing volumes of long-term health data of populations, and increasing capabilities in advanced analytics. This growing knowledge base will inform digital simulations that could eventually help medical professionals control or prevent genetic diseases and disorders.

WING WONG
PROFESSOR OF STATISTICS AND OF HEALTH RESEARCH AND POLICY, STANFORD UNIVERSITY

XUEGONG ZHANG
PROFESSOR OF BIOINFORMATICS AND MACHINE LEARNING, TSINGHUA UNIVERSITY

The project is daunting. Within the human body, DNA provides the instructions for cell growth, which are "expressed" within individual cells to create hundreds of different cell types, including blood cells, nerve cells, muscle cells, and immune cells. Different types of cells combine to produce tissues, which are combined to form organs; for example, there may be more than 10 different types of cells in the tissues that comprise the liver.

As a first step toward creating better virtual models of biological systems, we are working to understand the "instructions" that influence a cell's development into tissues and organs and, eventually, entire systems, such as the circulatory system. Our research builds on the development of single-cell genomics. Until recently, scientists were able to study only groups of cells, because they lacked the technical capability to extract enough DNA and RNA from a single cell to support genomic analyses. We're taking single-cell genomics findings to the next level, to understand how single cells construct the gene regulatory systems that underlie the different cell types in tissues and organs.

In Professor Wong's lab in California, we're studying the regulation of gene expression in cells, trying to understand how different genes are expressed and how those genes affect the cells they eventually create. Using advanced mathematical models, we are studying huge volumes of data to try to better understand how cells develop into tissues.

After cells and tissues, the next level is organs. In Professor Zhang's lab in Beijing, we are studying the heart to understand what types and subtypes of cells make up different parts of that organ. With a deeper knowledge of how the heart is constructed, we anticipate having a better understanding of how heart problems arise. By comparing what we're seeing in the lab with the heart conditions we see in the broad population, we expect to be able to better predict what conditions lead to which health outcomes—positive or negative.

We intend to expand beyond studying specific tissues and organs to construct a digital simulation of the human circulatory system. We're developing a framework to take in massive amounts of data generated by electronic health records and large-scale research mapping efforts, such as the Human Cell Atlas project.[20] But data sets alone are not very useful, so we're building a type of digital twin: a multilevel causal network,

a complex mathematical model to represent the functioning system and the underlying linkages between the different layers. One day, we hope to be able to connect all the data from the DNA in the genome to health outcomes in the general population to better understand how cell instructions, cell types, tissues, organs, and health outcomes are all interconnected.

Within the next three years, our goal is to build out a set of quantitative, layer-by-layer models to help interpret the genomic system. We expect the day will come when physicians will examine a newborn's genome sequence and understand the impact of its variants (that is, its differences from the reference genome) along with other factors, leading to insights for resolving or preventing disease or disorders. Over time, researchers may use these findings to create a digital twin of the entire human body to help us better understand and simulate how disease and other changes may manifest in the body. Meanwhile, we, along with researchers around the world, have a lot of work ahead.

EXECUTIVE PERSPECTIVES

STRATEGY

While digital twin technologies that simulate the physical world have been around for years, new advances warrant taking a second look at current capabilities. The combination of cheap sensors and IoT, machine learning, and the fast, frictionless nature of cloud enable more sophisticated analyses and real-time simulations. While manufacturing scenarios have used these capabilities for years, organizations are increasingly exploring ways to deploy digital twins for operations, city planning, smart infrastructure, and more. Moreover, as companies look to migrate to selling as-a-service business models, digital twins' increasingly sophisticated capabilities are worth a closer look. The challenging decisions will then be whether to make small investments to create tests and experiments or larger investments to support innovation more broadly.

FINANCE

Digital twins offer increasing potential to affect the bottom line of organizations but aren't consistently well understood by CFOs and their teams. To many in the finance function, traditional digital twin simulations of manufacturing processes and warehouse logistics are black boxes owned by manufacturing or engineering. However, the growing availability of high-quality simulations, machine learning, and embedded sensors is changing the art of the possible. Some organizations that are shifting from selling products to products-plus-services or as-a-service models are using robust digital twins. They are tracking usage with embedded sensors, creating new offerings for usage recommendations, proactive maintenance, or profitability optimization. Working with the IT function to understand digital twins' uses today and potential uses of tomorrow is becoming increasingly important, particularly to support new product and service design and delivery.

RISK

As digital twin technology integrates with IoT and AI, its disruptive power grows. In the current business climate, any potential technology-driven disruption has material risk implications for the entire organization. Digital twin–driven process efficiencies might not increase risk significantly, at least initially. But as reliance on digital twin technology grows, companies will be aggregating massive stores of data from sensor networks and other sources, which may, in turn, increase privacy or cyber risk. Likewise, if digital twin systems enable a new business model featuring several as-a-service offerings, organizations should understand what material impact these new revenue streams may have on finance, technology, and existing business models. If the potential risks are significant, companies will likely need to develop strategies for measuring and managing them before IT and the business proceed any further with the digital twin project.

ARE YOU READY?

1. Which of your systems, processes, products, or outputs would be strong candidates for inclusion in a digital twin pilot?
2. If you are moving to as-a-service models or bundling services with products, how can a digital twin reduce your time to market and reduce overall costs?
3. What infrastructure and technical platforms do you have in place today to support digital twin capabilities?

BOTTOM LINE

In the future, everyone and everything—people, services, global enterprises, and even cities—could have a digital twin. That scale may not happen in the next 18 to 24 months, but the *digital twins* trend will evolve and grow for years to come. Pilots and prototypes can help identify potential areas where companies can benefit from digital twin capabilities, but the time to embrace this next disruptive transformation phase is now.

LEARN MORE

EXPECTING DIGITAL TWINS

Learn how leading companies are using digital twins to increase efficiency, reduce costs, and build better products.

INDUSTRY 4.0 AND THE DIGITAL TWIN

Read on! With a digital simulation of a manufacturing process, you can solve problems more quickly and build better products.

INDUSTRY 4.0 COLLECTIONS PAGE

Check out this intriguing collection of articles that explores today's digital industrial revolution.

Authors

ADAM MUSSOMELI is a principal at Deloitte Consulting LLP with more than 25 years of experience delivering global, highly complex supply chain transformations. He is the Supply Chain & Network Operations National Offering leader, delivering substantial income statement and balance sheet benefits to his clients. Mussomeli cofounded Deloitte's Digital Supply Networks practice, which is redefining the supply chain for the digital age.

AARON PARROTT is a managing director with Deloitte Consulting LLP. With more than 20 years of experience in supply chain and network operations, he focuses on helping clients complete large-scale transformation in the supply network, developing analytic solutions to address difficult business issues, and implementing digital solutions to manage complex supply networks. Parrott's areas of expertise include specializing in digital supply networks, IoT solutions, enterprise lean transformation, and supply network advanced analytics.

BRIAN UMBENHAUER is a principal with Deloitte Consulting LLP. He is a leader in the Industrial Products & Construction sector, as well as the Global Sourcing and Procurement practice. In his two decades of experience, Umbenhauer takes a personalized approach to building consulting practices, collaborating with clients, driving engagements and, above all, measuring value. He has a proven track record in global business development, operations/business strategy advisory, and nontraditional approaches to creating client value.

LANE WARSHAW is a managing director with Deloitte Consulting LLP in the Strategy & Analytics, Analytics & Cognitive (A&C) market, focusing on enabling better use of data in the Industrial Products and Construction (IP&C) industry using next-generation technologies. As the IP&C lead for A&C, he focuses on delivering tangible value through supply chain and customer analytics programs enabled by data management, data warehouse, big data, data science, visualization, and cognitive technologies.

SENIOR CONTRIBUTORS

Saul Caganoff
Principal
Deloitte Services Pty Ltd

Chandra Kiran Reddy Narra
Managing director
Deloitte Consulting LLP

Tim Paridaens
Director
Deloitte Belgium CVBA

Sandeep Sharma
Managing director
Deloitte Consulting LLP

Andreas Staffen
Director
Deloitte

Jimmy Asher
Senior manager
Deloitte Consulting LLP

Rick Burke
Specialist leader
Deloitte Consulting LLP

Yang Chu
Senior manager
Deloitte & Touche LLP

Eduardo Pereira
Master lead specialist
Deloitte & Associados, SROC S.A.

Markus Stulle
Senior manager
Deloitte

Oleg Tyschenko
Senior manager
Deloitte MCS Limited

Anand Ananthapadmanabhan
Manager
Deloitte & Touche LLP

Piotr Kurek
Manager 3
Deloitte Advisory sp. z o.o. sp. k

Paulo Mauricio
Manager
Deloitte & Associados, SROC S.A.

Vikram Tuli
Senior consultant
Deloitte MCS Limited

Dan Lu
Consultant
Deloitte MCS Limited

Hermann Tsang
Consultant
Deloitte MCS Limited

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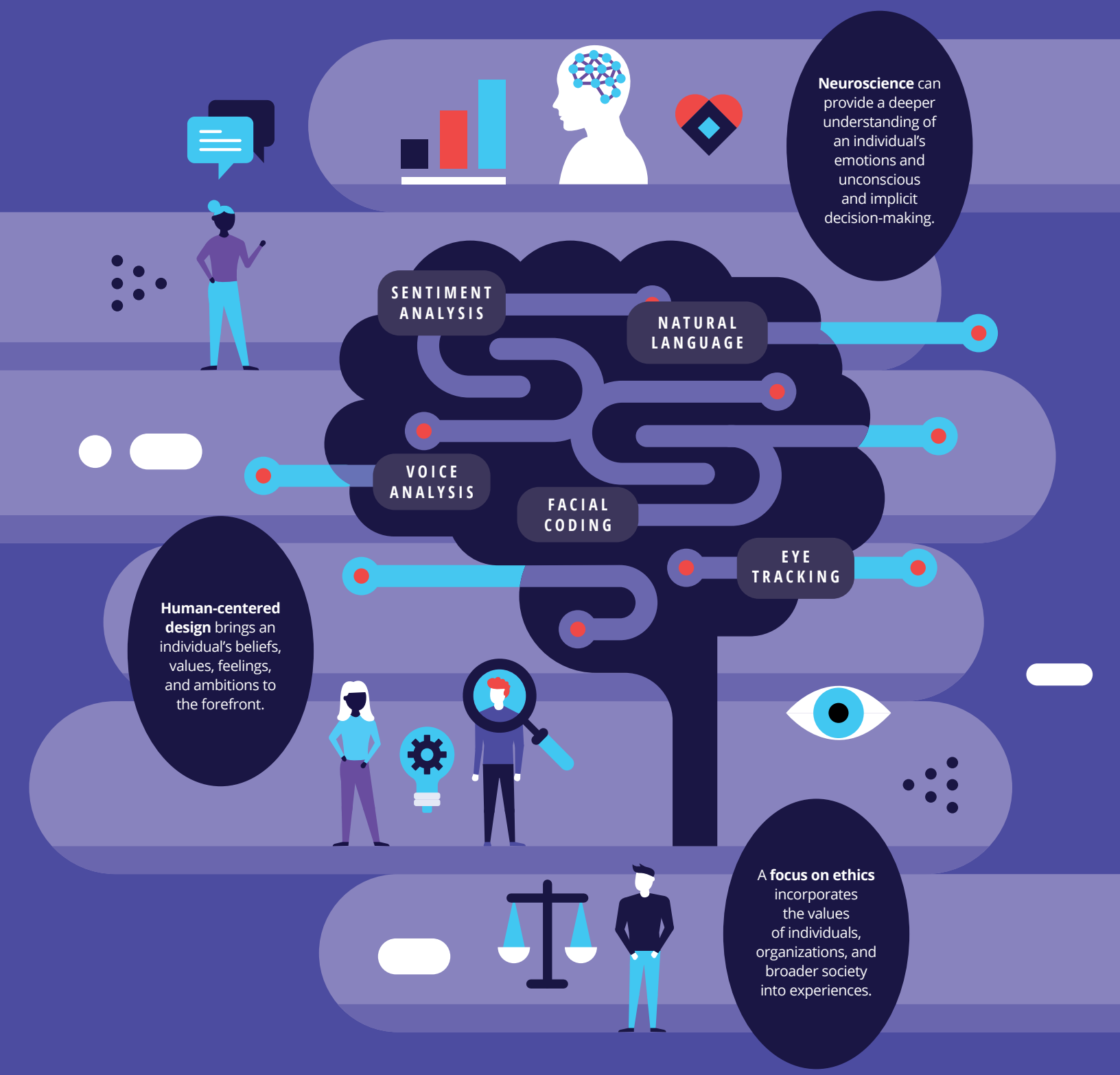
TREND SUMMARY

Reshaping human-machine connections through AI, neuroscience, and human-centered design.



DEFINITION

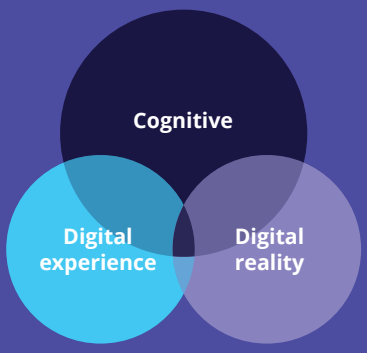
a-'fek-tiv / computing

Computing that relates to, arises from, or deliberately influences emotion or other affective phenomena.[†]

BY THE NUMBERS

of long-term customers in a Deloitte Digital survey use emotional language to describe their connection to favored brands.[††]

TREND BREAKDOWN



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Human experience platforms

Affective computing changes the rules of engagement

AS YOU ENTER the last leg of a long drive home, a network of cameras, microphones, and sensors embedded throughout your car monitors your facial expressions, voice, and the way you are using the car's functionality. Analyzing the inputs in real time, your car—using computer vision, voice recognition, and deep learning capabilities—determines that you are getting tired and distracted. In response, these AI-powered tools lower the thermostat and turn up the volume on the radio, and a conversational agent gently suggests you pull over or stop for a cup of coffee at a restaurant three miles ahead.[1]

These technologies are engaging you—a human driving a car—in human terms. Myriad technologies that detect physical states such as alertness are increasingly being used to infer emotional states such as happiness or sadness. Unlike their machine forebears that set rigid rules of engagement, these systems will follow rules, reading your mood, intuiting your needs, and responding in contextually and emotionally appropriate ways.

