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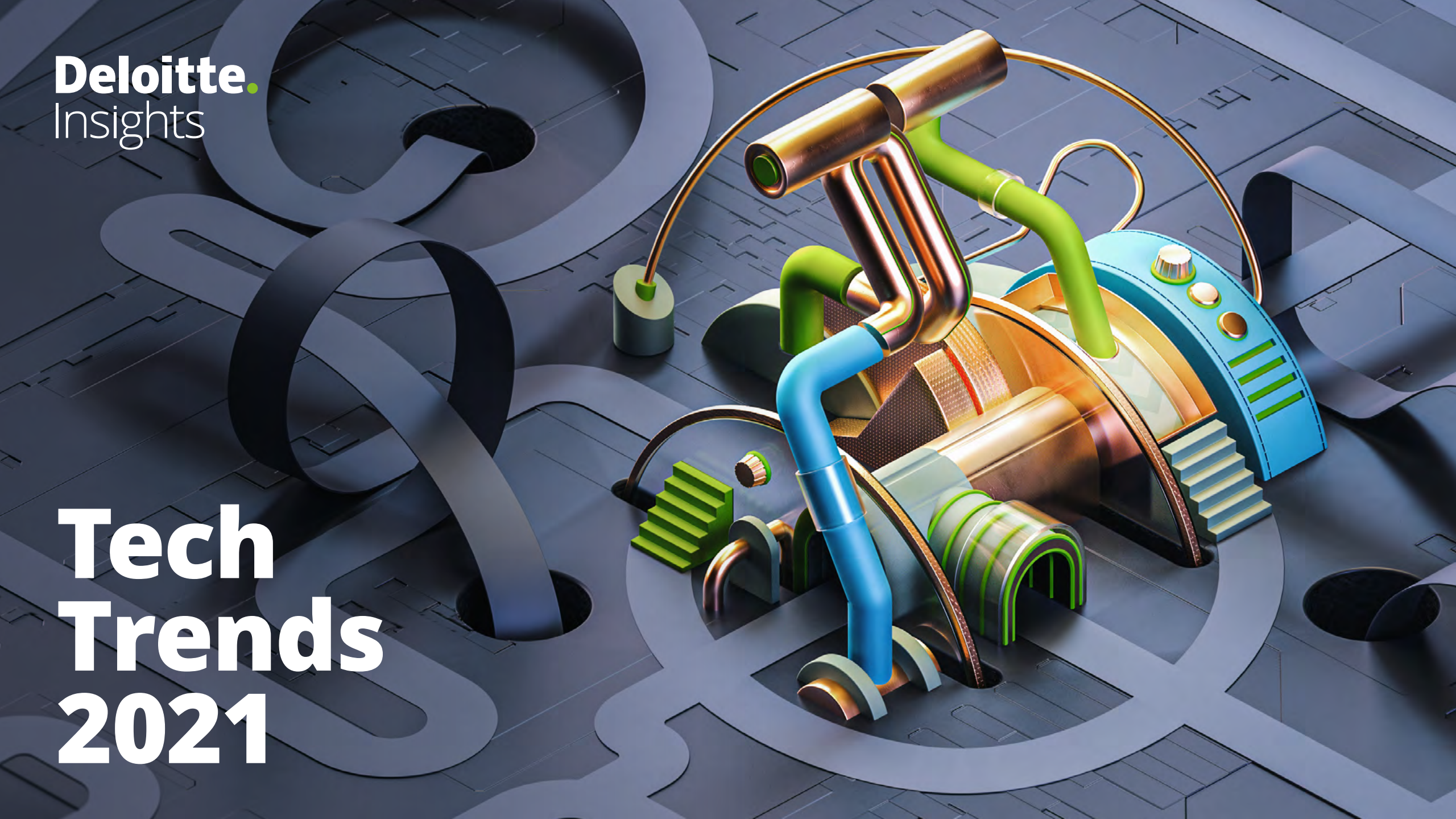
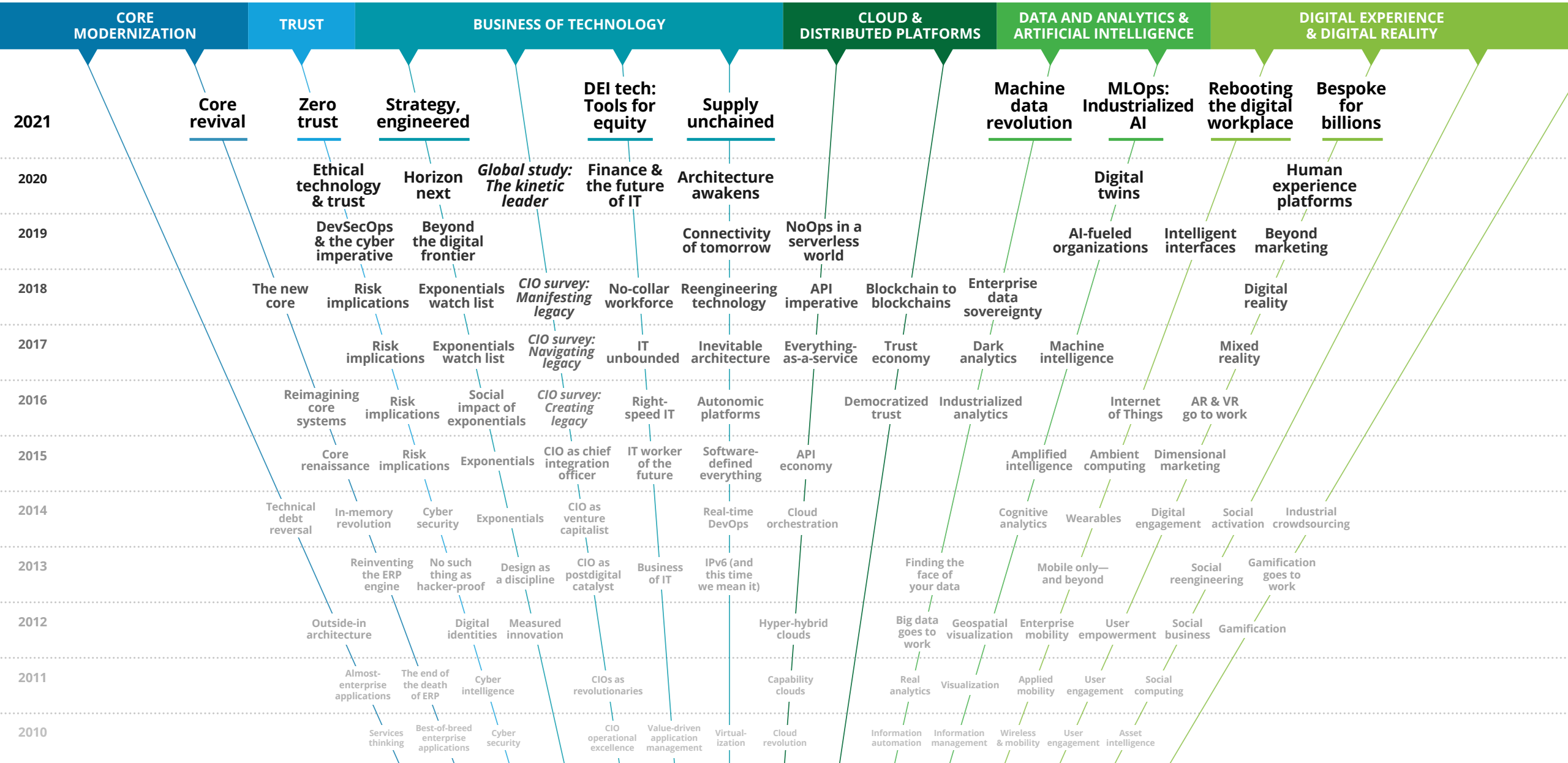
Tech Trends 2021



Trending the trends: Twelve years of research



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Letter from the editors

As poet Robert Burns mused, the best-laid plans of mice and men often go awry. In January 2020, most of us had plans—thoughtful road maps to guide our organizations, our technology, and our lives through the months to follow. And then COVID-19 punched the entire world in the mouth, rendering useless many of these best-laid plans. Seemingly overnight, a strange, historic event disrupted our assumptions and forced us, with a shocking degree of urgency, to become more adaptable and responsive than we had thought possible.

Mindful that the pandemic's impact continues to ripple across societies, markets, and lives, we present *Tech Trends 2021*. The theme of this year's report is *resilience*. To us, this means a stubborn determination to adapt and thrive in the face of change. We have seen countless, inspiring examples of resilience this past year as organizations and entire sectors assessed their circumstances, revised their strategic plans, and marched toward the future.

We anticipate that for most, the future they find will differ markedly from the realities of January 2020. The COVID-19 crisis has driven change in an important and unexpected way. A growing number of organizations across sectors are accelerating their digital transformation efforts not only to make their operations nimbler and more efficient but to respond to dramatic fluctuations in demand and customer expectation. For example, while many supply chain leaders were confident of their ability to function during disruptions, we found out, as Warren Buffett once quipped, who was swimming naked when the tide went out. Likewise, executive-level planning discussions about the future of work had been just that: about the future. The pandemic crashed comfortable schedules from years into weeks.

With that background, this year's *Tech Trends* report discusses the opportunities, strategies, and technologies that will drive new plans during the next 18 to 24 months and beyond:

- For enterprise technology, we spotlight the importance of aligning corporate and technology strategy; we revisit the critical core and how digital nonnatives are using cloud, low-code, and platform-first strategies to juice legacy assets; and we take a deep dive into supply chain transformation.

- For data, we investigate how leading organizations are industrializing their AI initiatives with "MLOps" and, consequently, developing new approaches to managing data for machine, rather than human, consumption. We also discuss emerging trends in cybersecurity.

- For human and machine interaction, we look at emerging trends in the future of the workplace, digital experiences, and technology that supports diversity, equity, and inclusion.

Taken together, these trends suggest that there is a more hopeful dimension to the turbulent events of this past year. New technology and business plans already being executed chart a promising path toward tomorrow. Confidently leading this journey will be CIOs and other executives, who have proven they can take a punch and get back on their feet.

Now *that's* what we call resilience.

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

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

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

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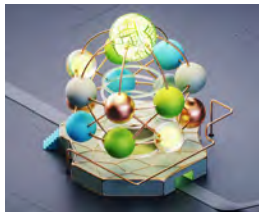
Strategy, engineered

Technology today is a source of new competitive advantage for some organizations and a threat to ongoing survival for others. As a result, the distinction between corporate strategy and technology strategy is blurring—each needs to inform the other. Savvy corporate strategists are looking beyond their organization's current tech capabilities and competitive landscape to consider a broader range of future possibilities about how technology can expand where they play and how they win. But the complex range of uncertainties and possibilities can be too much for the human brain to process on its own. That's why strategists are turning to strategic technology platforms equipped with advanced analytics, automation, and AI. Organizations are using these tools to continually identify internal and external strategic forces, inform strategic decisions, and monitor outcomes. As a result, companies are transforming strategy development from an infrequent, time-consuming process to one that's continuous and dynamic, helping strategists think more expansively and creatively about the wide range of future possibilities.

Core revival

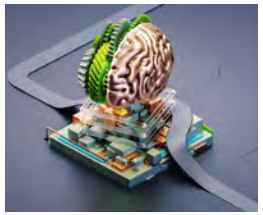
Modernizing legacy enterprise systems and migrating them to the cloud may help unleash an organization's digital potential. Until recently, these undertakings could also bust that same organization's digital transformation budget. For many, the cost of needed cloud migrations and other core modernization strategies can be prohibitive. This is about to change. In what we recognize as a growing trend, some pioneering companies are beginning to use clever outsourcing arrangements to reengineer traditional business cases for core modernization. Likewise, some are exploring opportunities to shift core assets to increasingly powerful platforms, including low-code options. Finally, many are advancing their platform-first strategies by addressing technical debt in ERP systems and migrating nonessential capabilities to other platforms. In a business climate defined by historic uncertainty, these innovative approaches for extracting more value from legacy core assets may soon become standard components of every CIO's digital transformation playbook.

Supply unchained



Long considered a cost of doing business, supply chains are moving out of the back office and onto the value-enabling front lines of customer segmentation and product differentiation. Future-focused manufacturers, retailers, distributors, and others are exploring ways to transform the supply chain cost center into a customer-focused driver of value. They are extracting more value from the data they collect, analyze, and share across their supply networks. Finally, some of these organizations are exploring opportunities to use robots, drones, and advanced image recognition to make physical supply chain interactions more efficient, effective, and safe for employees. Granted, transforming established supply chains into resilient, customer-focused supply networks will be a challenge, and for most organizations, it will be an ongoing journey—one of critical importance. The kind of disruption we have seen with the COVID-19 pandemic could well become the norm. When the next global event hits, technology and supply chain leaders won't be able to claim they didn't see it coming.

MLOps: Industrialized AI



Sophisticated machine learning models help companies efficiently discover patterns, reveal anomalies, make predictions and decisions, and generate insights—and are increasingly becoming key drivers of organizational performance. Enterprises are realizing the need to shift from personal heroics to engineered performance to efficiently move ML models from development through to production and management. However, many are hamstrung in their efforts by clunky, brittle development and deployment processes that stifle experimentation and hinder collaboration among product teams, operational staff, and data scientists. As AI and ML mature, a strong dose of engineering and operational discipline can help organizations overcome these obstacles and efficiently scale AI to enable business transformation. To realize the broader, transformative benefits of AI and ML, the era of artisanal AI must give way to one of automated, industrialized insights. Enter MLOps, also known as ML CI/CD, ModelOps, and ML DevOps: the application of DevOps tools and approaches to model development and delivery to industrialize and scale machine learning, from development and deployment to ongoing model maintenance and management.

Machine data revolution: Feeding the machine

With machine learning poised to overhaul enterprise operations and decision-making, a growing number of AI pioneers are realizing that legacy data models and infrastructure—all designed to support decision-making by humans, not machines—could be a roadblock to ML success. In response, these organizations are taking steps to disrupt the data management value chain from end to end. As part of a growing trend, they are deploying new technologies and approaches including advanced data capture and structuring capabilities, analytics to identify connections among random data, and next-generation cloud-based data stores to support complex modeling. Together, these tools and techniques can help organizations turn growing volumes of data into a future-ready foundation for a new era in which machines will not only augment human decision-making but make real-time and at-scale decisions that humans cannot.

Zero trust: Never trust, always verify

Sophisticated cyberattacks and shifting enterprise environments have undermined the traditional—and somewhat flawed—castle-and-moat approach to cybersecurity. Zero trust is rooted in the concept that modern enterprise environments necessitate a different approach to security: There's no longer a defined perimeter inside which every user, workload, device, and network is inherently trusted. In zero trust architectures, every access request should be validated based on all available data points, including user identity, device, location, and other variables that provide context to each connection and allow more nuanced, risk-based decisions. Data, applications, workloads, and other resources are treated as individual, manageable units to contain breaches, and access is provided based on the principle of least privilege. The automation and engineering required to properly implement zero trust security architectures can help strengthen security posture, simplify security management, improve end-user experience, and enable modern enterprise environments. But the move to zero trust could require significant effort and planning, including addressing foundational cybersecurity issues, automating manual processes, and planning for transformational changes to the security organization, the technology landscape, and the enterprise itself.

Rebooting the digital workplace

As the world's largest unplanned work-from-home experiment continues, many business leaders are asking as yet unanswered questions: When the dust settles, will remote work become the rule or the exception? Is a permanently remote workforce sustainable? How will productivity and employee well-being be affected? Will innovation suffer in the absence of face-to-face peer connections? What will be the role of the physical office? Companies may be able to overcome the digital workplace's deficits and ambiguities by more intentionally embracing its positive aspects, including the data generated by workers' tools and platforms. This can help organizations optimize individual and team performance and customize the employee experience through personalized recommendations, enabling remote work to be far more than a diminished proxy for the traditional office. And as onsite workspaces and headquarters evolve, organizations can use this data to create thriving, productive, and cost-effective offices that are seamlessly interwoven with the remote experience.

Bespoke for billions: Digital meets physical

When we look back, 2020 will likely be the turning point when most of the population adapted to digital interactions to conduct their everyday lives, whether working from home, online schooling, or ordering groceries. Yet the prevalence of digital interactions has left many of us pining for the days of in-person interactions. As we look to the future, we expect consumers will no longer be satisfied with distinct physical or digital brand experiences: They will expect a blend of the best of both—highly personalized, in-person experiences without sacrificing the convenience of online transactions. In the next 18 to 24 months, we expect in-person and digital experiences to become more seamless and intertwined. Online and offline interactions will not be separate experiences anymore—the customer's journey will be made up of in-person and digital elements that are integrated and intentionally designed to create a seamless brand experience that's tailored to fit the individual customer's behaviors, attitudes, and preferences.

DEI tech: Tools for equity

Many organizations are embracing diversity, equity, and inclusion as business imperatives, with a growing number adopting holistic, organizationwide workforce strategies that address biases and inequities to enhance enterprise and employee performance. While HR professionals often lead DEI strategies, technology leaders play a critical role as a strategic partner by designing, developing, and executing tech-enabled solutions to address increasingly complex DEI workforce challenges. Over the coming months, we expect enterprises to adopt new tools that incorporate advanced analytics, automation, and AI, including natural language processing and machine learning, to help inform, deliver, and measure the impact of DEI.

Macro technology forces

A taxonomy for emerging tech

For more than a decade, *Tech Trends* has explored the landscape of emerging technologies and sought to understand their impact on business strategy. Within this broad landscape, we have identified several macro technology forces as the backbone of business innovation and transformation. Discussed last year in the chapter *Macro technology forces*, these powerhouse trends distill 12 years of research into an easily consumable framework and taxonomy that can help organizations make sense of emerging technologies in order to articulate business direction, make strategic decisions, and prioritize technology investments.

Progressing from enabling technologies of the past decade to disruptors of the 2020s and to the technologies beyond the horizon, the macro forces framework shows the inextricable links between the defining technologies of the past, present, and future.

These powerhouse trends distill 12 years of research into an easily consumable framework and taxonomy.

- **Enablers.** *Digital experience*, *data and analytics*, and *cloud* have spawned multiple innovative business models and strategies. These enabling technologies have already powered a decade of disruptive change—and they have a lot more innovation mileage left in them.

- **Disruptors.** *Digital reality*, *artificial intelligence*, and *distributed platforms* are here today and are on the path to broad adoption, sparking rapid disruption along the way. Disruptors are currently shaping the next decade of business innovation.

- **Horizon next.** We expect *horizon next* technologies to mature over the coming decade and shape business and technology strategies of the future. *Ambient experience* envisions ubiquitous interfaces, seamlessly integrated into the

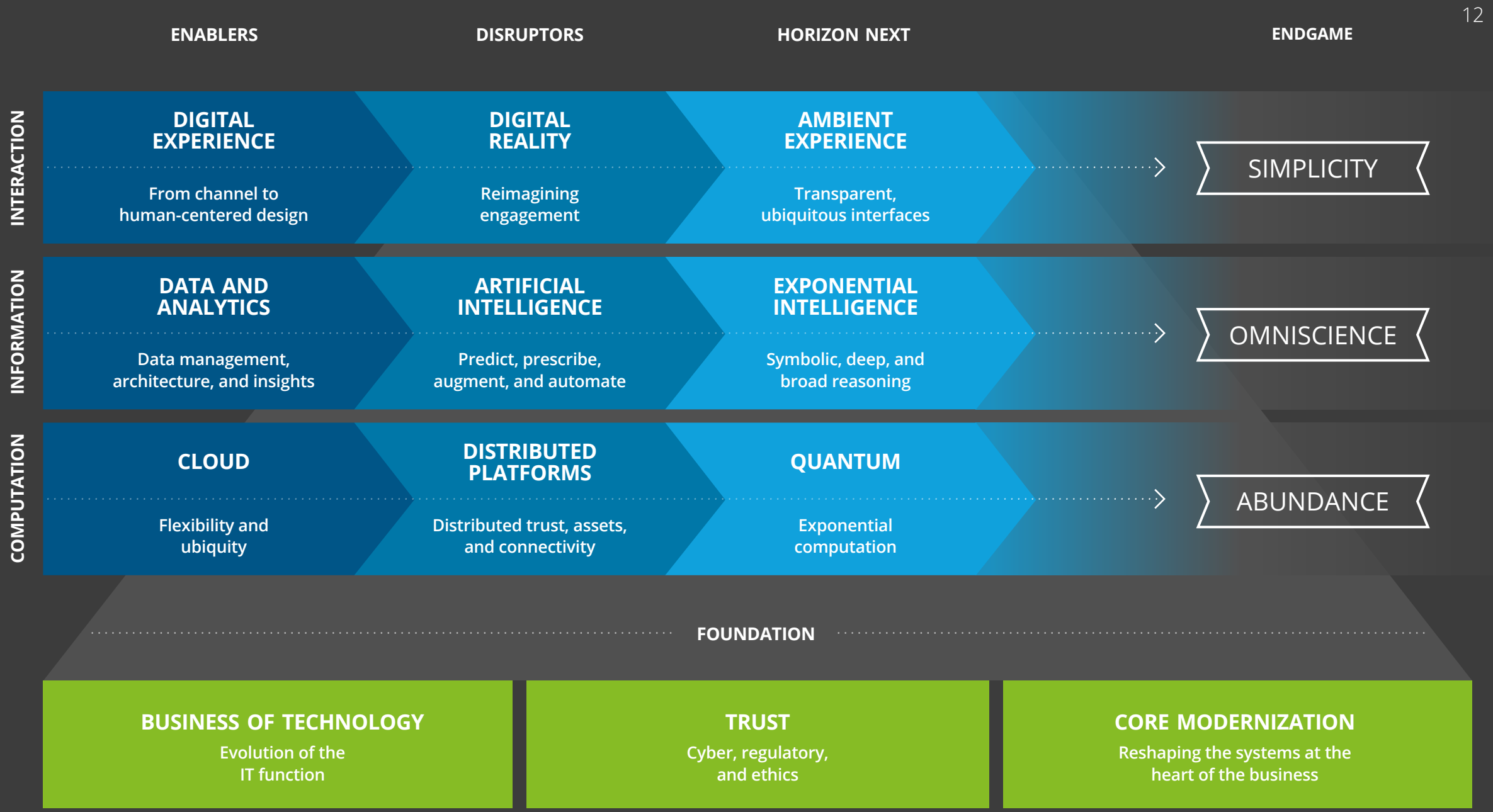
environment, that anticipate and meet human needs. *Exponential intelligence* builds on artificial intelligence, adding the capacity to recognize and respond to human emotions, understand the external environment, and perform any task. Meanwhile, *quantum* harnesses the properties of subatomic particles to solve problems that are too complex for today's supercomputers. The macro forces framework also helps visualize the evolutionary path of these technologies as they influence interaction, information, and computation.

- **Interaction.** As human-technology engagement continues to increase, the end game is simplicity—transparent and natural interactions.

- **Information.** As the ways that machines manage information evolve, the ultimate objective is omniscience—machines that combine insights and understanding to recognize not only correlation but causation.

- **Computation.** As computation abilities scale, the long-term goal is abundance—the limitless ability to work with and gain benefits from technology and information.

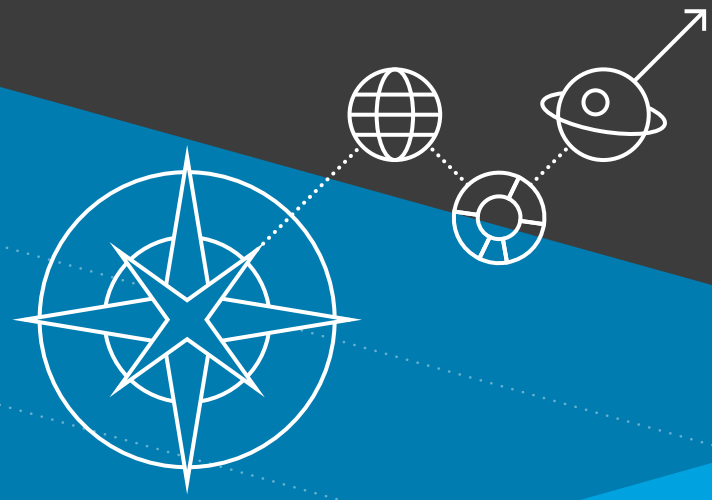
Finally, to scale sustainably, emerging technologies must rest on a solid **foundation** comprising: the *business of technology*, the evolution of the IT function; *trust*, encompassing risks related to cyber, regulatory, and ethics; and *core modernization*, the organization's approach to rejuvenating legacy core systems.


ENABLERS
DISRUPTORS
HORIZON NEXT
ENDGAME
INTERACTION
DIGITAL EXPERIENCE
From channel to human-centered design
DIGITAL REALITY
Reimagining engagement
AMBIENT EXPERIENCE
Transparent, ubiquitous interfaces
SIMPLICITY
INFORMATION
DATA AND ANALYTICS
Data management, architecture, and insights
ARTIFICIAL INTELLIGENCE
Predict, prescribe, augment, and automate
EXPONENTIAL INTELLIGENCE
Symbolic, deep, and broad reasoning
OMNISCIENCE
COMPUTATION
CLOUD
Flexibility and ubiquity
DISTRIBUTED PLATFORMS
Distributed trust, assets, and connectivity
QUANTUM
Exponential computation
ABUNDANCE
FOUNDATION
BUSINESS OF TECHNOLOGY
Evolution of the IT function
TRUST
Cyber, regulatory, and ethics
CORE MODERNIZATION
Reshaping the systems at the heart of the business

Strategy, engineered

FUTURE-READY STRATEGY

Strategists are making more clear, timely, and creative choices about where to play and how to win.



STRATEGY LEADS TECHNOLOGY

As strategy and technology become increasingly intertwined, strategic intent must inform technology choices.

TECH-ENABLED STRATEGY

Use strategy support platforms to identify driving forces, inform choices, and monitor execution and outcomes.

TREND 1

Strategy, engineered

Tech-enabled business strategy, optimized for agility

In a world where technology has emerged as a mighty strategic disruptor, savvy strategists are looking to make more clear, timely, and inspirational choices about future possibilities, continually scanning the horizon for new competitive advantages they can deploy and threats they should avoid. A growing number of organizations are also proactively pursuing novel competitive advantages by joining forces with existing and new ecosystem partners—from government and nonprofit agencies to complementary corporations and even "frenemies"—to envision how their combined offerings could expand where they play and how they win.

Winning in a volatile environment requires an integrated corporate and technology strategy, enabling organizational nimbleness, scalability, stability, and optionality.[1] The traditional process of strategy development is too infrequent and labor-intensive to enable strategists to sense and seize opportunities as they emerge. A growing number are shifting to a fluid and agile process for formulating, evaluating, and executing corporate and business unit strategies by employing technology tools that continually sense, anticipate, and monitor the effectiveness of their strategic choices and execution.

The result: more timely and smarter choices that could lead to faster adaptation, bolder strategic choices, and sustainable competitive advantage.

Close the technology and business strategy chasm

As business strategy and technology strategy become increasingly intertwined, many corporate executives are finding that their organization's past technology choices are limiting their strategic options and business agility. To resolve these technology limitations, these executives are finding it necessary to lean in to technology architecture and technology implementation choices to ensure the overall business strategy is supported by clearly aligned technology choices.

Obviously, having a strategy sitting on the shelf isn't enough—effective execution is critical.

And when asked about their strategic priorities and ability to execute, CSOs with disruptive, digital ambitions lack confidence in their ability to execute. In Deloitte's *2020 CSO Survey*,[2] most respondents (70%) rated disruptive growth as critical for their companies' success, but only 13% are confident that their company can deliver on this strategic priority.

Having a strategy sitting on the shelf isn't enough—effective execution is critical.

Effective execution requires continually monitoring the underlying strategic choices and assumptions, adjusting as needed. Even though most survey participants say they are seeking disruptive growth, 71% report spending more than three months on a single round of strategy development. Nearly half (45%) refresh their strategy annually, or even less frequently: every two years (23%) or three years (22%).

Ultimately, strategists should collaborate with tech leaders to confirm that the organization's critical technologies support the organizational strategy—and that the organization's technologists have the right framework and understanding of the corporate strategy to make their day-to-day technology decisions.

Getting from here to there

Agile strategy development and execution doesn't happen in a vacuum—to generate effective results, organizations need foundational elements in place.

Empowered strategy function. Whether it's the CEO, CSO, or other executive, an empowered executive strategy leader is critical to effective strategy development and execution. In collaboration with the CIO, the strategy leader can help expand and shape the vision of executive leaders and board members. As one executive from a leading oil and gas company said, "The CSO needs to challenge long-held views and get our fellow executives to think about a market environment that is different from the existing one." The successful strategy leader reinforces strategic discipline by looking beyond the organization's daily challenges, aligning key technology choices, and continually scanning the horizon to anticipate emerging challenges.

Tech-savvy C-suite. C-suite executives and board members should have a broad understanding of the critical technologies in which the company is, or should be, investing to gain competitive advantage and to build resilience against disruption. Leaders need to be supportive of investing in a portfolio of technology investments, from proofs of

concept to test emerging technologies to major implementations of proven platforms. Moreover, executives need to help challenge the critical assumptions of those implementing the technology to help make sure the implementation will be driving value for the enterprise.

Business-savvy tech leaders. Likewise, IT leaders and technologists should be engaged in strategy development processes and education that gives them a broad understanding of the business and its strategic objectives. As strategic partners, tech leaders can help strategy and business leaders identify and explore emerging technologies that support the strategic vision, with the objective of aligning the organization's technology and corporate strategies. In fact, in a Deloitte–*Wall Street Journal* Intelligence survey, 40% of CEOs said their CIO or tech leader will be the key driver of business strategy—more than the CFO, COO, and CMO combined.[3] Further, big technology bets require the active participation of the CEO/CSO to ensure that the organization's tolerance for risk is honored and well managed.

