# Tech Trends 2014
## Inspiring Disruption

# Contents

# Introduction

**W**ELCOME to Deloitte's fifth annual *Technology Trends* report. Each year, we study the ever-evolving technology landscape, focusing on disruptive trends that are transforming business, government, and society. Once again, we've selected 10 topics that have the opportunity to impact organizations across industries, geographies, and sizes over the next 18 to 24 months.

The theme of this year's report is *Inspiring Disruption*. In it, we discuss 10 trends that exemplify the unprecedented potential for emerging technologies to reshape how work gets done, how businesses grow, and how markets and industries evolve. These disruptive technologies challenge CIOs to anticipate their potential organizational impacts. And while today's demands are by no means trivial, the trends we describe offer CIOs the opportunity to shape tomorrow—to inspire others, to create value, and to transform "business as usual."

The list of trends is developed using an ongoing process of primary and secondary research that involves:

- Feedback from client executives on current and future priorities

- Perspectives from industry and academic luminaries

- Research by alliance partners, industry analysts, and competitor positioning

- Crowdsourced ideas and examples from our global network of practitioners

As in prior years, we've organized the trends into two categories. Disruptors are areas that can create sustainable positive disruption in IT capabilities, business operations, and sometimes even business models. Enablers are technologies in which many CIOs have already invested time and effort, but that warrant another look because of new developments, new capabilities, or new potential use cases. Each trend is presented with multiple examples of adoption to show the trend at work. This year, we've added a longer-form *Lesson from the front lines* to each chapter to offer a more detailed look at an early use case. Also, each chapter includes a personal point of view in the *My take* section.

Information technology continues to be dominated by five forces: analytics, mobile, social, cloud, and cyber. Their continuing impact is highlighted in chapters dedicated to wearables, cloud orchestration, social activation, and cognitive analytics. Cyber is a recurring thread throughout the report: more important than ever, but embedded into thinking about how to be secure, vigilant, and resilient in approaching disruptive technologies.

For the first time, we've added a section dedicated to what our contributing authors at Singularity University refer to as "exponential" technologies. We highlight five innovative technologies that may take longer than our standard 24-month time horizon for businesses to harness them—but whose eventual impact may be profound. Examples include artificial intelligence, robotics, and additive manufacturing (3-D printing). The research, experimentation, and invention behind these "exponentials" are the building blocks for many of our technology trends. Our goal is to provide a high-level introduction to each exponential—a snapshot of what it is, where it comes from, and where it's going.

Each of the 2014 trends is relevant today. Each has significant momentum and potential to make a business impact. And each warrants timely consideration—even if the strategy is to wait and see. But whatever you do, don't be caught unaware—or unprepared. Use these forces to inspire, to transform. And to disrupt.

We welcome your comments, questions, and feedback. And a sincere "thank you" to the many executives and organizations that have helped provide input for Tech Trends 2014; your time and insights were invaluable. We look forward to your continued innovation, impact, and inspiration.

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# Disruptors

# CIO as venture capitalist
## Trading on IT's assets, talent, risk, and results

**CIOs who want to help drive business growth and innovation will likely need to develop a new mindset and new capabilities. Like venture capitalists, CIOs should actively manage their IT portfolio in a way that drives enterprise value and evaluate portfolio performance in terms that business leaders understand—value, risk, and time horizon to reward. CIOs who can combine this with agility and align the desired talent can reshape how they run the business of IT.**

**C**IOS have historically focused on core delivery and operations with a budget and operating model built around low risk—buying enterprise-class software, building a talent base that could support a well-defined future state, driving for efficiencies in light of constant cost pressures. More and more CIOs, faced with disruptive forces such as crowdsourcing,[1] mobile only,[2] big data,[3] and cybersecurity,[4] are shifting from a world of known problems into one filled with unknowns. To make matters worse, organizational governance has become more complex as barriers for other parts of the business to enter the technical arena have fallen.