Welcome to the next stage of human-machine interaction, in which a growing class of AI-powered solutions—referred to as "affective computing" or "emotion AI"—is redefining the way we experience technology. These experiences are hardly confined to automobiles. Retailers are integrating AI-powered bots with customer segmentation and CRM systems to personalize customer interactions while at the same time capturing valuable lead-nurturing data.[2] Apps are designing custom drinks and fragrances for fashion-show attendees based on emotional quotient (EQ) inputs.[3] A global restaurant chain is tailoring its drive-through experiences based on changes in the weather.[4] The list goes on.

As part of the emerging *human experience platforms* trend, during the next 18 to 24 months more companies will ramp up their

responses to a growing demand for technology to better understand humans and to respond to us more appropriately. System users increasingly expect the technologies they rely on to provide a greater sense of connection—an expectation that should not be ignored. In a recent Deloitte Digital survey of 800 consumers, 60 percent of long-term customers use emotional language to describe their connection to favored brands; likewise, 62 percent of consumers feel they have a relationship with a brand. Trustworthiness (83 percent), integrity (79 percent), and honesty (77 percent) are the emotional factors that consumers feel most align with their favorite brands.[5]

Historically, computers have been unable to correlate events with human emotions or emotional factors. But that is changing as innovators add an EQ to technology's IQ, at scale. Using data and human-centered design (HCD) techniques—and technologies currently being used in neurological research to better understand human needs—affective systems will be able to recognize a system user's emotional state and the context behind it, and then respond appropriately.

Early trend participants recognize that the stakes are high. The ability to leverage emotionally intelligent platforms to recognize and use emotional data at scale will be one of the biggest, most important opportunities for companies going forward. Deloitte Digital research reveals that companies focusing on the human experience have been twice as likely to outperform their peers in revenue growth over a three-year period, with 17 times faster revenue growth than those who do not.[6] Moreover, inaction could lead to more "experience debt"[7] and user alienation as AI applications make us all feel a bit less human. Chances are, your competitors are already working toward this goal. Research and Markets projects that the size of the global affective computing market will grow from US$22 billion in 2019 to US$90 billion by 2024; this represents a compound annual growth rate of 32.3 percent.[8]

Time to get started. How will you create emotionally insightful human experiences for your customers, employees, and business partners?

Knowing me, knowing you

In *Tech Trends 2019*, we examined how marketing teams—by adopting new approaches to data gathering, decisioning, and delivery—can create personalized, contextualized, dynamic experiences for individual customers. These data-driven experiences, embodying the latest techniques in HCD, can inspire deep emotional connections to products and brands, which in turn drive loyalty and business growth.[9] The *human experience platforms* trend takes that same quest for deeper insights and connections to the next level by broadening its scope to include not only customers but employees, business partners, and suppliers—basically anyone with whom you interact.

In addition to data, human experience platforms leverage affective computing—which uses technologies such as natural language processing, facial expression recognition, eye tracking, and sentiment analysis algorithms—to recognize, understand, and respond to human emotion. Affective computing can help us achieve something truly disruptive: *It makes it possible for us to be human at scale*. What do we mean by that? Right now, true human connections are limited to the number of people we can fit into a room. Technologies such as phones or webcams connect us to other humans but remain only a conduit, and connections made through technology conduits are useful yet emotionally limited.

But what if technology itself could become more human? What if a bot appearing on the screen in front of our faces could engage us with the kind of emotional acuity and perceptive nuance that we expect from human-human interaction? Today, you may walk into a clothing store and barely notice the screens mounted on shop walls,

displaying items currently on sale; the ads aren't particularly relevant, so you don't give them a second thought. But imagine if you could walk into that same space and a bot appearing on the screen recognizes you and addresses you by name.[10] This bot has been observing you walk around the store and has identified jackets you might love based on your mood today and your purchasing history. In this moment, technology engages you as an individual, and as a result, you experience this store in a very different, more human way. AI and affective technologies have scaled an experience with very human-like qualities to encompass an entire business environment.

Designing for humans

The *human experience platforms* trend reverses traditional design approaches by starting with the human and emotion-led experience we want to achieve, and then determining which combination of affective and AI technologies can deliver them. The big challenge that companies will face is identifying the specific responses and behaviors that will resonate with—and elicit an emotional response from—a diverse group of customers, employees, and other stakeholders, and then developing the emotional technologies that can recognize and replicate those traits in an experience.

Think about the abilities comprising empathy—among them, the ability to relate to others, the ability to recognize ourselves in a storyline, and the ability to trust and feel complex emotions. As humans, we see these abilities in ourselves and, by using our senses, we can recognize them in others. Today a growing number of companies are exploring ways to develop a deeper understanding of the humans who will be using new technologies, and to incorporate these insights into technology designs. They include:

- **Neuroscientific research.** This method moves beyond traditional "soft science" market research approaches (surveys, questionnaires, data analysis, etc.) by deploying a variety of sensory recognition technologies to measure brain activity, eye movement, and other physical responses to stimuli. Analysis of this data can give companies a deeper understanding of individual's unconscious and implicit decision-making processes. (See sidebar, "Neuroscientific methods for measuring thought processes.")

- **Human-centered design.** HCD brings the human being into focus. It starts with the premise that individuals' beliefs, values, feelings, and ambitions are important because they form the foundation for who those individuals are and what they want from the organizations with which they engage. HCD involves using ethnographic research[11] and neuroscience to better understand individuals' unmet needs and using these insights to improve service design and delivery. Importantly, a design-led approach brings end users into the room with stakeholders to engage in rapid prototyping, testing, and iteration of solutions with the people for whom they are created.[12]

- **Removing bias and emphasizing values and ethics**. For experiences to resonate, they must reflect human values, such as trustworthiness, integrity and honesty—all emotional factors that humans feel about their favorite brands. But in the absence of ethical consensus on so many aspects of cognitive and affective technologies, individual companies on human experience journeys should factor ethical considerations—as well as their organization's values—into the development of their own AI solutions. As you build human experiences for your customers, employees, and business partners, ask yourself: What does ethical technology mean? How do governance

NEUROSCIENTIFIC METHODS FOR MEASURING THOUGHT PROCESSES

Two decades ago, neuroscience began investigating business-relevant questions by forming links with other disciplines such as economics and behavioral science. Today, this research plays a critical role in the *human experience platforms* trend. Using the following scientific methods—suggested by Deloitte Neuroscience Institute—to measure conscious and unconscious human thoughts, organizations can gain valuable insight into individuals' desires and emotions. They can also test the effectiveness of the sensing and analysis tools.

Electroencephalography (EEG). Measures electrical brain activity with highly temporal resolution relating to perception and thinking processes.

Eye tracking. Tracks eye movements and gaze in real time to monitor visual focus (mobile and fixed-to-screen versions).

Facial coding. Measures facial expressions to identify emotional reactions.

Galvanic skin response. Measures skin conductance to monitor physiological arousal in response to external events.

Implicit association testing. Reveals implicit beliefs and attitudes that respondents usually do not report in traditional explicit testing methods like interviews and surveys.

and ethics overlap? Do the algorithms we are creating align with our values and those of society in general? How can you build transparency into AI decision-making?[13] And how can you reduce cognitive bias in the development process by having more diverse teams be part of the design?[14] (Note: For a deeper dive into the ethical dimensions of technology development, check out the *ethical technology and trust* chapter of *Tech Trends 2020*.)

Implementing the experience

Once targeted experience has been designed using a combination of neuroscience, HCD, and the ethical guidelines and principles, it's time to implement it. Companies need to leverage *human experience platforms* that use AI, machine learning, natural language processing, visual recognition, and other technologies that can be combined to make the experience come to life. For example, if an employee contacts an automated internal call center, AI-based voice recognition and natural language processing tools will be able to recognize the nature of the employee's query from a list of things about which employees typically call. These tools also detect, based on the caller's tone of voice, that she is agitated. With this information, an AI-powered customer service bot can deliver the scripted response most likely to defuse this specific situation. The script may direct the bot to express empathy. All scripted responses are designed to help AI systems engage the caller in a human way, but also to keep the technology from violating the caller's or the organization's values. And the AI needs to know when to pass off the call to a human operator. In this human experience, designers have set up operating parameters but have left it to affective tools and AI, working in tandem, to fill in the blank spaces with the optimum response.

This can pose a whole new set of challenges as choices must be made explicit. Organizations can hire a human call center agent, give them a discretionary budget for returns or waived fees, and assume that they will employ decades of good judgment to dispense it. A virtual agent must be instructed. Moreover, we expect our virtual agents

SAMPLE AI TECHNOLOGIES SUPPORTING HUMAN EXPERIENCE PLATFORMS

To support the ability to detect stress and emotion in human experience platforms, computers rely on a combination of text analytics, voice analytics, voice recognition and response, video analytics, and more. AI's increasing ability to use video and voice to measure physical states and detect likely emotional states enables AI agents to respond more appropriately—mirroring mood, gestures, and tone.

Vision systems. Cameras and supporting algorithms to identity people, objects, surroundings, and extrasensory dimensions—thermal signatures, slow motion, ultra-zoom, long distance, and others.

Natural language generation. Generates appropriate responses and vocalizes them into human-like speech.

Natural language processing. Enables the processing of text to understand intent, questions, and queries.

Sentiment analysis. Analyzes text to detect overall sentiment toward topic—positive, negative, or neutral.

Voice recognition. Translates human speech into text for further processing.

Voice stress analysis. Measures relative stress levels to attempt to identify emotional reactions.

to be unbiased—imagine if the virtual agent were discovered to be consistently waiving fees for one group and not another. Next, virtual agents need context and history. Maybe the first penalty for late payment should be waived, but how about the second? Or the fifth? Finally, AI-powered agents need a set of outcomes for which to optimize. If they optimize for customer happiness, the agents may waive all fees—an outcome that would surely please customers but might not be optimal for the business. Ultimately, building rules to mimic "basic" human intuition is a tall order.

Now connecting

The work of making technology more human is hardly new. Voice assistants that only a few Christmases ago were the coolest gift under the tree are now ubiquitous, and the kiosk bots that engage mall shoppers in amusing ways today will soon be old news. And there are much bigger human experience initiatives underway. We're already seeing advanced use cases emerge in the biopharmaceutical sector, exploring ways to use augmented reality and virtual reality in care management.[15]

In the coming months, we expect growing demand for technologies to become more human. We've reached a point in the digital revolution at which everyone's connected to technology but not necessarily to each other. We are disintermediating processes and interactions and engaging directly with machines. It is unsurprising, then, that we crave what we are rapidly losing: meaningful connections. In response, we increasingly expect technology to treat us in more human—and humane—ways. Designing technologies that can meet this expectation will require deeper insights into human behavior, and new innovations that enhance our ability to anticipate and respond to human needs. But the incentive is there. In the near future, human experiences will likely deliver a durable and lasting competitive advantage.

LESSONS FROM THE FRONT LINES

Digital experience investment strengthens UBS client-adviser connections

IN A BUSINESS built around human interaction and high-touch advisers for high-net-worth clients, UBS seeks to balance the human experience with the digital experience. As part of its digital journey, UBS changed how its high-net-worth and ultra-high-net-worth clients invest and manage their finances, develop investment strategies, and engage with UBS financial advisers.

With a recently launched mobile app, the investment firm's primary goal was to create a digital experience that felt high-touch and human, according to Kraleigh Woodford, head of digital client experience at UBS Wealth Management USA.[16] UBS also wanted it to help deepen relationships between clients and financial advisers by using technology to deliver a more holistic wealth management experience.

UBS knew it needed to boost client-facing technology to incorporate personalized experiences and hands-on interactions. But at the heart of its wealth management business are financial advisers and their teams, who have cultivated deep, long-standing client relationships and connections. Recognizing that any technology solution should not disrupt the adviser-client bond, they sought to create a solution that would supplement and enhance rather than supplant these relationships.

To meet these objectives, UBS required a development process that was emotionally sensitive to the needs of its clients and advisers. The firm adopted an agile, business-led approach to product development, colocating business and technology teams to help ensure successful incorporation of both adviser and client feedback.

UBS leveraged its financial advisers' deep reservoir of client knowledge, collecting and incorporating their feedback into the creation process. It also brought clients into the design process, seeking to recognize and adapt to customer behaviors and preferences through end-user testing and research. The design team examined investment strategies, buying patterns, personal aspirations, and consumer choices to understand client definitions of wealth, key financial goals, and important milestones and achievements.

At the heart of the app is an AI-driven personalization engine. To calibrate and customize the client experience, the app asks questions that allow clients to share information about their specific interests, concerns, and long-term needs. It also incorporates information about their philanthropic interests, individual goals, and important people and relationships. An algorithm identifies tailored wealth management content so that clients receive a curated selection of investment and financial information.

Research indicated that clients wanted to share more data with advisers but didn't know the best way—and didn't want to take up too much of their advisers' time. To address this challenge, client information and insights flow directly into adviser-facing systems. Using data from the app, advisers can initiate conversations about wealth-building and personal goals and strategies, thereby enhancing ongoing client-adviser relationships.

Woodford says that since launching the app in March 2019, half of the clients using it have shared their interests and concerns to create a

more tailored experience; a quarter have shared important milestones in their investment journeys. And UBS has realized a significant uptick in the number of high-net-worth and ultra-high-net-worth clients using the app compared to the web portal. "Our motto was 'People first, then product.' This allowed us to balance practical needs such as accelerating growth with emotional needs such as supporting the client-adviser relationship," Woodford says. "We will continue to focus on this lesson."

Brain-computer interfaces improve wellness and performance by tracking emotions

DURING AN EXTENDED shift, an air traffic controller is handling a high volume of passenger jets and private planes. The day has been chaotic and stressful, with a couple of unexpected police and medical helicopter landings and a drone that deviated from its intended flight path. The controller hasn't taken a break in several hours and is feeling fatigued. She tries to focus on the radar system, but it sends her a message: "Christina, it's time for a break. Let's find someone to cover for you."