Aligned technology and partners. Effective organizations choose their technology platforms and ecosystem partners carefully, aligning their choices and implementation decisions with their strategic goals. When selecting important ecosystem partners, evaluate their long-term motives and agendas to understand whether their objectives and aspirations align with yours. In a worst-case scenario, a platform partner could become a competitive threat after they "learn" your industry.

Collaborative list of strategic assumptions. Early in the strategy development process, lead strategists, tech leaders, and ecosystem partners should explore and challenge the assumptions for a tech-enabled strategy to be effective. Consider holding the discussion in a neutral environment such as a workshop, where egoless answers are encouraged and cataloged so they can be used later to flag leading indicators of the strategy's success or failure.

Agile funding. Executing on agile strategies demands a flexible process for planning and funding the technology investments required to implement strategies. For insights into how to finance innovation at the speed of agile, see *Tech Trends 2020: Finance and the future of IT*.

Next up: Tech-enabled strategy

To compete in an increasingly complex world, not only are the strategies becoming more digital—so is the process of developing and executing strategies and monitoring outcomes. As leaders are forced to consider a wider range of variables and future scenarios, tech-enabled strategy platforms can help strategists think more expansively and precisely about the wide range of future possibilities.

Technology can also help leaders gain insight into seemingly unrelated occurrences that can drive smarter strategic choices on a continual basis. Strategists should evaluate technologies that help empower their imagination by identifying driving forces, informing strategic decisions, and monitoring outcomes. (See figure, “Strategy support technologies” on page 18.)

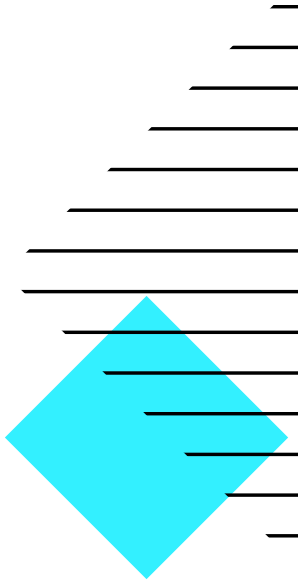
40% of CEOs said their CIO or tech leader will be the key driver of business strategy—more than the CFO, COO, and CMO combined.

Finally, technology plays an increasingly important role in helping companies translate a strategy into strategic initiatives, facilitate strategy execution, and monitor a strategy’s impact in the marketplace.

The way forward

Strategy development is not a one-and-done exercise but, rather, an ongoing, cyclical process. As technology and business become increasingly intertwined, business strategy drives technology strategy and vice versa. Around and around it goes—to the point where the complexity of known and unknown strategic drivers inside and outside the organization could blow the mind of even the most nimble-brained strategist.

While accelerating technology is a strategic complicator, executives can deploy it to simplify and accelerate smart strategy development and execution. Leading organizations are engineering their strategic function to be more agile, scalable, and stable, giving them an array of strategic options in their back pocket for whatever the future holds.



Strategy support technologies

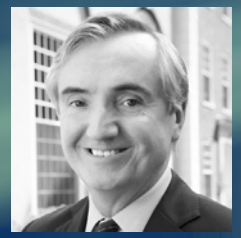
Advanced strategic platforms equipped with advanced analytics, automation, and AI, including natural language processing and machine learning, can help leaders think more expansively and precisely about the wide range of future possibilities.

OBJECTIVE	DESCRIPTION	KEY CONSIDERATIONS	EXAMPLE
Identify strategic forces	Trend-sensing technologies continually scan the environment, collecting, analyzing, and clustering leading indicators that challenge or confirm strategic assumptions to facilitate quick responses.	• External: Changes in society, technology, politics, economy, environment, and regulations • Business: Shifts in industry dynamics, customer expectations, competitor moves, and stakeholder behaviors, attitudes, and emotions • Organizational: Trends in products/services, operations, asset base, costs, and branding	The US Department of Homeland Security uses automated tools that scan news articles, patent filings, and more to identify emerging technologies that might disrupt or improve the process of securing the United States.
Inform strategic choices	Dynamic scenario tools and simulators help leaders identify threats and opportunities, quickly test potential outcomes of strategic choices, and prioritize critical uncertainties.	• Create alternate long-term scenarios to identify threats and opportunities • Develop simulations to test various strategic choices • Enhance human understanding and insight to determine potential implications, critical unknowns, and strategic responses	Three health care organizations (provider, plan, plan/provider) developed an agent-based model to simulate how competitive value-driven care dynamics could evolve, giving each organization new insights into where to play and how to win.
Monitor execution and outcomes	Analytics technologies continually track internal and external outcomes to inform ongoing leadership discussions and decisions regarding the organization's performance against the strategy.	• Are we honoring our strategic choices? • What's working? What's not working? What adjustments are needed? • Is our strategy and its associated commitments generating the projected value?	Deloitte uses AI-based sensing to monitor the trajectory of two important uncertainties that affect the firm's strategy: degree of regulation and technological/automation impact on professional services.

MY TAKE

Joseph Fuller

Professor of management practice, Harvard Business School



One thing I know about strategy: It's the assumptions that kill you, not your competitors.

Over the past 30 years, I've urged corporate strategists to identify and rigorously test key assumptions about their strategy, as well as their assumptions about the technology that will support it. Strategists should know exactly what assumptions they are making about their strategy and the supporting technology—and the competitive results they expect.

Corporate strategy has never been easy, but technological advances have made strategy development even more complex. Technology choices used to be binary: Either a software or hardware choice goes live or it doesn't. Today, the choices are more nuanced and intertwined. For example, in the 1960s, airline strategists were deciding, "Do I buy a jet or stick with propeller aircraft?" But in recent years, the technology choices have become much more numerous and intricate: *What tech will I use to manage pricing? Flight crew?*

Maintenance scheduling? Route assignments? Once implemented, these technology decisions are baked into everyday operations and are difficult to change. Until recently, it's likely that the airlines assumed that business travel would remain relatively stable. As we've seen this year, when a key assumption turns out to be wrong, the strategy can quickly unravel.

Of course, the outcome of any important strategic choice is inherently unknowable. You're never going to reduce the gray area to zero, but you can install controls that warn you that an important assumption is under question or, in fact, invalid. One way to do this is to ask the right questions. No one expects CEOs and CSOs to keep up with all the latest technologies, but they should know enough to ask the hard questions: *How will this technology interact with our strategic assumptions? What problem will it solve, or what uncertainty will be reduced? What advantage will we gain from it?*

And just as important: *What assumptions about the technology itself must be true for these results to materialize?* Too often, leaders and technologists succumb to magical thinking—if we invest in this technology, it will solve all these other problems. Instead, effective strategic leaders don't accept the promised benefits at face value—they carefully probe the logic behind the proposals, searching for disconfirming data, to make sure the technology team has carefully thought through their assumptions about how the technology will advance the strategy without taking on inadvertent risk.

Everyone has access to similar technologies—but it's how you use them that makes the competitive difference.

As assumptions multiply and tangle, the human brain needs help to anticipate outcomes and make course corrections. New technology tools can help strategists experiment with strategic theories, test the assumptions' validity and likely outcomes. Rapid simulation and experimentation can provide a quick, early read on possible outcomes while avoiding implementation risk. During execution, technologies can continually monitor the assumptions' validity in real time, providing insights that strategists can use to quickly and confidently course correct if needed. Additionally, sensing technologies can function as an early warning system to alert strategists when assumptions are being challenged.

Many of these strategy support technologies incorporate cognitive AI, which helps take the human ego out of the equation when decisions don't work out as anticipated. It's human nature to overlook or discount

data that doesn't support our beliefs, but a machine has no ego, which allows it to be objective. Plus, a machine can quickly pinpoint one exception out of thousands and identify subtle—but crucial—patterns and connections that could overturn a strategy. These capabilities significantly improve the odds that a human strategist will recognize a strategic flaw and fix it before it's too late.

In the end, though, the strategist's capabilities are more important than the technology she uses. I often tell my MBA students about a NASCAR experiment that gave each driver the same vehicle and pit crew. The researchers found that even when drivers have the same "tools," some perform better than others, simply because of their innate abilities and experiences. So, my advice to strategists is that everyone has access to similar technologies—but it's how you use them that makes the competitive difference.

MY TAKE

Peter Schwartz

Senior vice president of strategic planning, Salesforce

I've been working with scenario planning since the early 1980s and have even written several books on the topic, so the skills I've developed over the years are particularly useful now.

This pandemic is the biggest crisis the world has seen in nearly a century, and it's important that leaders recognize that the old normal is gone forever. It's up to leaders to figure out a new future—otherwise, it will be determined for them.

The pandemic has accelerated the pace of technological change, so when I think about technology and strategy, it is in the context of a malleable world of possibilities that didn't exist before. Because there are so many unknowns during the pandemic, we temporarily

shortened our planning horizon at Salesforce to nine-month scenarios to inform our strategic choices about the technology that will be needed in this new world and how we could tackle even bigger problems.

We are also working to harness the strategic thinking of our 50,000-plus employees. We've pivoted from the centralized communications cascade we used before the pandemic to a hyperdistributed enablement of strategic thinking. We gave every employee a copy of our near-term scenarios and asked them to consider: *How do you need to operate and adapt to this environment? How are you going to help your customers do this, too?*

Of course, we don't send them off without context. Every Wednesday, we have an all-hands call to keep our people up to date. We gave them a playbook that provides guidance for how to think about running their part of the company and how to interact with customers during this transition. But we didn't provide specific actions they should take—instead, we suggested the questions they should be asking themselves in this new environment.

Moreover, to succeed in an accelerating world where strategies and tactics are merging, leaders need to know what's going on. The ability to capture and display information for decision-making becomes hyperrelevant when you need to move this fast. Quickly adjusting strategy and tactics requires real-time data and sophisticated tools to create scenarios and forecasts.

For example, we're helping health agencies in California and Hawaii, as well as our own global organization, anticipate where the COVID-19 virus could spread next. We're using a mobile survey tool that follows cell phone movement without capturing personally identifiable information. When many cell phones move from a coronavirus hot spot to another area, the tool alerts local health organizations to give them time to prepare.

It's up to leaders to figure out a new future—otherwise, it will be determined for them.

Another example was the design and launch of Work.com in early May 2020. This new product helps businesses and communities get back to work safely. We accomplished in one month what would normally take a year. When you move this quickly, the organization's operational cadence must accelerate as well. During every good scenario exercise, leaders identify the leading indicators of potential problems. Our senior executives, especially Marc Benioff, are very familiar with these indicators and frequently question operational leaders to head off problems before they

can materialize. If something is supposed to happen and doesn't, it's noticed very quickly.

In times of crisis, business leaders have a different role than in ordinary times. In terms of strategy and tactics, it's insufficient to consider only how we can help our businesses. We need to step up and help deal with the crisis itself. *How can we help our community and society? How can we help the world deal with this crisis?* By engaging all of our people in bottom-up, independent thinking and innovation, we can do our part to help design the world's new future.

EXECUTIVE PERSPECTIVES

STRATEGY // The playbook for using technology to create competitive advantage is changing from, "Who owns the best tech?" to, "Who uses technology the best?" As a result, CEOs are realizing that their collaboration with IT needs to go a level deeper to understand whether and how their tech is providing an advantage. Strategy executives should find the right balance of education, control, and delegation when making decisions about technology adoption or implementation. In understanding what's possible within the bounds of their organization's tech stack, CEOs can develop an overall strategy that plays to their strengths or allows time for needed investments. As strategy becomes more dynamic in the coming months, CEOs would be wise to remember that their responses to trends will be only as good as their organizational technology permits.

FINANCE // Finance leaders are playing a larger role in strategy, with some even wearing both lead strategist and CFO hats. These leaders are drawing a fine line with technology-enabled strategy by making it dynamic without pivoting constantly. As capabilities such as market sensing and constant monitoring point to new directions, CFOs can actively manage the capital allocation available for such experimentation. This means placing some limits on the options available to the CEO, while helping to identify strategies that can generate robust profit streams in the future. Ultimately, the finance team may be responsible for communicating its decisions to the public in a way that emphasizes purposeful experimentation and profit potential, especially at a time when analysts and investors are highly attuned to uncertainty.

RISK // The COVID-19 pandemic has forced many companies to dramatically change their strategies or adopt more dynamic approaches to the annual planning cycle. Chief risk officers (CROs) should consider updating their organization's risk profiles around key assets (cyber, brand, core technology systems, etc.) to match changing strategies. For example, companies that relied heavily on brick-and-mortar business models require new risk profiles as they shift more to e-commerce. Going forward, strategy may become even more agile and dynamic, bolstered by market sensing and new technology capabilities. Moreover, an organization's demonstrated ability to manage risk amid uncertainty and disruption could become a strategic differentiator. CROs can decide which kind of leader they will be: one who manages risk by using governance to slow down adoption of new technologies, or one who optimizes risk in new technologies to deliver stronger business outcomes.

ARE YOU READY?

KEY QUESTIONS

1. Does your technology limit your organization's strategic options? If so, how can that be addressed?

2. How can strategy and tech leaders work better to understand the strategic plan as well as the opportunities and constraints of your technology architecture?

3. What assumptions must hold true for your strategy? How do you monitor these and make timely adjustments when needed?

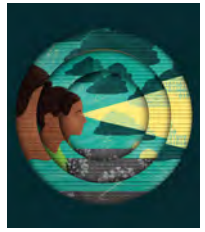
LEARN MORE

2020 Chief Strategy Officer Survey

Learn how corporate strategy leaders are evolving to navigate uncertainty and change strategic planning.

Uncovering the connection between digital maturity and financial performance

Gain insights into the key "digital pivots" that can affect financial performance.



A case of acute disruption

See how lessons of digital transformation can prepare an organization's response to sudden and severe disruptions.

AUTHORS

Our insights can help you take advantage of emerging trends. If you're looking for fresh ideas to address your challenges, let's talk.

Rich Nanda

US Strategy offering leader

Deloitte Consulting LLP

rnanda@deloitte.com

Tom Schoenwaelder

US Strategic Growth Transformation market offering leader

Deloitte Consulting LLP

tschoenwaelder@deloitte.com

SENIOR CONTRIBUTORS

Nicholas Reed

Senior manager,

Deloitte MCS Limited

Bruno Kakoobhai

Manager,

Deloitte & Associados, SROC S.A.

Raul Silva

Manager,

Deloitte & Associados, SROC S.A.

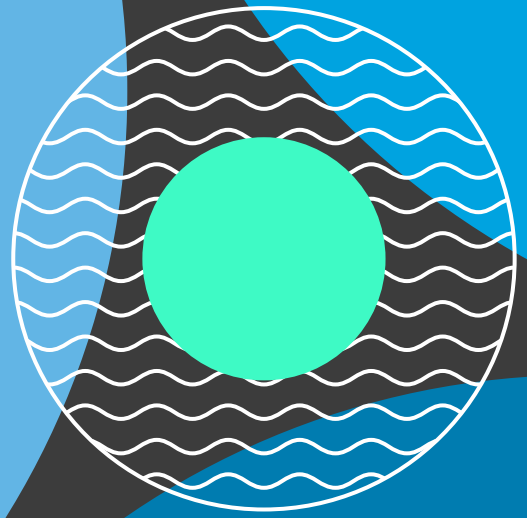
ENDNOTES

1. Gerald C. Kane et al., *The Transformation Myth: Leading Your Organization through Uncertain Times* (MIT Press, forthcoming 2021).
2. Bernardo Silva et al., *2020 Chief Strategy Officer Survey: Evolving the corporate strategy function for a world of disruptive change*, Deloitte Insights, April 16, 2020.
3. Khalid Kark et al., "Survey: CIOs are CEOs' top strategic partner," *Deloitte CIO Journal* on the *Wall Street Journal*, May 22, 2020.

Core revival

MAKE A FRESH BUSINESS CASE

Reengineer your business case for reviving the core with new financial offerings and approaches.



TRANSFORM CUSTOM CODE

Explore options for recreating legacy IT assets with a new generation of powerful low-code platforms.

REVITALIZE LEGACY ERP SYSTEMS

Pay down technical debt by refactoring critical code, removing unneeded functionality, and replatforming non-ERP capabilities.

TREND 2

Core revival

New technologies, techniques, and business cases to drive your modernization strategy

Since *Tech Trends* debuted 12 years ago, we have explored many of the transformational approaches and technologies that CIOs may take to extract more value from legacy core systems. This year, in what we recognize as an exciting new trend, some CIOs are exploring several innovative ways to redefine the core modernization business case. For example, new techniques are making efforts to lift-and-shift to the cloud more cost-neutral and operationally manageable. Likewise, an array of leading-edge technologies—including low-code/no-code, more intelligent business rule discovery, and core mapping—offer new ways to revitalize valuable core assets. Finally, looking beyond lift-and-shift, organizations can upgrade enterprise resource planning (ERP) systems by reducing technical debt and leveraging non-ERP platform capabilities in a more manageable, cost-effective way.

In the current economic climate, it's more strategically important than ever to help your legacy core systems support the agility, innovation, and new modes of working that fuel that digital potential. Yet costs associated with popular approaches to core modernization—particularly those used with custom-coded business transaction systems such as application rewrites and cloud migrations—can give some organizations pause.[1] Faced with pandemic-related uncertainty and tight budgets, many IT leaders and their C-suite peers are looking for new ways to fund modernization initiatives. Likewise, they want more from these investments than mere improvements to the enterprise IT plumbing—they want to create a lasting foundation for innovation and competitive advantage.

Over the next 18 to 24 months, we expect to see trend participants:

- Reengineer costs, project funding models, and the desired outcomes associated with their core (and, potentially, data center) modernization use cases by focusing on third-party platform management services. These services feature nontraditional funding arrangements and operate-to-transform approaches that combine modernization and innovation investments.

Trend participants can also lift-and-shift big, custom-coded transactional systems to hyperscaler cloud platforms.

- Explore opportunities to accelerate the discovery of the internals of black-box legacy systems to facilitate modernization. In addition, leaders will explore ways to use technologies such as PaaS low-code and no-code platforms to perform traditionally complex tasks and integrations via point-and-click, rather than by writing new code.

- Support a platform-first strategy by deploying leading-edge system analysis tools to identify redundant or extraneous code within legacy ERP systems, and either move this code to another platform or delete it altogether. The ultimate goal of this approach is to remove technical debt that accrued over years of using ERP as a development environment and, in doing so, return ERP assets back to a baseline state.

Then, going forward, CIOs and their teams will make key decisions about whether to develop mission-critical capabilities in the ERP system itself or on alternate platforms.

Lift, shift, and thrift

During the past few years, some companies began looking beyond lift-and-shift for opportunities to redesign core capabilities in the cloud;[2] they wanted to take full advantage of cloud platform offerings to enhance their existing capabilities. But many leaders were wary of potentially large future costs.[3] Even before COVID-19 disrupted the global economy, pragmatism—and a growing focus on the business case for core modernization—had begun informing more transformation decisions.

Today, we see renewed interest in migrations to the cloud, particularly from organizations that in this time of uncertainty need an efficient, cost-effective way to move rigid yet essential core assets. Revitalized in the cloud, these assets can provide a strong foundation for mission-critical innovation and growth strategies in areas such as artificial intelligence (AI), edge computing, and quantum.

Making a fresh business case

In the coming months, we expect to see creative approaches for financially reengineering the core modernization business case gain traction in the marketplace. Though the specifics will vary by need and industry, their common ground will be that they offer organizations the following ways to achieve their core modernization goals.

- **Operate and transform.** Organizations are exploring other creative operate-to-transform agreements with implementation

partners, holding them accountable for migrating and/or upgrading systems, and utilizing powerful tools. While these agreements will inevitably vary in detail and scope, many arrangements are designed to minimize capital-intensive efforts. In fact, some organizations are able to secure agreements whereby their systems will be modernized to cloud-native platforms in a few years, while organizational operating expenses stay neutral.

- **More bang for fewer bucks.** During the last few years, vendors have made significant improvements in proprietary tools that support transition to the cloud. By simplifying the process, these tools are giving rise to some compelling business cases in which migrations can be cost-neutral or lead to cost savings.

- **System rationalization—how less is more.** In many organizations, systems have sprung up over time to work around other limitations, leaving burdens of technical debt, outdated applications, and workarounds. Transitioning collections of systems to the cloud may enable (or force) the long-overdue process of rationalizing redundant systems, eliminating unnecessary dependencies, and modernizing capabilities. Modernizing a collection of related systems—or retiring some of them altogether—can lower care-and-feeding costs, increase efficiencies, and enhance system performance, all of which may lower cost allocations across the stack and bolster your business case for a core revival initiative.

Building a fresh business case for core modernization represents a different kind of transformation play. Hyperscalers are increasingly willing to chip in funding to help organizations transition to cloud offerings with expectation of recouping their investments over time. Professional services firms are willing to invest in back-loaded arrangements, to be rewarded for long-term impact while easing immediate cash-flow burdens. In some cases, all up-front fees can be deferred in exchange for a share on the upside of the business case. For clients, these options offer fast access to needed platform capabilities on what are, for some, attractive terms. The hyperscalers themselves can get more core systems operating in their clouds, make those clouds increasingly sticky, and over time support additional workloads for their customers.

Transforming custom code

New and improved technologies can help organizations revitalize legacy systems to either spruce up or retire core systems. Using the following advanced techniques, they can carve out pieces or wholesale replace legacy systems:

- **Improved low-code platforms.** Low-code (LC) platforms are dramatically more capable than even a few years ago. Some enterprise technologists may harbor doubts about LC scalability and performance, but the list of industry-specific LC platform opportunities continues to grow. Using LC offerings from Appian, OutSystems, Salesforce, ServiceNow, or other vendors, systems designers can carry out complex tasks and integrations through point-and-click rather than having to write code. Moreover, LC vendors are racing to integrate advanced AI/machine learning (ML) capabilities into their platforms to help augment the user experience. Finally, "case" and contact management are a core function of many of the LC platforms—and often an area of great need for agility in legacy platforms. As such, the impact that LC platforms can have on core modernization efforts cannot be overstated, a fact not lost on tech leaders and developers. Grand View Research valued the global low-code application development market at US$11.45 billion in 2019, and expects the market to grow 22.7% annually until 2027.[4]

- **Modernized business rule extraction.** Traditionally, the process of identifying and extracting business rules from custom code in legacy applications has required an extensive, manual effort and an army of specialized resources. Today, improved mining technologies and approaches make it possible to peer inside legacy code—regardless of language—and extract its business logic with less effort and higher fidelity. By scanning the code of an application that is a candidate for modernization, you can quickly identify essential business logic, as well as hot spots where a system issue is taking place, and either refactor the code in question, remove it, or perhaps replace the application itself with a microservice. In the context of core modernization, this represents a game-changing breakthrough: Not only can existing business logic fuel requirements or LC development—the tools are improving as tool developers apply AI/ML to increasingly automate aspects of the code extraction process.

- **Improved incremental modernization.** Another novel approach to application modernization involves a process known as *core mapping*. Using a set of increasingly sophisticated mapping tools, legacy systems can be visualized as a connected graph of constituent parts. A map of connected code modules works similarly to a social network graph on Facebook, in which lines and dots represent connected people. By identifying logical subgroupings, system engineers can identify and sever legacy interfaces, replacing the interfaces with modern API and service-based

techniques. Over time, these services can then be modernized individually as needed in a more predictable, consistent way.

Breathing new life into legacy ERP systems

If financially reengineering business cases and transforming custom code represent core modernization's yin, then deploying more efficient, cost-effective approaches for cleaning up nonessential code in ERP systems and addressing years of technical debt can be considered its yang. Both share a couple of important goals. First, they advance a platform-first strategy for the development of business-critical software designed to create competitive advantage. Moreover, they both increase agility by reducing ERP technical debt. Technical debt in ERP systems is typically a symptom of business complexity, outdated business and IT operational models, and a company culture grounded in the business priorities of yesteryear. Addressing these challenges can have the net effect on your ERP systems of jettisoning unneeded ballast.

Building a fresh business case for core modernization represents a different kind of transformation play.

As you look for ways to revitalize your core assets, monetize technical debt, and move existing capabilities to the cloud or low-code/no-code platforms, consider the following:

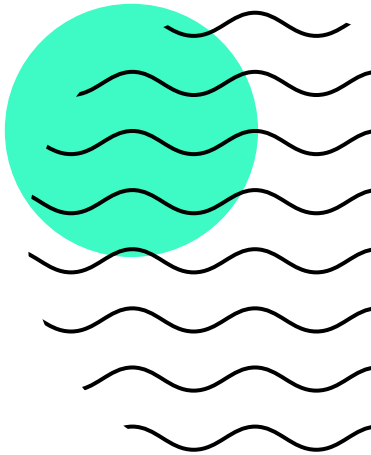
- **Is that all there is?** In the current economic climate, organizations with significant long-term investments in ERP assets have begun questioning the wisdom of spending seven or eight figures on a major ERP upgrade. Will these expensive, complex undertakings deliver lasting material benefit to the organization? Will enhanced ERP assets then support ongoing innovation and enable long-term business strategy? Or will ERP upgrades ultimately be just another cost of doing business? New approaches to modernizing legacy ERP systems represent a welcome evolution in approach to upgrading legacy ERP assets.

- **Refactor, remove, or replatform.** In the preplatform era, some companies used ERP as a development environment. Today, the residue of outdated requirements and governance, useless nice-to-have applications, workarounds and fixes, and customized code often lives on in a tangle of complexity that confounds system engineers and stymies digital

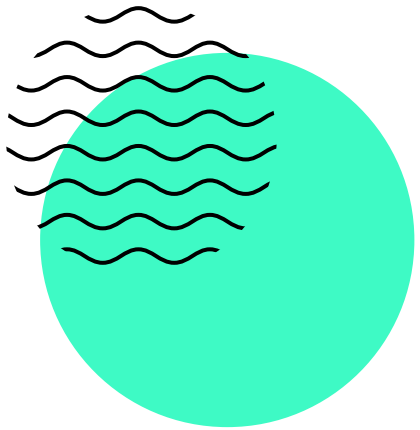
transformation efforts. In the face of such complexity, the process of upgrading an entire legacy ERP system to the latest release can be extremely expensive and time-consuming. But what if you could identify the ERP components that would make the biggest impact on your strategy or bottom line—for example, a proprietary pricing algorithm—and upgrade only those? Using advanced tools, you may be able to recode critical targeted capabilities—whether they be custom code or something like Java—while leaving them operating within you existing ERP system. Or you can move non-ERP capabilities to platforms on which they can create competitive advantage, thus monetizing your technical debt. Either way, reducing complexity and getting rid of technical debt can increase operational and strategic agility and, in turn, enhance the business's ability to evolve.

The way forward

The work of enhancing legacy core assets is not a one-time task—it's an ongoing opportunity. Core application scope is decomposing across platform ecosystems: What used to be a simple all-in-one ERP suite or an individual core module is becoming a decentralized, cloud-enabled, API-orchestrated collection of capabilities made cohesive by a simplified user experience. As this type of welcome innovative change continues its disruptive march into the future, organizations participating in the *core revival* trend will have a road map not only for adapting valuable core assets to new technological realities but also for funding this work in creative ways.



LESSONS FROM THE FRONT LINES



Albemarle takes on the core and more

Specialty chemical company Albemarle has completed its journey to one consolidated ERP system—a journey that in many ways exemplifies the art of the possible for core modernization.

After a series of multibillion-dollar acquisitions, this global leader of lithium, bromine, and catalyst solutions found itself with a stable of far-flung business units. Albemarle needed to integrate these acquired units, create a shared service center, and establish common best practices as soon as possible. But a major obstacle stood in the way: The business units in question did not share a common ERP platform. "Creating a single ERP platform was going to be essential to that business integration initiative," says Albemarle CIO Patrick Thompson. "Not only would it support our shared services model—it would eliminate the technical debt from more than 3,500 customizations that had been made to the two platforms."[5]

Albemarle spent almost a year vetting the business case for consolidation, refining the ROI metrics, and aligning on how to reduce their existing technical debt. Upon finalizing a detailed consolidation plan, the company kicked off its business transformation journey in mid-2017. During the next 18 months, the Albemarle team executed a series of four ERP deployments, resulting in a single ERP platform that serves the entire global enterprise with common processes and best practices. Along the way, Thompson and his IT team migrated the global operation from Lotus Notes to MS Office 365. (This latter step is no small feat in an organization with operations ranging from remote mining locations in Chile and Western Australia to manufacturing facilities in the Americas and China.)[6]

Albemarle's next step is notable: Once Thompson and his team had everyone operating on a single ERP platform, they executed a "big bang" version upgrade to the global ERP instance in a mere six months. How did this group of technologists achieve what may be a speed record for ERP upgrades? First, they eliminated their technical debt by electing to make no code changes or customizations to the global instance they deployed—it was basically out of the box, dramatically simplifying software upgrades. "We did create 70 extensions, but they were outside the code, and we used APIs for those," Thompson says. "We also had really good

methodology and talent. Over the course of this project, we have put a lot of work into developing the foundational framework and the talent that we need to execute upgrades. Going forward, we will be able to flex this muscle up and down as needed for upgrades."

As of January 2020, Thompson had completed the consolidation and upgrades, and began shifting his focus toward broad digital transformation. The company is accelerating its work on IT/OT convergence, particularly in its manufacturing operations. In the back office, Albemarle will be using robotic process automation and business process mining tools to elevate its first pass yield and rework process performance. And, on the customer side, the company is exploring opportunities to extend to customers some self-service ordering and track-and-trace.