CIOs are seeing this divergent behavior—and realizing that their current tools for managing risk and leveraging assets may not work in this new world. Instead, many are beginning to manage their technology portfolios in ways that drive enterprise value, actively monitor the performance of the portfolios, and communicate the portfolios' positions in language the business can grasp. To do this, CIOs are borrowing from the playbook of today's leading venture capitalists (VCs). As a result, they are reshaping how they run the business of IT.[5]

## Thinking like a VC

Effective VCs are often shrewd businesspeople who operate across a range of intertwined capabilities. They manage portfolios of investments, continually evaluating individual and aggregate performance in terms of value, risk, and reward. They deliberately attract entrepreneurial talent with technical skills and business savvy—as well as vision, passion, and the intangible spark of leadership. And they cultivate agile organizations to anticipate and respond to changing market conditions—open to decisions to exit, take public, reinvest, or divest. These capabilities are closely related to the CIO's leadership role in today's growth-oriented organization.

**Portfolio investment strategy.** CIOs today juggle an ever-growing portfolio of projects, ranging from long-term strategic initiatives to keeping the lights on. CIOs need clear lines of sight across their portfolio of programs and projects—the objectives, dependencies, status, finances, associated resources, and risk profiles. But in-flight initiatives are only one piece of their balance sheet. CIOs should also understand their assets—hardware, software, facilities, delivery model (the way work gets
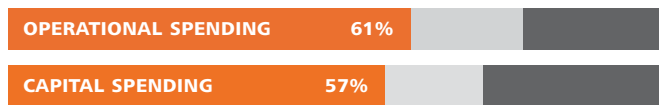
## Capabilities map for CIOs

### ⬤ Portfolio management[1]

As IT budgets continue to increase, it is more important to manage them closely. In 2013, 38% of organizations created a portfolio approach to IT.[2]
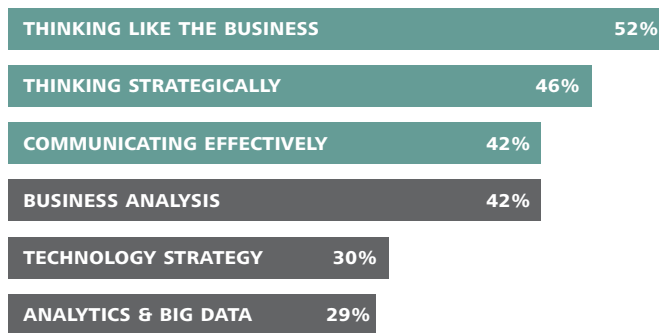
⬤ **Increase** ⬤ **Maintain** ⬤ **Decrease**

| | | |
|---|---|---|
| **OPERATIONAL SPENDING** | **61%** | |
| **CAPITAL SPENDING** | **57%** | |

### ⬤ Talent alignment[3]

IT needs the right skillset to maintain systems and innovate.

⬤ **Business skill gaps within IT** ⬤ **Technical skill gaps**

| | |
|---|---|
| **THINKING LIKE THE BUSINESS** | **52%** |
| **THINKING STRATEGICALLY** | **46%** |
| **COMMUNICATING EFFECTIVELY** | **42%** |
| **BUSINESS ANALYSIS** | **42%** |
| **TECHNOLOGY STRATEGY** | **30%** |
| **ANALYTICS & BIG DATA** | **29%** |

### ⬤ Agile[4]

CIOs are adopting agile methods to expedite delivery times and improve business alignment. Organizations using agile have seen promising results:

⬤ **Improve** ⬤ **Maintain** ⬤ **Worsen**

| | |
|---|---|
| **ABILITY TO CHANGE PRIORITIES** | **90%** |
| **PRODUCTIVITY** | **85%** |
| **PROJECT VISIBILTY** | **84%** |
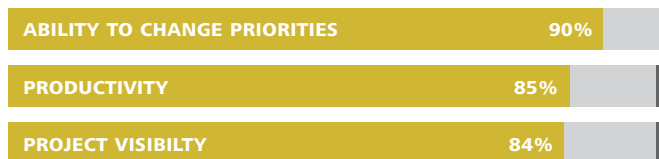
83% of businesses have future plans to implement agile, an increase from 59% last year.