The air traffic controller is wearing brain-sensing earbuds that contain electrodes measuring her brain's electrical activity. Upon analyzing these electroencephalographic (EEG) signals—the same ones used by doctors to understand brain (dys)function—machine learning algorithms detected increased distraction and stress in the controller's brain activity patterns and decided that she needed a pause.

A long-established medical and research tool, EEG allows physicians to establish medical diagnoses and enables researchers to understand the brain dynamics underlying human decision-making processes and behavior. It can also help individuals improve wellness and performance, says Professor Olivier Oullier, president of EMOTIV, a leading neurotechnology and bioinformatics company.[17]

EMOTIV develops EEG-based wearable brain-computer interface systems that can be used to monitor cognitive performance and emotional reactions to inform workplace wellness, learning, safety, and productivity and capture consumer insights.

EMOTIV has miniaturized wireless EEG systems and machine learning–based neurotechnology to develop a wearer-friendly form factor that detects brain activity as accurately as laboratory EEG caps that prevent mobility—and are neither stylish nor comfortable. The company's MN8 device looks and functions like standard Bluetooth earbuds, but squeezed inside is a mobile EEG lab that can measure and analyze levels of stress and distraction and provide the wearer—or other connected systems—with feedback on how to optimize wellness and performance.

Digital EEG signals are interpreted immediately using real-time analysis; optionally, they can be sent to the cloud for more advanced analysis and storage of the data at scale. EMOTIV's machine learning algorithms have been trained to identify and classify neuro-markers for different cognitive and affective states by a decade of EEG data sets. Data has been accumulated through both scientific studies involving thousands of volunteers who were taken through various experiences to prompt

different levels of the desired brain state[18] as well as from nearly 100,000 neuroheadsets owners that volunteered to share their real-life data anonymously with the company.

Insight into exactly how people's brains are reacting and evolving moment to moment, over time and in context of their actions, can be more valuable than self-reporting of emotions via written survey or verbal response. Self-reporting is important but doesn't paint a complete picture, since answers represent only a single moment in time and are often influenced by what people think others want or expect them to say.

"Until recently," Oullier says, "stress, focus, mental fatigue or cognitive load were challenging to measure scientifically and rigorously. In fact, they are cognitive and affective states that can now be detected by EEG neurotechnology. Quantifying these cognitive states in real time and in real-life situations such as in the workplace finally bridges the gap between perception and reality that exists when people self-report what they feel and experience."

As in the case of the air traffic controller, organizations can leverage real-time analysis of cognitive data to improve individual employee wellness, performance, productivity, and safety by instructing workers to take breaks when they're tired, changing the difficulty or the format of an interactive training or onboarding process when an employee is unfocused, or switching the employee to a less stressful task.

Companies can also mine the aggregated data to understand behavioral and work patterns. Taking these patterns into account, they can optimize workflows and procedures—for example, by building more breaks into workers' schedules, changing shift hours to avoid stressful commute times, or moving the time of a meeting that requires high levels of employee attention. "Brain data can shed light on the types of environments and situations that allow employees to flourish so that workplaces can adjust," Oullier says. "The purpose is to leverage neuroinformatics to personalize the work experience thanks to dynamic workplaces and systems that are more responsive to what employees feel."

Smart, sensitive, and efficient: A cognitive agent even a curmudgeon can trust

VIRTUAL AGENTS ARE increasingly the first points of contact for customers or employees who need help or information. When communicating with a machine, few callers expect more than an efficient way to get a fast answer to a simple question. But expectations are changing as some companies look to combine a virtual agent's efficiency with the problem-solving capabilities and emotional connections that a human agent can provide.

Increasingly, these companies are investing in sophisticated virtual support platforms that incorporate intelligent systems with affective computing—what some call "cognitive agents." Chris Butler,[19] IPsoft's chief product architect, says, "What's valuable about a cognitive agent is that it can help build trust," which encourages humans to use it for increasingly complex issues. Butler sees three steps that cognitive agents need to perform effectively to establish trust: demonstrate understanding, classify the issue, and select appropriate next steps.

First, demonstrating understanding—especially when encountering human emotion—is one of

the main use cases for cognitive agents. In many enterprise settings, human and cognitive agents are trained to follow a script when responding to questions and requests. Human agents tend to instinctively mirror callers by expressing a sentiment that demonstrates understanding, such as, "I'm very sorry to hear that" or, "Oh, that's great!" After mirroring the emotion, the agent tries to move on to the next step in the script. Cognitive agents use advanced AI techniques such as sentiment analysis in order to detect and mirror emotion before moving on through the script.

Second, cognitive agents can learn to automatically identify and classify issues using AI text analysis and natural language processing (NLP). Episodic memory enables cognitive agents to recall information that may be required later in the conversation, avoiding the need to assume information or repeat a question. Recent improvements in NLP will equip cognitive agents to handle new phrases, utterances, and colloquialisms. All together, these will help cognitive agents better understand and classify issues.

Finally, as companies learn to trust the ability of cognitive agents to classify underlying issues and select appropriate next steps, fewer are transferring customers to human agents. Not only can a cognitive agent develop skills for handling negative emotions—it can develop the ability to identify ways to increase customer loyalty, such as selecting qualified and amenable customers for upsell and cross-sell opportunities. And cognitive agents can increasingly detect when a customer should be escalated to a human agent, whether based on the company's policies and rules, detection of extreme negative emotions, or issues arising due to regulatory, audit, adjudication, or judgment calls.

IPsoft has incorporated mirroring into the text and voice recognition capabilities of its cognitive agent, Amelia. Now, the company is working on a next-generation appearance for video calls that will mirror emotions through sympathetic facial expressions. The company is also experimenting with voice and video biometrics to enhance Amelia's ability to discern human emotions by comparing a person's voice or expression against a normal baseline; when people feel tense or upset, their voices or expressions typically change.

It's possible that with appropriate training, a cognitive agent can perform as well as or, perhaps, even better than a human agent.

Butler advises organizations that are planning to use a cognitive agent to observe and learn how their most effective human agents work with a diverse range of customers and situations, to study how they follow scripts and respond to customer emotions, and use these insights to train models and create standard operating procedures for their cognitive agent. He also suggests that they consider giving experienced human and cognitive agents more latitude to make judgment calls.

It's possible that with appropriate training, a cognitive agent can perform as well as or, perhaps, even better than a human agent because it is encountering and learning from many more customer situations than a human is likely to encounter. And the agents are available 24/7 and can react to increases in demand by simply adding more computing power. The goal is not to fool customers into thinking they're dealing with a human agent—it's about providing faster, more efficient service that builds customer trust and loyalty.

MY TAKE

A FEW YEARS ago, Anthem adopted a goal of providing world-class consumer experiences while improving members' health and well-being. We also sought to deepen our relationships with members of our affiliated health plans.

ANIL BHATT
CHIEF EXPERIENCE OFFICER, ANTHEM

To do this, we needed to provide frictionless, consumer-centric interactions, which required us to enhance and expand our engagement skills as well as increase the level of emotional intelligence with which we approached health plan members.

We're leaning heavily on advanced predictive data analytics, cognitive technologies, and augmented reality to achieve these goals. For example, to create a more stress-free service experience, we've made significant investments in digital assistant technologies, predictive modeling with voice recognition, natural language processing, voice pattern identification, and sentiment analysis to analyze and predict consumer emotion and feedback in real time. This allows us to improve customer service as we engage with plan members across their preferred channels, especially as the ongoing growth of digital voice assistants signals an increasingly voice-oriented future.

With access to detailed data from a consumer's health insurance plan, our digital assistant provides personalized engagement and helps health plan members complete administrative tasks. The digital assistant technologies can identify when a person is growing frustrated, determine that it's time to route the customer to a human customer service representative, and does just that. This effort has helped us achieve higher customer satisfaction scores and task completion rates on our various portals and mobile apps, and our customer service center has demonstrated measurable improvements in first call resolution and average handle time.

We've also sought to help health plan consumers lower their likelihood of future illness in part by deepening relationships with them. Historically, individuals contacted us primarily to ask administrative questions about plans, premiums, benefits, or claim status. But we have the experience and know-how to have more meaningful member relationships, expanding our role from that of a health care administrator to that of a health care adviser that can help plan members choose healthier lifestyle options and guide them toward appropriate preventative care.

We do this by understanding their current health concerns and challenges and proactively designing and delivering tailored programs that build on our long-standing use of data-driven insights and cognitive technologies. Using predictive data models, we can identify individuals at risk for negative health outcomes and create personalized coaching and intervention programs—including follow-up care, social support, positive messaging, education programs, and health care advice—that help them better manage a disease. We can also turn the case over to a care provider who can work with the person to lead a healthier life.

In addition, augmented reality technology is helping us simplify the consumer experience. We get it: Nobody enjoys reviewing or completing applications and enrollment forms or insurance claims. So we're testing an AR-based mobile app to reduce some of the apprehension associated with reviewing and completing complex documents and forms. Using a mobile device camera, the app converts insurance-centric language into more commonly used phrases and terms, helping consumers quickly identify important information and visualize where to sign or initial forms. This has helped speed the process of reviewing and completing forms, reducing member frustration.

As Anthem transforms to a digital-first organization focused on enhancing the consumer experience, we'll continue to explore innovative ways to reduce the stress and frustration in consumer interactions and develop more meaningful relationships with health plan members. By leveraging advanced data analytics, cognitive technologies, and AR to deliver valuable, frictionless experiences and interactions, we can become a trusted health care partner that enables healthier lifestyles.

EXECUTIVE PERSPECTIVES

STRATEGY

CEOs and other strategy leaders immerse themselves in every aspect of the client experience to become the ultimate client champions and end-user ethnographers. What are customers' most subtle habits, desires, and subconscious concerns? With a nuanced understanding of these factors, CEOs can champion intuitive human experiences by pushing data to its maximum limit and setting the highest standards for execution. While machine learning and AI promise better signal detection, they are far from a complete solution to this challenge. Human experience platforms, by combining context (status of current account/order/payment), emotional state (inferred by sentiment detection, voice stress analysis, facial expressions, and more), and interaction proclivities (inferred by customer history) can help optimize the end-user experience across channels and interactions. This, in turn, can help create a more consistent human experience for all.

FINANCE

Targeted investments in technologies that continually improve the user experience can offer a clear value proposition. AI-based technologies are improving the detection of human emotion through sentiment analysis, voice stress measurement, and facial expression detection. And machine learning can help identify the likely cause for user contact—or even suggest a proactive outreach. With these changes, intuitive bots can increasingly handle user contacts that traditionally required human agents. Consider funding exploratory efforts or insisting that IT help other leaders identify potential use cases, benefits, and ROI. Expect use cases to proliferate as enterprise functions recognize opportunities to reposition products and services by making user experiences more emotionally intuitive and context-appropriate. Some of these opportunities will likely involve transforming existing business strategies and value streams. At this stage, the value propositions that human experience investments offer become more complex—and more compelling.

RISK

The kind of intuitive, emotionally intelligent human experiences to which leading organizations are shifting will affect ongoing risk management efforts in areas such as operations, marketing, finance, and management. The big difference going forward will be data—enormous volumes of highly personal data that reveal people's emotional states, the real-time contexts of their interactions, and their life stories. In this environment, the potential for fraud and identity theft may grow. How can cyber and risk leaders adequately protect myriad types of data that organizations have never captured before, such as information generated by eye-tracking platforms and exoskeleton gait analysis? Likewise, human experience data introduces a web of ethical issues. Human experience data will be harvested, analyzed, aggregated, and used in various ways to support differing enterprise strategies. Are there limits to the kind of data companies will not collect? Are there limits to the ways in which companies will use collected data? And who owns aggregated data? Expect the scope and complexity of risk management to grow as leaders try to answer these and similar questions.

ARE YOU READY?

1. What experience do you want your customers, employees, and partners to have when they engage with your organization? What company values do your experiences convey?
2. Which of your existing customer digital interactions could be pilots for demonstrating emotional and contextual understanding with affective computing?
3. How are you piloting human-centered design, ethical technology, and neuroscientific research capabilities to shape the development of your human experience platforms?

BOTTOM LINE

The *human experiences platforms* trend is fueled by a growing demand from system users that technologies engage us in more meaningful, human-like ways. In the coming years, we expect this demand to become a nonnegotiable expectation. Today, trend pioneers are integrating affective computing, AI, and neuroscientific research into their strategies and systems to transform the rules of user engagement. In the near future, "emotionally intelligent" technologies and tactics will likely give rise to new business models and ways of working. When that day comes, companies that didn't get around to developing their own human experience platforms could find themselves at a significant competitive disadvantage.

LEARN MORE

EMOTION-DRIVEN ENGAGEMENT

Learn why the ability to use emotional data at scale represents one of today's biggest business opportunities.

AI & COGNITIVE TECHNOLOGY

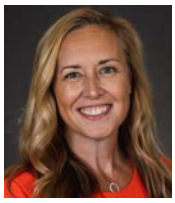
Explore how cognitive technologies can help leaders make wise strategy and technology choices.

PAYING DOWN THE EXPERIENCE DEBT

Read how leading brands use their values to elevate the human experience.

Authors

TAMARA CIBENKO is a principal with Deloitte Consulting LLP and leads the US Digital Experience practice. As a US Air Force veteran and a passionate advocate for the human experience, she focuses on the intersection of business, technology, and experience. Cibenko has spent over 15 years with Deloitte, leading large-scale complex digital transformation programs across industries. Her current program is focused on the intersection of digital and physical to enable a truly seamless end-to-end experience.



AMELIA DUNLOP is the chief experience officer for Deloitte Digital and leader of the US Customer Strategy and Applied Design practice for Deloitte Consulting LLP. She helps companies develop winning strategies that combine innovation, creativity, and digital strategy. Using human-centered design and customer insights to shift focus from the customer experience to the human experience, Dunlop helps clients create solutions and build organizational momentum to turn the future they imagine into reality.