"The work we did consolidating and modernizing our foundational platforms makes digital enhancements like these possible," Thompson says. "We no longer have to spend money on technical debt and customizations. Instead, we can invest those resources to make leapfrog progress with digital technologies that can transform our company."

Centuries-old tradition meets a low-code future

In a family-owned company like Sogrape that embodies the painstaking traditions of Portuguese winemaking, the immediate benefits of modern technology's speed and agility aren't easy to see—after all, the journey from vineyard to bottle can never be rushed. Consumers in more than 120 countries prize Sogrape's traditional approach to winemaking; over the years, public figures such as Jimi Hendrix, Queen Elizabeth, and Steve Jobs have savored the vintner's unique signature brand, Mateus Rosé.[7]

But when, in 2017, the company found itself with a burning legacy platform that could no longer support its needs, Sogrape head of IT Carlos Alves began looking for a way to harness core modernization in the service of methodical, artisanal winemaking. "We needed a consolidated platform that could connect all the functional steps in our winemaking process," he says. "At the same time, we—as a global organization operating in the 21st century—needed speed and agility."[8]

Alves considered upgrading Sogrape's in-house core systems to cloud-based offerings by the same vendors but instead chose to go with the OutSystems low-code platform. "We considered three factors: time to delivery, cost, and training time required to use the new technologies," he says. "In each area, low-code worked best for us."

Using OutSystems low-code technology, Alves and his team built "Wine Connection," an

integrated platform that offers on-site process control and real-time information-sharing to functional groups across Portugal, including viticulture, wineries, bottling, registration, contracts, and others. Users can access the platform via desktop, tablet, or mobile phone.

Alves says the Wine Connection platform has delivered several welcome outcomes. "We have been surprised by the increased efficiency and decreasing costs." He adds that low-code technology—coupled with Sograpе's recent embrace of Agile development methodology—is having a surprising impact on IT's ability to take new products to market. "We recently developed a digital platform for our restaurant customers in just three weeks," he says. "That same project using waterfall would have taken much longer."

The company's success using low-code and Agile in tandem has led to fundamental changes in the way IT operates. IT has developed a formal Agile methodology for low-code projects. Using this template, Alves and his team are standardizing the process that departments across the enterprise will use to create new products. "For example," he says, "we are starting a new three-phase project for human resources to develop a platform-based portal for employees to choose company benefits. This portal will be completely integrated with our ERP system."

Sograpе's embrace of low-code technology has also fueled ongoing digital transformation efforts. For example, winemaking containers are now connected directly to company systems through embedded sensors, making it possible for winemakers to control wine temperature more consistently. In another application, field sensors embedded within containers used to store harvested grapes can gauge the density of the fruit in individual containers. Sograpе's integrated low-code platform collects and analyzes sensor data. Understanding the precise density of specific harvest batches can help winemakers control the fermentation process.

Says Alves, "Wine Connection strikes the perfect balance between innovation and tradition."

GM Financial uses PaaS to build stronger systems for customers

GM Financial, the captive finance arm of General Motors, is in the early stages of modernizing a legacy loan origination system on which it relies to provide auto financing solutions to customers in North America.[9] For this core asset, the organization considered several approaches for addressing challenging architectural complexity and manageability issues, including outsourcing the system to a third-party hosted platform. In fact, IT and business leaders took advantage of

public cloud providers' analysis of alternative resources to make key decisions about the organization's future architecture. But in the end, says Bill Livesey, GM Financial's senior vice president of digital software solutions, the most compelling business case called for using cloud platform-as-a-service, when possible, to modernize legacy systems already in place.[10]

"It came down to controlling our destiny. We want to maintain our competitive advantage using core systems that we own and control," Livesey explains. "We've invested so much of our intellectual property in these platforms for so many years, it just doesn't make sense to give away that IP to others."

The business case for cloud and PaaS also included cost-related elements that Livesey could not ignore. "With PaaS, we could keep developing the products and services our business partners need right now. We wouldn't have stopped everything and shifted all of our energy toward migrating systems to a third-party platform." Moreover, the ability to push the burden of managing some core capabilities to a cloud provider was an attractive option, particularly for an IT team that had been gradually spending more and more time maintaining aging on-premises systems. Finally, business teams stood to benefit as well. Over the course of the project, the business and IT would have an opportunity to forge a strong collaborative partnership that could deliver innovation opportunities, enhanced operational efficiency, and more frequent deployments.

During the first leg of GM Financial's modernization journey, Livesey and his team went through a process of determining which system components were candidates for moving to PaaS. As it turns out, many were "very suitable" and will be migrated with few changes in the near future. Others, due to age or complexity, had no path to the cloud and will have to be refactored or deleted altogether.

IT undertook a similar process of careful analysis before deciding to migrate from a legacy on-premises database to a cloud-based alternative. "This was a big decision given the size of our loan origination system and the sensitivity of the financial data contained in it," Livesey says. "We ultimately became comfortable that a cloud-based solution could meet our standards for security and privacy."

GM Financial has more work to do as it reimagines its legacy loan origination platform in the cloud. But even in this first leg of the journey, the project enjoys broad support from across the organization. "Our partners in the business are excited about this effort," Livesey says. "We're taking a very large, sprawling architecture, and transforming it into a single, consolidated loan origination platform. They get powerful, reliable tools to support their work, and IT will get a stable, manageable production environment that we can modernize on an ongoing basis with minimal effort. Everybody wins."

MY TAKE

Justin Kershaw

Corporate vice president and CIO, Cargill

Over the last few years, I've noticed a big shift in the way boards and executive leadership think about enterprise technology—a shift that is redefining the way companies approach core revival initiatives.

Many of these decision-makers have traditionally viewed technology primarily in terms of cost, as in: "How much will this new system cost right now?" But many of these leaders are becoming more forward-looking, focusing less on technology's cost and more on its long-term value. This is a welcome change.

I see a growing recognition across industries of the strategic importance of running modern technology. What's more, I see a greater willingness to invest appropriately in such technologies and consider new approaches to core modernization—and to the business cases behind these efforts.

At Cargill, we have been on a core modernization journey for several years. From our HR systems to treasury, from distribution and transportation systems to manufacturing, we have modernized more than half of Cargill's systems. We have also invested heavily to update our approach to technology risk, both internally and externally. Such efforts are no small feat for a 155-year-old company with operations in 70 countries and an ambitious purpose of nourishing the world in a safe, responsible, and sustainable way.

For a company like ours, maintaining and operating core technology is more than just good business. Consumers and farmers, as well as some of the world's biggest food companies, retailers, and restaurant chains depend on Cargill. The pandemic-related disruption of supply chains and the global economy in 2020 served as a potent reminder to Cargill and companies everywhere that operating modern technology is critically important not just to business success. In many cases, it's vital to the safety and well-being of our societies.

The modernization journey for Cargill began with a shift to third-party managed services, enabling us to reinvest in core networks and infrastructure. We invested in technologies like advanced analytics, cloud, and ERP systems. Our leadership team and board are now seeing the value and returns from these efforts.

Going forward, we will move away from talking about "applications" and "infrastructure." Instead, the next phase of our modernization is creating "platforms" and "services." This will ultimately change our talent requirements—we will need more people who can build and maintain platforms and services. It will also change the way we will work with third-party technology providers, and how we serve our internal business partners and Cargill's external customers.

For example, we developed a single, unified platform called Maestro for Cargill's strategic sourcing department, an internal operation that accounts for more than US$5 billion in indirect spend annually. The investment in Maestro—a foundational platform that replaced dozens of systems—has modernized our sourcing operation. We've achieved significant sourcing improvements over the last few years that are improving the company's overall results.

In the analytics space, we stood up a data platform a few years ago and provided our employees access to two self-service analytics tools. We went from basically having no centralized, shared data to a platform that handles some 2 million daily transactions. Our data platform lets us wield information at the speed and scale our business demands, allowing our teams to make better, data-driven decisions. Meanwhile, our self-serve analytics tools and coaching services are now

helping about 30,000 employees. But the most impressive number—especially to our executive team and board of directors—is the more than 7x return on these investments.

We are also investing heavily to modernize our processes. Like many global corporations, we have some inefficient, disconnected systems—and more than a few manual tasks that can be automated. We are tackling this head-on. Working with our ERP vendors, we are creating perpetual, end-to-end processes throughout our organization. This is a complex task that involves system upgrades, process engineering, and a huge change-management effort. Putting new technologies in place is one thing—getting people to use them effectively is quite another. That said, we are making enormous progress on both fronts, and it has been well worth the effort.

My team's approach in the future will be to identify business needs and then build platforms, services, and digital products to meet those needs. Soon, Cargill customers using their phones will be able to access an entire portfolio of digital services, some even connecting them directly to the manufacturing floor. In IT, we will still have engineers with traditional skill sets focused on maintaining and modernizing our technology stack. And we'll also have teams focused on digital platforms and services. Together, these teams will build the kind of modernized platforms and processes that we need to support a digital ecosystem.

Modernizing our core systems and augmenting them with new services and platforms is transformational—and hard—work. But in the current technology and economic climate, *hard* is relative. Savvy C-level leaders and boards of directors now get it: Rather than evaluating a technology investment for its costs, these leaders view these investments as continual modernization that will create positive returns.

And even beyond modernizing, executives are coming to understand that progress on these technology journeys is vital to an entirely new form of disruptive competition in the market. Today's savviest business leaders know that the future belongs to companies that put in the *hard* work to future-proof their technology foundation.

Rather than evaluating a technology investment for its costs, these leaders view these investments as continual modernization that will create positive returns.

EXECUTIVE PERSPECTIVES

STRATEGY // Ongoing investments in core systems are necessary for IT to be an enabler of business value. Too often, executives view such investments in terms of immediate cost rather than future value. This is shortsighted: In many digital nonnative organizations, legacy core systems provide essential foundations for critical digital and business transformation initiatives. Several nontraditional approaches for financing core projects can help cost-focused CEOs find a different path to modernization. For example, working with the CFO, they can identify more cost-friendly opportunities to partner with hyperscaler cloud vendors or major ERP vendors and pursue smaller revitalization projects using low-code platforms. These and similar approaches can fundamentally rework the traditional business case for modernization by transforming a line-item cost into an investment in the company's future.

FINANCE // Many CFOs may have to make a crucial strategic decision about the future of their organization's core systems: procrastination or proactive modernization? The larger and more complex an entity is, the harder—and more expensive—an enterprise-level project such as core revival can be. Some CFOs may choose to wait for existing systems to break or become untenable before acting, but they can accumulate technical debt along the way. By contrast, finance leaders who are eager to modernize can consider a variety of approaches beyond large-scale migrations. For example, exploring creative deal structures with large cloud vendors or moving existing capabilities to low-code platforms can lead to cost-neutral options for establishing a future-ready foundation within core systems. Leveraging these and other core revival approaches, CFOs can become catalysts for fiscally responsible digital transformation and avoid being painted as a financial hurdle to the IT department's big goals.

RISK // Many core modernization initiatives today introduce leading-edge technologies into existing IT ecosystems. Risk officers should expect risks to emerge when old and new technologies intersect; they can work closely with CIOs to anticipate and manage risk in a manner that doesn't impede modernization efforts. Likewise, they can collaborate with the business side to identify opportunities to leverage risk management in new tech-enabled products and services as a strategic differentiator that helps build consumer trust. With these twin objectives in mind, CROs can help their organizations balance technology priorities and consumer sentiment against risks and regulatory concerns.

ARE YOU READY?

KEY QUESTIONS

1. Where would negotiating operate-to-transform arrangements with your technology vendor(s) be most useful?
2. Would you benefit from moving legacy applications to more modern platforms (for example, low-code or cloud options)?
3. What is your strategy for eliminating technical debt in your legacy ERP system?

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Scott Buchholz

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

Amit Chaudhary

Cloud Engineering offering leader
Deloitte Consulting LLP
achaudhary@deloitte.com

SENIOR CONTRIBUTORS

Thorsten Bernecker
Principal,
Deloitte Consulting LLP

Darwin Deano
Principal,
Deloitte Consulting LLP

Bjoern Langmack
Managing director,
Deloitte Consulting LLP

Jeff Powrie
Principal,
Deloitte Consulting LLP

Madhu Thejomurthy
Managing director,
Deloitte Consulting LLP

Franscisca Wahjudi
Managing director,
Deloitte Consulting LLP

Miguel Amaro
Associate partner,
Deloitte & Associados, SROC S.A.

Jason Cook
Technology fellow,
Deloitte Consulting LLP

Ravindranath Gourisetti
Technology fellow,
Deloitte Consulting LLP

Ryan Esposto
Specialist leader,
Deloitte Consulting LLP

Matt Fisher
Specialist leader,
Deloitte Consulting LLP

Anantha Ramadas
Senior manager,
Deloitte Consulting LLP

Thiago Sartorio
Senior manager,
Deloitte MCS Limited

Nathan Shilling
Specialist leader,
Deloitte Consulting LLP

Gabriel Santos
Manager, Deloitte Touche
Tohmatsu Consultores Ltda

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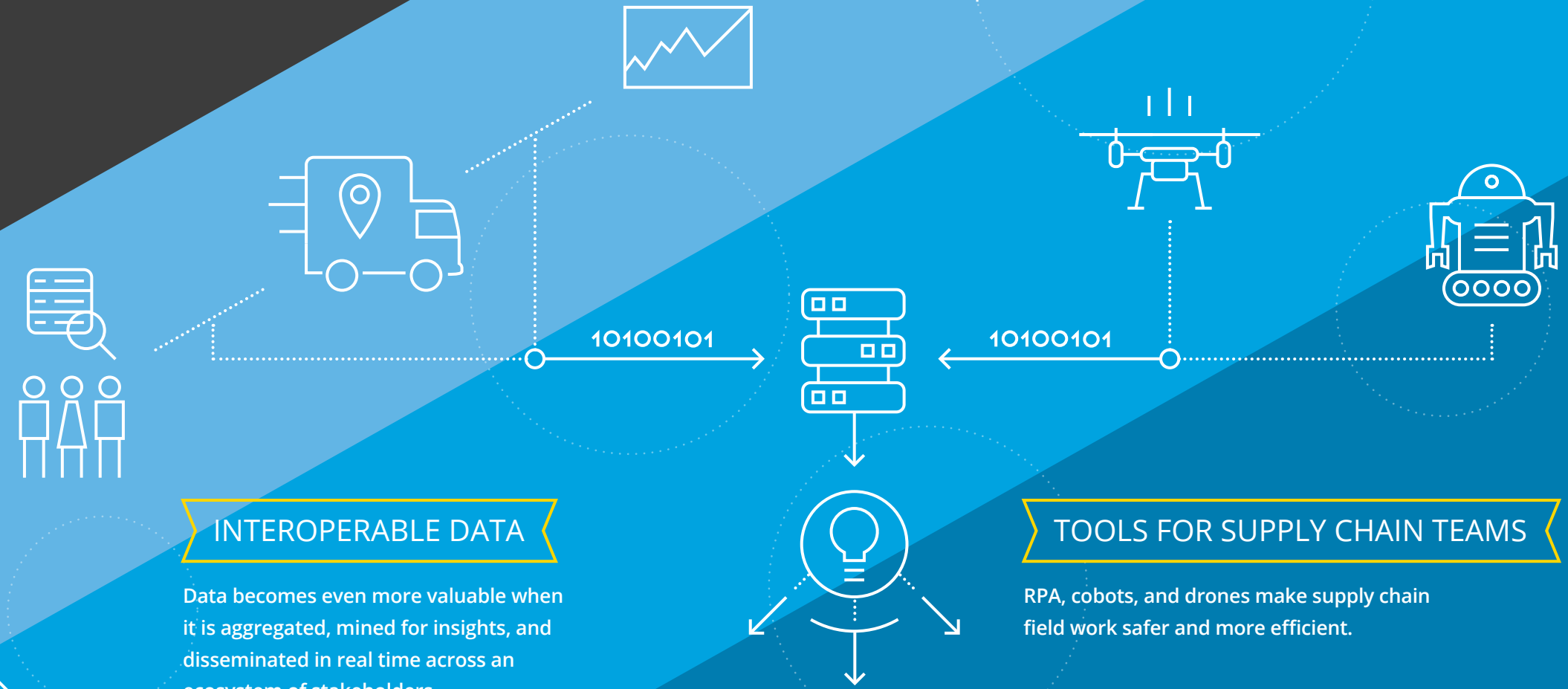
Supply unchained

COST CENTER TO VALUE DRIVER

Optimizing supply chain components to differentiate services provided to each customer can help companies find the sweet spot between cost and service.



INTEROPERABLE DATA

Data becomes even more valuable when it is aggregated, mined for insights, and disseminated in real time across an ecosystem of stakeholders.

TOOLS FOR SUPPLY CHAIN TEAMS

RPA, cobots, and drones make supply chain field work safer and more efficient.

TREND 3

Supply unchained

Transforming a traditional cost center into a value driver

Over the next 18 to 24 months, we expect to see manufacturers, retailers, and others take supply chain transformation to the next level by optimizing their supply chain ecosystems for resilience and risk. Moreover, they will begin transforming their supply chains from traditional back-office cost centers into value-driving operations. How? By following industry leaders' playbook for optimizing supply chains for customer segments:

- Trend participants can deploy an array of digital tools to hypersegment customers and capture demand signals from disparate parts of their *value chains*. They can then use this information to make supply chains more responsive to unique customer needs and to fluctuations in demand.

- They can explore ways to capture larger volumes of structured and unstructured data. By mining this data for operational insights, they can continuously optimize systems and processes throughout the organization. And by sharing the data more widely, they can look to optimize their entire supply ecosystem.

- Organizations may also pursue opportunities to use robots, drones, and other technologies to make supply chain teams more effective, efficient, productive, and safe.

While companies have been digitizing their supply chains for some time, recent shocks have provided fresh urgency for change. In Q1 2020, the world witnessed a decades-old supply chain model being disrupted, and it wasn't pretty. Driven by panic buying, consumer demand for paper products, cleaning supplies, and other nonperishable goods spiked dramatically.[1] Yet within domestic and global supply chains, these demand signals were not transmitted quickly to manufacturing floors and sourcing departments. After years of small-scope efforts to optimize and strengthen their supply networks, many leaders were confident that they had created robust, transparent supply networks. When COVID-19 hit, it quickly became clear that their efforts had been insufficient. Even the most flexible, resilient

supply chains proved to be only as strong as the weakest links of their suppliers' chains.

The ensuing disruption was widespread. In a recent survey of supply chain professionals, 97% of respondents said their organizations experienced COVID-19–related disruption.[2] Some of these organizations were caught off guard by the severity of the pandemic and the speed at which it unfolded. They shouldn't have been. The world has become ever more dependent on connectivity, vulnerable systems, and global supply chains, and this kind of high-impact disruptive event will likely occur with greater frequency.[3]

Against this backdrop, a growing number of leaders are realizing that their organization's supply chain optimizations may not suffice in an interdependent, unpredictable world. Indeed, in the same survey, 73% of respondents said their organizations are now planning major shifts in the way they approach supply chain management and procurement.[4] As a result, some are now taking a page from digital supply network pioneers. Using analytics to understand their customers more deeply and predict their behavior, a growing number of organizations are working to understand the sources of value for and buying behavior of those customers. By sharing information with their network of suppliers—and receiving information in return—they can better link supply and demand. And understanding their customers' value drivers makes it possible to optimize for deployment, logistics, procurement, and more in their new supply networks.

The work of turning a traditional cost center into a robust value driver will not happen overnight. Nor will building the flexibility, transparency, and resilience that complex supply networks need to weather disruption. But the time to start is now. COVID-19 portends a new, uncharted phase of globalization, interdependency, and—importantly—vulnerability.

Is your supply chain ready?

From cost center to value driver

The idea of transforming the supply chain from cost center to value driver is not new. Over the past two decades, leading companies have fine-tuned strategies for optimizing incentives and disincentives for online purchasing and delivery timing—strategies that manufacturing, retail, and other sectors may find helpful as they transform their supply chains. (See Lessons from the front lines "Pactiv Evergreen gets proactive with factory asset intelligence," on page 55).

Online retailers were among those pioneering the art of using predictive models to optimize the location and volume of

inventory, procurement, and replenishment. Using customer data, they developed highly detailed customer cost-to-serve profiles used to segment customers into groups based on location, preferences, and service expectations. These retailers found that in some cases, customers will pay premium prices for premium delivery services, while more price-sensitive customers will accept longer delivery time frames.

The work of turning a traditional cost center into a robust value driver will not happen overnight.

Developing nuanced insight into the complexities of demand and customer priorities helped these organizations pre-position products closer to demand, decrease transit time and risk, and increase delivery schedule reliability.[5] Meanwhile, they could maintain remote warehouses to supply nonurgent deliveries to the more price-sensitive. These insights transform supply chains into something new: a tool that encourages customers to make informed, personal buying decisions while simultaneously improving company profitability.

Hyperpersonalization and customer segmentation—made possible today by the systematic capture, aggregation, and analysis of vast volumes of unstructured data from increasingly nontraditional sources—have standardized across retail and are now poised to transform supply chains across industries. Some of these same approaches can help organizations in manufacturing, pharmaceuticals, energy, and other sectors better understand demand patterns and their impact on the supply chain, from point of sale to the manufacturing floor and all the way back to tier-three suppliers. Indeed, the extent to which customer information can be captured in real time to feed supply chain and manufacturing production decisions is already becoming a competitive differentiator.

Take, for example, a consumer products company that manufactures and sells liquid laundry detergent in plastic bottles. Analysis of this manufacturer's value chain data clearly shows the difference in revenues from bulk sales to big-box wholesalers and smaller sales to mom-and-pop stores in rural areas. Armed with this insight, the detergent maker can segment its customers based on profitability and service expectation. It doesn't want to overserve its mom-and-pop customers who don't need regular deliveries, and it cannot afford to underserve the valuable big-box customers who expect much more. *This is where the supply chain can become a powerful*

tool for engaging customers. By optimizing the component parts of its supply chain to differentiate services provided to each customer, the company can find and maintain the sweet spot between cost and delivery service.

Tightly controlled, robust supply networks can offer another advantage as well. When faced with rapid, unexpected spikes in demand such as we saw in the early months of the COVID-19 pandemic, digitized, data-driven supply chains that provide high levels of transparency may be able to synchronize their planning, production, and fulfillment functions effectively and minimize—or even prevent—widespread disruption.

Share and share alike: Data becomes interoperable

As supply chains are transformed into value-providing supply networks, it is critical that organizations understand the value they provide customers, develop greater clarity into internal operations, and work to make supply more visible across their networks. Data—from internal supply chain operations and external partnerships alike—is the keystone for these efforts. Enhanced data visibility and speedier data processing can fuel efforts to align the supply and value chains.

Over the next 18 to 24 months, we expect to see organizations taking part in the *supply unchained* trend take the following steps to capture and analyze more data:

- **Leverage IT/OT convergence.** The same smart factory applications and Industrial Internet of Things (IIoT) sensor technologies that marry IT networking with operational technology software and machines on the factory floor are finding new applications in smart warehouses, logistics, and sourcing. Aggregating real-time operational data from these and other supply chain functions into a commonly shared data platform enhances end-to-end transparency, live metrics that support human and machine-based decision-making, and operational efficiency.[6] In addition to IIoT sensors, visual, acoustic, and temperature monitoring tools can generate unstructured and nontraditional data streams that, once digitized and analyzed, can help maintenance teams identify anomalies and perform predictive maintenance.

- **Boost data capabilities at the edge.** In the arena of data management, time is money. Time-sensitive data can become essentially valueless after it is generated, often within milliseconds. Therefore, the speed at which organizations can convert data into insights and then into action across their supply chains is often mission critical.[7] Edge computing can turbocharge

this process by moving processing and storage capacity closer to the source of data. In this distributed architecture model, data does not have to go to the core or cloud for processing, analysis, and dissemination. For example, digital data generated at the point of manufacture or sale can be analyzed in the moment, its insights then disseminated in real time from the edge directly to disparate pockets within the supply chain ecosystem that may not have their own analytics and compute capabilities.

Meanwhile, as organizations optimize their internal operations to serve clients and customers better, they are realizing that they need more visibility into their external sources of supply. Some are starting to explore the idea of creating common logistics platforms that can be used to share information across all the suppliers in the network in real time. When platforms become transparent, they offer visibility into every organization's supply chain, not just their own. The platforms may bring an AI and advanced analytics layer positioned on top of all the information to enrich the entire data corpus. Data, then, becomes *interoperable*.

Enhanced data visibility and speedier data processing can fuel efforts to align the supply and value chains.

The journey to full data interoperability will take time. As a first step, consider constructing a two-tiered data framework that incorporates elements of a shared-data future. On one level, data will be interoperable. Companies can create a native standard that allows users operating anywhere within a supply chain network to share information. This can help address a perennial challenge of one group in the chain building a product or data model that others inside an organization alone cannot easily replicate or support. There can be a second level in the data framework that individuals or groups within the supply chain can use to fast-track portable enhancements that the market demands.

New tools for supply chain teams

When we think of supply chain in its historic role as a cost center, we cannot overlook the cost, safety considerations, and inefficiencies associated with some non–value-added tasks performed by supply chain talent. For example, consider a traditional fulfillment model: When an order comes in, a coordinator hands a printed form to a forklift driver. The driver goes into a warehouse, lifts the

purchased product onto a palette, and then drives to an adjacent rail yard, where he loads the palette into a boxcar. Though an integral part of many supply chain operations, processes in which human workers operate heavy machinery in transit hubs and enclosed warehouses are often costly and inefficient. They may also carry a degree of safety risk. In the energy and utility industries, where field teams work with power lines and telecom towers in remote locations, the risks and the costs can be even higher.

Organizations are realizing that they need more visibility into their external sources of supply.

As the *supply unchained* trend gathers steam in the coming months, we expect to see more organizations address this challenge head-on with an array of technologies:

- **Autonomous robots and collaborative cobots.** Implementing autonomous robots can drive value by reducing direct and indirect operating costs and increasing revenue potential. They can lower labor costs and increase productivity by working around the clock.[8] Likewise, cobots work alongside human workers, augmenting their performance. Their movements are easily programmable, which enables them to perform specific, limited tasks such as sorting packages. In material transportation environments, cobots can zip past each other, humans, or moving objects in a warehouse or on a factory floor thanks to advanced collision avoidance capabilities.[9]

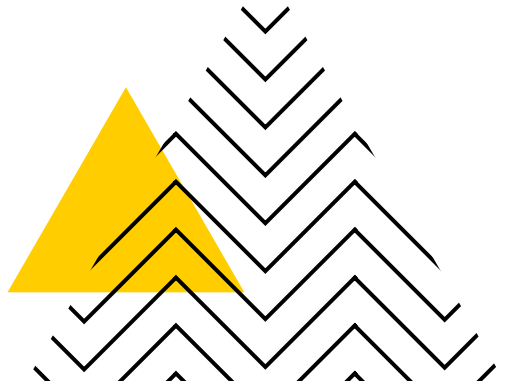
- **Aerial drones.** Companies can use unmanned drones for a variety of tasks, from providing inbound logistics in time-critical situations to carrying materials from storage to factory and transporting directly from receiving to shipping. Drones can also scan inventory efficiently and reduce labor costs.[10]

- **Computer vision.** Cameras are rapidly becoming ubiquitous and connected. Supply chain operators are placing them, in tandem with AI, throughout warehouses and freight yards to count stock. Companies are also using these computer-vision technologies on factory floors and in offices to monitor social distancing among employees, validate safety protocols, and help maintain procedural compliance. More advanced computer vision capabilities make it possible to visualize temperature radiation, detect subtle movements imperceptible to the human eye, and “ultra-zoom” in on individual parts of a complex whole.

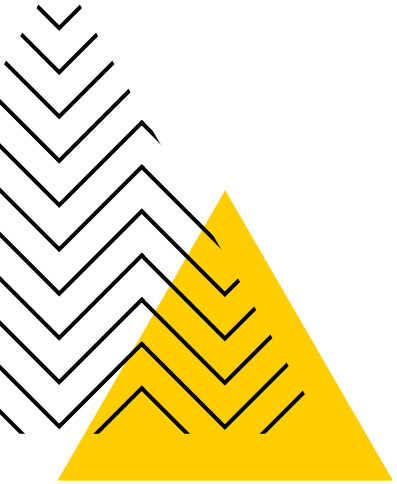
Interoperable data, AI, and machine learning also have a role to play. The ability to tie even the most remote supply chain functions into a seamless network with real-time data and, then, automate those functions or control them from a central location will be critical to lowering costs, while enhancing worker safety and efficiency.

The way forward

The list of promising tools and techniques in this field will continue to grow in the coming years as organizations work steadily to transform their supply chains from cost center to value driver and to prepare for the next big disruption. The time to begin this work is now. Digital tools and advanced techniques that seemed mildly interesting to supply chain leaders only a few years ago are mission critical. The COVID-19 pandemic has not only undermined many long-held assumptions about globalization and business-critical dependencies—it has laid bare the vulnerabilities of traditional supply chain models operating in a world where large-scale disruption may be no longer the exception but the rule.



LESSONS FROM THE FRONT LINES



Pactiv Evergreen gets proactive with factory asset intelligence

The factory floor is a critical component in a supply chain's overall flow from materials to finished products. Within this controlled environment, manufacturers not only create value but, to a degree, set the pace at which other supply network components such as sourcing and distribution operate. When factory machines malfunction, the impact can ripple across the entire supply chain, which is why a growing number of companies deploy an array of digital technologies on factory floors to generate the data they need to better understand machine efficiency and create a continuous machine optimization cycle.