2012   2013

Sources: [1] Computer Economics, *IT spending and staffing benchmarks 2013/2014*, chapter 1, http://www.computereconomics.com/page.cfm?name=it%20spending%20and%20staffing%20study, accessed January 3, 2014. [2] CIO Magazine, *2013 state of the CIO survey*, January 2, 2013, http://www.cio.com/slideshow/detail/79671, accessed January 3, 2014. [3] Deloitte MCS Limited, *The Deloitte CIO Survey 2013. Reconnect. Rebuild. Reimagine. Redeliver.*, 2013. [4] VersionOne, *Seventh annual state of agile development survey*, 2013, http://www.versionone.com/state-of-agile-survey-results, accessed January 3, 2014.

done), contracts, vendors, and people. The portfolio of IT is a complex one. But that complexity is no excuse for flying blind.

**Valuation.** An effective portfolio view enables the CIO to continually evaluate the strategic performance of each asset, project, and vendor in terms that business leaders understand. A CIO with a VC mindset doesn't just report on the organization's to-do list or inventory of assets; the CIO communicates the quantitative and qualitative value the IT organization contributes to the business. This means delineating the strategic importance of programs, projects, and assets. What initiatives are mission-critical for the business? What is the confidence level around on-time, on-budget delivery? How deliberately are business case results tracked? Which hardware and software assets are identified for growth? For sunsetting? For active retirement? How "heavy" a balance sheet do you want to carry?

**Handicap.** In many emerging areas, there are no clearly identifiable winners. How much do you know about the product roadmap of your existing providers? Are you actively scanning small and emergent players? No part of your portfolio should be off-limits— software, hardware, services, talent, data, methods, and tools. Do you have the skills and the discipline to evaluate and predict how the landscape will evolve—not only in the market but, more importantly, for your company, for your customers, and for your business partners? Make sure you are getting what you need in order to provide what the business wants from IT. And be ready to reevaluate in light of market shifts, M&A events, or leadership transitions.

**Hedge.** What emerging investments are you making, whether in broad technologies or with specific entities? At what stage are you getting involved? How will you incubate, invest, divest? If you build dependencies on start-ups or niche players, you will need to evaluate not only the technology but the founders and their business models. Build a concession architecture that allows you to port assets to different players or to shutter underperforming investments or partnerships in order to move on to the next opportunity.

**Promotion.** The brand of IT is maligned in some organizations, with the CIO viewed as the operator of the company's technology assets but not as a strategist or catalyst for innovation.[6] Rethinking the role as a VC gives the CIO a backdrop for the business to elevate the understanding—and appreciation—of his or her function. There's no overnight fix. Understand your current brand permission, then build awareness about IT's mission, effectiveness, and vision. Internally, this is important in order to enhance IT's charter. IT should be a board-level topic—recognized as one of the crown jewels of the company. Externally, it's important to attract talent— and attention. Even some leading VCs have launched PR and marketing efforts.[7] Don't assume that once it's built, they will come.

**Talent brokering.** The portfolio mindset extends to talent management as well. Talent scarcity is a universal concern, but it has a particular impact on IT. Consider the skills and capabilities that will be needed to deliver on strategic initiatives, as well as those required to maintain existing systems and processes. Where are the gaps? Which capabilities can be grown from existing staff? Which should be acquired? How can top talent be identified, developed, and hoarded—regardless of title or tenure? How can external talent be tapped? Think beyond consultants, agencies, and contractors. Can you leverage the crowd— either transactionally[8] or by finding a way to activate customers and hobbyists?[9] CIOs need doers and thinkers just like VCs, but they also need leaders. Use this age of innovation as a means to launch initiatives to reward (and retain) demonstrated talent with the curiosity and horsepower to help lead growth areas. Demand for talent is outstripping supply in many shops—and expected time to value is shrinking.

**Agility.** Disruption is a given in technology today, and is extending into many aspects of the business. The balancing act is delicate— driving for more nimble, responsive delivery while maintaining architectural integrity and making solutions built to run.

In this new world, the CIO's role should expand from enabling operations with technical services to building a technology footprint that fuels, and can be responsive to, the executive team's growth and investment strategy. Integration, data, and architecture capabilities should be developed into disciplines, serving as the core pillars of business agility.