NELSON KUNKEL is the chief design officer for Deloitte Digital and leads the growth of Deloitte's experience design teams across a network of global studios. He has spent a career building brands across multiple industries and holds several design patents; several leading publishers on brand design and digital experiences have released his work. Having traveled the world as an entrepreneur, Kunkel is obsessed with learning from others, collecting stories, and finding relationships between ideas.

SENIOR CONTRIBUTORS

Scott Mager
Principal
Deloitte Consulting LLP

Robbie Robertson
Partner
Deloitte Touche Tohmatsu

Steve Rayment
Partner
Deloitte Touche Tohmatsu

Tânia Conceição
Manager
Deloitte & Associados, SROC S.A.

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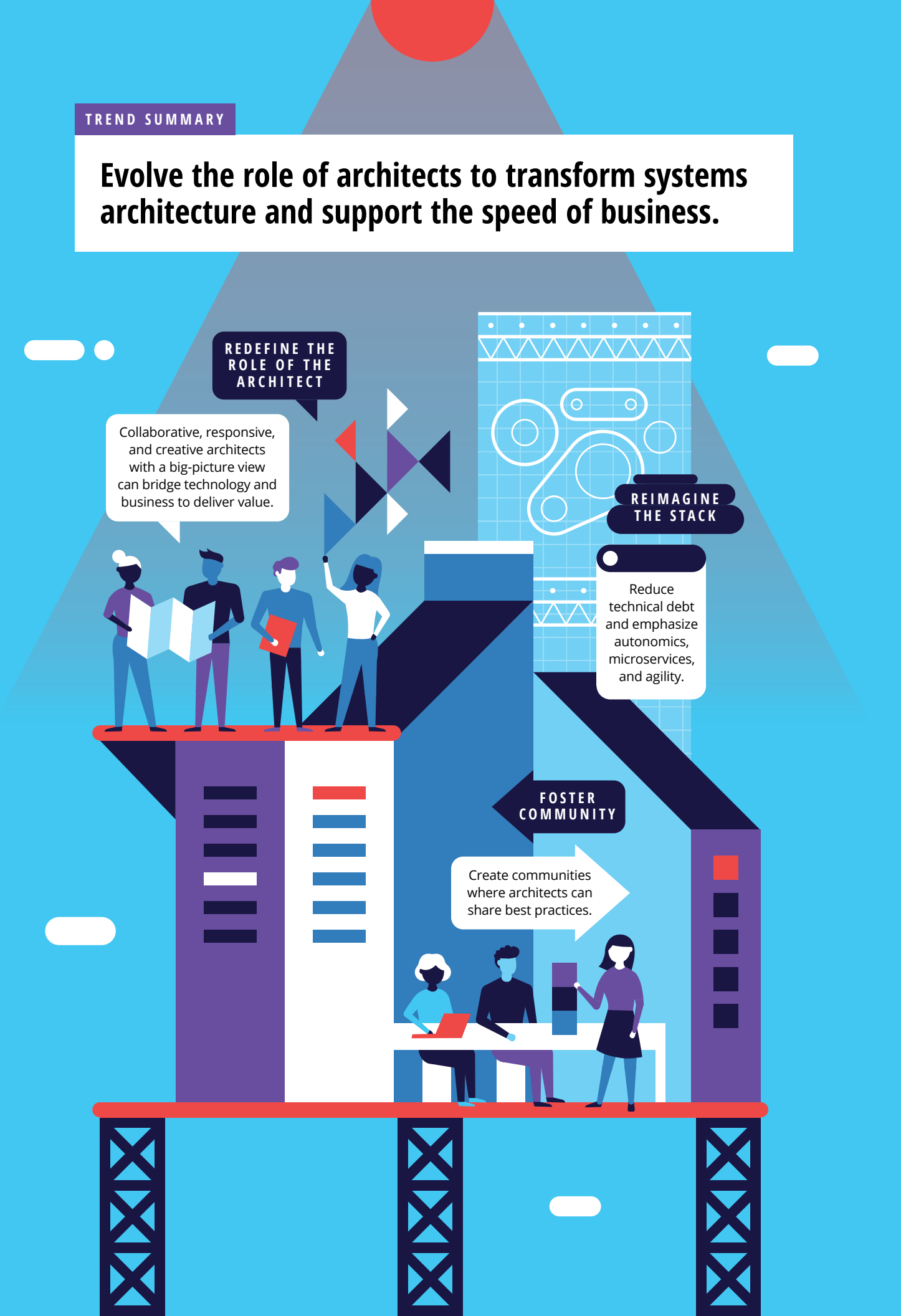
TREND SUMMARY

Evolve the role of architects to transform systems architecture and support the speed of business.



DEFINITION

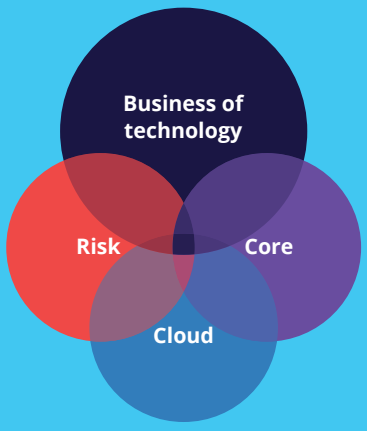
är-kə-tekt

Individuals responsible for the design, implementation, and oversight of technology components, applications, and infrastructure and their respective interactions. Deep experts in their domains, they are often responsible for finding a path to the future.

BY THE NUMBERS

of Deloitte Tech Execs Dbriefs webcast respondents said their organization has skilled architects in sufficient quantity; 54% report gaps in skills or headcount.[†]

TREND BREAKDOWN



[†]Deloitte Dbriefs webcast, "The future of architecture: Designing a foundation for growth," Deloitte, October 3, 2019.

Architecture awakens

Let the evolution begin

THE *ARCHITECTURE AWAKENS* trend is a direct response to external pressures many CIOs face today. Innovation continues its disruptive march across business and technology landscapes. Young companies—largely unburdened by legacy systems and technical debt—are moving quickly to harness digital advances. And some established organizations are struggling to keep pace, with IT systems that increasingly seem slow, rigid, and expensive. Deloitte's *2018 Global CIO Survey* found that only 54 percent of CIO respondents thought their organization's existing technology stacks are capable of supporting current and future business needs.[1]

Growing numbers of technology and C-suite leaders are recognizing that the science of technology architecture is more strategically important than ever. Indeed, to remain competitive in markets being disrupted by technology innovation, established organizations will need to evolve their approaches to architecture—a process that can begin by transforming the role technology architects play in the enterprise.

In the coming months, we expect to see more organizations move architects out of their traditional ivory towers and into the trenches. These talented, if underused, technologists will begin taking more responsibility for particular services and systems—and will become involved in system operations. The goal of this shift is straightforward: to move the most experienced architects where they are needed most—to software development teams that are designing complex technology. Once redeployed and empowered to drive change, architects can help simplify technical stacks and create technical agility that currently gives younger competitors a market advantage. They can also be held directly responsible for achieving business outcomes and resolving architectural challenges.

Moreover, companies embracing the *architecture awakens* trend will begin redefining the architect role to be more collaborative, creative, and responsive to stakeholder needs. Big-picture architects may find themselves working in the trenches on multidisciplinary project teams with application-focused architects and with colleagues from IT and business. Going forward, their mission will be to do bold new things not only with traditional architectural components but with disruptive forces such as blockchain, artificial intelligence (AI), and machine learning.

The *architecture awakens* trend is grounded in a business logic that CEOs, CFOs, and brand leaders understand: Investment, careful planning, and nurturing can make a company grow. And investing in architects and architecture and promoting their strategic value enterprisewide can evolve the IT function into a competitive differentiator in the digital economy.[2]

Architects go big

How do enterprise teams use architects today? Do they use them because they have to, or because architects make their lives easier and projects more impactful? A big metric of success for architects is that enterprise teams *want* to work with them. Unfortunately, in some IT organizations architects rarely work shoulder to shoulder with their business or even IT peers. To transition from "doing architecture" to delivering value, architects should be given opportunities to work in different ways, develop their skills, and become recognized leaders in their technology discipline.

These opportunities include:

- **Driving agility and speed-to-market.** As technology complexity and the pace of innovation accelerate, architects can play an instrumental role in helping to understand the bigger picture in terms of operating and managing complex system landscapes such as hybrid, multi-cloud, and edge workloads. Architects can also help define how DevOps and NoOps architectures and practices should be structured and help drive the cultural and training efforts needed to make the initiatives successful.

- **Becoming more accountable for solution outcomes.** Architects—like everyone else in IT—should be able to thrive within constraints of budget, schedules, and skill shortages. As architects begin working more closely with fast-moving development teams, their remit will expand to include designing for the specific architectural and technology needs of individual projects. For architects unaccustomed to working "in the weeds" with front-line technologists, this represents a sea change in approach. Architects, along with the rest of the team, should be held accountable for overall project outcomes.

- **Increasing developer productivity.** IT leaders can enhance developer productivity by building architectural concerns into off-the-shelf tools and languages, thus removing any need for developers to make architectural decisions. The work of tailoring developer tools and languages requires hands-on collaboration between architects and developers with architects obliged to stay grounded and current in a rapidly changing technology landscape.

- **Balancing business and technology priorities.** To the nontechnical business laity, architects can seem more like academics than technologists. Their proposals, while conceptually sophisticated, may be unbounded by real-life constraints of time and budget. As the *architecture awakens* trend picks up steam, architects will work to become more fluent in the goals and strategies of the business so that

they can credibly make tradeoff decisions that balance technology and business priorities. Without this broader understanding of business, the architect's role—and influence in the broader enterprise—will be limited.

- **Optimizing operating costs.** As organizations migrate to the cloud, there are a variety of different options with differentiated cost profiles and degrees of vendor lock-in to consider. Choosing infrastructure-as-a-service, platform-as-a-service, software-as-a-service, or function-as-a-service can lead to orders-of-magnitude differences in operational costs, depending on the nature of service/system usage and access patterns. System designers will increasingly need to move from static cost sizing and estimation to more dynamic predictions as part of the system design process.

- **Spreading architecture's message.** It's not uncommon for architects to feel that their companies underinvest in architecture. The unfortunate reality is that architecture will likely remain underfunded if architects cannot effectively make a strong business case for investing in architecture by connecting its value to specific business outcomes. They need to quantify the value of the business agility, product offerings, and innovative services that architecture enables—and spread architecture's message across the organization.

The good news is that many IT leaders are already thinking about ways to grow their architects' roles. During a recent Deloitte Dbriefs webcast titled "The future of architecture: Designing a foundation for growth," more than 2,000 CIOs, CTOs, and other technology leaders were asked to describe the future scope of the architect role in their organizations. Forty-two percent said that "architects will be expected to be both more technically specialized, and more attuned to the enterprisewide landscape."[3]

Reimagining the technology stack

Incumbents not "born in the cloud" often find themselves hamstrung by decades of legacy technology that suffers from system and organizational inertia. In this environment, IT leaders struggle to deliver new capabilities within timeframes that the business demands.

42%

of Deloitte Tech Execs Dbriefs webcast respondents said that in the future, architects at their organizations "will be expected to be both more technically specialized, and more attuned to the enterprisewide landscape."

In response, forward-thinking companies are rebuilding their technology stacks by emphasizing autonomics, instrumentation, and cloud-native tooling. What's more, they embrace Agile techniques and flexible architectures that can help them compete in a rapidly changing world.[4] The urgent need to build and maintain the kind of technical agility that currently gives younger competitors a market advantage is the primary force that will drive the *architecture awakens* trend over the next 18 to 24 months.

This imperative means that transforming your technology stack is not optional. Future-forward technology stacks should include DevOps and NoOps concepts, and utilize open-source technologies.[5] Importantly, the transformed stack can help lower interest payments on technical debt, which will likely go a long way in helping IT create the budgetary headroom needed to deliver new digital products and services.

These kinds of changes won't come cheap. But to make them more financially manageable, leaders should consider creating explicit budget lines for technology stack items, with business cases. Automated cloud management services, AI workbenches, code quality scanning services, regression test beds, and other architecture investments can potentially increase efficiency and thereby accelerate delivery, lower costs, and more. The goal should be to shift from best practices to deployable patterns, platforms, and tools.

It's not difficult to recognize a causal relationship between investing in technical agility and any number of potential strategic and operational benefits.

Finally, consider funding exploratory projects that bring together small multidisciplinary teams comprising business experts, architects, and engineers, tasked with recreating existing business solutions using new technologies. Bounded, time-boxed research projects such as these can enhance technology strategies in a number of ways:

- They help IT leaders and stakeholders develop a better understanding of the strengths and limitations of various technologies—think cognitive agents, computer vision, or quantum—andhowtheycouldpotentiallyaffectarchitecture designs.
- They help development teams identify optimum technologies for a variety of business use cases—and the specific skill sets needed to eventually execute on these cases. For example, evaluating open-source options requires different kinds of analysis, since open-source developers don't generally invest in responding to feature checklist requests.
- Exploratory projects can help IT and business leaders get a jump on the competition by uncovering new opportunities to reinvent the business and identify areas that are vulnerable to disruption. With this information, decision-makers can develop strategies for countering disruption (for example, acquisition versus build), for disrupting markets themselves, and for creating the architectural agility needed to pursue these objectives.

It's not difficult to recognize a causal relationship between investing in technical agility and any number of potential strategic and operational benefits. For example, a flexible, modern architecture provides the foundation needed to support rapid development and deployment of solutions that, in turn, enable innovation and growth. In a competitive landscape being redrawn continuously by technology disruption, time-to-market can be a market differentiator. In this light, consistently funding technology stack modernization initiatives—while remaining mindful of tradeoffs—may be well worth the investment.