Case in point: Pactiv Evergreen, one of the world's largest producers of food and beverage plastic, paper, and foam containers, wanted to explore opportunities to use digital capabilities including IoT, visualization tools, and advanced analytics to increase overall equipment effectiveness (OEE) to drive increased revenues without a significant investment in additional factory equipment. Leaders also wanted to reduce operating costs by making the company's existing industrial assets more efficient.

The company embarked on a factory asset intelligence program to merge the physical and digital worlds by investing in IoT technology, artificial intelligence, and advanced analytics to drive both asset and people performance improvements.

First, Pactiv Evergreen had to "light up" the dark data that already existed within plant assets and ingest it into a platform for both real-time and historical analyses. Because much of the equipment used within the processes was decades old, none of the machines communicated with one another or with operations personnel beyond the control panels. Project teams defined high-value use cases and then added secondary sensors across production lines to monitor and predict material flow issues from the silos to the hopper train cars, as well as specific asset health including vibration, temperature, and amperage. The teams also harvested data from other sources—including downtime, quality, and production—that, upon analysis, provided a holistic view of plant activity.

Pactiv Evergreen wanted to transition from reactive maintenance to condition-based monitoring, as a precursor to building up sufficient data history to become predictive. By utilizing edge processing technologies to capture critical data points such as vibration, temperature, and pressure, leaders were able to predict downtime and failures based on anomalies in real time. This information fed a library of proprietary condition-based monitoring applications, which were customized for different user groups. These apps pushed actionable insights to the right people, who could then address potential problems before production disruptions occurred.

As part of the initial plant deployment, project teams also experimented with signal analysis and video analytics to understand asset health throughout the production process. For example, the grinder is the most unintelligent asset on the production line, but if it goes down, the entire production line goes down. Using acoustic signal analysis, Pactiv Evergreen developed an algorithm based on machine learning that would predict grinder blade wear and alert maintenance to replace the blades during the next changeover, thus preventing unplanned downtime.

Finally, Pactiv Evergreen developed a factory control tower to allow plant leadership to monitor line asset performance as well as the OEE for each line and the entire plant. The control tower also provides insights on raw material consumption (blend insights) to control quality and material usage variances, machine and human performance insights (activity insights), and overall production health (production insights).

Pactiv Evergreen's factory asset intelligence initiative has transformed the company's entire approach to operational monitoring and maintenance, resulting in a 9% boost in OEE and a positive impact on the bottom line. "The results so far have been excellent," says CFO Mike Ragen. "We have seen a lift of about 19% in output, and that that equates on one line to about US$2 million of profitability. Extrapolating that across the 18 lines, we should see a US$36 million lift."[11]

MY TAKE

John Tomblin, PhD

Senior vice president for industry and defense programs and executive director, NIAR, Wichita State University

Every week, a squadron of B1-B Lancer bombers takes off from Ellsworth Air Force Base in South Dakota on routine missions over North America.

These venerable aircraft were designed and manufactured during the Cold War yet continue to serve as workhorses in America's strategic air wing. Their longevity can be attributed, in part, to a complex supply chain that provides maintenance crews and engineers with hard-to-find parts needed to keep B1-Bs running at peak performance. This is not a supply chain in the classical sense—rather, it is an interconnected ecosystem of digital tools and capabilities that monitor wear and tear on aircraft parts, enable predictive maintenance, and optimize inventory and fulfillment functions to help keep costs down. In other words, next-generation digital supply chain technologies are helping taxpayers extract more value from legacy assets.

My team at Wichita State University's National Institute for Aviation Research (NIAR) collaborates with the US Air Force to develop digital tools and predictive models for the B1-B airframe. For example, we have engineered digital-twin capabilities that offer maintenance teams an unprecedented 3D view into how particular aircraft parts will stand up to use over time. In the coming years, this capability will help aviation mechanics perform predictive maintenance on the B1-B and other legacy aircraft when—and only when—needed. What's more, using digital-twin data, they will be able to 3D-print long-obsolete replacement parts, extending the fleet's usefulness for the lowest possible cost.

Digital technology's ability to generate this degree of visibility—not only into the status of objects, but into operational processes and contextual environments—is poised to disrupt longstanding manufacturing and supply chain models. There is a digital transformation movement underway in which organizations are integrating design, manufacturing and other components within larger supply chains. Entire ecosystems connected by a digital thread increasingly share the same high-quality data in real time from end to end. A part supplier is now connected to designers and engineers who are, in turn, sharing data with workers and machines on the factory floor, and on through to warehousing and fulfillment. Every aspect of the product life cycle is integrated into a unified, data-driven, digital process that optimizes costs and efficiency over time.

Every aspect of the product life cycle is integrated into a unified, data-driven, digital process that optimizes costs and efficiency over time.

In our work with smart factory technology at Wichita State, I see how some of the digital advances we are making with smart factories can help transform other components in a digital supply network. A smart factory is a highly digitized and connected production facility that uses technologies such as artificial intelligence, IoT, and robotics to manufacture products; it can self-adapt and autonomously optimize manufacturing operations. Machines on a smart factory floor can automatically boost production based on demand signals or slow down production based on supply signals. Likewise, with smart factories acting as the beating heart of digital supply networks, timing and production change signals can ripple out across a network in real time, thus maintaining operational coordination.

We are also exploring ways to use digital-twin technology to design smart factories, and to depict the most detailed aspects of their operations digitally. Companies can review

the designs, see them in operation, and make needed design adjustments long before pouring concrete and laying bricks. If design changes are needed during construction, they can be made much more quickly to minimize unnecessary delays and costs. Likewise, we can reengineer existing factories for the digital world. We make a digital twin of the legacy factory and then generate a virtual world overlay that illustrates changes needed to a single production line—or to an entire factory.

Ultimately, a factory is merely a process for taking input and turning it into output. In fact, we're using factory principles to assemble a high-volume COVID-19 testing lab in Wichita, Kansas. Whether the process keeps a plane in the air, manages virus testing, or delivers a smart phone, data drives it. Data—along with digital tools—can deliver the unprecedented insight customers need to innovate, optimize, and keep their operations soaring, like the B1-B, for years to come.

EXECUTIVE PERSPECTIVES

STRATEGY // Transforming an organization's supply chain from cost center to profit driver can have a significant impact on overall business strategy. While CEOs may not dive too deeply into the minutiae of data interoperability and demand signal capture, they should focus on the potential value that data-driven customer segmentation, digital optimization, and ecosystem transparency can help create. Taken together or individually, these opportunities are relevant to business and financial planning, risk management, and organizational efficiency. Notably, they can also help organizations optimize their supply chains for resilience and flexibility, which in the current global economic environment should be on every CEO's priority list.

FINANCE // To manage current supply chain disruptions, and to make supply chains more resilient for the future, CFOs can explore opportunities to invest in new technologies for greater integration. Case in point: blockchain.[12] The CFO, along with the broader C-suite, may be interested in the possibilities of increasing blockchain adoption for greater supply chain resilience in the postpandemic world. In fact, 40% of CFOs in a recent Deloitte survey expected their supply chains to be more diversified after the effect of coronavirus.[13] To achieve this diversification—and stay profitable—CFOs may need to dive deep into tactical items such as supplier payment terms, vendor assessments, and interest rate negotiations. No technology or reassessment should be out of bounds in the transformation from supply chain to network.

RISK // Global supply chains have faced acute disruption and increased regulatory scrutiny as a result of the pandemic; risk leaders today may not even be aware of all the points of risk in their supply chains. Even so, they may be able to respond effectively to future disruptions by learning more about vulnerabilities in their supply chain. Technology now makes it possible for organizations to understand the risk profile of their vendor landscape, share data in real time, protect IP, and track contractual terms. More disruptions are inevitable in increasingly complex supply networks, but forward-thinking CROs can take steps today to reduce potential points of failure throughout all parts of their supply chains.

ARE YOU READY?

KEY QUESTIONS

1. What technologies and techniques can you deploy to capture and analyze more internal and external data from across the supply and value chains?

2. How could you benefit from sharing information more freely across your supply network?

3. Which nonrepetitive supply chain tasks carry elevated safety risks? Which of these tasks could be performed by robots, cameras, or other technologies?

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AUTHORS

Our insights can help you take advantage of emerging trends. If you're looking for fresh ideas to address your challenges, let's talk.

Patrick Gallagher
Synchronized Planning & Fulfillment leader
Deloitte Consulting LLP
patgallagher@deloitte.com

Hussain Mooraj
Supply Chain & Network Operations chief futurist
Deloitte Consulting LLP
hmooraj@deloitte.com

Tim Gaus
Supply Chain & Network Operations chief transformation officer
Deloitte Consulting LLP
tgaus@deloitte.com

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

Stephen Laaper
Smart Factory leader
Deloitte Consulting LLP
slaaper@deloitte.com

SENIOR CONTRIBUTORS

Jennifer Brown
Principal,
Deloitte Consulting LLP

Rafael Calderon
Principal,
Deloitte Consulting LLP

Ramsey Hajj
Principal,
Deloitte & Touche LLP

Jim Kilpatrick
Principal, Deloitte LLP

Bill Lam
Principal,
Deloitte Consulting LLP

Sarah Noble
Director,
Deloitte MCS Limited

Diogo Carneiro
Senior manager, Deloitte & Associados, SROC S.A.

Paulo Souza
Senior manager,
Deloitte Touche Tohmatsu Consultores Ltda

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MLOps: Industrialized AI

AI + DEVOPS PRINCIPLES

Like DevOps, MLOps features automated development pipelines, processes, and tools that streamline machine learning model development and operations.

STRENGTH IN NUMBERS

Multitalented teams of technologists and machine learning professionals can help organizations operationalize and scale AI.

OPEN THE BLACK BOX

MLOps can help AI teams promote trust by addressing data management challenges such as accountability and transparency, regulation and compliance, and ethics.

TREND 4

MLOps: Industrialized AI

Scaling model development and operations with a dose of engineering and operational discipline

Sophisticated machine learning models help organizations efficiently discover patterns, reveal anomalies, make predictions and decisions, and generate insights; Forrester reports that more than half of global data and analytics technology decision-makers have implemented or are in the process of implementing some form of AI.[1] As machine learning and AI increasingly become key drivers of organizational performance, enterprises are realizing the need to shift from personal heroics to engineered performance to more efficiently move ML models from development through to production and management.

Despite growing ML adoption, many organizations are hamstrung in their efforts by clunky, brittle development and deployment processes that stifle experimentation and hinder collaboration between product teams, operational staff, and data scientists. In one survey of nearly 750 business decision-makers, only 8% considered their companies' ML programs to be sophisticated. And deployment happens too slowly: Twenty-two percent said it takes between one and three months to deploy a newly developed ML model into production—where it can deliver business value—with another 18% saying that it takes more than three months.[2]

As a result, IDC reports, 28% of AI/machine learning projects fail, with lack of necessary expertise, production-ready data, and integrated development environments cited as the primary reasons for failure.[3] Many more projects (47%) fail to even make it out of the experimental phase and into production.[4]

Many organizations are constrained by artisanal development and deployment techniques, with star data scientists frequently treated as virtuosos and given considerable creative control. Typically, these models are developed and deployed using manual, customized processes that, however clever, aren't terribly scalable. And enterprise data infrastructure is not designed to support rapid, consistent, streamlined development of machine learning models, as the chapter *Machine data revolution* discusses.

Organizations may need to rethink cultural norms, organizational structures, and governance mechanisms to more efficiently leverage AI resources, according to Jeff Butler, director of research databases at the Internal Revenue Service. "AI and machine learning can transform the way business is done, but only if organizations can fundamentally reshape organization structures, cultures, and governance frameworks to support AI," he says. "Scaling AI across the IRS means that we are thinking differently about how models are created and managed, how to get the skills and talent we need, and how to hold ourselves accountable to taxpayers."[5]

Indeed, as we noted two years ago in the *Tech Trends* chapter *AI-fueled organizations*, to integrate AI and machine learning into every process and system, businesses must be able to deploy them consistently and at scale.[6] To realize the broader, transformative benefits of AI and machine learning, the era of artisanal AI must give way to one of automated, industrialized insights. Enter MLOps, also known as ML CI/CD, ModelOps, and ML DevOps: the application of DevOps approaches and tools to model development and delivery to industrialize and scale machine learning.

MLOps optimizes development, deployment, and management

Twenty years ago, similar development and operational challenges faced in software development led to the birth of DevOps. By standardizing and automating application development, deployment, and management, DevOps transformed the way many IT teams release and manage software, enabling them to dramatically improve development efficiency, delivery schedules, and software quality.

Today, it's AI's turn for the DevOps treatment. MLOps is an approach that marries and automates ML model development and operations, aiming to accelerate the entire model life cycle process. MLOps helps drive business value by fast-tracking the experimentation process and development pipeline, improving the quality of model production—and makes it easier to monitor and maintain production models and manage regulatory requirements. The MLOps market is expected to expand to nearly US$4 billion by 2025.[7]

The DevOps approach recognizes that improving software operations warrants attention, just as improving software development does. Like DevOps, MLOps features automated pipelines, processes, and tools that streamline all steps of model construction. Through continuous development, testing, deployment, monitoring, and retraining, MLOps can

improve collaboration among teams and shorten development life cycles, thereby enabling faster, more reliable, and more efficient model deployment, operations, and maintenance as well.

With automation and standardized processes, MLOps can encourage experimentation and rapid delivery, helping enterprises industrialize machine learning. For example, new techniques and approaches, supported by better data organization for use by machines, can reduce to days or even hours the process of customizing and adjusting the way models learn to generate the most accurate outcomes, known as model tuning. To help ensure that the best processes are industrialized, productionized, and scaled, teams can reevaluate and automate existing processes for creating, managing, and curating the data, algorithms, and models at the heart of machine-driven decision-making.

Once models have been deployed to production and begin encountering more data, monitoring their performance can help ensure they continue to deliver business value. If unchecked in production, unexpected bugs could be introduced into the pipeline. And as the data used to train and validate models ages, predictive accuracy can deteriorate.

MLOps can encourage experimentation and rapid delivery, helping enterprises industrialize machine learning.

This concept, known as model drift, is one of the leading reasons that models miss performance targets. For example, COVID-19 disrupted many supply chains because demand planning models weren't updated frequently enough to account for the quickly emerging "new normal" as the pandemic began. As discussed in the chapter *Supply unchained*, many businesses had either too much or too little supply, in large part because their demand planning models were operating on data and assumptions that became outdated nearly overnight.

MLOps helps organizations monitor model performance and manage model drift's predictive inaccuracies by helping standardize processes for maintaining alignment of AI models with evolving business and customer data. Human ML experts can monitor production models, observe how they change and behave as they scale, and decide when they need to be retrained or replaced. As a result of this planning and monitoring, model drift is diminished, and development and deployment become more flexible and responsive.

Development focus shifts from exceptionalism to professionalism

Bringing the discipline of DevOps to machine learning can help AI adopters scale model development and deployment, but they must also tackle a significant skills gap. In a recent Deloitte study, 68% of executives surveyed described their organization's skills gap as "moderate-to-extreme," with 27% rating it as "major" or "extreme."[8]

Typically, enterprises rely on a small number of highly skilled data scientists and analysts to develop and test complex ML models and then deploy them to a production setting. With expertise in statistical analysis and experience in determining appropriate ML approaches, developing models, making prototypes, and ensuring the models' predictive accuracy, these data scientists are in high demand.

But relying on a few experts has limits, chiefly related to scalability and repeatability. Every data Jedi typically prefers their own set of model development and deployment workflows, based on education, experience, and personal preferences. They then often build models with bespoke data extracts that can require significant effort to recreate when later brought into a production setting using real-world, large-scale data. As machine learning permeates the enterprise, a more scalable, efficient, and faster approach is needed to improve development resilience, reduce production bottlenecks, and increase the reach of ML projects.

Organizations need supporting teams of multitalented technology and ML professionals to help with activities such as data management, model deployment, and postdeployment monitoring and management. MLOps practices encourage communication between expanded development and production teams; like DevOps, it's a deeply collaborative approach, enabling a broader and larger team of professionals to work together more efficiently to get more done in a standardized manner. Tools can help too: Automated machine learning, or AutoML, can accelerate model development by helping data scientists quickly test different models and variants.

These new players can help data scientists test and fine-tune their creations, deploy models to production, manage production models, address issues related to security and governance, and remove impediments to AI and ML initiatives associated with outdated data infrastructures. Together with MLOps, data engineers and technologists can expand the focus of AI teams from model building to operationalizing. By lightening the load on the still-critical data scientists, the new supporting cast and crew can help ensure that the entire production is as Oscar-worthy as the lead actor's performance.

MLOps helps address emerging challenges associated with data use

Despite the many similarities between DevOps and MLOps, machine learning spawns complex, data-related issues not commonly faced in the software development process, such as accountability and transparency, regulation and compliance, and AI ethics.

For example, ML models often make predictions that drive decisions related to medical diagnoses, loan applications, prison sentencing, and other consequential matters. These require model and algorithm transparency to shed light on how and why these decisions are made. There may also be privacy and consent issues related to both training and production data sets. And because ML systems often use sensitive personal information, data protection may further need to meet regulatory compliance standards, such as HIPAA, PCI, or GDPR. Another challenge: the use of biased data that reinforces and amplifies societal prejudices—sometimes overt but often implicit. And it's not enough to simply retrain models with unbiased data, because developers can unintentionally build their own biases into algorithms and models.

MLOps can help organizations manage such dilemmas by establishing and enforcing program-level guardrails that can drive accountability as a baseline requirement. Within a robust MLOps framework, development and deployment teams will find it easier to adhere to governance and compliance protocols and privacy and security regulations. Similarly, programmatic traceability standards can help ensure that model transparency—and to a degree, fairness—are standard ingredients in any model's design and implementation. MLOps tools can automatically record and store information about how data is used, when models were deployed and recalibrated and by whom, and why changes were made.

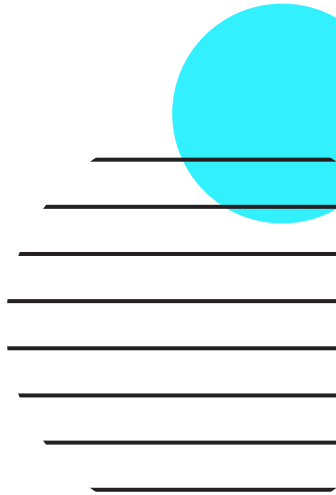
Another challenge: the use of biased data that reinforces and amplifies societal prejudices—sometimes overt but often implicit.

Without MLOps procedures in place, it would be infeasible, if not impossible, to prove proper data handling or use in response to an external inquiry.

As model development and deployment is standardized and automated—and becomes a team sport—accountability is diffused and shared throughout the process. The responsibility, then, sits at the process level, with the baseline requirement to produce more auditable, accountable AI. Cracking open the black box of machine learning can result in transparency that enables stakeholders to more easily interpret, understand, and trust the data and logic upon which decisions are founded.

The way forward

As enterprises seek to scale AI development capacity from dozens to hundreds or even thousands of ML models, they can benefit from the same engineering and operational discipline that DevOps brought to software development. MLOps can help automate manual, inefficient workflows and streamline all steps of model construction and management, but organizations likely will also need to infuse AI teams with fresh talent whose capabilities complement those of highly skilled data scientists, further extending teams' focus from model building to operationalization. When armed with MLOps tools and processes, these expanded AI teams likely will be better able to address challenges related to accountability and transparency, regulation and compliance, AI ethics, and other issues related to managing and organizing data for machine-driven decision-making. As a bonus, this approach enables data scientists to focus on experimenting and innovating with new AI technologies that go beyond core techniques, enabling organizations not only to scale ML initiatives but to be more operationally resilient and agile in the face of technological change.



LESSONS FROM THE FRONT LINES

The next wave of AI research

Researchers at the National Oceanic and Atmospheric Administration (NOAA) are increasingly leveraging AI and machine learning to better understand the environment and make potentially life-saving predictions. With an extensive network of environmental satellites and observation systems that collect real-time weather, climate, and ocean data, the federal agency currently uses AI to interpret earth, ocean, and atmospheric observations, improve weather forecasting, monitor marine mammal and fish populations, and aid many other applications.

As NOAA seeks to expand its use of AI and ML to every mission area, it recently launched an effort to improve the efficiency and coordination of AI development and use across the agency. Historically, NOAA scientists have undertaken AI initiatives and machine learning models independently, with every researcher potentially having a different idea about how to leverage AI for a specific project; development happens organically. As a result, line offices, made up of multiple research centers and divisions, are each at a different stage of maturity in the AI journey.

"To create truly transformational products, we need a more consistent, synchronized approach to AI across the agency," says Sid-Ahmed Boukabara, principal scientist for strategic initiatives at NOAA's Center for Satellite Applications and Research, the research arm of the National Environmental Satellite, Data, and Information Service.[9] "We aim to dramatically expand the application of AI in every NOAA mission area by improving the efficiency, effectiveness, and coordination of AI development and usage across the agency."

NOAA developed a bold strategy focused on achieving five strategic goals.[10] One of those entails the establishment of a virtual AI center, allowing line offices to share best practices and integrate efforts when appropriate. The NOAA AI Center was proposed in the latest presidential budget request and is being discussed on Capitol Hill.

Regardless of where a line office, division, or center sits on the maturity curve, the NOAA AI Center is envisioned to work with those scientists and researchers to help them effectively transition AI projects from idea to operations. Initially, the agency aims to increase the use of small-scale demonstration projects related to specific areas such as weather forecasting,

which can serve as proofs of concept for larger-scale efforts. Another objective of NOAA's AI strategy has been to strengthen and expand partnerships in order to enhance the use of AI to achieve the NOAA mission.[11]

In addition to partnerships and coordinating AI research, the NOAA AI Center is expected to be responsible for making NOAA's data AI-ready and available to the agency and public, promoting ML algorithm development, AI labeling, application development, information exchange, and general AI awareness generation and workforce training. Technical specialists from the NOAA AI Center, embedded in the line offices, will provide researchers with the know-how, tools, and support to execute their ideas. "We'll make sure to not stifle scientists' creativity and instead help them conserve resources and enhance their use of AI when needed," Boukabara says. "By cross-fertilizing knowledge across the agency, we'll be able to benefit all line offices by efficiently leveraging the newest machine learning techniques when scientifically appropriate."

Scaling to thousands of models in financial services

AI and machine learning technologies are helping financial services firm Morgan Stanley use decades of data to supplement human insight with accurate models for fraud detection and prevention, sales and marketing automation, and personalized wealth management, among others. With an AI practice that's poised to grow, the firm is leveraging MLOps principles to scale AI and ML.[12]

"We need to be able to scale from hundreds of models to thousands," says Shailesh Gavankar, who heads the analytics and machine learning practice in Morgan Stanley's Wealth Management Technology department. "There are limitations to doing everything manually as long as data scientists and data analysts are working on their own 'island' without the ability to collaborate or share data."

Currently, the practice is using common platforms for managing data and developing, deploying, and monitoring ML models. To build and test models, people created a sandbox with access to a centralized data lake that contains a copy of the data used in the production system, a technique that makes it easier to bring models from development into production.

In the development environment, data scientists, business analysts, and data engineers across the practice can access the same standardized data in near-real time, enabling them to efficiently and collaboratively explore, prototype, build, test, and deliver ML models. Advanced techniques mask

personally identifiable information so the teams can generate insights without exposing sensitive data. "Across our AI practice, processes are built around data accuracy and privacy," Gavankar says. "Applying the highest standards to the training system ensures that we meet data compliance and regulatory requirements."

For good model governance, transparency, and accountability, an independent, in-house model risk management team was established. With years of experience deploying trading models, the team is responsible for assessing risk and validating the quality of ML models before they go to production. The team evaluates the accuracy of the models and works to identify sources of bias or other unintended consequences. They also review data lineage as well as plans for production monitoring and intervention should the model start to drift.

As its AI practice evolves, Morgan Stanley Wealth Management will be focusing on continuing to improve speed to market by further automating the model risk management process and integrating the sandbox and production systems. "As MLOps tools and processes enable us to operationalize models more efficiently," Gavankar says, "we can continue to increase the number of models in production and more fully leverage AI's ability to drive better business decisions."

One-stop shop for model development and deployment

As AI and machine learning transform health care, health insurer Anthem, an industry leader in the use of clinical, customer-facing AI applications, is increasingly leveraging AI to reimagine and reinvent critical back-end business processes. About two years ago, the company embarked on an AI-supported journey to streamline claims management. As part of that process, leaders built a platform that consolidates model development and deployment across the enterprise.

Anthem initially built several ML models that revealed patterns in claims data, made predictions to speed processing, and identified and corrected errors. The models were successful—and leaders realized they needed to scale. "As the models began to deliver business value, we realized we needed infrastructure that could help us develop and operationalize machine learning more efficiently," says Harsha Arcot, senior director of enterprise data science.[13] "To address this challenge, we decided to build a single interface for all AI and ML solutions across the Anthem ecosystem."

The company built an integrated development environment and an end-to-end platform that serves as a one-stop shop where developers and data scientists prepare and store training data, build and validate models via easy-to-use interfaces, and deploy them at scale. A feedback mechanism allows models to continuously learn and improve while a separate platform monitors the performance of production models.

Simultaneously, the company has been working on an initiative that consolidates data from seven systems into a single repository. With most of that work complete, the process of finding the data to build, train, and operationalize models is much more efficient.

The platform also provides Anthem with the flexibility to duplicate models for multiple use cases. For example, if a pipeline is already built out into the legacy claims system for a commercial use case, it can also be easily deployed on the consumer side. "It's much more efficient than when we used to develop a model for each use case from scratch," Arcot says.

Using the platform, Anthem data scientists have developed a number of models, including those that fast-track the processing of pre-approval claims, identify and automatically reject duplicate claims, and determine whether a medical procedure needs preauthorization. Previously, a human claims examiner or clinician needed to manually review and process all of these claims.

Arcot says the platform has dramatically increased model deployment speed. "Before we developed the platform, it took about six months to deploy very simple models," he says. "Now we are able to develop much more complex initiatives in half the time."

MY TAKE

Swami Sivasubramanian

Vice president, Amazon Machine Learning, AWS

We are entering the golden age of machine learning, with adoption increasing across all customer segments.

Once considered peripheral, ML technology is becoming a core part of many business strategies around the world. From health care to agriculture, fintech to media and entertainment, ML holds great promise for many industries. Driven by the wide availability of cloud-based computing power, storage capacity, and easy-to-use AI toolsets, the normalization of AI and ML continues at a rapid pace. However, before enterprises can scale from dozens to thousands of ML models and make machine learning an integral part of their strategy, they need to address the AI skills gap and integrate ML practices into individual lines of business. They must also get their data strategy in order, tackle governance issues, and streamline model production. Let's look at each of these gaps.

Organizations must have a strategy to contend with the global shortage of AI skills—one of the biggest barriers to adoption. Across

the lines of business, from engineering to product teams, people need a broader understanding of AI and ML concepts and tools to help identify relevant business opportunities and understand the potential of this technology for customers and other key stakeholders. At Amazon, we addressed this skills gap by building a Machine Learning University in 2014.[14] Available to anyone interested in machine learning, the university helps AI professionals keep their skills sharp while giving product managers, program managers, and other novices the opportunity to learn the basics of AI and ML.

Armed with an understanding of AI fundamentals, business stakeholders can play a collaborative role in developing strong business cases for ML initiatives and develop ML-driven solutions that matter to their customers and business. When data scientists and business stakeholders team up to identify strategic problems to which AI might be applied, they can meaningfully move the needle for the business. Without collaboration, AI teams risk building impressive prototypes that never get business buy-in or have real-world customer impact.

Armed with an understanding of AI fundamentals, business stakeholders can play a collaborative role in developing strong business cases for ML initiatives and develop ML-driven solutions that matter to their customers and business.

When it comes to ML adoption, data is often cited as the No. 1 challenge. In our experience, more than half of the time spent building ML models can involve data wrangling, data cleanup, and pre-processing stages. If you don't invest in establishing a strong data strategy, ML talent will be forced to spend a significant portion of their time dealing with data cleanup and management instead of inventing new algorithms. Specifically, poor data and model governance are also significant challenges to widespread AI adoption. Driven by concern that data will be used inappropriately, many business divisions tend to hoard data into silos and are reluctant to share it with others. Good data governance can give business partners confidence that their data will be used properly, thereby encouraging sharing and typically leading to more accurate models. Similarly, strong model governance mechanisms and monitoring processes can help AI adopters maintain accuracy once models are in production. Automated monitoring tools can

provide feedback on how the model is changing and alert human developers when the models need to be retrained and recalibrated.

In addition, a solid strategy for managing and storing data can help optimize data scientists' skills and time. Automating time-consuming data management tasks can help free up these professionals to focus on what they do best: developing algorithms and building models. By simplifying the process of classifying data and controlling access, automated data management can help address data governance challenges.

Finally, as businesses scale their ML practices, it is important for builders to focus on what is meaningful for the business instead of worrying about developing ML infrastructure—an undifferentiated but heavy workload. Streamlining model production can help organizations use their talent and other resources more wisely. For example, many companies invest in developing, deploying, and managing models. This undifferentiated heavy lifting can distract talent from value-driving tasks such as solving critical business problems and building customer-focused solutions. For many companies, a more efficient solution might be to leverage existing platforms and tools, such as Amazon SageMaker, that expedite and simplify the model production process, drawing humans into the loop for critical decision-making. Similarly, organizations nowadays do not have to spend time building an automatic speech recognition model for transcribing contact center calls—instead, they can use cloud AI APIs, such as Amazon Transcribe, or fully packaged AI products, such as Contact Lens for Amazon Connect, that modernize contact centers.