# Lessons from the front lines

## Growth and change

Cisco's IT organization uses a three-tiered model to drive its mission: Run the business—focusing on efficiency, quality, and optimization of cost performance; grow the business—helping to drive investments that impact business performance; and change the business—transforming how the organization operates and the markets in which it competes. At Cisco, line-of-business CIOs are encouraged to drive more of their investment portfolio towards growth and change. This doesn't mean that total cost of ownership isn't emphasized, but the "better, faster, cheaper" mindset is not just applied to the business of IT—it's just as important to the business of the business. Technology spend is anchored in running or changing the business—which requires not just bilateral commitment, but ongoing education and teaming between IT and the business.

Line-of-business CIOs look at initiatives as vehicles for tech-enabled business growth and see their roles as orchestrators and shapers. At the financial level, this means actively managing a portfolio of assets with an understanding of cost, return, risk, and strategic importance. More than just inventorying and reporting, it means helping to set priorities, translating the potential of disruptive technologies and making them meaningful, and setting up the organization for speed and agility. Traditional waterfall methodologies have given way to agile—fast, iterative deployments where the business is fully engaged.  At the technology level, orchestration is about creating a seamless experience across a technology landscape that is growing more diverse and complex, bringing together a mix of on- and off-premises solutions—and making sure employees, customers, and business partners aren't exposed to behind-the-scenes complexity. Integration and architecture have been established as key disciplines fueling immediate investments in sales effectiveness, digital marketing across devices/channels, and the technical backbone behind the Internet of Everything.

Cisco has also started to engage more directly with the venture capital and start-up communities. Corporate CIO Rebecca Jacoby has established a company-wide reference architecture covering business, operational, systems, and technology aspects. Emerging solutions that comply with the reference architecture are actively pursued—often in response to specific problems or opportunities the company is trying to address. Like other IT investments, though, an assessment of the solution is made not just on its ability to change the business, but on the ongoing impact on running the business. Like a venture capitalist, the IT organization measures the portfolio in absolute terms—potential value weighed against total cost of service. Cisco emphasizes measurement of vision, strategy, and execution according to the needs of the business. Because of these approaches, Cisco is prepared to deal with whatever the future brings—acquisitions, product innovation, and investments in adjacent services and solutions.

## A view from the Valley[10]

Founded in 1989, Hummer Winblad Venture Partners (HWVP) was the first venture capital fund to invest exclusively in software companies. HWVP has deployed over $1 billion of cumulative capital in software investments starting at the first venture round of over 100 enterprise software companies. As such, HWVP has a singular perspective into not just what it takes to effectively manage an investment portfolio, but also into how Fortune 100 companies are responding to this seminal time in the history of technology. Unlike those who see innovation as a crescendo steadily building over time, HWVP sees a different, bumpier reality—defined by periods of disproportionate change, embodied by today's era of technology disruption.

Historically, large enterprises have encouraged new software vendors to focus on "embracing and extending" in-place software infrastructure. This approach can work if innovation is gradual, but can break down if innovation impacts overall business strategies. We are at a major disruption point where legacy systems likely cannot be extended. The digitization of the customer experience across industries—driven by mobile, social, cloud, and big data—is changing the nature of data itself, as businesses shift their focus from products to customers. Siloed systems aren't equipped to handle behavioral data, sentiment, and largely unstructured context. Digital requires a different horizontal stack.

The need to keep pace with new business and technological realities could be a great backdrop for CIOs to shift focus from cost, compliance, and maintenance to being in the business of "new." CIOs should be a strategy anchor for big companies: a board-level position that doesn't just enable but is a catalyst for growth.

HWVP doesn't have a "VC handbook" that guides its investments. And neither will CIOs. HWVP co-founder Ann Winblad believes we are entering an era where companies should take risks: They should swim in the river of innovation and be prepared to make multiple bets to discover what innovation really means for their company. It could lead to near-term competitive disadvantage—especially as large organizations react to the exploding population of small vendors that are defining tomorrow. Firms that CIOs may not have heard of with a small operating footprint may become essential partners.