Architects reach fighting trim

As the roles of architects and the architecture function itself evolve, it will be important to

FIGURE 1

Trends in architecture at a glance: Elevated mission and mindset

Aspect	1990s–2000s		Today
Scope	Technology only	>	Business and technology
Mission	Technology standardization	>	Business transformation
Style	Portfolio governance	>	Collaborative and engaged
Approach	Analysis and modeling	>	Agile problem-solving
Control	Strict governance	>	Guidance over governance
Business impact	Indirect	>	Direct and maximized

Source: Deloitte Dbriefs webcast, "The future of architecture: Designing a foundation for growth," Deloitte, October 3, 2019.

preserve some aspects of the status quo. For example, even though architects may be working primarily as part of product and service teams, they will still need to connect with one another. CIOs should consider creating online and on-site communities where architects can share in-the-trenches learning, bounce ideas off of each other, and align their approaches to solution shaping and enablement. As an alternative, they could create a matrixed organization in which architects report to product teams *and* a centralized architecture function. In this model, architects can meet local delivery needs while continuing to share best practices with colleagues. Either way, the important thing is to recognize and sponsor valuable technologists. It's not just a matter of helping them succeed in the near term. In today's IT talent market, demand for technology engineers already exceeds the supply, which could put many architectural transformation initiatives at risk.[6] Providing experienced architects with opportunities to mentor younger IT talent may soon become a CIO's most effective means for meeting the staffing demands of tomorrow.

With disruptive change happening at an unprecedented pace, planning architecture deliberately has become critically important. Three decades ago, a small number of technology architects put in place architectures that have enabled their companies to continue processing transactions to this day. Of course, few things in the world of enterprise technology last decades, much less several decades. But the question bears asking: *How can we build our systems today to accommodate the innovation and disruption that will surely continue for decades to come?* By architecting them effectively. And who can do that? Architects.

Architecture has awakened. Let the evolution begin.

LESSONS FROM THE FRONT LINES

Enterprise architects get an upgrade

IN A MARKET disrupted by the rise of flexible lodging alternatives, hospitality companies are transforming operations to meet guest demand for technology-driven services, conveniences, and experiences. For example, in the last five years, InterContinental Hotels Group (IHG) launched a cloud-based guest reservation and revenue management system, created a common user interface across all hotel-facing applications, and embraced an advanced analytics solution that enables real-time use of structured and unstructured data.

To make the multinational hospitality company a more agile and responsive business partner, IHG's IT team is modernizing processes and architectures. Cynthia Czabala, IHG's VP of Enterprise Services, recognized that changes to the deployment and usage of architects could enable rapid adoption of strategic technologies, which would more effectively support the company's business goals.[7] "We needed a systematic process that would align us more closely with business priorities, allow us to rapidly evaluate and deploy technologies, and improve the efficiency of enterprise and solution architects and developers," she says.

Czabala changed the deployment model for enterprise architecture, shifting the roles, responsibilities, and reporting lines of enterprise architects (EAs). Two-thirds of the EAs, originally part of her centralized team, were moved to serve directly on technical projects, managing business requirements and architectural approaches. Czabala pushed them out to the lines of business to help them better understand plans and priorities. The remaining EAs in the central, smaller team now have a more strategic role. They focus primarily on the first implementation of every technology architectures expected to drive strategic change across the enterprise, such as event-driven architecture, cloud, containerization, microservices, and other future-looking technologies.

Enterprise architects work hand in hand with project solution architects and lead developers to deliver and ensure the success of the initial project implementation.

In addition, the EAs who remain in Czabala's centralized team are no longer required to be chargeable resources, freeing them from the constraints of project billing and allowing them to focus on the strategic work of vetting technologies, determining how they should be operationalized and governed, and delivering enterprisewide guidelines and reference models. No ivory towers here, though: EAs work hand in hand with project solution architects and lead developers to deliver and ensure the success of the initial project implementation.

Armed with the EAs' standardized reference models and road maps, development teams are empowered to design and implement future deployments of these technologies, without duplicating development work or circumventing IT

processes. “We trust development teams to follow the guidelines and standards without watching over them,” Czabala says.

All of the architects maintain a sense of community and stay in close contact via weekly architecture forums for sharing information on new concepts and approaches, EA-led working groups charged with building out standards and reference models, and bimonthly town halls that provide specific details about new coding techniques, tools, and technologies.

EAs are far more strategic now that they’ve switched their focus from developer oversight and governance to planning and implementing IHG’s future architecture. And they enable Czabala’s entire team to be more strategic as well. “Being closely aligned with the business and having resources that are looking forward allows us to develop an enterprise architecture roadmap that can evolve at the pace required by the business,” she says. “Working hand in hand with business teams to define and support business strategy helps us be more efficient at prioritizing investments and planning projects.”

Enterprise architects set the direction at Thomson Reuters

IN A BID to redefine how it competes and innovates, Thomson Reuters is seeking new ways of designing and building agile, adaptable enterprise architecture. The company’s technology team is rallying resources and investments around digital platforms and defining common, reusable capabilities and services. In addition, the multinational media and information company is transforming its operational and organizational structures, says Jason Perlewitz, director of technology.[8]

Thomson Reuters’ journey began a couple of years ago, when it began migrating legacy data center systems and applications to the cloud; with an even mix of native cloud-built applications and legacy data-center applications, the company is now at about the halfway point. The company adopted a business-centric approach to technology that emphasized overarching corporate strategy and integrated business partners into the architectural decision-making process.

As part of this holistic approach, Thomson Reuters sought to restructure its technology organizations to optimize the development and use of common processes and reusable capabilities, systematize and speed innovation, and maximize the value of its technology assets across the enterprise. This included a cultural transformation to recalibrate the role of architects to bring both the voice of the customer and a business perspective to architecture development and forge deeper connections between technology operations and system design.

Previously, architects, developers, and operational support were siloed into separate teams that were not closely aligned; the architect’s role was to ensure technology standards and modern practices were incorporated into the technical direction of an entire suite of applications. Thomson Reuters integrated these groups into smaller, agile teams responsible for a single application or specific reusable component, embedding architects in individual teams.

Architects are still technology direction-setters who partner with developers and other technologists, but they’re also responsible for the integration of the application and its operational fitness. Leaders evaluate and incent them not just on traditional

technological capability metrics but on operational and business measures that provide an indirect measure of how well technology is serving the business needs and help give architects a deeper understanding of the business mission.

Architects have become invaluable advocates of the platform-centric architecture evolution and technology organization restructuring.

Relevant business metrics include an application's contribution to positive net promoter scores, customer recommendations, and customer retention and acquisition rates. Operational proficiency might depend on: the inclusion of built-in security, operational support, and system management; the ability to self-diagnose and provide heuristic automation and analysis; testability; and the number of service disruptions.

Technology leaders developed monthly forums to encourage information-sharing and collaboration and foster a sense of community. To support the culture, architects are evaluated via metrics that emphasize sharing and collaboration, such as leveraging reusable capabilities built by others and applying common processes to common problems. And a monthly forum serves as a readout from business functions, which share information and answer questions from technologists about strategy, customer needs, and other key topics.

Other initiatives aimed at increasing architects' exposure to business and customer needs are percolating. For example, the technology and user experience teams are working on ways to integrate architects into customer meetings to discuss functions and features. Perlewitz is partnering with customer-facing business functions to position architects as the connective tissue between these functions and development teams.

Architects have become invaluable advocates of the platform-centric architecture evolution and technology organization restructuring. "They believe in our vision of making architecture more accessible to the masses and help promote it throughout the company," Perlewitz says. "Their vocal support and engagement have made a significant impact in driving acceptance to change."

Engineering an agile enterprise: National Australia Bank expands the role of the technology architect

NATIONAL AUSTRALIA BANK (NAB) is in the midst of a multiyear, multibillion journey to transform itself into a financial institution that can respond more quickly and efficiently to customer needs. To that end, the bank is replacing its legacy architecture with a flexible technology ecosystem. Just as important, the organization is reorganizing and training talent to support the digital transformation. Sergei Komarov,[9] who has deep experience in enterprise architectural transformation, was hired as one of NAB's technology leaders.

In early 2019, NAB restructured its enterprise architecture function to support more agile ways of working. Komarov sees technology architecture

as a distillation of engineering experience at its core. Good technology architects should be hands-on—building and experimenting with different technologies and architecture models. They should take a holistic view and be accountable for making sure that the architectures they oversee are cohesive and that the parts fit together within the agile ecosystem.

Agile organizations are built on collaboration—a significant change for architects accustomed to a more separate remit.

To support this philosophy, NAB's reorganization introduced a stewardship model organized by services that represent durable assets, or capabilities, of the bank. Three types of stewardship roles were created: service architects, specialized technology architects, and business-facing initiative architects. These complementary roles are vital to the overall architectural function, increasing agility across the bank. For many of NAB's existing architects, the transition was a dramatic shift from a relatively isolated role to one that's ongoing, collaborative, and future-focused.

First, each service architect is responsible for overseeing the modernization of a specific business domain service; they are expected to develop a deep understanding of their assigned service, its current and target states, and its proper role in the overall IT ecosystem. And their mandate involves addressing key questions: Is the service resilient and secure? Which applications or systems are destined for obsolescence? Which are up-and-coming? Where are redundancies? How can the service be simplified and improved over time? Is the service loosely coupled with other enterprise services?

Next, specialized technology architects provide in-depth knowledge of technologies that affect multiple services, such as distributed systems, data technologies, and microservices. Technology architects are concerned with specific technology patterns, practices, and tools applicable across many services; they set the technology standards that influence the work of the other two types of architects.

And finally, initiative architects are responsible for the design of a project or business-facing initiative. They work with business units to help them define and shape their technology needs to fit within the goals of the overall agile enterprise, utilizing capabilities delivered through enterprise services.

Agile organizations are built on collaboration—a significant change for architects accustomed to a more separate remit. NAB is using metrics to encourage teamwork and engagement, supported by social and training opportunities. Each architect has a billability target to help them balance their time between project deliverable–oriented work and more proactive strategic planning and thinking. This also helps foster a more effective division of labor that yields a combination of business acumen, expertise in emerging technologies, and in-depth understanding of NAB's evolving technology estate to achieve common goals.

"The industry has sometimes been confused about the role of the architect in the context of agile, thinking that an agile organization doesn't require any forethought, planning, or coordination," Komarov says. "That's magical thinking. Enterprises are beginning to realize that agility requires a cohesive, flexible IT ecosystem. And it's the architect's job to be an expert in the construction of such ecosystems."

MY TAKE

WITH TECHNOLOGY SERVING as the backbone for differentiated digital experiences, innovative products and services, and optimized business operations, enterprise architecture carries increasingly critical workloads. When it's agile and scalable, enterprise architecture can drive value and help businesses realize their strategic vision. When it's not, it can hamstring digital transformation, expand technical debt, and increase system and software entropy—ultimately leading to organizational inertia.

CHARLIE BELL
SENIOR VICE PRESIDENT,
AMAZON WEB SERVICES

There's never been a greater need for the steady hand of effective technical leaders who can build and manage flexible, architecturally sound systems aligned with business needs. When our customers meet with us, I expect them to ask questions about our road map or products, but most of them want to understand how our architects lead the design and building of enterprise systems in support of our business strategy.

However, we don't have the traditional architect role at AWS. The responsibility for technical architecture design lies in the hands of our principal engineers, while our solutions architects help customers design solutions using AWS services. These roles are not functionalized, as is often the case with architects—we discovered that the best mechanism for enforcing common design and centralized thinking is organizing around products. In the early days, we needed a middle-tier application server, but we couldn't find a cost-effective commercial product that was built for web-based workloads. Several teams were working on duplicative efforts to solve this problem; we took the best one, formed a team around it, and turned it into a product that others could consume.

Today we still use this same model to solve architectural problems. We don't need to centralize principal engineers. Instead, principal engineers are assigned to product teams—such as Amazon Alexa, Amazon EC2, Amazon Simple Storage Service (Amazon S3), or Amazon DynamoDB. We've found that being focused on a specific set of customer needs for longer periods of time allows engineers to be more effective than moving between multiple short-term projects.

Our product development approach emphasizes starting with the customer and working backwards to the product. Before any idea is funded, the product team presents to AWS leadership a one-page internal press release that describes not only the finished product but the customer problem it solves, the specific customer impacted by the problem, and its advantages over existing solutions. The team also develops and presents a five-page Frequently Asked Questions (FAQ) that includes so-called rude questions, such as, *With what aspect of the product will customers be most disappointed?*

The review process forces product teams—given a single hour to make their case to senior AWS leaders—to gain a deep understanding of the market, customer needs, and product benefits. I participate in reviews of almost all "working backwards" documents, as does our CEO. We discuss and debate the product's merits, and if the review team decides to allocate resources, the team moves to the planning phase. Often, the review process reveals product weaknesses, and teams go back to the drawing board, make changes, and prepare the press release and FAQ for a second review. Being a part of this process helps orient principal

engineers and product managers around a common goal and allows them to experience the pressures of delivery and customer needs.

As strategic members of our product teams, principal engineers help find solutions to Amazon's most demanding problems. The chief arbiters of design are charged with delivering artifacts—from designs to algorithms to implementations. They establish technical standards, drive the overall technical architecture and engineering practices, and work on all aspects of software development.

Our principal engineers are visionary, but they're also pragmatic. To earn the respect needed to be effective technical leaders, they need to be close to the project details. They don't waste time developing abstract business requirement documents or hand off development guidelines and technology frameworks to project teams—they roll up their sleeves and pitch in. Principal engineers own all aspects of the services they build, from development efforts to operational responsibilities. They spend time with customers and understand and apply themselves to customer problems, but they're also in tune with their product's day-to-day operations, helping shape activities such as operational readiness reviews and change management. If something goes wrong with a service in the middle of the night, the principal engineer gets the call.

A self-organized community of principal engineers meets weekly to develop standards, share information, and build relationships. The group holds talks featuring topics such as the design of a specific service or the availability of new ideas or tools. Typically, hundreds of engineers are in the room, with additional thousands watching the video stream. Group members created a set of fundamental values that outline the overarching philosophy of the role and function; these tenets help set performance standards and serve as decision-making guidelines. The community also organizes design and operational reviews that give members opportunities to provide feedback on new services and solutions in development. Several times a year, members hold offsite meetings to build a sense of community and maintain alignment of the different product teams.

Principal engineers have worked in this way since I started working at Amazon more than two decades ago. Because it works so well for us, it's almost unthinkable that we'd change. As their teams' guiding technical light, principal engineers set the standard for engineering excellence, provide unprecedented understanding of customer problems, and equip our enterprise architecture to maximize our innovation speed.