Removing these and other roadblocks standing in the way of efficient ML adoption can help industrialize and scale AI across the enterprise, enabling organizations to efficiently ingrain machine learning into business processes and embed it into new products and services.

EXECUTIVE PERSPECTIVES

STRATEGY // With ML adoption growing across industries, CEOs—particularly those whose companies operate in low-growth sectors—are exploring how to use machine learning to grow market share and lower costs. CEOs may want to speak to their CIOs and IT teams about their vision for applying AI/ML to boost the bottom line. For example, if they hope to increase earnings per share by 10 points, CEOs should make their priorities clear and spend time understanding what can be achieved and/or what investments are needed. As the organization hires AI/ML talent to scale capabilities, leaders should provide a clear mandate to these new teams for how and when technology should augment human decision-making.

FINANCE // As organizations are increasingly pressed to make good decisions faster and develop better models for demand forecasting, finance leaders are quickly realizing that their organizations need machine learning at scale. Assuming that technology speed and capability will continue to increase exponentially, making a machine-based decision in the future will cost a fraction of a nonscalable human decision today. Indeed, 67% of executives in Deloitte's State of AI survey are already leveraging ML for efficiency gains, such as faster account reconciliation or more accurate accruals.[15] To ready their organizations for this change, CFOs can choose between becoming more technically savvy or buying financial planning and analysis as a service. Whether they sponsor data officers or take on the task themselves, finance leaders may soon rely on the power of machine-driven insights for their regular updates to analysts and shareholders.

RISK // ML deployments are quickly scaling up and enabling algorithms to make key decisions for the organization. Yet trust remains an issue: Humans are undeniably prone to bias, but the press and the public often take particular notice of biases in machines and biased outcomes of ML models.[16] CROs can work with their CIOs, CDOs, and other IT leaders to anticipate potential brand risks and suggest design workarounds. They can also make purposeful choices with AI and ML algorithms not only to help maintain public trust in their organizations but to position risk management protocols for AI/ML as a competitive differentiator.

ARE YOU READY?

KEY QUESTIONS

1. Do you have the skill sets and organizational structure needed to meet your AI goals today? In two years?

2. How can you improve the time to market of models and improve their performance in production?

3. How can you improve models' governance, accountability, and transparency? What precautions can reduce developer and data bias? How can you better protect sensitive data?

LEARN MORE

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AUTHORS

Our insights can help you take advantage of emerging trends. If you're looking for fresh ideas to address your challenges, let's talk.

Beena Ammanath

Executive director, Deloitte's AI Institute
Deloitte Consulting LLP
bammanath@deloitte.com

David Kuder

US AI Insights and Engagement Market offering leader
Deloitte Consulting LLP
dkuder@deloitte.com

Frank Farrall

AI Ecosystems leader
Deloitte Consulting LLP
frfarrall@deloitte.com

Nitin Mittal

US AI Strategic Growth offering leader
Deloitte Consulting LLP
nmittal@deloitte.com

SENIOR CONTRIBUTORS

Paul Phillips
Managing director,
Deloitte Consulting LLP

James Ray
Senior manager,
Deloitte Consulting LLP

Paulo Maurício
Senior manager, Deloitte & Associados, SROC S.A.

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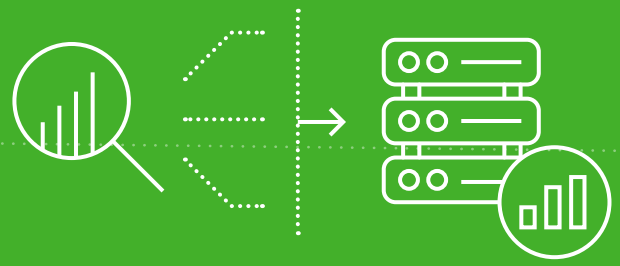
Machine data revolution: Feeding the machine

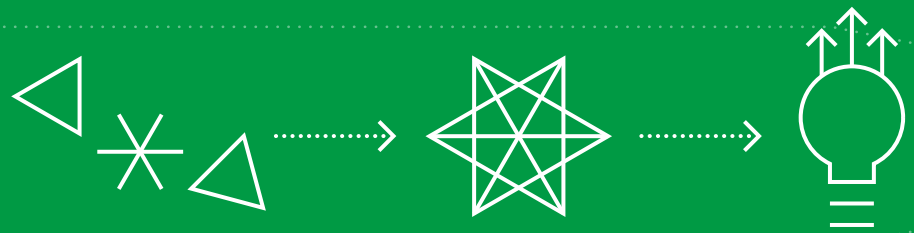
CAPTURE AND STORE

Search legacy systems and databases for valuable unstructured and nontraditional data. Aggregate and store it in cloud-based offerings optimized for machine learning.



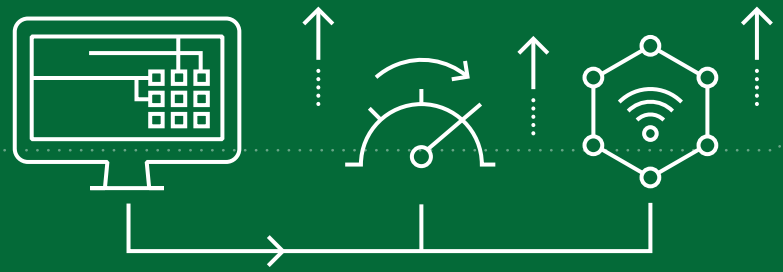
DISCOVER AND CONNECT

Use cognitive data steward technology to illuminate insights and connections among disparate data.



AMPLIFY ML CAPABILITIES

Explore opportunities to use edge computing and 5G to boost real-time data capabilities and decrease latency.



TREND 5

Machine data revolution: Feeding the machine

Disrupting the data management value chain for the ML age

With machine learning (ML) poised to augment and in some cases replace human decision-making, chief data officers, data scientists, and CIOs are recognizing that traditional ways of organizing data for human consumption will not suffice in the coming age of artificial intelligence (AI)–based decision-making. This leaves a growing number of future-focused companies with only one path forward: *For their ML strategies to succeed, they will need to fundamentally disrupt the data management value chain from end to end.*

In the next 18 to 24 months, we expect to see companies begin addressing this challenge by reengineering the way they capture, store, and process data. As part of this effort, they will deploy an array of tools and approaches including advanced data capture and structuring capabilities, analytics to identify connections among random data, and next-generation cloud-based data stores to support complex modeling.

Some companies are already embracing this trend as part of larger AI initiatives. In Deloitte's third annual *State of AI in the Enterprise* survey, when asked to select the top initiative for increasing their competitive advantage from AI, respondents singled out "modernizing our data infrastructure for AI."[1]

For digital nonnatives participating in this trend, the stakes are high. Some of their digital native competitors, largely unburdened by outmoded data models and processing capabilities, are already monetizing more diverse data, more quickly.[2] Importantly, end users have less and less patience for the kind of latency that legacy systems and data models often deliver. The optimum latency time between click and desired response is less than 50 milliseconds—any longer and users become irritated by the delay and make "executive decisions" themselves.[3]

Humans, machines, and data

In the coming months, participants in the *machine data revolution* trend will explore opportunities to reengineer their data management value chains to support ML's possibilities. In the arena of data management,

this marks a distinct change of course. For decades, companies have collected, organized, and analyzed data with one goal in mind: helping humans make decisions based on statistical fact rather than hunches and emotion. Humans tend to look at aggregated data characterized by two or three major factors. When faced with more complex data, many humans struggle to process the information presented and to articulate a useful decision. As such, we typically organize data for humans in clean tables and rows, with precise labeling. Machines, by contrast, can assess multiple factors simultaneously and objectively. ML models can extract low levels of statistical significance across massive volumes of structured and unstructured data. They work around the clock and can make clever decisions in real time.

When used in areas in which human decision-making is nonscalable—such as cleaning up raw data[4] or making personalized product recommendations—ML may only need to make *good enough decisions*, not perfect ones. For example, a retailer would presumably see value in the ability to recommend, in real time, an assortment of products tailored very broadly to thousands of individual online shoppers simultaneously. The products that ML algorithms recommend might not perfectly match each customer's unique tastes, but they might be sufficient, in that moment, to drive a sale. Across an enterprise, each good-enough data-based decision that machines make, rather than humans, drives down the overall cost per decision, which in turn enables companies to extract value from even the lowest-level decisions. Creating an automated pipeline that replaces low-level or nonscalable human decisions with those made by machines brings to mind the promise of Moore's Law. Over time, speed and capability will increase so dramatically that making that data-based decision in the future will cost a fraction of what it does today.

Though approaches can vary by industry, market, and organizational need, many trend participants will likely focus on their reengineering efforts on the following areas:

Capture and store

Chances are, your organization has troves of data that's potentially valuable yet untapped. Some of it is probably traditional enterprise data residing in databases, files, and systems; other troves may be more recent data generated by machines or mobile devices. Still others may be unstructured text, or nontraditional data from video or audio recordings. In all likelihood, this data was previously too hard or too expensive to capture and utilize in a cost-effective way, so it lies fallow. This is a lost opportunity. No one knows which data amid vast stores of raw information might turn out to be predictive or confer some decisioning value down the line, so it is critical to capture all the data you can.

Moreover, you are probably throwing out some data today that, with the right tools and approaches, you can use. Take utility companies, for example. What information do they need to predict power or equipment failures? Traditionally, they may have collected data only on failure. But for predictive purposes, they would also need data on uneventful everyday operations to understand what *normal* looks like. This same idea applies to people visiting your company's website. Do you have website data for both success and failure? In a world where data quality no longer matters as much as it once did, what changes can you make to your current data practices to make them more predictive?

In terms of storage, organizations are becoming less focused on storing clean data that fits neatly into tables, rows, and columns. To feed ML algorithms and advanced analytics tools, many are exploring opportunities to store massive volumes of unstructured data from IoT, social media, and AI in a variety of modern database technologies, including:

- **Cloud data warehouses.** The cloud-based data warehouse, which a growing array of major and emerging public cloud vendors are offering as a service, aggregates data from disparate sources across an enterprise and makes it available to users for real-time processing and mining. This permissions-based, centralized system eliminates the need for colocated data and data pipelines. In addition to collation and storage capabilities, cloud data warehouses also typically offer search engine tools for querying data and analytics capabilities.[5] This combination of public cloud ease-of-use, the ability to scale up or down as needed, and advanced data processing and analysis tools is fueling considerable growth in the cloud data warehouse market. Prescient & Strategic Intelligence forecasts the data warehouse-as-a-service market will reach US$23.8 billion in value by 2030.[6]

- **Feature stores.** In the near future, it will be commonplace for an organization to have hundreds or thousands of data models operating independently of each other, and in parallel. Each of these models will use different feature sets. For example, some require immediate decisions while others do not, thus placing broadly different demands on data and on processing power. Pushing real-time compute uniformly in every model is a waste of computing power. Likewise, some models probably share features while other features may be used exclusively in a single model. How can you manage all of these competing demands across data models? Feature stores provide a mechanism for allocating compute, sharing features, and managing data efficiently,

and at scale, which makes this mechanism integral to driving down decision costs. What's more, by leveraging AI, feature stores may eventually be able to predict demand of certain features based on the types of data being modeled.[7]

- **Time series databases.** The popularity of time series database technologies has grown considerably over the last two years, with good reason.[8] Unlike relational databases that record each change to data as an update, time series databases track and record them—and the specific time they were made—as a unique insert into a dataset. With the explosion of temporal data from IoT and monitoring technologies, among others, both historical and predictive analysis increasingly depends on the ability to query a data value from one point in time and track it continuously, accurately, and efficiently.[9]

- **Graph databases.** Highly interconnected data can be challenging to analyze and use to its fullest potential. Using traditional relational databases in which data are organized in tables, one can identify and manage a limited number of data relationships. But as data grows more voluminous and less structured, the number of relationships and interconnections increases exponentially, thus becoming unmanageable (and unsearchable) in traditional database models. Graph databases are designed specifically to address this challenge by storing not only data but information on each data point's relationships in a native way. With this model, queries about complex relationships among data can be fast, efficient, and more accurate.[10]

With storage costs continuing to fall, aggregating and organizing massive volumes of data is no longer cost-prohibitive.[11] What's more, modern self-healing, fault-tolerant data architecture typically requires less maintenance, which can reduce administrative and repair costs. Thus, the potential benefit of increasing storage capacity could far outweigh whatever costs you may incur. ML and advanced analytics can discern low levels of statistical significance across a large number of factors, which in turn can provide a significant lift that would be near impossible to achieve using traditional data storage and modeling techniques.

Organizations are becoming less focused on storing clean data that fits neatly into tables, rows, and columns.

Discover and connect

As you begin capturing more data, it will likely include fragmented data generated across different devices, channels, and geographies. How can you connect fragmented data in a way that characterizes an individual customer in an individual context—or reveals an unmet need the marketplace or an internal opportunity for greater efficiency? Unlocking the full value of all data resources, including dark and nontraditional data, can be complex and expensive, particularly in large, established enterprises with hundreds of legacy systems, duplicate data stored around the globe, and inconsistent naming practices. As you start work to build data's future-ready foundation, you will likely face a twofold challenge. First, to make the strongest data-driven decisions, you will need to analyze more than just the obvious data. Indeed, you will need the *non*obvious data—information that no one knows even exists. Then, even if you can collect all known and unknown enterprise data, how can you tie these disparate, inconsistently formatted and named data points together in a way that is meaningful? The work of discovering and connecting enterprise data can be formidable and costly. Yet shirking this challenge could cost even more if your company misses out on potentially valuable opportunities.

To make the strongest data-driven decisions, you will need to analyze more than just the obvious data.

The good news is that ML-powered *cognitive data steward* technologies available today can help accelerate the processes of discovering data and illuminating its insights and connections.[12] Here's how:

- Analytics, semantic models, and cognitive technology can automate manual, costly stewardship activities—thus freeing up data scientists to focus on more advanced analysis.
- Identifying similarities in underlying data systems' code makes it possible for data scientists to use custom data algorithms in multiple data models.
- Finally, by leveraging ML capabilities to automate the processing of master data, cognitive data stewards can help users visualize relationships in data, improve data readiness and quality, and enable greater data management efficiency.

In the near future, expect data steward capabilities to grow with new tools that aid with ingestion, classification, management, and discovery. And as the trend gains momentum in the coming months, look for

data steward deployments to expand further into transactional systems, supply chain ecosystems, and smart factory environments.

Serving up ML's secret sauce

The ability to process larger volumes of diverse data in real time is the secret sauce of ML-based data decisioning. The faster that big data systems can capture and process data, feed it into ML and analytics platforms, and then serve up insights to users, the more impactful your data investments can be.

To this end, a growing number of organizations are exploring ways to make decisions at data's point of entry into the network rather than sending it first to the core or cloud. Some are building edge computing capabilities that can decrease latency in data systems while also making these systems more reliable and efficient. Edge computing means pushing compute and processing power away from a centralized point and closer to a network's "edge" or periphery. It does not replace enterprise or cloud-based data centers but helps distribute processing work—including analysis and decisioning—more evenly across a network. Rather than sending raw data back to a cloud or data center, a device operating at the edge generates action independently or sends only already-refined data to the network, in effect storing, processing, analyzing, and reacting locally. Edge computing can be particularly useful when deploying ML algorithms, which require uninterrupted, real-time access to large quantities of recent data.[13]

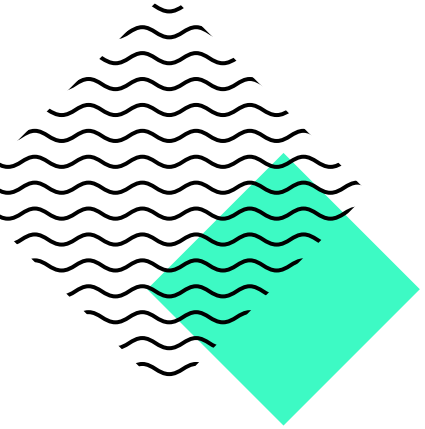
Advanced connectivity also has an important enabling role to play in real-time decision-making at data's first point of entry. Current generation connectivity, such as 4G/LTE and Wi-Fi, can support some edge computing and real-time data processing needs, but they are limited by bandwidth, latency, and the number of devices they can effectively manage. 5G can deliver faster speeds and millisecond latency. It can also expand bandwidth capacity to simultaneously manage many more devices per square kilometer.[14]

The way forward

As we discuss in this report's *MLOps: Industrialized AI* chapter, ML initiatives are gaining momentum across industries. Indeed, the ML technologies market is currently growing at a rate of 44% annually and is expected to reach US$8.8 billion in value by 2022.[15] But ML algorithms and platforms will deliver little ROI in companies with outdated data infrastructure and processes that were leading-edge in 2002.

How will you reengineer your data strategies to build a new foundation for your company's future?

LESSONS FROM THE FRONT LINES



Adventures in data democracy

Since its founding 144 years ago, AT&T has reinvented itself many times to harness historic disruptive innovations such as the transistor, the communication satellite, and more recently, the solar cell.[16] Today, the global technology, media, and telecommunications giant is reinventing itself again—this time as a pioneer in the use of ML, which it is deploying broadly in areas such as IoT, entertainment, and customer care.[17]

The company is also leveraging ML to reimagine the way it finds, organizes, and uses data. "One of the things we wanted to do was automate some of the routine cleansing and aggregation tasks that data scientists have to perform so they could focus on more sophisticated work," says Kate Hopkins, vice president of data platforms, AT&T Chief Data Office.[18] Likewise, the company wanted to develop a way to democratize meaningful data, to the extent consistent without privacy, security, and other data use policies, making it more broadly available to qualified personnel across the enterprise. These efforts, Hopkins says, have already borne fruit. New tools have shrunk the time to market required to go from prototype to full scale production for ML models. These models have had dramatic results, such as blocking 6.5 billion robocalls to customers, deterring fraud in AT&T stores, and making technicians visits to customer homes more efficient.

AT&T started its data transformation journey in 2013 when it began aggregating large volumes of customer and operational data in data lakes. In 2017, the company created a chief data office with the goal of leveraging these rapidly growing data stores for "hyper-automation, artificial intelligence, and machine learning." The ongoing work of achieving these goals has presented several significant challenges. First, in a company as large as AT&T, it was sometimes difficult to find and access potentially valuable data residing in legacy systems and databases. And even when data scientists eventually found such data, they occasionally struggled to understand it, since it was often labeled inconsistently and offered no discernable context or meaning. Finally, there was a formidable latency challenge across all data systems that, left unaddressed, would stymie the real-time data needs of ML models.

To address these challenges, the chief data office developed the Amp platform. Amp enables a culture of technology

and data-sharing, reusability, and extensibility at AT&T. Pari Pandya, director of technology and project manager for Amp, says that what began a few years ago as an internal online marketplace (aggregating microservices, APIs, chat bots, designs, etc.) for accelerating automation, has evolved into a single, powerful source of data truth for systems and users. Consider this: As data flows through multiple systems and processes, its definitions change. Amp not only finds legacy system data, it uses metadata to ascribe meaning to this data, and provides a clear lineage to help users better understand the data. "It serves as a business intelligence platform that provides not only meaningful data but analytic and visualization tools that empower business teams, strategists, and product developers to leverage data in more advanced ways and share insights through data communities," Pandya says.[19]

To meet the challenge of latency, AT&T is on a multiyear journey to move some of its data and tools to the public cloud. Working closely with cyber teams to ensure data and IP security, the company is leveraging the cloud's ability to scale up compute power as needed. The cloud's power is helping create the real-time access that ML—as well as enterprise stakeholders and customers—require. Unlimited access to compute on demand through the cloud and the availability of business-ready data is accelerating the journey.

Hopkins notes that AT&T's data transformation journey has yielded another welcome benefit. "The business units have become much more knowledgeable about data science and are identifying opportunities to use data in new ways. Across the board they're requesting much more mature and sophisticated data," she says, adding that "being able to democratize data and make the process transparent across the enterprise can deliver exponential payback."

Data and IT double-team digital transformation

How can a 100-year-old retail organization efficiently and accurately take data from legacy applications that were designed for very specific use cases to accomplish something that those applications were never intended to do?

"Every legacy company faces this challenge," says Paul Ballew, chief data and analytics officer at the leading Canadian food and pharmacy retailer Loblaw.[20] "You have to bring those data assets together from across your ecosystem in a way that's scalable, repeatable, and governable, which is no small task."

Taking an ecosystem approach to data is particularly formidable in a successful retail organization such as Loblaw, which operates 2,400 stores and maintains an expansive

e-commerce presence. “We are a legacy company trying to leverage technologies that digital natives are born with,” Ballew says.

Yet despite its challenges, data represents a unique opportunity on the path to Loblaw’s digital future. And unique opportunities require unique approaches. Like many digital nonnatives, the company is shifting its focus from traditional data management priorities such as storage, curation, and quality to a new, more complex arena in which data analytics and digital solutions drive day-to-day operations. “It requires a different approach to ‘baking the soufflé,’” Ballew says. “We source and mix ingredients differently, and then serve it in new ways to those consuming it.”

Recognizing the critical importance of data in the company’s digital future, Loblaw set up a distinct data organization that works in tandem with IT to drive digital transformation and engage the business.

From a technology standpoint, Loblaw takes a three-layered approach:

- **Data layer.** An array of data management and digital capabilities that make data assets, many from legacy applications, consumable in near-real time to a variety of complex use cases.

- **Analytics and development layer.** A collection of AI/ML and advanced analytics technologies that bring data assets to life and glean insights from structured and unstructured data to support better decisions and more efficient workflows.

- **Solution delivery layer.** Provides tools to systematically integrate decisions and insights into processes and applications, helping meet the organization’s digital strategy goals.

“Once you’ve coordinated these three layers, you have to manage the analytic solutions, refresh cycles, and monitor to ensure strong and consistent governance,” Ballew says, noting that because Loblaw does a variety of things from selling groceries to providing pharmacy and health services, the company has a sliding scale in terms of data sensitivity, privacy concerns, and legal compliance. As such, robust data governance is critical in protecting sensitive data and determining model sensitivity to bias and other factors. “We have to be proactive stewards of customer data and leverage it in a manner that results in providing benefits to them in a transparent manner,” he says.

Data’s ascent as a decision-driving, business-critical asset has redefined the roles of Loblaw’s data and IT teams. “Our work around data and digital helps the business make critically important decisions: who to talk to, how to optimize marketing, run a factory,

or engage customers—the list goes on," Ballew says. "In terms of data, we helped the organization and leadership understand the art of the possible and the implications—good and not-so-good—of taking a comprehensive approach. The change has been beneficial overall, but it has impacted our entire ecosystem and those working in it."

And Ballew's advice to those managing similar change in their own companies? "Seek to understand before you seek to be understood."

Banking on distributed data architecture

ABN AMRO is taking a modern approach to data management. Rather than engineering endless workarounds to accommodate problems with the data pulsing through its systems, the Netherlands-based global bank has developed a feedback mechanism that enables data scientists to request data quality issues be fixed at the source and focus on turning data into value. "In the past, data scientists would find a problem, fix it, and keep going," says Santhosh Pillai, chief architect and data management. "Now they can provide feedback to the source where data is mined, and say, 'do it differently.' Over time, data quality improves, and data scientists don't have to spend as much time on cleansing and querying."[21]

Strengthening governance at the source is just one component of a three-pronged approach the bank is taking to prepare for what Pillai calls "the AI decade"—an era when AI increasingly augments or even replaces human decision-making. The second component focuses on the consumption side, where ABN AMRO has engineered an advanced analytics and AI layer to support business strategies that are evolving rapidly. "In an increasingly digital world, being client-centric means being data-centric," Pillai says. "Particularly in the post-COVID era, companies can't meet face-to-face with clients, so they rely more heavily on data and analytic insights. The analytics capabilities we have in place deliver these insights and unleash the value contained within our data."

The third component of ABN AMRO's data transformation effort is a multifaceted data mesh model that moves data anywhere it needs to go within the ecosystem, from source all the way to consumer. This "data supply chain" serves not only as a distribution mechanism but as a timing guarantee mechanism that enables real-time access to meet demand. It also features a self-service "marketplace" where consumers of data—both human and machine—can access high-quality data that is usage-approved and regulatorily compliant.

Like many established organizations, ABN AMRO didn't originally design its data architecture

to be event-driven—or for current data usage patterns. Today, algorithms and end users read up-to-the-minute data far more frequently than they use it in transactions. Legacy data management models were not designed to respond to constant read queries and real-time updates.

"We solved this challenge by putting each original record in a data store and replicating it," Pillai says. "On the consumer end, users see replicated data delivered with minimal latency and think they are seeing real-time data generated at the point of consumption. In fact, that data they are reading is coming from another part of the ecosystem."

Pillai sees great potential in this data replication model, particularly in the area of cloud storage. "Traditionally, technology was designed to optimize data storage. But as we approach the AI decade, I expect to see more companies develop mechanisms for replicating data that is stored in several clouds and even moving that data between multiple cloud vendors."

MY TAKE

Lutz Beck

Chief information officer, Daimler Trucks North America

Daimler Trucks North America, a leading producer of heavy-duty commercial vehicles, is transforming itself into an intelligent company—one in which data is a key asset.

Whether we are becoming more efficient through automation, creating new services for customers, or making better decisions, by using analytics and other digital technologies to work with data in real time, we can see things in different ways and steer our efforts in new directions.

Consider, for example, our trucks. Each Daimler truck that rolls off the factory floor is a new digital asset. An array of onboard sensors and other technologies monitor vehicle performance continuously, generating data that offers Daimler real-time insights on a truck's health. But rather than simply providing the vehicle owner with a status report, we can now apply analytics to vehicle performance data to predict when a part might fail. In urgent cases, we share this

information with the vehicle owner and initiate a "service now" event, directing the owner to a nearby service facility where mechanics—made aware of the problem and confirmed to have the needed part in stock—can address the issue without delay.

The ability to provide this kind of predictive vehicle performance data presents an opportunity to create an entirely new value-added service. Now, because we can predict and solve a maintenance issue proactively, we can offer our customers an "uptime guarantee": In this instance, data presents an opportunity for us and our customers.

Of course, thinking of our trucks as digital assets and fully embracing data-driven decision-making represents a cultural shift in a traditional company with deep roots in industrial manufacturing. Traditionally, we designed and built vehicles for sale to customers and, later, provided vehicle service opportunities. In the intelligent-company model, our relationships with customers deepen after the vehicle purchase. We use technology and data to refine existing products and services to meet unique needs as well as to create new services around the vehicle. This is a completely different way of working—one that we are embracing wholeheartedly.

Data presents an opportunity for us and our customers.

It is important to note that this new way of working presents challenges as well as opportunities. Data volumes are growing, and in our industry, the pace of this growth will accelerate dramatically with the standardization of automated, connected vehicles, smart traffic management systems, and other digital transportation advances. As such, data governance is more important than ever. In addition to managing the data itself, there are more and more regulations governing data use, and we must understand which data can be used and which services can be provided while always maintaining regulatory compliance. Likewise, we must clearly understand customer preferences and expectations for the way we use their data, which also affects the way we offer services. Should we offer individual services, or can we bundle them? How do different expectations of privacy in the nations of North America come into play? To meet this complex challenge, we are setting up a data intelligence hub where a chief data officer and data analysts work with our growing data catalog. This team of data experts helps us put in place the governance we need to leverage data to its fullest potential within legal parameters.

We are still on our journey toward becoming a fully data-driven, intelligent company. Right now, the biggest limiting factor remains our

thinking and our behavior, so we must make sure we build a culture in which we learn and think about data holistically. We need to work with the data and look at it in a completely different way. If we do this, within the next three to five years we will reach our goal: Daimler Trucks will have all the data-driven insights necessary to anticipate what our customers and dealers need tomorrow, and the day after that, and on into the future.

EXECUTIVE PERSPECTIVES

STRATEGY // CEOs are rarely involved at the deeper levels of data management. But those whose companies are deploying ML and other data-dependent AI tools may want to spend some time thinking about data strategy. Existing enterprise systems and data pipelines were not designed with AI needs in mind, so CEOs can engage their IT teams to lay the groundwork for this shift. They should hold the CIO or chief data officer accountable to carry out preparations for turning the organization's MLOps vision into a reality. They can also expect ongoing investments, as data is gradually prepared for algorithms first instead of humans. These new investments in data can eventually be paid back through increased profits or lowered cost per decision.

FINANCE // As the capabilities of modeling and ML become more robust (as detailed in our MLOps trend), finance leaders are leaning into data stewardship and even sponsoring data governance roles. With better data comes better modeling, which means CFOs can more accurately produce internal reports, predict quarterly performance, and shape the perceptions of market analysts and shareholders. However, the data needed for good modeling is not always internally owned—consider the example of parts manufacturers that monitor flight statistics to predict aluminum demand. Such combinations of raw, external data with company data can lead to actionable insights amid uncertainty. To enable these insights in the next 18–24 months, CFOs may need to think outside of the box to source new types of data, enable agile model governance, and optimize for modeling outcomes.

RISK // In the Age of With,[22] data strategies focus on providing analysis and insights that augment human decision-making. In this construct, algorithms—rather than data scientists and executives—may be consuming raw and unstructured data, but the inherent risks associated with managing large volumes of data remain constant. CROs can play a key role in defining risk parameters around protection, confidentiality, and integrity of large volumes of ML-optimized data. They can also develop separate risk strategies for more sensitive customer data and determine whether and how such data can be used in ongoing MLOps efforts. By delving deeper into these issues, CROs can help their organizations become more deliberate about where to apply AI in the business and, perhaps, explore opportunities to monetize risk data with new products and services.