Large companies should not wait for new market leaders to emerge. That means performing your own market analysis and increasing the value of existing partners and alliances—asking them to broker introductions or co-invest in early prototyping. Instead of asking small players to go through qualifying paces, create low-cost, low-risk prototypes and pilots to experiment with their technologies to solve business problems. Many CIOs of large companies use start-ups to enable lines of businesses—and help jointly own the investment in tomorrow.

HWVP is in the business of identifying—and sometimes provoking—patterns. It's the "venture" part of venture capital. With the customer as the business's new cerebral cortex and growth moving at the speed of digital, CIOs should act more like VCs. Not every bet will be a winner, but by keeping a portfolio of investments, moving ahead of tested (and sometimes stale) market trends, and keeping a mindset towards engagement, big companies can be poised to compete in these unprecedentedly exciting times.

# My take

## Charles Weston, SVP and chief information officer (retired), Bloomin' Brands

There are multiple drivers for why CIOs need to think like a venture capitalist. The first is the incredible pace of technological change. CIOs need to place bets—like VCs do—that a given product or service is going to hit the market at the right time and fill a niche that others don't. It's often no longer acceptable to use one vendor for all your technology needs. Second, given all the information now accessible to everyone, it's hard to gain a competitive advantage. VCs try to create a competitive advantage by investing in companies to make a profit— and CIOs try to create a competitive advantage by investing in services and capabilities to reap the benefits before competitors can. And third, to avoid trailing your competitors, CIOs need to take risks. VCs take balanced risks, conducting market research, and being thoughtful about selection and the company's fit with the team. Taking risks is the hardest part for CIOs; we've all seen the damage failed projects can do to the IT department's reputation. But taking risks means accepting not just the potential, but the inevitability of failure. In my judgment, if you're too afraid of that, your company will likely always trail your competitors. The key is to work with the rest of the C-suite to recognize that some level of risk is part of the ground rules. And if you're going to fail, fail fast— cutting your losses and moving on to the next bet.

In addition to my role as CIO of Bloomin' Brands, I also serve on the CIO advisory board for Sierra Ventures, a venture capital firm. Having that exposure into a VC firm has influenced my behavior as a CIO. When I first joined Bloomin' Brands, one of my priorities was to focus on where the market was going to be three years out and find something that would allow us to get out in front. At that time, we weren't yet a cloud organization, but I knew we eventually would be, and invested in a cloud-based integration product. Some in my IT organization were nervous at the time, knowing the integration would be challenging, but we knew it would also be challenging for our competitors—and we were able to be an early adopter and gain the advantage.

I have also adapted my approach to vendor and talent management. The current landscape changes how you deal with vendors. You're working with both large, established companies and the new set of entrants, many of whom are entrepreneurs who sometimes have never done an enterprise contract before. On the talent side, we increasingly hire for agility. We look for people who can be nimble and move at the same pace as the business. We recruit those who learn based on principle rather than by rote syntax and command so they can more easily move from one product to another.

As much as there are similarities between VCs and today's CIOs, there are also some tenets of venture capitalism that don't necessarily make sense for a CIO to adopt. The first is the size of your investment portfolio. While the VC can have 15–25 investments at once, the CIO may be able to balance only a handful. The second is the breadth of the portfolio. The VC can afford to go after multiple spaces, but the CIO's lens is rightfully constrained by the company's industry and the needs of the business. There may be some interesting capabilities you need to turn down because they just aren't the right fit.

To start on the path of CIO-as-venture-capitalist, try to open your mind to becoming more of a risk taker and to look at technology solutions that are less established. Work through your own risk profile—with the rest of your C-suite—and determine how much risk you are willing to take on. Then, align yourself with folks who can help you start to venture into this space and take advantage of some of the early-stage solutions.

# Where do you start?

**M**ASTERING VC capabilities may challenge many CIOs whose traditional role has been to meet business demands for reliable, cost-efficient technologies. And even if the capabilities could materialize overnight, earning the credibility that is required to become active participants in strategic leadership conversations will likely be a gradual process for many CIOs.