EXECUTIVE PERSPECTIVES

STRATEGY

Technical debt and legacy technology constraints can undermine even the best innovation strategy. If your organization is so hamstrung by system complexity that it is unable to take advantage of new tools that are disrupting your markets, your company is likely already losing its competitive advantage. CEOs typically do not engage directly with architects, but they can support architects in their expanded roles by creating an enterprisewide culture of risk-taking, innovation, and cross-pollination. This means encouraging everyone to step outside of their skill silos and broaden their perspectives by talking to others across the organization. Because architecture is now more strategically important than ever, it follows that architects should engage regularly with strategy stakeholders of all stripes. Diverse perspectives often lead to more effective decision-making—a rule of leadership that CEOs have long embraced. This same rule can benefit architects. They are, after all, the individuals who understand existing systems and constraints and are best positioned to design the strategies that will support emerging technologies and strategic priorities during the next decade.

FINANCE

As demands for computing and data services grow, CFOs, CIOs, and architects can collaborate to future-proof technology and reduce organizational technical debt. They should consider four key questions about their existing computing architecture. First, can the existing computing architecture meet the company's growth needs, either organically or through M&A? Second, is it flexible enough to support strategy changes, for example, divesting a business without leaving stranded costs? Third, what are the primary risks to the architecture—for example, obsolescence, scaling, and technical debt? Finally, how will architecture shape future capital expenditure and operating expense models? For example, with the growth of cloud services, moving key architecture components to the public cloud may drive operating costs and capital expenditures to differ significantly from those in models. Working together, finance and IT can model out likely future tech costs and then allocate capital to flexible architectures that meet the changing needs of the business.

RISK

Risk lies in changes being made to existing technology stacks and systems. The more dynamic those changes are, the more important it will be to consider potential risk impacts from the earliest planning stages of any project. As you begin redeploying architects to IT's front lines, consider embedding them in DevSecOps teams to make sure that architecture concerns are factored into any projects. Likewise, in architecture transformation initiatives, architects can take greater responsibility for understanding and addressing risk issues. Unfortunately, in some initiatives, planners treat risk as a box to check. Without a baseline understanding of a project's risk profile, it becomes more difficult to determine the most effective way of managing risk in the future. Does the project require just only an initial assessment, or is it sufficiently dynamic to justify ongoing assessments? And what impact could flexible, component-based architectures have on overall risk profiles? The stakes are too high to answer these questions retroactively. Modernization and risk planning should be part of the same process.

ARE YOU READY?

1. What role do your most senior architects play in shaping future systems and services? How are they directly responsible for achieving business outcomes?
2. What teams are your architects part of? With whom do your architects work daily—each other, software developers, business colleagues, end users?
3. What programs do you have in place to recruit, grow, and retain skilled architects with both depth and breadth across technology architecture domains?

BOTTOM LINE

IT leaders at incumbents are realizing that the science of architecture—and the technologists who practice it—are more strategically important than ever. The *architecture awakens* trend offers CIOs an opportunity to move architects from their traditional ivory towers to the IT trenches where their talents can have greater impact. Empowered architects can then work at the vanguard of digital transformation efforts, turning rigid architectures into flexible platforms for future business success.

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Authors

SAUL CAGANOFF is a principal with Deloitte Consulting Australia and serves as the chief technology officer for Platform Engineering. He has more than 25 years' experience as a software engineer and enterprise architect working across business sectors, including financial services, utilities, government, and education. Caganoff specializes in systems integration, digital transformation, and architecture modernization—helping companies to be young again.

KEN CORLESS is a principal and the chief technology officer in Deloitte Consulting LLP's Cloud practice. With more than 25 years of experience, he is responsible for evangelizing the use of cloud at enterprise scale, prioritizing Deloitte investment in cloud assets, and driving technology partnerships in the ecosystem. Corless's experience brings together digital, cloud, and emerging technologies to help clients create breakaway products, services, and processes.

STEFAN KIRCHER is a managing director and the chief technology officer in Deloitte Consulting LLP's Innovation & Platforms practice. With more than 20 years of experience in software, he focuses on delivering strategic technology concepts, road maps, and effective implementations. Kircher also leads research for the Innovation & Platforms practice on key topics such as blockchain, artificial intelligence and machine learning, quantum computing, and IoT, and advises on open source as part of Deloitte's asset strategy.

SENIOR CONTRIBUTORS

David Sisk
Managing director
Deloitte Consulting LLP

Dan Spar
Managing director
Deloitte Consulting LLP

Vishveshwara Vasa
Managing director
Deloitte Consulting LLP

Peter Long
Director
Deloitte MCS Limited

João Faria
Senior manager
Deloitte & Associados, SROC S.A.

Debi Kar
Specialist leader
Deloitte Consulting LLP

Thiago Sartorio
Senior manager
Deloitte MCS Limited

Lori Olson
Specialist leader
Deloitte Consulting LLP

Laks Venkateswaran
Specialist master
Deloitte Consulting LLP

Maciej Żwirski
Manager
Deloitte Advisory sp. z o.o. sp. k.

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TREND SUMMARY

Look beyond *what's new* to *what's next* to help guide today's business and technology decisions.

Horizon next

A future look at the trends

"THE BEST WAY to predict the future is to create it." Peter Drucker's well-worn adage contains at least two distinct ideas. The first: that initiative and determination trump passivity and idle speculation. The second? The notion that prediction is itself a fool's errand because the future is essentially opaque and unknowable.

But as we discussed in *Tech Trends 2019*, if you can be deliberate about sensing and evaluating emerging technologies, you can make the unknown knowable. The principled consideration of tomorrow can be a profoundly useful tool in guiding *today's* business and technology decisions. Using a traditional one-to-two-year budgetary lens, a company might be inclined to incrementally adjust last year's budget by factoring in next year's forecast. A longer view challenges us to rethink this approach and make entirely new bets. Disciplined futurism can help us avoid overindexing on the past.

There's an inherent tension in planning for the horizon beyond. While the full potential of the technologies explored in this chapter may not become clear for several more years, there are relevant capabilities and applications emerging now that can provide a foundation for what's coming next. If you wait several years before thinking seriously about them, you may have to wait three to five years beyond that for your first nonaccidental gain. Because these forces are developing at an atypical, nonlinear pace, the longer you wait to begin exploring them, the further your organization may fall behind.

Prospection, not just prediction

Prediction is useful, but it is only one of the modes of thinking we employ when factoring for the future. A more appropriate umbrella term is *prospecting*. Futurists acknowledge that there are many prospective futures, and that organizations would be wise to actively maintain a "matrix of maybes"—an inventory of not-ready-for-prime-time technology prospects that may (or may never) drive widespread business impact.

It will no longer matter if the necessary talent and technology is built, borrowed, or bought.

This process of sensing, scouting, and scanning can help expand apertures for what is looming beyond the horizon, and for when and by whom. This last point is important. Companies can challenge "not invented here" organizational bias by embracing ecosystems of new players that can help make strategies real. It will no longer matter if the necessary talent and technology is built, borrowed, or bought. Armed with numerous à la carte prospects as an input, leaders can use research-based methods to determine which prospects are viable.

Many of today's emerging technologies are created out in the open, by collaborative amateurs and professionals. By studying open-source software trends, you can begin to detect those technology prospects that have the most gravitas and momentum.

RESEARCH AND DEVELOPMENT

Signals that can alert you to what's happening in R&D come from several sources. Tracking activity over time can help triangulate investment, solution maturity, and patterns of advancement. A deeper understanding of each can give you the confidence you'll need to tackle the hardest piece of the equation: timing any investment. Sources of intel include:

- **Grant funding** provides a window into prospects' earliest momentum. Because transformational technologies are often born in academic and lab environments, a periodic pulse check on grant awards can help you learn more about individual initiatives and macro movements.

- **Patent applications** begin to spin off as concepts mature from ideas to inventions. Patent filings and awards, which are matters of public record, provide not only detailed visibility into *what* technologies are coming of age but, critically, *how* they are being designed and architected.

- **Open-source activity** is another helpful R&D lens. Twenty years ago, high-value software was largely a heavily guarded trade secret. Many of today's emerging technologies are created out in the open, by collaborative amateurs and professionals.[1] By studying open-source software trends, you can begin to detect those technology prospects that have the most gravitas and momentum.

- **Startup activity** and venture capital inflows can provide insights into the early inklings of a concept's financial viability. By further monitoring startups' commercial traction, you can begin to understand directional product-market-fit. In short, you can bear witness to a concept's graduation from an experimental technology to a sustainable business model.

AWARENESS AND ACTIVATION

The first collection of signals track money and invention. The signals below are equally important, representing traction and growing impact across enterprises as they mature and are deployed in the world.

- **Acquisitions activity** tells the story of an emerging concept's breakthrough from disruptive outsider to constructive insider. While any individual M&A deal may distract with gaudy financials or a curious strategic rationale, the landscape view is typically telling.

- **Media and PR** are also a "tell." As accelerating technologies turn the corner from hope to hype, media research and sentiment analysis quantify the buzz, shining a light on new entrants' marketability and virality. Some skepticism here is warranted, as hype cycles can distract and disguise barriers to investment.

- **Established vendor road maps** mark an organization's enthusiasm for, and commitment to, a new technology. As organizations transition from PR and media campaigns to budgeted investment in strategy, processes, and people, the pivot from *talk* to *walk* begins in earnest.

- **Commercial momentum** formalizes an emerging technology's coming of age. Whereas the aforementioned lenses are inherently supply-side in nature, commercial transactions, at scale, denote quantifiable market demand. These can be told via press releases, vendor case studies, keynotes, and even sometimes earnings reports.

- **Job postings** can be the final proof point for accelerating maturity. From salaried job openings to increases in demand on crowdsourcing marketplaces, expressed need for talent aligned to a given topic or technology is a great proxy for growing mindshare and investment.

HORIZON NEXT

To make sense of the vast number of technology prospects, there's a clear need for a unified view organized by both the *macro technology forces* and by their anticipated time horizon. The construct in figure 1 is neither exhaustive nor precise. But it does convey our confidence that in a world of uncertain futures, it is possible to bring order to and focus attention on a meaningful collection of known technologies that can help you shape your ambitions, focus your investments, and chart a path to tomorrow.

As organizations transition from PR and media campaigns to budgeted investment in strategy, processes, and people, the pivot from talk to walk begins in earnest.

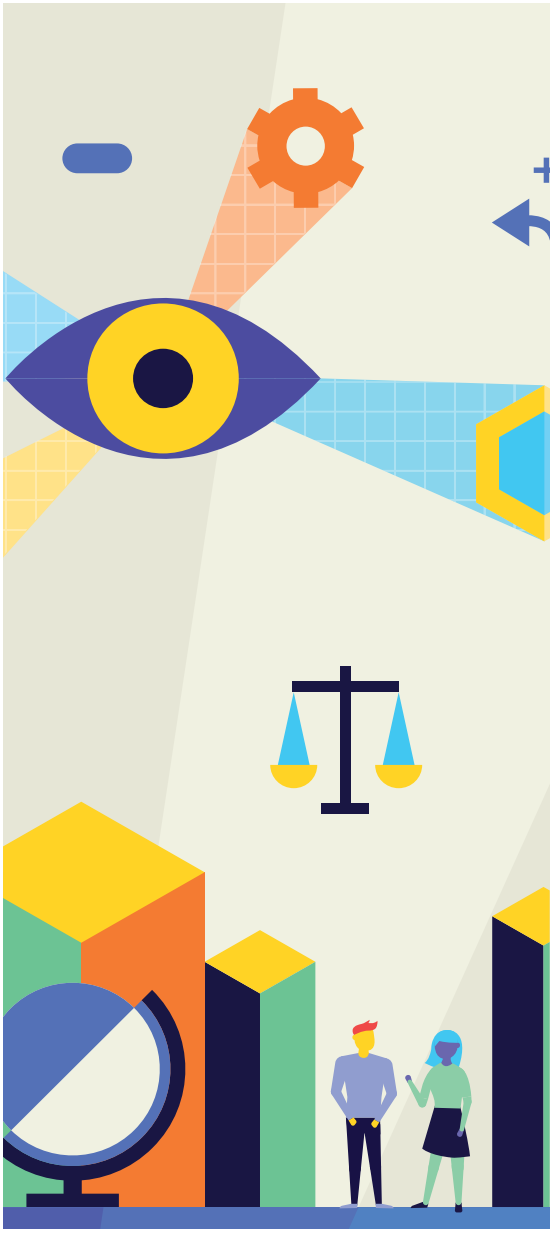
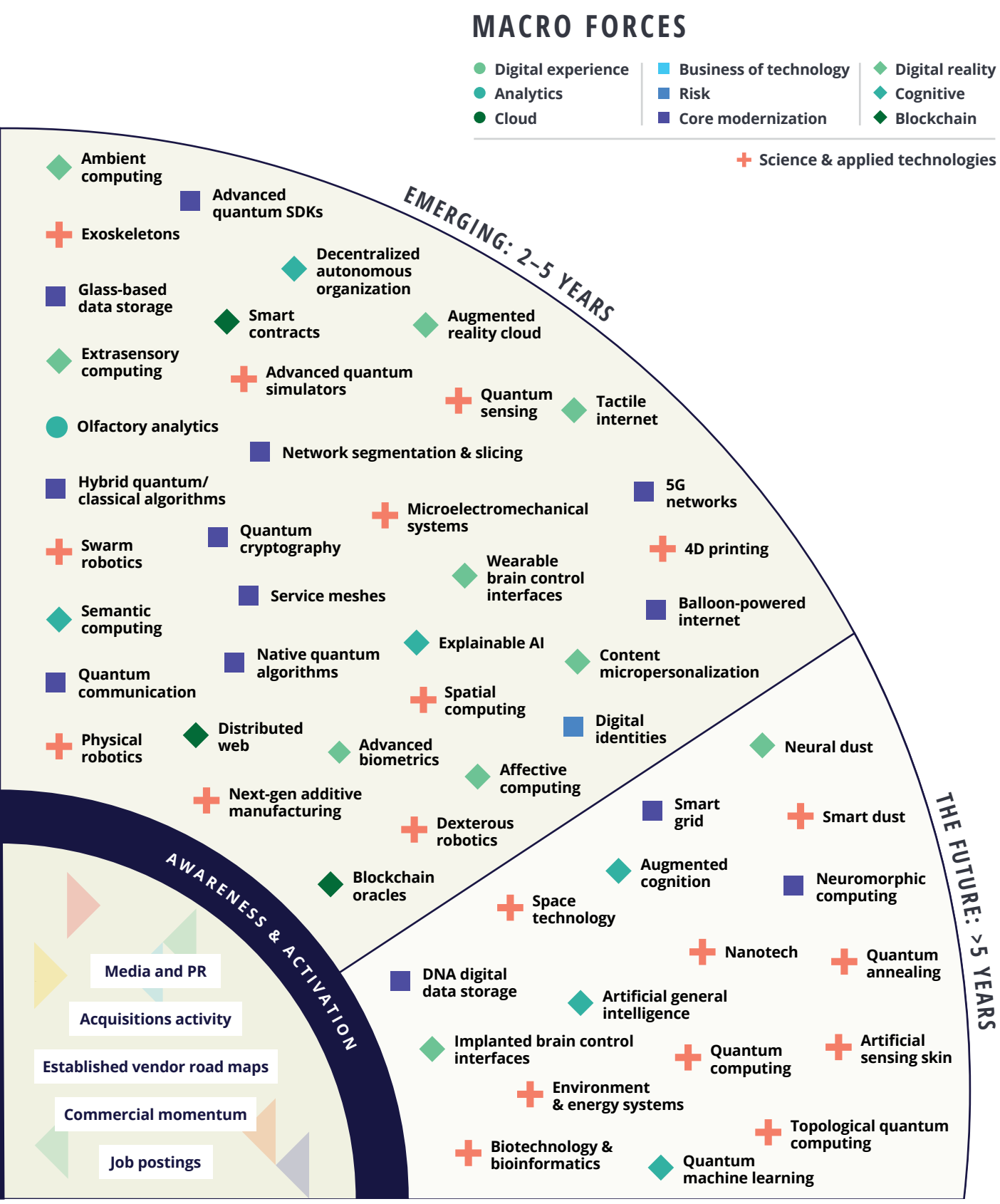