ARE YOU READY?

KEY QUESTIONS

1. How have you reevaluated data governance and data management as you move to increase the use of AI and ML?
2. What mechanisms support accessing data from key legacy systems? Do they meet your current and future needs?
3. Which untapped sources of data could have the greatest impact on your decision-making?

LEARN MORE

Data management barriers to AI success
Learn about the challenges to preparing data for AI initiatives and where businesses can find support.

Exploring the future of artificial intelligence
Read about the many ways AI can augment standard business processes for better outcomes.

Seven lessons COVID-19 has taught us about data strategy
Study the key lessons learned from governments that have used data to combat the coronavirus pandemic.

AUTHORS

Our insights can help you take advantage of emerging trends. If you're looking for fresh ideas to address your challenges, let's talk.

Paul Phillips
Hux chief technology officer
Deloitte Consulting LLP
paulphillips@deloitte.com

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

Irfan Saif
US AI Strategic Growth offering leader
Deloitte & Touche LLP
isaif@deloitte.com

Juan Tello
Chief data officer
Deloitte Consulting LLP
jtello@deloitte.com

SENIOR CONTRIBUTORS

Edward Bowen
Managing director,
Deloitte & Touche LLP

Carl Gerber
Managing director,
Deloitte & Touche LLP

Adarsh Gosu
Managing director,
Deloitte Consulting LLP

Jason Price
Managing director,
Deloitte & Touche LLP

Piyush Sacheti
Senior manager,
Deloitte Consulting LLP

Matt Iames
Specialist master,
Deloitte Consulting LLP

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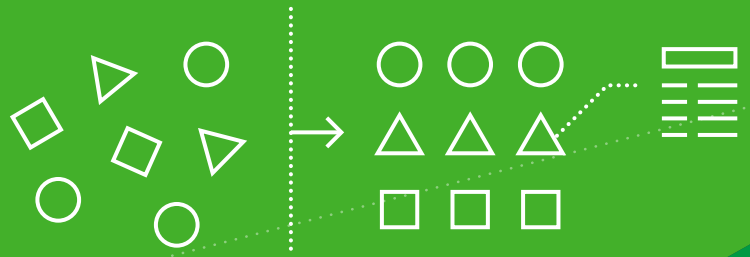
Zero trust: Never trust, always verify

BOLSTER CYBER BASICS

Beefing up basic cyber hygiene principles and practices can help companies realize the full benefits of zero trust.

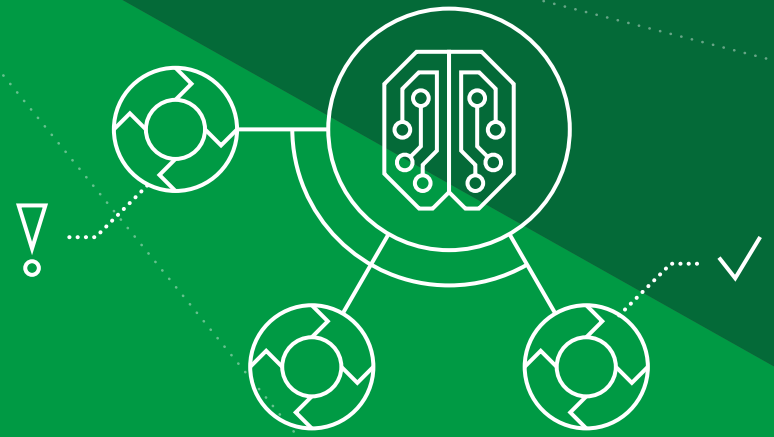


RETHINK THE CYBER ORG

Zero trust may require enterprises to rethink their organization's security approach and the skills, processes, and technology that support it.

AUTOMATE SECURITY TECH

Simplifying, integrating, and automating the security tech stack can improve the efficiency of security teams and streamline security processes and operations.



TREND 6

Zero trust: Never trust, always verify

Security in the age of the porous perimeter

Conventional castle-and-moat cybersecurity models, which rely on secure network perimeters and virtual private network-based employee and third-party remote access, are proving to be no match for evolving cyberthreats, particularly as business models and workforce dynamics evolve. For instance, the move to cloud and hybrid IT environments—along with increasing numbers of cloud-based systems, remote workers, and connected devices—are constantly expanding and dissolving the network perimeter. The anticipated growth of smart devices, 5G, edge computing, and artificial intelligence promises to create even more data, connected nodes, and expanded attack surfaces.

With cloud now mainstream, businesses managing services across multiple cloud providers are responsible for securing these technologies. As an enterprise more frequently relies on third-party vendors to host and manage data, infrastructure, and other services, the attack surface expands. In one study, 59% of companies surveyed had experienced a data breach due to a vendor or other third party;[1] another study concluded that multiparty security incidents result in 13 times the financial losses of single-party events.[2]

In fact, while perimeter-based security assumes the trustworthiness of users and devices connected to the organization's network, stolen credentials cause more than a quarter of security breaches.[3]

Consider the case of an employee who logs in regularly on weekdays from her home and occasionally on weekends from a coffee shop. When her username and password are used on a Saturday night from somewhere in Eastern Europe, traditional approaches might allow the connection. But because a *zero trust* architecture is more risk-driven and context-aware, it recognizes the inconsistency, automatically denies the access request, and raises an alert. Automated response capabilities could be triggered to temporarily disable the user's account, given the likelihood that its credentials have been compromised.

Proper design and engineering of zero trust architectures can result in simple, modular environments and straightforward user access

control and management. Streamlining the security stack can eliminate considerable management headaches, significantly reduce operational overhead, and help scale to tens of thousands of users. Similarly, onboarding employees, contractors, cloud service providers, and other vendors can become more efficient, flexible, responsive, and secure.

Carefully designed zero trust architectures that embed automation and orchestration capabilities can amplify and work in concert with other automated IT practices such as DevSecOps and NoOps. The use of APIs across the technology ecosystem can facilitate system management in a zero trust manner by providing a consistent control layer. And cloud-based services enable organizations to leverage the substantial ongoing security investments of cloud vendors.

A final key element of the zero trust approach is microsegmenting networks, data, applications, workloads, and other resources into individual, manageable units to contain breaches and wrap security controls at the lowest level possible. By limiting access based on the principle of least privilege, a minimum set of users, applications, and devices has access to data and applications.

The anticipated growth of smart devices, 5G, edge computing, and artificial intelligence promises to create even more data, connected nodes, and expanded attack surfaces.

By removing the assumption of trust from the security architecture and authenticating every action, user, and device, zero trust helps enable a more robust and resilient security posture. The organizational benefits are complemented by a considerable end-user perk: seamless access to the tools and data needed to work efficiently.

As the benefits of zero trust continue to pile up, enterprises are catching on. The global zero trust market is expected to grow to US$38.6 billion by 2024, a 20% increase from 2019.[4]

Beefing up basic cyber hygiene

The zero trust mindset shift brings with it a set of design principles that guide security architecture development and build on existing security investments and processes. To enforce access control, companies must have situational awareness of their data and

assets; companies that lag on basic cyber hygiene principles and practices may be challenged to realize the full benefits of zero trust. Fundamentals include:

- **Data discovery and classification.** Data governance, inventory, classification, and tagging are critical. To create the appropriate trust zones and access controls, organizations need to understand their data, the criticality of that data, where it resides, how it is classified and tagged, and the people and applications that should have access to it.

- **Asset discovery and attack-surface management.** Many organizations lack a real-time, updated inventory of all IT resources—including cloud resources, IP addresses, subdomains, application mapping, code repositories, social media accounts, and other external or internet-facing assets—and therefore can't identify security issues across the complete attack surface. To facilitate risk-based policy decisions surrounding their assets, it's critical for organizations to understand the enterprise IT environment.

- **Configuration and patch management.** Without the ability to efficiently manage and document baseline configurations of key technology systems, deploy appropriate patches, test patched systems, and document new configurations, companies cannot easily identify changes and control risks to these systems. Malicious actors can exploit any vulnerabilities to gain a foothold within an organization.

- **Identity and access management.** To ensure that access to technology resources is granted to the proper people, devices, and other assets, enterprises need to standardize and automate their identity life cycle management processes. They can extend their operations beyond traditional boundaries while protecting critical resources and maintaining an efficient user experience by moving the identity stack to the cloud, consuming identity-as-a-service, or implementing such advanced authentication methods as physical biometrics, behavioral monitoring, and conditional access.

- **Third-party risk management.** To fully understand their entire risk surface, organizations need greater visibility into cyber risks related to their supply chains and ecosystem partners, including suppliers to third-party vendors.

- **Logging and monitoring.** To identify potentially malicious incidents and issues, security teams need automated logging and monitoring systems with advanced AI and machine learning capabilities to help simplify the process of tracking, analyzing,

and correlating data from volumes of detailed logs as well as alerts generated by internal and external systems, security controls, networks, and processes.

Engineered security automation and orchestration

Many security operations center (SOC) teams are challenged to keep pace with the volume of information generated by their technology and security controls. They must monitor, manage, and act upon continuous alerts and streams of data generated by fragmented security architectures and disparate, disconnected tools.

The number and nature of risk factors interrogated to support zero trust authentication and authorization—users, devices, or credentials and contextual data points such as location, privileges, application requirements, and behaviors—warrants a more automated approach to monitoring, decision-making, enforcement, and auditing.

Many existing security technologies can be leveraged to build out zero trust architectures. To ensure more efficient automation and orchestration, zero trust adopters should rationalize the security stack and eliminate unnecessary and duplicative technologies or those that contribute to data overload, delay detection and response, and complicate system maintenance and management.

With a simplified security stack, existing systems and tools can be integrated via API connections to a security orchestration, automation, and response (SOAR) platform that can automate workflows and repetitive and manual tasks, and coordinate the flow of data and alerts to the SOC. SOAR platforms help add context to triggered events and can auto-remediate identified and known vulnerabilities, enabling staff to keep pace with incoming alerts and notifications, improving operational efficiency and accuracy, and decreasing response time.

Many existing security technologies can be leveraged to build out zero trust architectures.

"Migrating to zero trust architectures can seem like a heavy lift, especially in large enterprises saddled with legacy technologies and a lot of technical debt," says a senior technology leader at a large financial institution. "You have to break it into manageable chunks where you can identify a discrete win, such as deploying pervasive endpoint segmentation, and understand that win as part of your larger story of operationalizing zero trust."

Rethinking the role of the cyber organization

Zero trust represents a philosophical shift in how security is managed and likely requires cultural change across the enterprise. Creating a culture in which all key stakeholders understand their vested interest in securing the enterprise can help build confidence in zero trust.

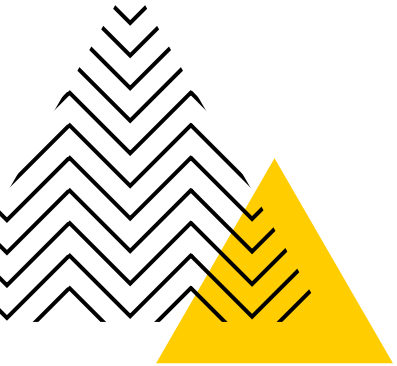
For example, zero trust could significantly change the day-to-day activities of the cyber workforce. To design and continually refine and evolve the zero trust architecture, enterprises likely will need more cyber engineering skills. And the role of the SOC will likely evolve as the security architecture takes command of manual, day-to-day tasks and processes, replacing them with more accurate machine-driven decision-making and faster response time and freeing SOC staff to focus on critical security issues and higher-risk incidents that require human analysis. Organizational structures will likely need to be reconfigured to account for new automated workflows, and it will be important to retrain security analysts to focus on strategic activities instead of tedious daily tasks.

In addition, to embed zero trust principles into every business initiative from inception, organizations will likely need more collaboration and integration between security teams and the lines of businesses they support. Business-function system owners likely will need to become more engaged in security planning. For example, to provide the security team with a better and deeper understanding of appropriate system behavior and access requirements, business partners can help identify who accesses and uses applications—and how. Business areas may need to become more intentional about system access, including limiting access privileges and making them more granular.

The way forward

The *zero trust* approach is not a product, solution, or platform—it's a philosophical shift in the way enterprises think about security. The process of migrating to an effective zero trust security architecture tends to be a marathon rather than a sprint, with organizations not only tackling foundational cybersecurity issues and embracing security automation and orchestration but preparing for the organizational and cultural changes that accompany such mindset shifts. To build confidence in zero trust, organizations will need to engage stakeholders ranging from cyber and IT to business area system owners and application end users. An iterative and incremental approach aligned to business objectives can help demonstrate the value of zero trust and enhance stakeholder confidence and acceptance.

LESSONS FROM THE FRONT LINES



Zero trust mindset enables digital growth

Like many global pharmaceutical companies, Takeda Pharmaceuticals supports better patient outcomes by innovating and collaborating across a diverse group of internal and external stakeholders—including, in its case, more than 52,000 employees and thousands of research partners, logistics partners, and other third-party service providers as well as patients, physicians, and other health care providers. The ongoing need to extend access to applications and systems to its broad external ecosystem spurred the Tokyo-based pharmaceutical giant to begin a journey toward a zero trust-based security architecture.

"We realized that the demarcation between internal and external was no longer relevant or scalable," says chief information security officer (CISO) Mike Towers. "The zero trust mindset—assuming that every request to connect is coming from an unknown access device on the internet that can't be predicted or controlled—is a much better way to move forward."[5]

Previously, access to an internal application would require granting access to the Takeda network, which inherently enabled access to a number of additional, unrelated services. "We could have tried to manually manage and restrict this additional system access, but, invariably, things will be missed over time," says Scott Sheahen, global head of information risk management. "With the zero trust approach, we eliminate superfluous system access and thereby reduce the avenues that could be exploited in a future cyberattack. Now we have granular, policy-based controls so that people have access only to needed resources."

This approach provides users with a more efficient way of navigating Takeda's complex technology environment—a mix of cloud-based applications and services and legacy systems residing on internal servers and in data centers—and eliminates the difficulty of accessing systems via multiple firewalls and VPNs. The transition to zero trust, well underway before COVID-19 struck, helped the company securely manage the sudden shift of its global workforce to a work-from-home model. "Our China workforce, the first affected by the pandemic, had less experience and comfort with work-from-home, so it was really important for us to get it right,"

Towers says. "By having shifted to zero trust-based access, we were able to aggressively and quickly move China to the work-from-home model."

Setting clear expectations with business partners is critical during the transition, says Thomas Likas, global head of security architecture and engineering. He recommends that security and IT organizations planning a zero trust migration engage with business partners from the beginning of the journey. "The business—not IT—has the best understanding of how people access and use their applications," he says. "In the zero trust world, the business will need to determine who should have access to their systems and data."

Indeed, Likas continues, "this knowledge needs to be baked into the access model from the very beginning. To business partners, this might seem like a lot of work, but as a bonus, the organization gets a solid understanding of their application landscape."

Towers believes that once leaders understand the numerous benefits, most companies will inevitably adopt the zero trust mindset. "Frankly," he says, "I don't think that businesses can digitally or technologically scale in any other way."

Zero trust secures the "new perimeter"

A zero trust approach is helping Halliburton, a global provider of products and services to the energy industry, meet its strategic business goals and objectives. Several years ago, as part of a drive to be more operationally efficient, the company began adopting cloud, mobile, and Industrial Internet of Things platforms to reduce costs and improve productivity. At the same time, Halliburton's vendors and suppliers began pushing their products and services to the cloud. "With the dispersion of our computing resources from the data center to the internet, we realized that our traditional network perimeters were dissolving," says Mary Rose Martinez, CISO and senior director for IT architecture.[6] "This impelled us to develop a zero trust strategy."

Halliburton's zero trust approach revolves around securing people, network connections, and data. "We are moving toward a reality where it doesn't really matter if employees are on the network or not," Martinez says. "The new perimeter is identity, whether user identity, endpoint device identity, or service identity."

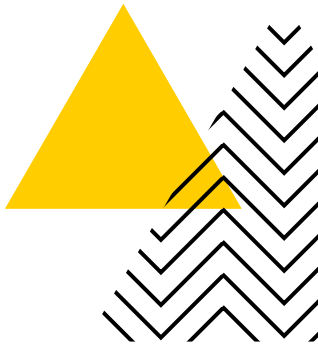
When Halliburton began its zero trust journey about two years ago, it focused first on securing mobile devices through multifactor authentication—using identity credentials, an authenticator, and registered devices. Soon after, the company migrated to cloud-

based identity providers to further secure its people. Over time, the number of applications accessible without using a VPN continues to grow. A longtime adopter of the principle of least privilege, data encryption, and other data controls, the company is also working to enhance the classification and protection of unstructured data.

The more granular security controls that are part of Halliburton's zero trust approach have created a more disciplined security posture. Because it controls user devices and endpoints, the company can push policies to any device via the internet. And because VPN access isn't required for the zero trust-enabled applications, employees have a considerably improved user experience.

Martinez is quick to emphasize that zero trust is not only a technology initiative—it is also a people initiative. For example, whether Halliburton employees are on the company network or the internet, in the office or at home, they receive a verification prompt before accessing applications protected by multifactor authentication. This workflow change required education and awareness. And it is incumbent on users to guard their credentials and devices. "Raising security awareness has to be part and parcel of the zero trust approach," Martinez says. "An ongoing education program that includes increasingly sophisticated phishing simulations can help people become more aware."

Halliburton's adoption of zero trust is an ongoing journey, with many components that are constantly moving and changing shape. "Because of the fluid nature of technological advancements, the end state will probably always be a moving target," Martinez says. "But we've laid a foundation that's both solid and adaptable, and upon which we can continue to build over time."



MY TAKE

John Kindervag

Field CTO,
Palo Alto Networks

When I worked as a security analyst, I became fascinated by how people and businesses anthropomorphized their digital environments by applying the concept of trust to computing—that somehow a device could be trusted and that it cared that it was trusted.

Back then, many CISOs and CIOs adhered to the idea—and many still do—that what's inside the corporate firewall can be trusted. This idea of *inside versus outside* became a variable that was used to determine security policy, with many organizations operating under the adage "trust, but verify." In the trust-but-verify model, trust is the default. When identity is verified, trust is assumed and access is granted.

But trust applies only to people—not digital environments. Identity credentials can be stolen, networks can be hacked, and insiders with

bad intent are often in positions of trust. This means it's impossible to know with certainty that the originator of network traffic can truly be trusted: An asserted identity is only an assertion, not an actual person.

In response to what CISOs and CIOs told me about their cybersecurity strategies, I created the concept of *zero trust*, which is framed around the principle that no network user, packet, interface, or device—whether internal or external to the network—should be trusted. Some people mistakenly think zero trust is about making a system trusted, but it really involves eliminating the concept of trust from cybersecurity strategy. By doing this, every user, packet, network interface, and device is granted the same default trust level: zero.

Zero trust should be thought of as a strategy or framework. It requires companies to rethink their philosophy and approach to trusted network users and devices. Zero trust is not a product, although zero trust-based security infrastructures can be implemented by using many different products. Nor does zero trust require organizations to rip and replace existing security infrastructure—rather, it leverages existing technology to support the zero trust mindset, with new tools added as needed.

The hallmark of zero trust is simplicity.

The hallmark of zero trust is simplicity. When every user, packet, network interface, and device is untrusted, protecting assets becomes simple. To reduce the complexity of cybersecurity environments, organizations can prioritize security technologies and tools that support simplicity by automating repetitive and manual tasks, integrating and managing multiple security tools and systems, and autoremediating known vulnerabilities.

Zero trust is a journey best taken one step at a time. I recommend that organizations begin by prioritizing the smallest possible protect surfaces—a single data set, asset, application, or service—depending on the level of sensitivity or business criticality. Then, they can create a microperimeter around each protect surface and granularly control the traffic allowed into the perimeter.

I encourage security teams to learn and practice on less sensitive protect surfaces, moving to protect increasingly more sensitive or valuable protect surfaces as they fine-tune their approaches and their confidence increases. Over time and with lots of practice, they'll be ready to migrate their most critical assets to the zero trust environment. Finally, when high-value assets are protected, teams can focus on less important assets. And by continuing to maintain a zero trust mindset, organizations can protect themselves even as security technologies and tools evolve.

EXECUTIVE PERSPECTIVES

STRATEGY // The stakes are high for CEOs when it comes to cyber risk. Beyond the damage that security breaches can have on companies, shareholders, and customers, they can end careers. CEOs are often answerable to the public for their organization's security posture, especially as it relates to consumer data, and they should thus approach this topic as the stewards of the organization's brand reputation and trust. By appointing a CRO, CISO, or other appropriate leader, they can look to new security postures such as *zero trust* that simplify protection of data, people, and networks without sacrificing user experience. Setting security priorities from the top can help the organization align on the importance of strengthening cyber defenses.

FINANCE // Reporting on cybersecurity breaches is among the CFO's more unpleasant responsibilities. When these events happen, CFOs are often on point, reporting to auditors and answering to the board, regulators, and the public. In a time when cyber risk is increasing and bad actors regularly test organizational defenses, CFOs should develop and maintain technology fluency and the awareness they will need to mitigate cyber events. Moreover, they should clearly understand the risks and rewards of their company's security posture—particularly as it applies to key strategic, physical, and financial assets—and then improve security by enabling zero trust adoption. Ultimately, the CFO—working in tandem with other risk and security leaders—can become a de facto crisis manager, working to predict and prevent threats to brand reputation, shareholder trust, and more.

RISK // Zero trust is fast becoming the modern standard for managing infrastructure, network, and data in a more secure manner. Despite the concept's broad benefits, many see it as solely a technology issue. To change that, over the next 18–24 months, CROs should consider placing zero trust adoption at the top of their agendas. CROs can first clarify the security benefits to the organization and then work with the CIO, CISO, and other leaders to enforce the new approach. Thorough adoption can eventually help risk posture and processes evolve in lockstep with innovation while reducing the frequency of cyber incidents.

ARE YOU READY?

KEY QUESTIONS

1. How far are you on your journey moving away from network and server "zones of trust"? What is your next step?

2. How could you improve the skills and capacity of your cybersecurity organization relative to today's challenges? What about tomorrow's?

3. How can you better involve business-function system owners in security planning? Would their help in identifying areas requiring more restricted access improve the overall security posture?

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AUTHORS

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Deborah Golden

US Cyber & Strategic Risk leader

Deloitte & Touche LLP

debgolden@deloitte.com

Mark Nicholson

Cyber & Strategic Risk marketplace development leader

Deloitte & Touche LLP

manicholson@deloitte.com

Kieran Norton

Cyber & Strategic Risk infrastructure security solution leader

Deloitte & Touche LLP

kinorton@deloitte.com

Arun Perinkolam

Cyber & Strategic Risk core infrastructure and network offering leader

Deloitte & Touche LLP

aperinkolam@deloitte.com

Andrew Rafla

Cyber & Strategic Risk zero trust offering leader

Deloitte & Touche LLP

arafla@deloitte.com

SENIOR CONTRIBUTOR

Wil Rockall

Partner, Deloitte MCS Limited

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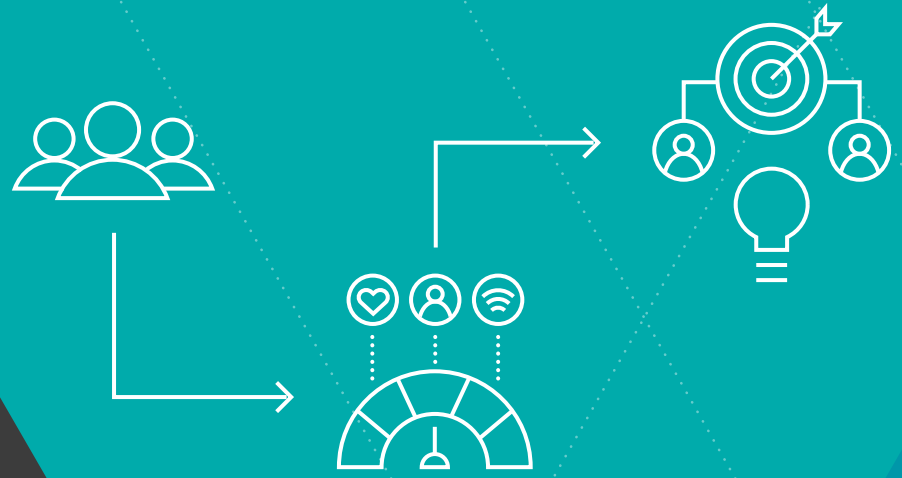
Rebooting the digital workplace

MEASURE AND MANAGE

The digital workplace's technologies and tools can help employers gain insights that enable them to identify patterns, make predictions, nudge behaviors, and fine-tune performance.



WORK IN NEW WAYS

Data and insights from the digital workplace can help organizations improve work processes and employee experience to create better outcomes.

OFFICE OF THE FUTURE

As the office becomes a hub for collaborating, innovating, and meeting, digital technologies can augment the onsite work experience.

TREND 7

Rebooting the digital workplace

Data can drive new ways of working remotely and in the office

Driven by COVID-19, the abrupt shift to remote work as the default for much of the labor force has altered work as we know it. One study found that only 15% of those employed pre–COVID-19 worked from home; these workers were joined after the pandemic by an additional 35%, suggesting that fully half of the employed labor force now works from home.[1]

With the work-from-home cat out of the bag, it could prove challenging to coax these professionals back to prepandemic levels of in-office work. Staffing firm Robert Half found that 60% of professionals who had transitioned to a remote setup said they have better work/life balance, and that 74% of respondents would like to continue to telecommute more after pandemic restrictions are eased.[2]

As organizations manage a growing number of offsite employees—working from home or other nontraditional workspaces—many are beginning to accept the inevitability of a digital workplace where work is completed by a mix of onsite and remote workers that must operate in synchrony to meet business objectives. Some leaders approach the prospect of the digital workplace with a number of concerns:

- **Productivity.** Distractions and poor supervision could impede collaboration and derail productivity, and the lack of social support might lead to high employee dissatisfaction and turnover.
- **Relationship building and onboarding.** Strong existing relationships typically remain so after a remote work transition, but weak ones often erode. And it can be challenging to virtually cultivate new relationships and onboard new employees.
- **Development and learning.** It could be difficult for workers to virtually develop and maintain skills and professional networks they need to advance.
- **Impact on innovation.** The loss of serendipity—the unexpected and opportune employee interactions that fuel exploration and invention—could have a long-term negative impact on innovation.

Companies may be able to overcome the digital workplace's deficits and ambiguities by more intentionally embracing its positive aspects, including the data generated by workers' tools and platforms. This can help organizations optimize individual and team performance and customize the employee experience through personalized recommendations, enabling remote work to be far more than a diminished proxy for the traditional office. And as onsite workspaces and headquarters evolve, organizations can use this data to create thriving, productive, and cost-effective offices that are seamlessly interwoven with the remote experience.

The digital workplace is more measurable and manageable

If it's true that you can't manage what you don't measure, then the digital workplace is eminently manageable. Its technologies and tools can help employers gain insights ranging from individual employee performance to team-level productivity to companywide morale, enabling them to identify patterns and make predictions, nudge positive employee behaviors, and fine-tune individual, team, and organizational performance.

Enabling technologies include people analytics solutions that help deliver actionable insights on employee and team behavior and productivity, AI-driven personal productivity assistants and other artificial intelligence (AI) technologies that use workforce data to make personalized recommendations to optimize performance, and workflow management solutions that streamline work processes and automate decision-making, actions, and responses.

On the backend are strong cybersecurity solutions, such as zero trust architectures (as discussed in the chapter *Zero trust: Never trust, always verify*), along with hybrid and multicloud environments and services that support secure remote access and scale with flexing workloads. Of Deloitte's own experience in rapidly enabling its workforce, unified communications infrastructure lead Aaron Roe notes that previous infrastructure upgrades proved their value. "Because we had already moved to cloud-based unified communications, we were able to migrate the entire firm to remote work in less than four days without overloading our data centers," he says. "And our move to a zero trust security model allowed employees to securely access needed resources without using a VPN."[3]

On top of these foundational technologies, organizations can layer tools such as organizational network analysis, which is currently used to track organizational information flow. Such analysis can help gauge remote workforce connectivity—for example, identifying isolated employees and measuring interactions between and among teams.

Workplace social media can help teams tap into the power of the entire workforce, regardless of location, to generate ideas and collaborate, democratizing formerly privileged exchanges of ideas. And with research demonstrating that videoconferencing's traditional grid of boxes taxes people's brains and causes fatigue,[4] new videoconferencing solutions based on virtual and augmented reality stand ready to enable persistent, simulated collaboration environments—such as those found in online video games—where users can meet, communicate, interact, and collaborate in a more natural-feeling setting.[5]

Finally, with collaboration tools now ubiquitous, a collaboration ecosystem strategy can help optimize technology investments in chat-based workspaces, video and phone conferencing, individual and team project and task management, whiteboarding and brainstorming, file-sharing and storage, and other tools. This can help enterprises curate these collaboration tools and seamlessly integrate, architect, and use them in a coordinated manner to reduce confusing or repetitive workflows and alerts. Not only can this improve team productivity—it can improve the quality of data and insights that help leaders better understand and manage their employees.

Measuring employees' digital activity provides an additional opportunity for employers to lean into the ongoing move away from decision-making based on gut instinct and assumptions. Transparency about how they plan to use the data—and what they're measuring and why—can help organizations manage privacy concerns. And rather than focus on individual performance, they can aim to identify and bend overarching trendlines by aggregating and anonymizing data.

The next-level ability to measure and manage will drive new ways of working

The transition to the digital workplace could follow a path reminiscent of the evolution from analog LPs to digital CDs and, later, to MP3s and streaming services, which ushered in measurability, portability, scalability, and countless other benefits. The resulting data enabled services to suggest songs and artists to users based on previous listening habits, creating a better and more tailored fan experience.