To complicate matters, new technology shifts—especially those powered by analytics, mobile, social, cloud, and cyber—intensify talent shortages and process constraints. These gaps make creating a balanced portfolio across traditional and emerging IT services even more difficult. As business users bypass IT to adopt cloud-based point solutions, organizational technology footprints are becoming more and more complex. Visibility into, and control of, the portfolio becomes harder to attain. CIOs have an imperative to get ahead of the curve.

This is especially true in M&A, where change is constantly disruptive. Many industries are rife with potential investments and divestitures. But few organizations can acquire, sell, or divest with surgical precision without reinventing the wheel with each transaction. Seventy percent of mergers and acquisitions fail to meet their expectations. The value from mergers, acquisitions, and divestitures is more directly linked to getting IT right than anything else.[11]

Transformation takes time, but small first steps can make a difference:

- **Inventory the technology portfolio.** What technologies does your organization deploy today? Focus on the full range, including solutions procured outside of IT. What projects are in play? What vendors do you depend on? What assets are in use, and where are they located? How does each asset contribute to the business mission, and what is its useful remaining life? It's not enough to rationalize your assets. Create a model to describe the categories of assets and investments, and use that to guide priorities. Many organizations use Gartner's Pace-Layered Application Strategy, breaking down their IT landscape into systems of record, systems of differentiation, and systems of innovation. Inventorying and classification is just an enabling step, though. What matters is how you use the visibility to direct focus and capital, balancing across the categories in a way that enables (and amplifies) your business strategy. Budgeting cycles typically run like *Shark Tank*—with funds allocated by the business based on its priorities.

- **Evaluate the portfolio.** Define the risk, value, and strategic importance of each portfolio item. Identify where costs/risks outweigh value. Pinpoint potential trouble spots, such as contracts with unclear service-level agreements or data ownership provisions. Understand each vendor's viability—not just in terms of capital and capacity, but also how well the vendor's roadmap aligns with your company's vision. Look for portfolio clusters: Is the proportion of investments in maintenance and upkeep appropriate when compared with investments in new strategic opportunities? Are there gaps that could hold the organization back? Strive for balance between extending legacy systems and investments in innovation. Aim for transparency, letting your business counterparts appreciate the exhaustive demand curve as well as the thinking that defines priorities.

- **Double down on winners.** And fold the losers. VCs expect some assets to underperform, and they are willing to cut their losses. CIOs should encourage intelligent risk-taking within the organization. Failure due to poor execution is unacceptable, but setbacks resulting from exploring innovative ideas are inevitable for organizations that want to compete in a high-growth environment. Borrow from the VC playbook—intentionally being conservative in initial funding to inspire creativity and creating more natural checkpoints. In either case, be prepared to recommend that the organization pull the plug when a project isn't delivering.

- **Direct line of sight to revenue.** Come up with an approach to vet technologies and their companies to better identify and evaluate winners and losers. Share your accomplishments and goals in terms that the business understands. Openly discuss the state of the projects and assets in which the business has invested. While few CIOs today have the sole power to initiate or withdraw substantial investments, many should develop the ability to evaluate the portfolio objectively. The first few wins can become the centerpiece of your campaign for change.

## Bottom line

At first blush, comparisons between CIOs and venture capitalists may seem like a stretch. For example, CIOs can't shoot from the hip on risky investments. They provide critical services that the business simply can't do without, where the risk of getting it wrong could be catastrophic. At the same time, there's a lot to learn from the portfolio mindset that VCs bring to their work: balancing investments in legacy systems, innovation, and even bleeding-edge technologies; understanding—and communicating—business value; and aligning talent with the business mission. Venture capitalists operate in a high-stakes environment where extraordinary value creation and inevitable losses can coexist inside a portfolio of calculated investments. So do CIOs.