FIGURE 1

Horizon next

To make sense of the vast number of technology prospects, we have grouped them by influencing macro force and anticipated time horizon. The resulting view is neither exhaustive nor precise, but it does convey our belief that today's realities can offer a glimpse of tomorrow's possibilities.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EMERGING: 2–5 YEARS
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Exoskeletons
Decentralized autonomous organization
Glass-based data storage
Smart contracts
Augmented reality cloud
Extrasensory computing
Advanced quantum simulators
Quantum sensing
Tactile internet
Olfactory analytics
Network segmentation & slicing
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Explainable AI
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Digital identities
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Smart dust
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Artificial general intelligence
Implanted brain control interfaces
Quantum computing
Artificial sensing skin
Environment & energy systems
Topological quantum computing
Biotechnology & bioinformatics
Quantum machine learning
THE FUTURE: >5 YEARS
AWARENESS & ACTIVATION
Media and PR
Acquisitions activity
Established vendor road maps
Commercial momentum
Job postings

Patterns between signals

Sensing, scouting, and scanning across horizons are techniques meant to help make the future more navigable. At the very least, they can define the playing field of potentialities. Unfortunately, the reality of the volume of concurrent advances and the accelerating pace of change can have the opposite effect: They can seem overwhelming while stoking cynicism, undermining the confidence of companies pursuing emerging tech. With so much going on, how can you possibly decide what matters, much less what to do about it?

Luckily, many of the individual technologies noted earlier are themselves building blocks of larger categories of change that have the benefit of being less volatile, more easily understood, and having clearer applications to one's business or mission. The macro forces construct—enablers, disruptors, foundation, and horizon next—introduced in the *macro technology forces* chapter is an attempt to distill decades of technological change into a set of manageable clusters. Besides being more digestible, they remain relevant for longer periods of time, allowing momentum to build externally—consolidation of ecosystems, maturation of product and solution offerings, increased and increasingly insightful coverage by analysts and the media—and internally, with concrete examples of positive impact leading to growing investment appetite and positive word of mouth across the organization.

This is no ontological shell game. For most business and IT executives, the piece-parts that can lead to significant technology breakthroughs aren't just ungainly—they're incomprehensible. Much like traditional R&D and scientific labs, the combinations of underlying technology lend themselves to applications and products for the broader market. Looking forward is necessary, and some of the individual advances will no doubt lead to bold new thinking. That said, these broader categories will likely represent the biggest bang for the emerging technology buck.

MACRO FORCES REVISITED

The macro technology forces have evolved over Deloitte's 11 years of technology trends research. With our eyes on the next horizon, we'll do a quick deconstruction of ambient experience, exponential intelligence, and quantum to look at today's building blocks as we wait for technology advances required to realize the full vision.

But first, let's apply this thinking to a more established, familiar concept such as cloud. In our first *Tech Trends* report in 2010, much of the dialogue with our clients focused on cloud's definition, its potential impact, and its projected expanded role in enterprises. Seasoned CIOs were dismissive of the concept, arguing that it seemed like some old mainframe concepts being repackaged. The response 11 years ago is the same as today's response: Those naysayers were not technically wrong, but neither was their thinking complete. Cloud is *absolutely* an evolution of essential mainframe concepts, from logical partitioning to distributed storage to virtualization. It also represents advances in standardized data transmission, network protocols, grid computing, multitenant resource pooling, identity and access management, dynamic provisioning, measured services (the ability to meter, bill for, monitor, and control underlying resources), and more, at scales historically unimaginable, at price points that would have been unthinkable, and with an unprecedented road map of expanding capabilities up, down, and across the technology stack. Choose your metaphor: "Cloud" is the meal made from these individual ingredients, the symphony for these instruments, the molecule for the atoms.

The most important fact is this: The focus has moved from conversations about what's under the hood toward investments in the composite driving real business impact. The same is happening for the other macro forces at the horizon now and next and will, eventually, happen for those at the horizon beyond.

Each of the macro forces and the broader inventory of emerging technologies will mean different things to different industries and geographies. But one thing is universal: None of these individual technologies comprises a strategy. Balancing the maturing of each individual technology with the need to project potential business use cases as they come together is where the action is. It is also nearly impossible to do without an intentional, structured approach to sensing and incubation.

PATH TO TOMORROW

Ambient experience, exponential intelligence, and quantum are the nascent macro forces we currently see on the distant horizon. Like cloud technologies before them, they will evolve over time and perhaps cross-pollinate with other forces to create something wholly new. For each, here's a quick exploration of where they're heading, and a snapshot of some of the technology breadcrumbs helping build toward that potential.

Ambient experience. Represents a world where the physical and the digital are intertwined with such elegance and simplicity that we shift to natural, intuitive, and increasingly subconscious (maybe even unconscious!) ways of engaging with complex technologies.

- Machine-to-machine interfaces
- Internet of Things
- "Smart" devices
- Computer vision
- Intelligent conversational interfaces
- Beacons
- 5G
- Edge computing
- 3D object modeling
- Spatial computing
- Dynamic digital content management
- Digital identities
- Brain-computer interfaces
- Extrasensory computing

Exponential intelligence. General-purpose superintelligence able to build algorithms, confident predictions, and automated responses across complex, dynamic, and constantly evolving domains.

- Deep learning
- Neural networks
- Symbolic AI
- Reinforcement learning
- Generative confrontational networks
- Semantic computing
- Advanced data management
- Advanced visualization
- Data simulation engines
- Cognitive assistance
- Autonomics
- Algorithm exchanges
- Dynamic taxonomy platforms
- Quantum algorithms

Quantum. Evolution of computing to harness the power of quantum dynamics to dramatically unlock new workloads and insights.

- Advanced quantum SDKs
- Hybrid quantum/classical algorithms
- Native quantum algorithms
- Quantum machine learning
- Quantum cryptography
- Quantum communication
- Quantum sensing
- Advanced quantum simulators
- Quantum computing
- Quantum annealing
- Topological quantum computing

MY TAKE

ENTERPRISE BUSINESS AND technology leaders are not that different from venture capitalists. In an era in which innovation is a business imperative, we share many of the same challenges. We're all trying to predict which technology trends have the potential to drive the most value.

There's no secret formula for finding the next big breakthrough. Andreessen Horowitz partners sit through thousands of entrepreneur pitches every year and serve as board members for hundreds of startups. Those conversations are a window into the future—not necessarily because they allow us to identify the next new tech trend but because they give us insight into how current industry trends are evolving to influence enterprises in the future. Here are three current trends we expect to leave their mark on enterprises in the coming three to five years.

MARTIN CASADO
GENERAL PARTNER,
ANDREESSEN HOROWITZ

Ascendancy of data. In the past, a software system's code dictated its performance, accuracy, security, and compliance. Increasingly, these characteristics are dictated by the data being fed into systems: The code (via machine learning) obediently learns from the data and spits out business insights and predictions. Technologists know how to handle code, but dealing with data is intrinsically more challenging. Data is heavy-tailed and complex, and like a fractal, it's self-similar—closer to computational physics than to engineering. The toolsets for working with data are completely different than those for working with code. As a result, we expect the entire enterprise technology stack to be refreshed to accommodate data's primacy over code.

The ascendancy of data also presents a volume challenge. The availability of inexpensive data warehouses allowed enterprises to amass vast amounts of data. But the economies of scale that are often seen with software and hardware products are missing—in fact, the unit economics of increasing data are almost always worse. Many entrepreneurs and business leaders seem to expect that turning an algorithm loose on a large volume of data will magically conjure valuable patterns and insights. But more data also means more noise, more redundancy, and more effort to keep it fresh. Identifying the value of their data can help enterprises develop a sustainable plan for using it to gain competitive advantage and build a defensible long-term business.

Cost and margin structure of cognitive technologies. Businesses are using machine vision, machine learning, and natural language processing to tackle problems at scale that we could never dream of before. Consider, for example, large operational centers that deal with huge amounts of data or industrial applications such as picking and packing agricultural products.

Software-driven business process automation historically helped companies achieve higher profit margins, but we don't fully understand the margin structure for some cognitive technologies, particularly those that use a lot of data storage and computational power—for example, image processing, text recognition, and natural language processing. It costs roughly the same to use human workers to make complex judgments using unstructured and paper-based information as it does to use cognitive technologies to do the same.

We can begin to see a cost differential when we use cognitive technologies to deal with more structured and electronic information.

The progress we've made has led some business and technology leaders to adopt an "end of theory" philosophy. In this line of thinking, even when a company doesn't know a business problem exists, applying artificial intelligence, machine learning, and/or automation will reveal both the problem and its solution. But until it's clear that leaning heavily on these technologies can actually lower costs, a good way to deliver value is to first understand the costs and margins of cognitive applications and, then, determine the appropriate combination of human workers and cognitive technologies that produces the best cost/performance ratio.

Bottom-up technology adoption. The decentralization of technology buying from procurement specialists to the business end user will continue to have huge implications for product design and adoption. For many years, CIOs and other technology leaders have been managing the security, support, and budget implications of this issue—variously termed consumerization of IT, "consumerprise," B2C2B, or shadow IT—aiming to strike a comfortable balance between controlling technology and employee productivity and morale. Consider the user-driven enterprise adoption of consumer-branded smart watches, hardware security keys, SaaS productivity and collaboration solutions, and even open-source core infrastructure.

Today's most promising startups are betting their businesses that bottom-up enterprise technology adoption will soon encompass nearly every enterprise technology product and solution. When everybody's a technology buyer, products will continue to become easier to use and the cost per product or license will decrease. The shift to bottom-up technology adoption mandates a massive shift in the way organizations adopt and purchase technology. Businesses will need—soon—a comprehensive plan for addressing this purchasing shift.

The startups and entrepreneurs we talk to are our eyes and ears in the market. Their product and solution pitches help us understand consumer and business problems and how today's technology and business trends are evolving to address them. By understanding how bottom-up technology adoption, the ascendancy of data, and the cost and margin structure of cognitive technologies are influencing their business models now and will continue to do so in the future, enterprises can take a step toward future-proofing their businesses to support agility and innovation.

Backcasting: From probable to profitable

By stepping back from the possible, through the probable, we can get to the sober work of *backcasting*: planning today's technology decisions and investments in concert with tomorrow's likely ends. Enterprising leaders see these emerging technology prospects not as threatening disruptions or distracting shiny objects but, rather, as the building blocks of their organization's future.

There's growing interest among enterprises in looking beyond *what's new* to *what's next*, and little wonder—an understanding of what's coming can inform early budget planning and enable the relationships that make it possible to reap the associated rewards when the time comes.

But at present, many enterprises lack the structures, capabilities, and processes required to harness these macro forces and innovate effectively in the face of exponential change. It might be tempting to fund a stable of smart scientists and engineers and let them pursue ideas and technical proofs of concept in a vacuum. While this approach can bring technologies to life, this group often struggles to create solutions that truly add lasting value to the company.

Leading organizations have a disciplined, measured innovation program that aligns innovation with business strategy and a long-term technology landscape. They take a programmatic approach to sensing, scanning, vetting, experimenting, and incubating these future macro technology forces—until the technology, the market, and the business applications are ready on an enterprisewide scale.

CLARIFY THE LANDSCAPE OF NEW TECHNOLOGIES AND PLAYERS

With sensing, organizations can stay on top of new developments in technology, and identify and understand how they are driving advancement. Establishing a culture of curiosity and learning in your organization helps but likely won't be enough, considering the pace of change and the complexity of emerging fields. To survey the landscape and unearth the technologies and companies that may be defining the future, leaders should consider several concurrent approaches.

- **Sense-making.** Many organizations are establishing internal sensing functions to explicitly monitor advances and imagine impacts on the business. Begin building hypotheses based on sensing and research. Identify a macro technology force and hypothesize its impact on your products, your production methods, and your competitive environment in early and mid-stage emergence. Then perform research around that hypothesis, using thresholds or trigger levels to increase or decrease activity and investment over time.