Similarly, by understanding data and behaviors that most closely correlate with workplace success and failure, companies stand to improve work processes and create personalized employee experiences that create better engagement *and* outcomes.

The most agile companies will investigate the patterns remote workers are encoding in data and use them to develop new ways of working. As ways of working and collaborating are standardized, the knowledge that can be extracted from emerging work patterns will become more precise and more valuable.

If it's true that you can't manage what you don't measure, then the digital workplace is eminently manageable.

Employee engagement and well-being. In a remote situation, managers may be unable to readily identify employees who are at risk for low productivity or in danger of leaving. With data generated by the digital workplace, managers can identify employees suffering from emotional stress and burnout and proactively intervene to address such challenges as low engagement and lack of inclusivity.[6] Psychographic data such as boredom, stress, and fatigue levels can help leaders better allocate tasks and ensure that employees are appropriately challenged and empowered to manage their career goals and be productive while avoiding burnout.

Flexible workplace 2.0. Digitization unlocks a new era of workplace customization. In the same way that streaming music services offer individual users customized, data-driven experiences based on personal tastes, remote workforce data and predictive analytics can help organizations provide employees with high-quality, customized experiences—a mix of benefits, rewards, assignments, and learning based on personal experiences and tacit and explicit preferences. The digital coach of the future—enabled by organizational AI—could offer employees assignments predicted to be both interesting and skills-aligned. The coach "knows" the skills and experiences that each employee needs to be optimally challenged and makes suggestions to improve behavior, collaboration, and specialized skills in real time.

Digital serendipity. Data generated by collaboration channels can map worker interactions and relationships, revealing informal structures that are often more influential than formal organizational design. It could identify workplace relationships that could be proactively developed or strengthened to foster serendipitous, cross-disciplinary connections that help drive innovation. Virtual connection-building tools can nudge contacts between individuals and teams, make customized recommendations to link employees with mentors and like-minded colleagues, and support onboarding by connecting new hires with teammates

and peers. Gig platforms, or internal talent marketplaces, can help connect employees with internal and external opportunities, mentorships, stretch assignments, and rotation programs and enable managers to find needed skills.

The office is dead, long live the office!

While the office may be undergoing a pandemic-driven existential crisis, it's not down for the count. (The everyday commute, on the other hand, appears to be on life support.) However, just as e-commerce changed the way consumers and retailers think about brick-and-mortar storefronts, so is the forced mass adoption of remote work changing the way employers and employees think about the physical workplace.

For example, even though employees desire the flexibility to work remotely, most aren't ready for an online HQ. In one survey, nearly three-quarters of workers said they prefer a balance of working at home and in the office.[7] The primary draw of the office, according to another study, is face-to-face human connection,[8] particularly for millennials and Gen Z workers.[9]

While the office may be undergoing a pandemic-driven existential crisis, it's not down for the count.

How do we reconcile these competing needs? The office may not be dead, but it's unlikely to return in its previous incarnation. Employers could find that creating exciting environments that employees are eager to experience is the best way to entice them back to the office. Perhaps, as architecture and design firm Gensler predicts, the post–COVID-19 workplace will shift from a place where people work to a place where teams meet, socialize, and connect.[10]

The smart money is on flexible and configurable work environments, technology-driven workplace services, and new ways of managing fewer people and less space without sacrificing collaboration and innovation. As the office evolves to become both a collaboration hub for project teams and a creative center for client meetings, employees can expect a hybrid work style that supplements working from home with targeted in-office experiences, especially for critical events such as onboarding. And while coworking spaces took an immediate occupancy hit when COVID-19 first struck, in

the long term, they could be a more flexible, less expensive office alternative for businesses that are canceling or renegotiating their leases.

Offices of the future will likely be infused with the same digital technologies and tools used in the remote workspace. The same capabilities that enable a personalized employee experience in the digital workplace can similarly augment the physical workplace experience.

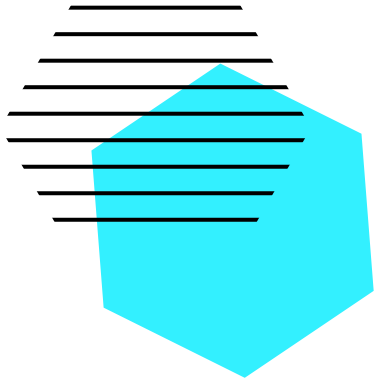
The office will likely be retooled to more easily permit virtual, multidirectional collaboration with remote workers. For example, in Deloitte offices, all conference rooms, phone rooms, and other closed-door meeting spaces will be enabled for video with platform-agnostic videoconferencing solutions that integrate all leading applications. Teams are exploring how technologies can create parity of experience between people meeting in the office and remote participants. Deloitte's boardroom, featuring individual cameras with advanced optics and noise-canceling microphones at each seat to provide remote attendees with a more realistic experience, serves as a model for how such parity might be achieved.

Organizational AI can help teams organize the dates, times, and locations of in-office meetings to maximize the value of space and promote team interactions. And with good office design, companies can measure the impact of traditional office orthodoxies such as in-person conversations, water-cooler discussions, and spontaneous hallway encounters that generate real business value. Yet the return on investment for the office of the future will likely be more carefully examined than it has in the past.

The way forward

In the wake of the mass forced adoption of remote work, many organizations are considering how to configure and manage a digital workplace in which work is completed by both remote and onsite workers. The data generated by workers' tools and platforms can help organizations fine-tune individual productivity and team performance, deliver customized employee experiences, and optimize the use of office space. As employees return to the office, this data can also help remote and onsite teams work in concert and ensure the parity of remote and in-office employee experiences.

LESSONS FROM THE FRONT LINES



New tools, good timing support remote work rollout

New tools and good timing helped Thomson Reuters navigate the pandemic-driven shift to remote work, says Rob Newnes-Smith, CTO of digital, employees, and partners for the business information services and global media company.[11] When the majority of its 25,000 employees began working from their homes in March 2020, Thomson Reuters was putting the finishing touches on a major global rollout of cloud-based enterprise systems and platforms, including collaboration and productivity tools that made it easier for employees to quickly adapt to remote workflows and maintain productivity.

A significant portion of Thomson Reuters employees were accustomed to periodic virtual work, but these previous experiences provided only partial insights into the impact of long-term remote work and lockdown isolation on well-being, especially when other factors such as home-schooling and care for elderly relatives were in play. Company leaders recognized the importance of extending the corporate culture to the home workplace. The use of videoconferencing tools became the norm for daily meetings while the use of desk phones faded. In many cultures, a deep-rooted sense of formality toward behavior in the work environment made some employees feel awkward about the casualness of working from home. Team leads cultivated authenticity and compassion by modeling more relaxed attire and the use of home areas not typically seen as office space, with perceived erosion of boundaries such as videoconference interruptions by children or pets.

Having successfully enabled its employees to be productive in the remote work environment, Thomson Reuters is working to define the postpandemic workplace experience. Its well-timed modernization of enterprise systems puts the company in a good position to adapt to “the next normal” with access to personalized, consumable information, improved use of automation and AI to complement self-service functionality, and richer levels of insights available for the executive leadership team. Newnes-Smith envisions employees routinely dividing their time between regional hubs and their home offices so that they can enjoy the best of both worlds: face-to-face collaboration, socializing, and unplanned

interactions along with the flexibility of telecommuting to create an improved work/life balance.

Moving forward, the Thomson Reuters HR, real estate, and technology teams are deliberately reenvisioning in-office technologies, including integrated communication and collaboration platforms, new tools such as smart whiteboard technology, idea management software to crowdsource innovative ideas from employees, predictive talent insights, automation of key talent acquisition base processes, and AI-based tooling as part of a new learning system platform. "We plan to leverage our collaboration platforms to create a frictionless, seamless experience as employees move between their chosen places of work," he says.

Ensuring equity between in-office and at-home work experiences is critical. As we move into the ninth month of COVID-19, Thomson Reuters continues to hone its use of various collaboration tools to ensure employees' voices are heard and faces are seen. "When everyone is an equal square on a screen," Newnes-Smith says, "it has a way of leveling the interaction, whether you're located at home, in an airport, or in the office."

Lloyd's of London accelerates innovation with virtual underwriting room

When the COVID-19 pandemic hit the United Kingdom, Lloyd's of London—the renowned commercial insurance marketplace that intermediates between clients, underwriters, brokers, and insurance companies—closed its market floor, known as the underwriting room. From their hastily set up home offices, brokers and underwriters transitioned from in-person deal-making to electronic trading.

It was a dramatic change for participants in the insurance market, which had never in its 330-year history halted in-person trading.[12] Traditionally, the four-story underwriting room is a bustling trading hub packed with insurance brokers and underwriters who conduct face-to-face meetings to negotiate deals between policy buyers and sellers. On a usual day, the underwriting room hosts about 5,000 market participants; around 45,000 people have badges to enter. "Historically, the market floor is the heart of Lloyd's. Business is grounded in the physical space, where brokers walk the market floor and wait in queues to see which underwriters are at their booths and whether they might be interested in insuring a particular risk," says product owner Sam Irving. "COVID-19 was a monumental event because it completely disrupted these well-established workflows."[13]

As Lloyd's worked toward a phased September reopening, leaders looked to leverage digital

technologies to make connecting more operationally resilient, instead of simply returning to business-as-usual in the physical underwriting room. "This wasn't a completely new idea for us, but the pandemic's challenge to the old ways of working really accelerated our thinking," Irving says.

Leaders decided to develop a virtual underwriting room that would complement Lloyd's' in-person counterpart. This meant identifying gaps in the existing electronic trading experience, such as the ability to schedule on-the-fly meetings, ask and answer quick questions, and meet spontaneously—the hallmarks of the market floor. The goal was not only to improve the current work-from-home experience but to leverage those learnings to improve the traditional in-person trading process.

On an accelerated timeline—and backed by an extensive research and design process that centered the needs of brokers and underwriters—Lloyd's established a virtual room that connects brokers and underwriters via digital collaboration platforms, enabling them to schedule trading conversations with colleagues in different locations around the world. The virtual room includes searchable broker and underwriter profiles and a market directory, availability settings, and flexible chat functionality. This allows brokers to search for underwriters by specialty, view underwriter profiles, see who's free for an immediate chat, and schedule meetings or videoconferences. The market directory and profiles help underwriters promote themselves by providing more visibility into the types of opportunities they're seeking.

Lloyd's unveiled its virtual underwriting room to selected users in tandem with the September reopening of the market floor. The goal is for the virtual and physical rooms to work in synergy and provide equally efficient and supportive experiences whether the user is trading remotely or on the market floor. For example, the market directory improves the efficiency of brokers in the physical underwriting room by enabling them to check underwriters' availability without walking around the market floor, and as market profiles develop, this could help brokers confirm underwriter interest in potential deals without standing in queue.

An unintended benefit of the virtual room is that publishing users' availability can aid their work/life balance. "Working from home removed the traditional end-of-the-day boundary of physically leaving the market floor and going home, and people routinely contacted each other on their mobile phones during nonwork hours," Irving explains. "Setting their availability gives remote users more control over developing and maintaining work/life boundaries."

Lloyd's continues to build on the initial launch of the virtual underwriting room, adding and improving features and releasing improvements weekly. Top priorities for the future include virtual queuing, integrated calendars, and mobile applications.

Human-centric technology critical to workplace redesign and workforce performance

COVID-19 has made a permanent imprint on the way workplaces operate, forever changing how people work—and where they work. Many business leaders are trying to determine how these new ways of working will affect their organizations—and their real estate portfolios. Commercial real estate services company JLL, which has long tracked trends in workplace strategies, design, and technologies, expects the road to the "next normal" to be fluid and complex.

COVID-19 has accelerated the transformation of the workplace by five to 10 years, says Marie Puybaraud, JLL's global head of corporate research, who specializes in the study of human performance and the human experience at work.[14] "The distributed workforce that we're seeing now was always going to happen, but we were expecting a slower evolution," she says. "The pandemic simply sped up the timeline."

JLL's research shows that high-performing workers have flexible work hours and remote work opportunities—but that during lockdowns, these high performers missed being in the office more than others. "While remote work seems to have a positive effect on performance, workers are not ready to abandon the office, because collaboration with colleagues and the ability to manage or feel supported waned during the pandemic," Puybaraud says. "Therefore, we don't expect office environments to retain traditional designs. We have a flexible workforce, and we will need workplaces to be equally adaptable."

For example, instead of a single corporate HQ, a business might have multiple smaller offices that are geographically distributed to maximize available talent pools, with employees dividing their time between home, corporate offices, and other co-working places. Puybaraud sees this as the New Golden Age of the Worker—and sees a worker-centric approach as critical in redesigning these workplaces.

Nearly half of workers who participated in a recent JLL survey say they desire offices with dedicated areas for socializing, connecting to nature, and learning, as well as doing focused work. Typically, however, about two-thirds of space in today's office environments is reserved for individual work, with only around

a third set aside for collaborative purposes. To meet the needs of the future workforce, these proportions likely will need to flip, with roughly three-quarters of the workspace for collective use and the rest set aside for individual work.

This likely will require businesses to significantly retool and redesign their office environments to meet workforce preferences and reenvision the workplace as a social hub to boost human experience and performance. JLL is exploring how artificial intelligence, virtual and artificial reality, 3D modeling, and other technologies can help push the built environment beyond its current limits. Besides transforming the physical workspace, technology can enable the dispersed workforce to collaborate and innovate effectively. For example, future technology platforms need to enable those who aren't physically present in future collaboration spaces to interact naturally and productively with those who are.

The success of the mass work-from-home experiment conclusively proved the value of technology, Puybaraud says. "Technology established itself as a successful enabler of remote work. By and large, businesses were able to continue to operate efficiently because of technology platforms. However, with employees dispersed among multiple office locations and home offices, companies will probably need to expand those platforms as we move forward. There is a lot of opportunity for new solutions that deliver more realistic, engaging, human-centric experiences. While nothing can replace the real-world interactions that most people crave, technology can make interactions between on-site and remote colleagues even more efficient."

MY TAKE

Dan Torunian

Vice president, employee technology and experiences and data centers, PayPal

When COVID-19 caused PayPal to move our 23,000-plus employees from 90 onsite locations to a work-from-home model, our emphasis evolved from ensuring their safety to improving efficiency.

But as it became clear that the workforce would remain offsite for the foreseeable future, we shifted our focus, using the rapid move to remote work as an opportunity to reexamine the ways we work together in teams and as a company.

To achieve our business goals and continue to provide a world-class experience to all employees—whether onsite or offsite—we are developing new ways of working and collaborating. Our goal is to enable the workforce to be productive in terms of velocity and output while also promoting learning, innovation, and collaboration. And we want to help employees address some of the fundamentally human

challenges of working away from the corporate office.

Before the pandemic, work processes, collaboration tools, communication channels, learning opportunities, and culture—even the way we socialized with colleagues—were necessarily optimized for the traditional workplace. For example, about half of our employees work in operational roles in customer service, collection, and fraud. Before the pandemic, they worked in highly controlled, metrics-oriented call centers; their colleagues were all within arm's reach. COVID-19 required us to evaluate the sustainability of such traditionally designed teams. Now, these same employees are working solo—or with roommates, spouses, and children—in unstructured home-office environments. They're still meeting their productivity goals, but with new challenges related to communicating, collaborating, skill-building, and networking as well as such inherently human challenges as sustaining social connections with colleagues, managing family members during work hours, and maintaining work/life balance. The digital workplace requires employers to reengineer the way their people connect, communicate, collaborate, and support each other within and across various functional areas.

With most or all employees operating from their homes, it's incumbent upon employers to optimize remote worker experiences, intentionally evolving them to be as efficient and delightful as onsite experiences are.

With most or all employees operating from their homes, it's incumbent upon employers to optimize remote worker experiences, intentionally evolving them to be as efficient and delightful as onsite experiences are. Moving forward, for example, we're looking for ways to tailor the digital collaboration process: We're exploring how to deliver the same capabilities and experiences across multiple collaboration platforms so that each employee can work with others using their preferred tools.

Employers can also identify and nurture local and regional working norms, differences in IT infrastructure, and technology preferences that could affect employee work styles and processes. For instance, bandwidth capacity, internet support, and network capabilities, along with cultural differences in attitudes toward working from home, vary among regions. Understanding and adapting to such factors can help companies

further differentiate and customize the employee experience.

It's also important to capture the natural feeling of tapping a colleague on the shoulder and spontaneously grabbing a coffee—a feeling that's missing from formal videoconference invitations. To help with this, we created an app that randomly pairs interested employees for virtual coffee breaks. We envision expanding it to create a virtual environment where users feel as though they're enjoying coffee together in their favorite café, instead of staring at a square on a screen.

The rapid move to remote work provided PayPal and other organizations with an unprecedented opportunity to reexamine people's ways of working. Ultimately, this will help our employees effectively meet business objectives and serve customers in more than 200 countries while enhancing the experience of working from a corporate workspace, bedroom office, coffee shop, or hot desk.

EXECUTIVE PERSPECTIVES

STRATEGY // For many CEOs, this year's comprehensive shift to remote work remains top of mind. Leaders who are eager to improve the work experience can look to new digital tools that monitor online interactions to explore short-term improvements such as better collaboration as well as longer-term innovation. The virtual office also offers an opportunity for leaders to practice and promote radical transparency in communication. Still, CEOs should be highly purposeful in architecting their goals for remote work, as the choices they make can affect company culture well beyond the pandemic. They can either help employees feel more connected than ever to each other and to the company's vision or leave them feeling disconnected and alone in the new normal.

FINANCE // The challenges of the rapid-onset digital workplace continue to be top of mind throughout the C-suite and broader organization. CFOs should consider the potential financial impacts of these challenges, including the downsizing of large, urban offices into dynamic, smaller workspaces. But they should also anticipate potential costs of diminished productivity and creativity, as employees no longer congregate physically. In virtual settings, we often lose the ability to read social and facial cues, or to brainstorm during informal, water-cooler conversations. Finance leaders can lead differently in remote work by setting a strategy to address some of these gaps in the new workplace—for example, they can implement AI tools to analyze meetings in real time and nudge decision-makers to solicit opinions from quieter participants.[15] Whether or not companies adopt such technology measures, people will look to CFOs to find ways to support employees' well-being and their ability to deliver outcomes that sustain the company.

RISK // This year's jarring shift from onsite to remote work offers CROs an opportunity to redefine security standards for remote collaboration. For example, home networks now process the same level of workloads as corporate networks, and the increase in VPN usage means increased commingling of company data and personal devices. As digital collaboration and file-sharing become routine, risk leaders should try to respond constructively to the increasing pace of change without hampering the organization's ability to keep pace with the market. They can work closely with the CIO and CTO to assess upcoming changes to collaboration tools and decide on a risk posture that works for the near term. Risk leaders can also anticipate further challenges and changes as a broad return to corporate offices takes place.

ARE YOU READY?

KEY QUESTIONS

1. How do you assess employee and team performance of remote workers? What steps are you taking to improve performance?

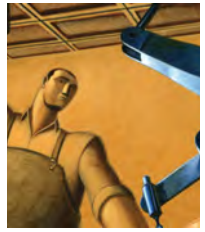
2. What steps have you taken to virtually nurture the spontaneous employee connections and dialogue that drive innovation?

3. What have you concluded about the long-term role of physical workspace? How will office design and technology tools support optimal collaboration and productivity?

LEARN MORE

The future of cloud-enabled work infrastructure

Study the cloud solutions, security, and DevOps methodology that can make virtual business infrastructure work.



Future of Work collection

Survey the latest changes in store for the workplace, workforce, and the nature of work itself.

Superminds, not substitutes

Navigate the future of human-machine collaboration in the workforce as AI adoption grows.

AUTHORS

Our insights can help you take advantage of emerging trends. If you're looking for fresh ideas to address your challenges, let's talk.

Steven Hatfield

Global Future of Work leader

Deloitte Consulting LLP

sthatfield@deloitte.com

Robin Jones, PhD

US Workforce Transformation leader

Deloitte Consulting LLP

robijones@deloitte.com

Content developed in collaboration with **Annie Dean**, director of remote work, Facebook. Dean was previously VP of workforce transformation, Deloitte Consulting LLP.

SENIOR CONTRIBUTORS

Jeff Schwartz
Principal,
Deloitte Consulting LLP

Yasar Butt
Director,
Deloitte MCS Limited

Julie Olivieri
Senior manager,
Deloitte & Touche LLP

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

Gordon Lavery
Manager,
Deloitte MCS Limited

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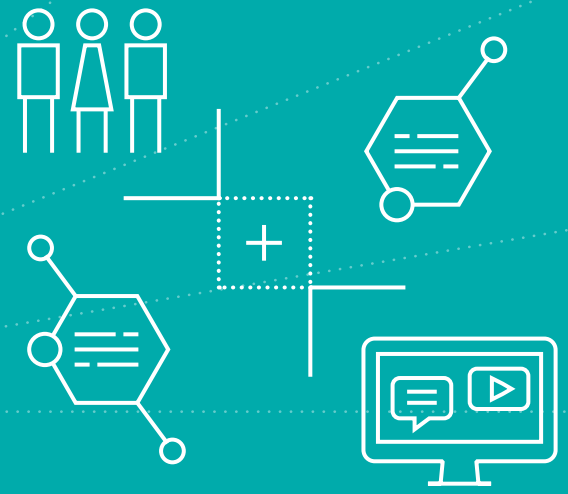
Bespoke for billions: Digital meets physical



PHYSICAL + DIGITAL MERGE

Customer journeys integrate in-person and digital elements to create compelling, customized brand experiences.

DESIGN FOR AN AUDIENCE OF ONE

Designers and coders tailor human experiences to the individual's behaviors, attitudes, and preferences.

TECH SCALES TRUST

Thoughtful design amplified by trust-enabling tech supports a future with bespoke, human experiences.

TREND 8

Bespoke for billions: Digital meets physical

Creating human experiences at scale

During the COVID-19 pandemic, a tailor on London's Savile Row—unable to travel to customers—found himself measuring clients two continents away in Seoul for bespoke suits ... with the assistance of a robot.[1] By necessity or choice, people have increasingly embraced digital interactions in all aspects of their everyday lives, whether in working remotely, online schooling, or ordering groceries.

Yet our growing reliance on digital interactions has left many of us pining for more personalized human experiences. In Deloitte surveys conducted during the pandemic's early months, more than half of the participants said they wanted their virtual experiences to feel more "human."[2]

In what we recognize as an emerging trend, consumers are becoming less satisfied with distinct physical or digital experiences. They want the best of both: personalized interactions combined with the convenience of digital. During the next 18 to 24 months, we expect to see leading companies embrace the *bespoke for billions* trend by exploring ways to use human-centered design and digital technology to create personalized, digitally enriched interactions at scale.

The trend carries a degree of urgency, for one simple reason: Customers are impatiently waiting. Two-thirds of participants in a spring 2020 Deloitte survey said they had already tried a new digital experience—virtual concerts, social gatherings, government transactions, or something else. These digital alternatives to in-person activities initially seemed adequate, but the law of diminishing returns quickly asserted itself.[3] As it turns out, many of the digital experiences that have become mission-critical leave customers wanting more, which is hardly a recipe for long-term success.

Our growing reliance on digital interactions has left many of us pining for more personalized human experiences.

What does a bespoke digital experience look like for your customers? They're looking for an answer.

Physical + digital is the new bespoke

Humans have long valued experiences and products that are customized for them. Since the early 1800s, London tailors have created bespoke experiences working intimately with clients who select fabrics, buttons, and patterns to compose a physical expression—a flattering one, naturally—of their taste, personality, and ambitions. Traditionally, a tailor might create custom clothes for only dozens of regular customers during a career. In a field long based on hands-on personal attention rather than technology and automation, comparatively few have experienced creating and wearing bespoke clothing.

Savile Row's challenge and opportunity is to retain the cachet of customization while widening availability, with the aid of various technologies. Leading companies and brands are looking to arrive at the same place—from the opposite direction. Many are in the early stages of experimenting with existing and emerging technologies, combining them in innovative ways to design and scale more personalized human experiences and outcomes. As opposed to *mass customization*, in which consumers can choose from a limited number of options, a *bespoke* experience is tailored specifically to an individual's behaviors, preferences, values, and beliefs. Eventually, we expect that technological advances will allow companies and brands to create bespoke experiences for billions of people—not just the privileged.

Right now, there is typically a smartphone or tablet between the consumer and the experience. But over time, the device will no longer be needed as an interface: The consumer will get the experience delivered when, where, and how they want it without even requesting it. As an early example, for years ride-share companies have used ML and data-driven algorithms to predict where and when consumers might need rides.[4] As a result, the ride-share car is often right around the corner when you exit the building, before you even open the app.

Large gaps remain in many physical-plus-digital consumer experiences. Let's say a couple downloads an online retailer's augmented reality (AR) app that allows them to envision a sofa in various styles, fabrics, and colors in their living room. While digital experience can suggest whether and how the size and design will complement their living space, the experience is incomplete, since the customers are unable to experience the sofa's physical comfort. Indeed, because many consumers are still reluctant to purchase

without physically experiencing items—especially expensive ones—some online retailers are opening physical stores to round out the shopping experience. For example, Casper, an online mattress company, has opened 20 stores, with plans for more, to allow customers to try out their mattresses; they can even book a nap.[5]

Without a digital infrastructure in place, sectors traditionally grounded in the physical world will likely be slower to evolve. To overcome this challenge, some brick-and-mortar companies are partnering with digital natives to blend their physical human experiences with digital elements. For example, one social media platform offers its retail advertisers a customized online storefront that delivers a seamless digital experience to attract new customers from the platform's vast social network. Targeted social ads entice a consumer to click on desirable items to learn more, which takes the consumer to a mini website stocked with curated items based on that individual's online behaviors and preferences.[6]

Imagine that consumers could opt in to continue that journey in the physical world with a personal experience tailored to their individual tastes and preferences. One consumer may like a dress she sees online but hates dealing with returns; she wants to try the dress on before deciding to buy. Perhaps this customer requests a reminder when she finds herself in the vicinity of a branch of the department store. If she prefers not to interact with a salesperson, her mobile device—equipped to access the spatial web—could help her locate the dress in the store. Another individual may prefer that the store's virtual stylist arrange to have the dress, along with coordinating accessories in her preferred colors and sizes, waiting for her in a private dressing room. And yet another individual may simply want a personalized selection of clothing delivered to her home.

Over time, we expect, digital interactions will enhance a growing number of physical experiences, and vice versa. The convenience and simplicity of digital interactions will eventually be seamlessly infused with the warmth and assurance of meaningful human exchanges.

Design for an audience of one

In a January 2020 survey, 3,000 C-suite executives said that they believe elevating the human experience should be a top organizational priority, yet 96% of them have struggled to design and launch anything resembling human-centered experiences.[7]

Pioneering companies and brands are exploring ways to fill this need with human experience designers who create value-enriched human interactions, both physical and digital. These designers possess the

sensibilities, empathy, and imagination needed to create satisfying, trust-enhancing interactions for personas, which are groups of consumers who share similar needs, behaviors, and goals. They create highly nuanced elements of the customer journey and specify the various ways those elements can be strung together to reach an outcome that's satisfying for both the customers and the brand. Experiences designed for groups of similar people can be more satisfying than *one-size-fits-all* but still do not meet the notion of *bespoke*.

The companies and brands further along in the quest for bespoke experiences are pairing designers and coders in cross-functional teams with the goal of designing for an audience of one—a truly customized experience tailored to the behaviors, needs, and values of a single individual.
But human experience design is evolving so fast that even designer/coder collaboration could become obsolete. There's a new breed of human experience creative: designers who use code as their medium, eliminating the gap between design and execution. By combining creative sensibilities with technical know-how, these designers/coders can create increasingly seamless experiences based on individuals' behaviors and preferences, defined by real-time data that's relevant in the moment.

There's a new breed of human experience creative: designers who use code as their medium.

Using AI and ML, designers/coders can develop a deeper understanding of what *individual* consumers want, enabling them to tweak the experience to suit that person, essentially creating bespoke experiences based on understanding who the individual is, where they are, and which offers they are likely to want.

Technologies scale trust for billions

As physical and digital experiences merge, building trust will become an even more critical element in delivering meaningful human experiences. Looking back to our London tailor, trust is at the heart of the client's experience during the design and creation of his custom-made suit—or any bespoke experience, for that matter. Trust is why the client returns to his tailor again and again, even when a pandemic makes travel difficult. He's unlikely to trust a robot to fit his suit, except when his tailor is directing its movements.
So how can companies scale intimate one-to-

one experiences to fit billions? Accomplishing this will require thoughtful human design amplified with trust-enabling technologies. Two main technologies that can enhance—or destroy—trust are AI and the use of personal data.

Building trust will become an even more critical element in delivering meaningful human experiences.

To drive increasingly powerful—and personal—human interactions, algorithms and systems will need vast amounts of personal data and information. To build the trust that's essential to the interaction, organizations will need to carefully design technologies to behave in trustworthy and ethical ways, as we described in *Ethical technology and trust* in *Tech Trends 2020*. Moreover, meeting the local, regional, national, and transnational patchwork of data and data-usage regulations will require careful planning and engineering.

Intuitive, experiential technologies supporting the *bespoke for billions* trend today are laying the groundwork for an era in which it will be possible to be human at scale. As we discussed in *Tech Trends 2020*, affective computing technologies such as natural language processing, facial expression recognition, eye tracking, and sentiment analysis algorithms recognize, understand, and respond to human emotion. 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 they remain only a conduit. Connections made through technology conduits are useful yet emotionally limited.