## Authors

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# Endnotes

1.  Deloitte Consulting LLP, *Tech Trends 2014: Inspiring disruption*, 2014, chapter 3.

2.  Deloitte Consulting LLP, *Tech Trends 2013: Elements of postdigital*, 2013, chapter 2.

3.  Deloitte Consulting LLP, *Tech Trends 2013: Elements of postdigital*, 2013, chapter 6.

4.  Deloitte Consulting LLP, *Tech Trends 2013: Elements of postdigital*, 2013, chapter 9.

5.  Deloitte Consulting LLP, *Tech Trends 2013: Elements of postdigital*, 2013, chapter 10.

6.  CIO Journal by Wall Street Journal, "The four faces of the CIO," October 28, 2013, http://deloitte.wsj.com/cio/2013/10/28/the-four-faces-of-the-cio/, accessed December 19, 2013.

7.  Nicole Perlroth, "Venture capital firms, once discreet, learn the promotional game," *New York Times*, July 22, 2012, http://www.nytimes.com/2012/07/23/business/venture-capital-firms-once-discreet-learn-the-promotional-game.html?pagewanted=all&_r=1&, accessed December 19, 2013.

8.  Deloitte Consulting LLP, *Tech Trends 2014: Inspiring disruption*, 2014, chapter 3.

9.  Deloitte Consulting LLP, *Tech Trends 2014: Inspiring disruption*, 2014, chapter 7.

10. Ann Winblad (co-founder of Hummer Winblad Venture Partners), discussion with the author, January 9, 2014.

11. Janice M. Roehl-Anderson, *M&A Information Technology Best Practices* (New Jersey: Wiley, 2013).
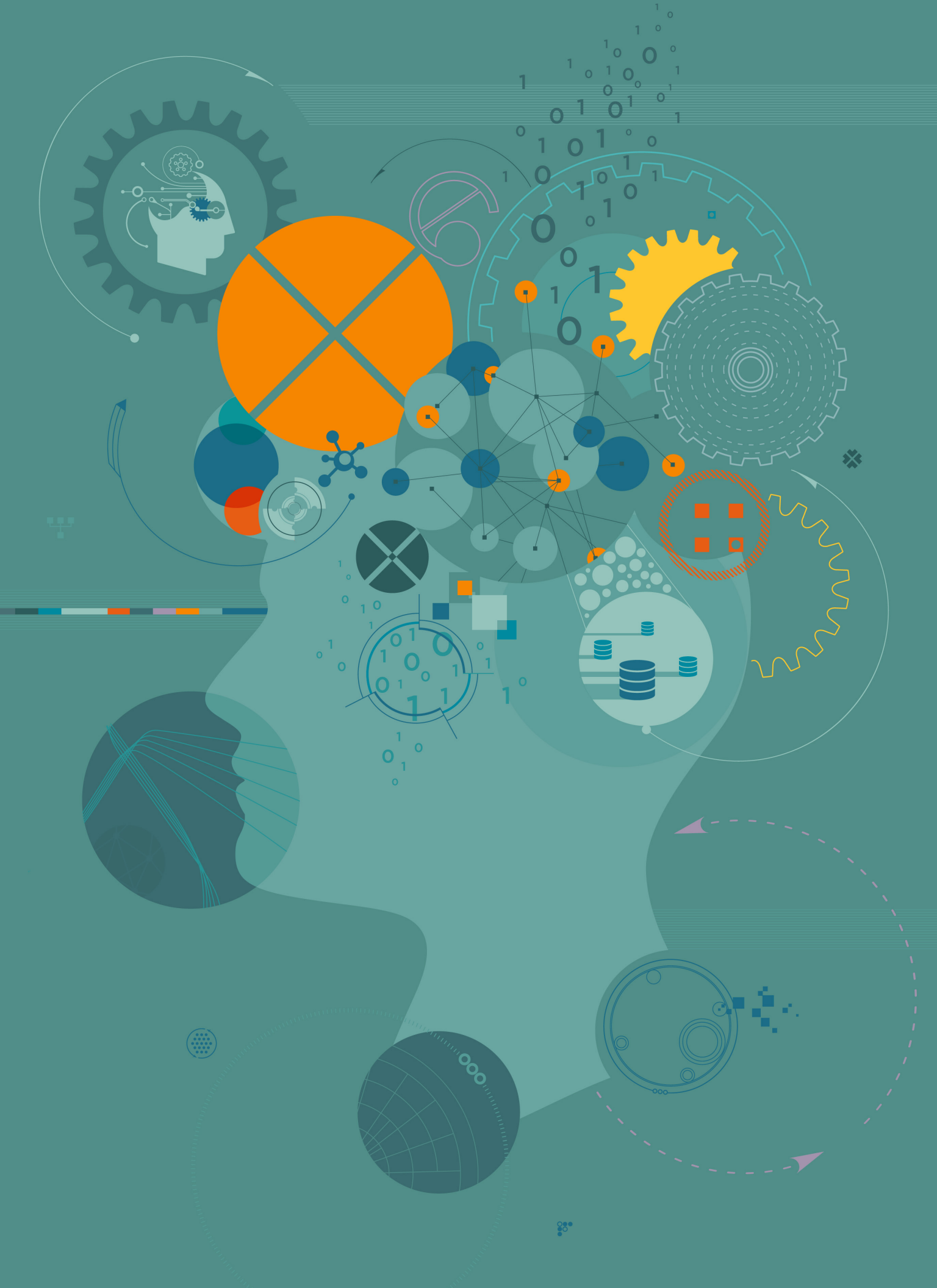
# Cognitive analytics
## Wow me with blinding insights, HAL