- **Trusted collaborators.** Companies can leverage their existing set of vendors and alliances to get the pulse of their direct and closest collaborators. Consider holding joint innovation workshops to understand the variables directly affecting an organization. It can help your organization tap into new thinking, and your established partners' road maps can, in turn, spur new ideas. This can also start the process of collaboration within traditional circles while identifying and launching leading change agents.

- **A nontraditional path.** Some leading companies are also forging new relationships. Develop a broader ecosystem with nontraditional stakeholders—such as startups, scientists, incubators, venture investors, academia, and research bodies—which can lead to a wide range of fresh perspectives. In turn, your organization can serve as the lifeblood for startups, whose existence may rest on finding the right partners and customers quickly to create an interconnected market.

HARNESS THE POSSIBLE

At some point, your research reaches a threshold at which you can begin exploring the "state of the possible." In early stages, forgo exhaustive business cases and instead focus on framing scenarios around impact, feasibility, and risk.

- **Show versus tell.** Look at how others in your industry are approaching or even exploiting these forces. At this point, *show* is better than *tell*. Try to collect 10 or more examples of what others are doing. These can help you and your colleagues better understand the technology forces and their potential.

- **State of the practical.** Once your organization better understands the future macro forces and their potential impact, convene around the "state of the practical." Specifically, could those same approaches harm or benefit your business? What about this opportunity is desirable from a customer perspective? And importantly, do you have the critical capabilities and technology assets you will need to capitalize on this opportunity?

- **Exploration into experimentation.** To move beyond exploration and into experimentation, try to prioritize use cases, develop basic business cases, and then build initial prototypes. If the prototypes yield results—perhaps with some use case pivots—then you may have found a winning combination of technology, innovation, and business strategy.

INCUBATE NEW PRODUCTS, SOLUTIONS, SERVICES, AND BUSINESS MODELS

When the experiment's value proposition meets the expectations set forth in your business case, then you can consider more substantial investment by moving into incubation, where you foster the growth of technology-driven products, solutions, services, and even new business models.

- **Dedicated team.** Some companies have established innovation centers that are separate from the core business and staffed with dedicated talent. These formal initiatives typically have incubation and scaling expertise. They may also have the capacity to carry out the level of enhancement, testing, and hardening needed before putting your innovation into production.

- **Turtle or hare?** Be cautious about moving too quickly from incubation to full production. Even with a solid business case and encouraging experiments with containable circumstances and uses, at this stage your new innovation is not proven out at scale. You will likely need an incubator that has full scaling abilities to carry out the level of enhancement, testing, and fixes needed before putting your new idea out into the world at full force.

BOTTOM LINE

Some think of technology innovation as nothing more than *eureka!* moments. While there is an element of that, harnessing advanced technology to create new opportunities is more about programmatic, disciplined effort, carried out over time, than it is about inspiration. Organizations should consider how to establish a program that can effectively identify, evaluate, and incubate these future macro technology forces to transform their enterprises, agencies, and organizations—before they themselves are disrupted. In a world of seemingly infinite unknowns, it is possible to focus attention on a meaningful collection of known technologies that, taken together, can help you chart a path to the next horizon.

Authors

MIKE BECHTEL is a managing director with Deloitte Consulting LLP. An inventor, investor, and futurist, he leads the research and development of novel and experimental technologies. Bechtel also helps Deloitte and its clients best engage the startup community, catalyzing profitable relationships between established enterprises and emerging entrepreneurs. A former VC and CTO, he also serves as a professor of corporate innovation at the University of Notre Dame.

BILL BRIGGS is a principal with Deloitte Consulting LLP and is the global chief technology officer. With more than 20 years of experience, he helps clients anticipate the impact that emerging technologies may have on their businesses in the future, and how to get there from the realities of today. He also helps define the vision and incubate the future of Deloitte Consulting LLP's evolving technology services and offerings. Briggs serves as executive sponsor of Deloitte's CIO Program, offering CIOs and other IT executives insights on how to navigate the complex challenges they face in business and technology.

SCOTT BUCHHOLZ is a managing director with Deloitte Consulting LLP and serves as the Government and Public Services chief technology officer and the national Emerging Tech Research director. A leader and visionary with more than 25 years' experience, he advises clients on how to navigate the future using existing and emerging technologies. Buchholz also leads Deloitte's efforts to incubate nascent technology offerings.

SENIOR CONTRIBUTORS

Sonal Naik
Managing director
Deloitte Consulting LLP

Endnotes

1. Bill Briggs, Stefan Kircher, and Mike Bechtel, *Open for business: How open source software is turbocharging digital transformation*, Deloitte Insights, September 17, 2019.

Executive editors

Bill Briggs
Global chief technology officer
Deloitte Consulting LLP
wbriggs@deloitte.com

Bill Briggs' 20-plus years with Deloitte have been spent delivering complex transformation programs for clients in a variety of industries, including financial services, health care, consumer products, telecommunications, energy, and the public sector. He is a strategist with deep implementation experience, helping clients anticipate the impact that new and emerging technologies may have on their businesses in the future—and getting there from the realities of today.

In his role as CTO, Briggs is responsible for research, eminence, and incubation of emerging technologies affecting clients' businesses and shaping the future of Deloitte Consulting LLP's technology-related services and offerings. He also serves as executive sponsor of Deloitte's CIO Program, offering CIOs and other IT executives insights and experiences to navigate the complex challenges they face in business and technology.

Scott Buchholz
Emerging Technology research director and
Government & Public Services chief technology officer
Deloitte Consulting LLP
sbuchholz@deloitte.com

With more than 25 years of experience in technology innovation and implementation, Scott Buchholz focuses on helping clients transform the way they deliver their missions and businesses through technology. He supports organizations across industries by providing advice and insights on how to evolve their technology and their organizations to improve performance, effectiveness, and efficiency.

In his role as CTO for Deloitte Consulting LLP's Government and Public Services practice, Buchholz works with clients to implement innovation across a diverse set of areas, including legacy modernization, eGovernment and eCommerce solutions, and solution architecture.

As the emerging technologies research director and the sponsor of *Tech Trends*, he helps identify, research, and champion the technology trends that are expected to have significant impact on the market and clients' businesses in the future.

Executive perspectives authors

STRATEGY

Benjamin Finzi
US Chief Executive Program leader | Deloitte Consulting LLP

Benjamin Finzi is a managing director with Deloitte Consulting LLP and coleads Deloitte's Chief Executive Program. As a founder of New York's Deloitte Greenhouse® Experience, he has designed and facilitated hundreds of immersive "lab" experiences for CEOs and their leadership teams, combining principles of business strategy with behavioral science and design thinking to address clients' challenges. Finzi has been focused for more than 20 years on researching and understanding how companies succeed in disruptive markets.

FINANCE

Ajit Kambil
CFO Program global research director | Deloitte LLP

Ajit Kambil is the global research director of Deloitte LLP's Chief Financial Officer Program. He oversees research in areas such as leadership, capital markets, and risk. Kambil created *CFO Insights*, a biweekly publication serving more than 38,000 subscribers, and developed Deloitte's Executive Transition Lab, which helps CXOs make an efficient and effective transition into their new role. He is widely published in leading business and technology journals.

Moe Qualander
Principal | Deloitte & Touche LLP

Moe Qualander is a principal with Deloitte & Touche LLP's Risk & Financial Advisory practice. He has more than 20 years of experience, specializing in assessing internal controls in financial business operations and IT. Qualander leads Deloitte's Chief Financial Officer Program's Center of Excellence, focusing on creating and enhancing relationships with clients' CFOs. As dean of Deloitte's Next Generation CFO Academy, he assists future finance executives with enhancing their leadership, influence, and competency skills.

RISK

Deborah Golden
US Cyber Risk Services leader | Deloitte & Touche LLP

Deborah Golden is a principal with Deloitte & Touche LLP and Deloitte's US Cyber Risk Services leader. She brings more than 25 years of information technology experience in industries that include government and public services (GPS), life sciences and health care, and financial services to the role, and previously served as Deloitte's GPS cyber leader, as well as GPS Advisory market offering leader. Golden also serves on Virginia Tech's Business Information Technology and Masters in Information Technology advisory boards.

Chapter authors

MACRO TECHNOLOGY FORCES

Bill Briggs
Global chief
technology officer
Deloitte Consulting LLP
wbriggs@deloitte.com

Scott Buchholz
Government & Public
Services chief technology officer
Deloitte Consulting LLP
sbuchholz@deloitte.com

Sandeep Sharma, PhD
Deputy chief
technology officer
Deloitte Consulting LLP
sandeepksharma@deloitte.com

ETHICAL TECHNOLOGY AND TRUST

Catherine Bannister
Technology Fluency and
Ethics global director
Deloitte Services LP
cbannister@deloitte.com

Deborah Golden
US Cyber Risk Services leader
Deloitte & Touche LLP
debgolden@deloitte.com

FINANCE AND THE FUTURE OF IT

John Celi
Business Agility US leader
Deloitte Consulting LLP
jceli@deloitte.com

Ajit Kambil
CFO Program global
research director
Deloitte LLP
akambil@deloitte.com

Khalid Kark
US CIO Program
research leader
Deloitte Consulting LLP
kkark@deloitte.com

Jon Smart
Business Agility UK leader
Deloitte MCS Limited
jonsmart@deloitte.co.uk

Zsolt Berend
Business Agility senior manager
Deloitte MCS Limited
zsoltberend@deloitte.co.uk

DIGITAL TWINS: BRIDGING THE PHYSICAL AND DIGITAL

Adam Mussomeli
Supply Chain & Network Operations leader
Deloitte Consulting LLP
amussomeli@deloitte.com

Aaron Parrott
Supply Chain & Network Operations managing director
Deloitte Consulting LLP
aparrott@deloitte.com

Brian Umbenhauer
Industrial Products and Construction leader
Deloitte Consulting LLP
bumbenhauer@deloitte.com

Lane Warshaw, PhD
Analytics & Cognitive managing director
Deloitte Consulting LLP
lwarshaw@deloitte.com

HUMAN EXPERIENCE PLATFORMS

Tamara Cibenko
US Digital Experience lead
Deloitte Consulting LLP
tcibenko@deloitte.com

Amelia Dunlop
Deloitte Digital chief experience officer
Deloitte Consulting LLP
amdunlop@deloitte.com

Nelson Kunkel
Deloitte Digital chief design officer
Deloitte Consulting LLP
nkunkel@deloitte.com

ARCHITECTURE AWAKENS

Saul Caganoff
Platform Engineering chief technology officer
Deloitte Consulting Pty Ltd
scaganoff@deloitte.com.au

Ken Corless
Cloud chief technology officer
Deloitte Consulting LLP
kcorless@deloitte.com

Stefan Kircher
Innovations & Platforms chief technology officer
Deloitte Consulting LLP
skircher@deloitte.com

HORIZON NEXT: A FUTURE LOOK AT THE TRENDS

Mike Bechtel
Managing director
Deloitte Consulting LLP
mibechtel@deloitte.com

Bill Briggs
Global chief technology officer
Deloitte Consulting LLP
wbriggs@deloitte.com

Scott Buchholz
Government & Public Services chief technology officer
Deloitte Consulting LLP
sbuchholz@deloitte.com

Contributors

Mukul Ahuja, Zillah Austin, Randall Ball, Sonali Ballal, Tushar Barman, Neal Batra, Jonathan Bauer, Mike Brinker, Randy Bush, Rachel Charlton, Sandy Cockrell, Allan Cook, Megan Cormier, Amit Desai, Anant Dinamani, Sean Donnelly, Matt Dortch, Deborshi Dutt, Karen Edelman, Michael Fancher, Frank Farrall, Jourdan Fenster, Bryan Funkhouser, Andy Garber, Haritha Ghatam, Cedric Goddevrind, Jim Guszcza, Maleeha Hamidi, Steve Hardy, Blythe Hurley, Lisa Iliff, Siva Kantamneni, Mary-Kate Lamis, Blair Kin, Kathy Klock, Yadhu Krishnan, Michael Licata, Mark Lillie, Veronica Lim, Mark Lipton, Kathy Lu, Adel Mamhikoff, Sean McClowry, JB McGinnis, Meghan McNally, Kellie Nuttall, Melissa Oberholster, Arun Perinkolam, Ajit Prabhu, Aparna Prusty, Mohan Rao, Hannah Rapp, Scott Rosenberger, Mac Segura-Cook, Preeti Shivpuri, Lisa Smith, Gordon Smith, Tim Smith, David Solis, Alok Soni, Patrick Tabor, Sonya Vasilieff, Aman Vij, Jerry Wen, Mark White, Drew Wilkins, Abhilash Yarala, Andreas Zachariou, and Jim Zhu.

Research team

LEADS

Cristin Doyle, Chris Hitchcock, Betsy Lukins, Dhruv Patel, Andrea Reiner, and Katrina Rudisel.

TEAM MEMBERS

Stephen Berg, Erica Cappon, Enoch Chang, Tony Chen, Ankush Dongre, Ben Drescher, Ahmed Elkheshin, Harsha Emani, Jordan Fox, Riya Gandhi, Dave Geyer, Maddie Gleason, April Goya, Adhor Gupta, Alex Jaime Rodriguez, Morgan Jameson, Solomon Kassa, Pedro Khoury-Diaz, Emeric Kossou, Dhir Kothari, Shuchun Liu, James McGrath, Hannan Mohammad, Spandana Narasimha Reddy, Gabby Sanders, Joey Scammerhorn, Kaivalya Shah, Deana Strain, Samuel Tart, Elizabeth Thompson, Samantha Topper, Kiran Vasudevan, Greg Waldrip, and Katrina Zdanowicz.

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Deloitte Insights contributors

Editorial: Matthew Budman, Blythe Hurley, Abrar Khan, Rupesh Bhat, Anya George Tharakan, and Nairita Gangopadhyay

Creative: Anoop K R and Emily Moreano

Promotion: Hannah Rapp

Cover artwork: Vasava

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