The figure "Technology tools of the bespoke experiences trade" (page 141) outlines the foundational technologies supporting the *bespoke for billions* trend; many of these have been around for years, becoming more sophisticated with each evolution. What's new are the possibilities that are created at their intersection. Consider the innovations that could result from increased deployment of LIDAR sensors and AR capabilities on mobile phones, or the hypertargeted personalization possible via AI/ML platforms. In these cases, and many more, the power is in the intersection of technologies.

Individually, each of these technologies is incredibly powerful. Together, the ability to recognize and respond to emotions, transact seamlessly across channels, move effortlessly between virtual and digital space, and leverage the increasing power of mobile platforms is enabling the next generation of human experiences.

Technology tools of the bespoke experiences trade

Many of the technologies that underlie the *bespoke for billions* trend have been around for years, becoming more sophisticated with each iteration. What's new is the exponential capabilities that are enabled when these technologies are combined in meaningful ways.

Omnichannel marketing platforms

As digital and physical interactions begin to merge, we are seeing omnichannel platforms evolve from previous generations of digital marketing platforms. Combining the ability to accurately target consumers in real time in the digital world with the increased ability to identify consumers in the physical world enables more targeted and more helpful interactions. Increasingly, through the power of *MLOps*, these platforms can generate better and more cost-effective recommendations, nudges, and promotions to support customers.[8]

Handheld devices as platforms

Mobile phones and other devices have evolved from devices simply enabling phone calls to sophisticated mobile computing platforms. Today, advanced devices feature increasingly powerful cameras, GPS and location sensors, LIDAR for measuring spaces, native AR libraries for overlaying virtual objects on reality, 5G high-speed connectivity, and much, much more. The near future will feature body scanning to support virtual clothing fittings and the ability to identify or produce perfectly fitted clothing.[9]

Affective computing

Also sometimes known as "Emotion AI," affective computing is increasing the ability of computers to interpret and react to human emotions in real time. Whether through natural language processing and sentiment analysis, voice stress analysis, or cameras cataloging microexpressions, AI is increasingly capable of recognizing our emotional state and intent. It might manifest as a helpful virtual salesperson who welcomes you to your favorite store and directs you to sale items you might love. Or it could be the virtual customer support agent who echoes your frustration while following a "save" script to persuade you not to cancel your service; only this agent has access to all of your data and history and the ability to tailor the perfect proposal to entice you to stay.[10]

Spatial web

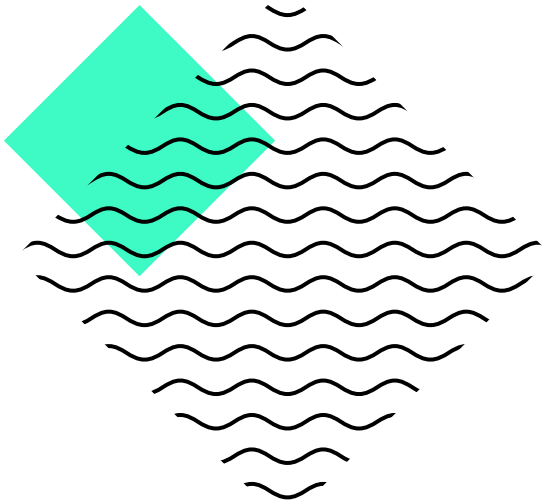
By combining high-resolution mapping of the physical world with AR and VR capabilities, spatial web technologies allow the projection of virtual objects into the physical world. Leveraging the increasingly powerful technologies built into phones, tablets, headsets, and more, the spatial web allows users to interact with increasingly lifelike virtual environments. As this technology evolves, users will be able to interact with information within physical spaces, instead of relying on traditional screens, tablets, and phones.[11]

Next-generation identity management

The underpinning of trusted interactions is the knowledge of the identity of the user. Without robust identity verification, organizations risk losing trust by leaking data. Identity management systems are hard at work to supplement credential validation and two-factor authentication to also include biometrics, behavior validation, and other advanced mechanisms for validating identity.

The way forward

The instability and uncertainty created by the pandemic seem to have only amplified the need for authentic human connection. Organizations are combining and refining existing and emerging technologies to create a more meaningful blend of physical and digital experiences to engage their customers. And the best of those experiences will be targeted to an audience of one, in a more human, trustworthy fashion, creating the possibility of bespoke experiences for billions—delivering to each exactly what they want, when, and how they want it.



MY TAKE

Hans Neubert

Principal and global practice leader, Digital Experience Design, Gensler

Physical environments are an important beacon for the relationships we have with brands and companies.

Even digital-first companies are building physical outlets as another way to create engagement with their customers. In many ways, blending digital and physical experiences is easier for them because they already have a robust digital infrastructure in place.

The building sector is ancient, and understandably slower to evolve. As the world's largest architecture firm, Gensler has refined the physical process of orchestrating thousands, sometimes millions, of moving parts to create something that's safe, useful, and beautiful. Real estate is just at the beginning of its digital transformation. Our advantage in this new world is that architecture has always been bespoke, so we're accustomed to tailoring designs for individuals.

My design team's role is to disrupt our firm from within. We are helping Gensler transform its approach to architecture from creating

physical buildings and interiors to creating holistic experiences. We are merging physical spaces and digital interactions to create personalized experiences for the end users, whether they are employees, sports fans, students, passengers, or shoppers.

The pandemic has accelerated technological change and acceptance of new innovations. Some of those conversations began earlier, but today people are paying more attention: Now, CEOs listen when we describe how their office building can be a more personalized, engaging environment by enriching the built environment with digital experiences. For example, in the analog world, there is a physical sign on the building that shows the way to the exit or the elevator. In the new world, when a remote worker visits the corporate office, the meeting invitation on his computer tablet is the clearing pass for security, the elevator key, and the map to the conference room. That may not sound revolutionary to a digital native, but it *is* for an analog industry like real estate. In a way, we've moved ahead seven to 10 years in just six months.

We are helping Gensler transform its approach to architecture from creating physical buildings and interiors to creating holistic experiences.

Gensler has also broadened our design reach to include the user's experience before, during, and after visiting a building. For example, a soccer fan doesn't engage with the team only when they're in the stadium—that built environment is part of a greater journey. So, as the team owner, you have a vested interest in not just enriching a fan's interactions in the stadium—you also want to understand how to connect and engage with your fan before, during, and after the game. We're considering the full 360-degree fan engagement.

Likewise, we're diversifying the people we involve during the design process to better understand the end-user benefits. Beyond the CEO and the real estate leader, we bring in IT, marketing, brand, HR, and other stakeholders to integrate more multidisciplinary and multifunctional views.

One big challenge that's holding us back from offering more personalized experiences is the lack of an "urban platform," a common chassis for building customized digital elements for the physical world of architecture. We're actively working on that but until that's fully

evolved, designing and building 360-degree user experiences will continue to be slower and more expensive than we and some clients would like.

Meanwhile, Gensler is committed to creating experiences that serve a higher purpose. We design for the end user, not just the building owner or real estate developer. And because it's no longer acceptable to consider only half of the population's needs, we must design for equity. Likewise, designing for safety isn't enough—we must also design for global health. And finally, because buildings are a major contributor to climate change, we must design with a lens toward protecting the environment.

Transforming our traditional architecture firm into an experience design firm that leads with architecture hasn't been easy, and the payoff for this innovation isn't immediate. We're able to do this because we're an employee-owned firm, and we keep investing in the next generation. We're very much driving our own future.

EXECUTIVE PERSPECTIVES

STRATEGY // The pandemic has given fresh importance to the CEO's role as an end-user ethnographer.[12] Organizations are scrambling to respond to customers' values, risk appetites, and preferences as they design safe experiences that blend the physical and digital. CEOs are on point for directing this human experience strategy. They should consider shifting trends on what technology is enabling (for example, increases in virtual shopping and service) as well as the differences in what people are expecting from brands. Ultimately, a consistent, humane experience is the goal, and setting direction from the top down can help CEOs lead their organizations in line with their values—and their vision for responding to unprecedented times.

FINANCE // As human-centered design improves and IT brings more use cases to the finance team, CFOs should be mindful of the business case: Which metrics (ROI, cost per impression, etc.) will justify investments, and which products or services are ripe for disruption? Moreover, in a primarily digital economy, CFOs should consider how human connections drive accounting and valuation. They may need to revisit concepts of impairment or sales tax implications to assess whether such standards preclude them from showing strong financial statements. Likewise, the value of high-quality human experience platforms may be difficult to quantify, but it can also become a leading indicator of an organization's performance.

RISK // Physical and digital are blending to create hybrid user experiences. In this new environment, privacy-related issues may be amplified relative to purely physical or digital customer interactions. This shift can lead to CROs rethinking traditional forms of security such as the password and opting for newer methods such as mobile biometrics. They should pay close attention to privacy as technology enables organizations to increasingly identify unique customers and their data across channels. Risk leaders may also be dealing with a generational divide on human experience, as expectations vary widely between digital natives and older generations.[13] Leaps in cybersecurity and blended experiences may require organizations to bring along customers who aren't ready for the change. Accordingly, the CRO's role in creating trust among consumers becomes more important than ever.

ARE YOU READY?

KEY QUESTIONS

1

How agile are your customer journeys? Are they seamless and consistent across all channels, both physical and digital? What does it feel like from your customers' perspective?

2

Is your organization experimenting with technologies that will lead to offering more personalized experiences, both in-person and digital?

3

Is your customer data formatted in a way that is machine-readable? Can you access customer data beyond demographic and transactional data to include behaviors, attitudes, emotions, and preferences? How can you use technology to build customer trust?

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AUTHORS

Our insights can help you take advantage of emerging trends. If you're looking for fresh ideas to address your challenges, let's talk.

Erik Duffield

General manager, Deloitte Digital experience management platform
Deloitte Consulting LLP
eduffield@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

SENIOR CONTRIBUTORS

Alex Kelleher
Managing director,
Deloitte Consulting LLP

Rich Whalen
Managing director,
Deloitte Consulting LLP

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DEI tech: Tools for equity

THE TECH LEADER'S ROLE

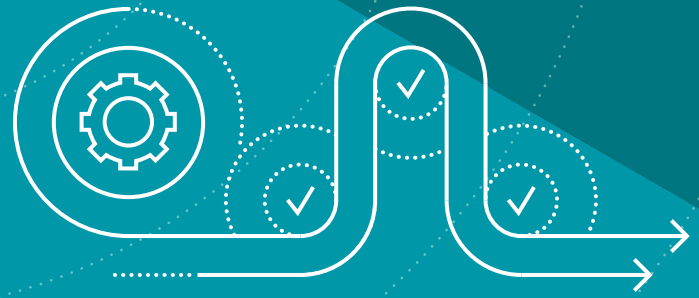
Work with DEI and business leaders to address complex workforce challenges with tech-enabled solutions.

DEI WORKFORCE OUTCOMES

DEI tech can support workforce outcomes across recruitment and advancement, leadership and culture, and measurement and analytics.

DEI TECH CONSIDERATIONS

Partnerships, responsible data practices, and feedback mechanisms are important elements in tech-enabled DEI workforce strategies.



TREND 9

DEI tech: Tools for equity

Elevating the tech leader's role in propelling workforce imperatives

Even before social justice protests drew the world's attention in the summer of 2020, business leaders understood the case for diversity, equity, and inclusion (DEI). But those events spurred many organizations to elevate DEI as a business imperative. In fact, 96% of CEOs now consider DEI to be a strategic priority.[1] And striving for social justice is hardly the only reason: An earlier study showed that organizations with inclusive cultures are twice as likely to meet or exceed financial targets as those without, three times as likely to be high-performing, six times more likely to be innovative and agile, and eight times more likely to achieve better business outcomes.[2]

Workforce DEI programs and policies encourage and support representation and participation of all people within an organization. Definitions of *diversity*, *equity*, and *inclusion* vary based on an organization's focus and culture, but generally, a diverse workforce includes a wide mix of demographics, skills, and experiences, while equity provides all workers with fair access, opportunity, resources, and power to thrive. An inclusive culture supports fairness, equity, and respect, giving workers a sense of belonging and being valued and empowered.

Diversity, equity, and inclusion are important to current as well as potential employees worldwide. A 2020 Lenovo/Intel global employee study suggests that an organization's DEI policies and performance are significant factors in a candidate's decision to apply for or accept a job.

More than half of employees across all markets said that DEI performance is "extremely" or "very" important when deciding where to apply and whether to accept an offer. This percentage is even higher for employees in China (89%), Brazil (88%), and the United States (75%).[3]

Though most organizations view DEI as important, there's a lot of work ahead. In Deloitte's external *2020 Human Capital Trends* survey, 79% of participants said fostering a sense of belonging in the workforce was important to their organization's success, and 93% agreed it drives organizational performance. Unfortunately, only 13% of respondents said their organization is "very ready" to address the trend.[4]

We expect enterprises looking to close this readiness gap to increasingly use technologies to support DEI outcomes across all aspects of the employee journey—from talent sourcing and selection through employee experience, compensation, retention, and development.

Technology's role in supporting the DEI workforce strategy

Early DEI workforce initiatives focused on the individual—mentoring, sponsorship, training, and development. In recent years, a growing number of enterprises have adopted a more holistic view, with organizationwide workforce initiatives supported by leader-sponsored strategies that encompass policies, processes, and culture to address individual and organizational biases and inequities.

While HR professionals often lead DEI workforce strategies, technology leaders can play a critical role as strategic partners by designing, developing, and executing tech-enabled solutions to address increasingly complex challenges. They can help identify areas that lack diversity or equity by reengineering the way data is collected, managed, analyzed, and reported. Technology leaders can also provide the technical expertise and strategic vision required to integrate solutions that span the workforce life cycle, eventually embedding them into the organization's technology stack and processes to drive DEI across the workplace.

Diversity, equity, and inclusion are important to current as well as potential employees worldwide.

These tools could be seamlessly integrated into the work and collaboration software that workers and managers use every day, allowing workers to opt in to technology solutions that nudge behaviors toward equity in moments that matter. For example, a manager who is preparing to conduct annual performance reviews may receive a notification to enroll in a microtraining on unconscious bias.

AI capabilities can help leaders understand individuals' behaviors and how they change over time, helping them reinforce and optimize behaviors that promote DEI. A growing number of vendors offer point solutions to support elements of an organization's DEI strategy, and human capital management suites offer cloud-based analytics and dashboards that can be customized to support DEI across the talent life cycle, providing a more holistic view of the organization's progress and opportunities.

DEI tech designed to address workforce challenges

DEI technology solutions may use AI/ML and advanced analytics to provide granular insight into such areas as talent acquisition, advancement, well-being, and retention. Others offer feedback and coaching capabilities for leaders and decision-makers. All seek to make decision-making less prone to human errors and biases while improving organizational performance and innovation. Here are just a few examples of how organizations are using technology tools to support DEI outcomes.

AREA	DESCRIPTION	OPPORTUNITIES
Recruitment and advancement	Tools can help identify, recruit, develop, and advance a more diverse talent pool.	• Identify and address biased language in job postings using natural language processing (NLP) • Nudge recruiters at key points in the hiring process to increase awareness of potential bias using AI • Access pools of qualified, diverse candidates through candidate search platforms • Objectively identify "optimal" candidates for jobs or promotions using AI, machine learning, and automation[5]
Leadership and culture	Tools can help leaders build inclusive cultures, including engagement and retention of diverse talent.	• Support efforts to build inclusion and belonging within work groups using organizational network analysis and community-building social platforms • Encourage more objective performance reviews using NLP and ML • Gain insight into behavior changes needed to develop inclusive leaders using behavioral assessment tools and learning platforms
Measurement and insights	Data and analytics tools can be used to establish organizational baselines, measure progress, and deliver actionable insights.	• Monitor DEI KPIs, including compensation and advancement equity, using advanced analytics, data visualization, and interactive dashboards • Match people to diverse workplace opportunities and coaches using data insights • Predict which workers are likely to leave using predictive forecasting models to proactively intervene • Evaluate qualitative and quantitative outcomes of DEI efforts using advanced analytics

Considerations for using technology to drive DEI outcomes

Some organizations consider a DEI effort to be a short-term initiative to "fix" a specific workforce challenge instead of a long-term strategy with a road map to improve overall performance and innovation. Here are a few lessons shared by organizations committed to achieving the long-term benefits of their workforce DEI strategies:

- **Partner across the organization.** An empowered executive DEI leader, sponsored by the CEO, is important to developing and executing an effective DEI strategy. The DEI leader should partner with tech leaders to select and implement technology tools that will support the strategy by generating meaningful metrics, insights, and data.

- **Include plans and infrastructure to support corrective actions.** Before collecting sensitive data, be sure you have a clear plan for what you will do with that data, including the types of possible actions you may take based on a range of potential findings. Having knowledge of inequities without following through on planned remediations may create legal liabilities for the organization. It is important to work closely with legal and human resource advisors when considering such data collection and/or analytics initiatives.

- **Take advantage of existing data.** Many organizations have a vast amount of useful workforce data stored in siloed databases. This data can be used to identify opportunities and create a historical baseline that can be used to evaluate the outcomes of the DEI strategy. (The *Machine data revolution* chapter discusses how organizations are addressing data challenges.) It is important to consult with legal and privacy teams to understand whether, and how, previously collected data may be leveraged for various purposes. Also consider using publicly available data sources. For example, one US government agency created a tool using open-source and purchased data to identify locations for recruiting diverse candidates.

- **Tread carefully with gathering new data.** Organizations should consult with their legal and privacy teams to understand what, if any, notices to/consents from employees may be appropriate, as well as how they can use and safeguard any personal data that is collected. Since some people may be uncomfortable sharing DEI-related information, allow workers to opt in, with the assurance that participation is optional, and be transparent about how the information will be used. Consider

masking information so that it cannot be connected to an individual, while still providing aggregate information that's useful for decision-making. Deloitte's *Tech Trends 2020* provides more insights into how to *ethically use technology* to maintain employee trust.

- **Solicit diverse feedback on DEI tools.** With many new technologies entering the DEI technology market, some tools, especially those with AI/ML capabilities, may reinforce or introduce new biases. When considering new DEI technologies, encourage and act on feedback from diverse teams that can think critically about the tool to detect unexpected problems and understand others' sensitivities.[6]

The way forward

DEI technology tools can deliver meaningful insights, metrics, and data that can provide the objectivity and credibility needed to propel DEI strategies forward. But even the best tools rely on humans to follow through with meaningful action. Technology, used appropriately, can support human objectivity, consistency, and fairness, but it will work only when backed by ongoing leadership commitment to building a diverse workforce, equitable environment, and inclusive culture.

OUR TAKE

Doug Beaudoin
Chief information officer,
Deloitte LLP

Stephani Long
Chief talent officer,
Deloitte Consulting LLP

Kavitha Prabhakar
Chief DEI officer,
Deloitte Consulting LLP

Deloitte as a firm has championed DEI for years, but until recently, we had not deeply explored how technology and data-driven insights can help us deliver more diverse, equitable, and inclusive experiences across Deloitte's talent life cycle.

The unique societal moments of 2020 inspired us—as they did leaders at many other organizations—to openly discuss our commitment to workforce DEI as top priorities for the firm and to follow through by taking actions that accelerate our progress.

The sponsorship and commitment of Deloitte's board and executive committee—specifically US board chair Janet Foutty and US CEO Joe Ucuzoglu—provided the support we needed to make significant progress quickly. We challenged ourselves to balance the risks that

could result from unconscious inequities that could be uncovered through talent data transparency with the risks of *not* being transparent, which could threaten our people's engagement and productivity.

Beyond executive sponsorship, an effective DEI strategy requires collaboration across the organization. Deloitte's IT function is partnering with the businesses, the talent organization, and the DEI team to appropriately incorporate data and technology tools as one component of Deloitte's holistic workforce strategy.

One of our goals is to leverage technology to better understand our workforce and make more-informed decisions. To do this, we needed access to talent data beyond what's required for regulatory reporting. Historically, we've had a wealth of data available in different systems, but it was not integrated in a way that was easy to access. So, Deloitte is implementing a people analytics program to consolidate talent data and generate insights to help create a more diverse, equitable, and inclusive workplace.

We're also collecting and securing more self-reported information about our people's diversity, both visible and invisible. Individuals now have the option to self-identify their background and other attributes, as well as to opt in to communications from affinity groups and other networks that can help them engage and network across the firm.

We plan to move from using data for hindsight insights to predictive analytics that support decision-making. For example, we would like to know the key pieces of historical data that indicate that a person is likely to leave the firm. By monitoring this data for our current workforce, we could aim to identify those who may be flight risks so that we have an option to take appropriate preemptive actions.

New collaboration tools can also help to build inclusion in a virtual environment. Fortunately, Deloitte was on the verge of implementing videoconferencing when the pandemic began. The visual nature of video calls helps people see the diversity in their teams and encourages inclusion and equitable opportunities for participation. Of course, there's room for improvement. For example, our IT function has taken on the challenge to improve our people's online visual images. We're working on an app that will automatically adjust web cameras and lighting to accurately capture a more diverse range of skin and hair tones and help everyone look their best.

During recent months, Deloitte has made significant progress in collecting and safeguarding appropriate workforce data and analyzing it for meaningful, actionable insights across the talent life cycle. We're also adopting and refining technology tools to support a more inclusive culture. There's much work ahead, but we're dedicated to helping build a more diverse, equitable, and inclusive society for the benefit of all.

EXECUTIVE PERSPECTIVES

STRATEGY // A growing number of CEOs have set ambitious goals for DEI but have struggled to measure progress. Emerging DEI tools can help CEOs make the cultural shifts needed to reduce bias and create inclusive workplaces. For this to be successful, CEOs should fully understand DEI tech capabilities and require CIOs and diversity leaders to design purposeful constraints so that tools are used for good. In some cases, organizations with advanced DEI analytics have struggled to act on their new insights and created more complex problems. With this in mind, CEOs should work with stakeholders to develop tailored strategies and informed teams for each inclusion issue they'd like to address.

FINANCE // More than ever, leaders are answering to the public for the organization's vision of social responsibility. Accordingly, many forward-thinking CFOs are taking a stronger role in defining what that vision is, since talent remains a top-five priority for them. With new workforce entrants aware of employers' commitment to DEI, social responsibility may soon play a stronger role in retaining talent. CFOs may be less concerned than others with the granular details of inclusion technologies used to monitor recruiting bias, but they should keep a keen eye on tools that can help train and develop a diverse workforce with needed skill sets. Especially in the current virtual environment, CFOs can also capitalize on remote work models to identify and recruit diverse candidates who would normally be unavailable.

RISK // In the arena of social issues, many often see technology as being biased. However, the fundamental issue with workplace bias lies not with software tools but with the biased humans who build or use them. Tools such as those discussed in this chapter can provide the nudges or insights needed to reduce human bias. They can also manage the data that can help hold an organization accountable to its vision of diversity, equity, and inclusion. When chief risk officers (CROs) manage the inherent risks of transparency, data gathering and analysis from such tools may help organizations measure progress on DEI. Risk leaders can then look for ways to use predictive risk analytics to intervene before issues arise.

ARE YOU READY?

KEY QUESTIONS

1. Which tools and platforms are you evaluating to support your overall organizational DEI efforts?
2. How can your DEI technology efforts focus on spanning the employee life cycle rather than standalone initiatives such as reducing recruitment bias?
3. How are DEI and tech leaders collaborating to implement technology that will provide meaningful DEI outcomes?

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AUTHORS

Our insights can help you take advantage of emerging trends. If you're looking for fresh ideas to address your challenges, let's talk.

Christina Brodzik

Principal, Consulting DEI practice lead

Deloitte Consulting LLP

cbrodzik@deloitte.com

Kristi Lamar

Managing director

Deloitte Consulting LLP

klamar@deloitte.com

Anjali Shaikh

US CIO Program experience director

Deloitte Consulting LLP

anjalishaikh@deloitte.com

SENIOR CONTRIBUTORS

Bill Docherty
Managing director,
Deloitte Consulting LLP

Donna Cobb
Senior manager,
Deloitte Consulting LLP

Louise Nickson
Director,
Deloitte MCS Limited

Devon Dickau
Senior manager,
Deloitte Consulting LLP

Cindy Skirvin
Principal,
Deloitte Consulting LLP

Josh Graham
Senior manager,
Deloitte MCS Limited

Marc Solow
Managing director,
Deloitte Consulting LLP

Kamilah Smith
Senior manager,
Deloitte Consulting LLP

Simona Spelman
Principal,
Deloitte Consulting LLP

Richard Odufisan
Manager,
Deloitte MCS Limited

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Acknowledgments

Executive editors

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

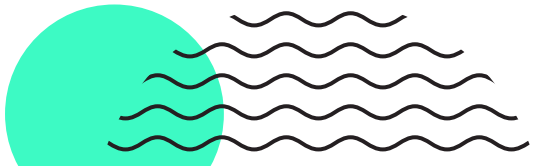
With more than 25 years of experience in technology innovation and implementation, Scott Buchholz focuses on helping clients transform the way their organizations deliver their missions and businesses through technology. He supports organizations across industries by providing advice and insights on 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 emerging technologies, legacy modernization, and solution architecture. As the firm's 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. Buchholz also leads Deloitte's efforts to explore quantum computing and quantum technologies.

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

As chief futurist with Deloitte Consulting LLP, Mike Bechtel helps clients develop strategies to thrive in the face of discontinuity and disruption. He researches the novel and exponential technologies likely to materially impact the future of business, and builds relationships with the startups, incumbents, and academic institutions creating them.

Prior to joining Deloitte, Bechtel led Ringleader Ventures, an early-stage venture capital firm he cofounded in 2013. Before Ringleader, he served as CTO of the Ounce of Prevention Fund, a national not-for-profit focused on early childhood education for at-risk youth. Bechtel began his career in technology R&D at a global professional services firm where his dozen US patents helped result in him being named that firm's global innovation director. He currently serves as professor of corporate innovation at the University of Notre Dame.



Executive perspectives contributors

STRATEGY

Benjamin Finzi
US and Global Chief Executive Program leader | Deloitte Consulting LLP

Andrew Adams
Principal | Deloitte Consulting LLP

Louis DiLorenzo Jr.
Principal | Deloitte Consulting LLP

Ashok Divakaran
Principal | Deloitte Consulting LLP

Anne Kwan
Managing director | Deloitte Consulting LLP

Benjamin Stiller
Principal | Deloitte Consulting LLP

FINANCE

Steve Gallucci
US CFO Program leader | Deloitte LLP

Ajit Kambil
CFO Program global research director | Deloitte LLP

Moe Qualander
Principal | Deloitte & Touche LLP

RISK

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

Irfan Saif
Deloitte US board member | Deloitte & Touche LLP

Contributors

Sachin Agarwal, Zachary Aron, Angel Ayala, Nithyasree Balasubramanian, Leo Barbaro, Amod Bavare, Hanif Bejestani, Armando Betancourt, Rupesh Bhat, Andrew Blau, Mike Brinker, Rick Burke, Michael Calienes, Sudeep Chakraborty, Enoch Chang, Ashish Chauhan, Mike Clendon, Dave Couture, Andrea D'Alessandro, Titikhya Dey, Tatiana Dominguez, Aaron Dozzi, Michael Fancher, Art Fitts, Nairita Gangopadhyay, Shubhrapratim Ghosh, Purba Ghosh, Nidal Haddad, Diogo Henriques, Sarah Jersild, Andrew Jolly, Samikhya Joshi, Sriram Kailasanathan, Alexandria Kang, Khalid Kark, Jon Kawamura, Rupert Kay, Abrar Khan, Aref Khwaja, Vamsee Kota, Yadhu Krishnan, Manish Kumar, Vishnu Kumar, Naren Kunapareddy, Santosh Kutty, Rafi Lav, Jesus Leal Truillo, Victoria Lee, Mark Lillie, David Linthicum, John Lu, Alpesh Makwana, Cesar Marto, Brian Meeker, Grace Messara, Mariahna Moore, Narasimham Mulakaluri, Sampath Murki, Sri Myneni, Aleks Ontman, Genevieve Oudar, Shruti Panda, Ann Perrin, Dalibor Petrovic, Jack Polson, Jose Porras, Vishal Prajapati, Jason Price, Megha Priya, Muthu Rajendran, Bill Roberts, Aaron Roe, Keihan Sedghi, Karen Shea, Kushagr Singh, Hariom Sinha, David Sisk, Kelly Smith, Anna Spikings, Joey Suing, René Theunissen, Jon Tidd, Arpan Tiwari, Brian Umbenhauer, Aman Vij, Jason Wainstein, Mike Wyatt, Sourabh Yaduvanshi, Abhilash Yarala, Thomas Zipprich, and the Deloitte Insights Knowledge Services team.

Research team

LEADS

Erica Cappon, Cristin Doyle, Dave Geyer, Chris Hitchcock, Emeric Kossou, Dhruv Patel, Alex Jaime Rodriguez, Katrina Rudisel, and Samantha Topper.

TEAM MEMBERS

Roudy Antenor, Shenbagamoorthy Arunachalam, Angela Chen, Serena Chen, Andrea Cuadros, Rahul Datta, Chirag Dixit, Ankush Dongre, Carrie Ge, Mayank Gupta, Ripu Jain, Carter Johan, Heather Kelly, Dhir Kothari, Shantanu Kulkarni, Nitin Kumar, Siva Kuna, Madeline Mantych, Allie McIlwain, Katherine McNally, Spandana Narasimha Reddy, Rani Patel, Abhishek Pattnaik, Kshitij Pratap Singh, Rohit, Rohit Singhal, Elizabeth Thompson, and Paige Zellner.

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Promotion: Hannah Rapp

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