**Artificial intelligence, machine learning, and natural language processing have moved from experimental concepts to potential business disruptors—harnessing Internet speed, cloud scale, and adaptive mastery of business processes to drive insights that aid real-time decision making. For organizations that want to improve their ability to sense and respond, cognitive analytics can be a powerful way to bridge the gap between the intent of big data and the reality of practical decision making.**

**F**OR decades, companies have dealt with information in a familiar way—deliberately exploring known data sets to gain insights. Whether by queries, reports, or advanced analytical models, explicit rules have been applied to universes of data to answer questions and guide decision making. The underlying technologies for storage, visualization, statistical modeling, and business intelligence have continued to evolve, and we're far from reaching the limits of these traditional techniques.

Today, analytical systems that enable better data-driven decisions are at a crossroads with respect to where the work gets done. While they leverage technology for data-handling and number-crunching, the hard work of forming and testing hypotheses, tuning models, and tweaking data structures is still reliant on people. Much of the grunt work is carried out by computers, while much of the thinking is dependent on specific human beings with specific skills and experience that are hard to replace and hard to scale.

## A new approach to information discovery and decision making

For the first time in computing history, it's possible for machines to learn from experience and penetrate the complexity of data to identify associations. The field is called *cognitive analytics*™—inspired by how the human brain processes information, draws conclusions, and codifies instincts and experience into learning. Instead of depending on predefined rules and structured queries to uncover answers, cognitive analytics relies on technology systems to generate hypotheses, drawing from a wide variety of potentially relevant information and connections. Possible answers are expressed as recommendations, along with the system's self-assessed ranking of how confident it is in the accuracy of the response. Unlike in traditional analysis, the more data fed to a machine learning system, the more it can learn, resulting in higher-quality insights.

Cognitive analytics can push past the limitations of human cognition, allowing us to process and understand big data in real time, undaunted by exploding volumes of data or wild fluctuations in form, structure, and quality. Context-based hypotheses can be formed by exploring massive numbers of permutations of potential relationships of influence and causality—leading to conclusions unconstrained by organizational biases. In academia, the techniques have been applied to the study of reading, learning, and language

development. The Boltzmann machine[1] and the Never-Ending Language Learning (NELL)[2] projects are popular examples. In the consumer world, pieces of cognitive analytics form the core of artificial personal assistants such as Apple's Siri® voice recognition software[3] and the Google Now service, as well as the backbone for the Xbox® video game system's verbal command interface in Kinect®.

Even more interesting use cases exist in the commercial realm. Early instances of cognitive analytics can be found in health care, where systems are being used to improve the quality of patient outcomes. A wide range of structured inputs, such as claims records, patient files, and outbreak statistics, are coupled with unstructured inputs such as medical journals and textbooks, clinician notes, and social media feeds. Patient diagnoses can incorporate new medical evidence and individual patient histories, removing economic and geographic constraints that can prevent access to leading medical knowledge.

## Highlights in the history of cognitive analytics
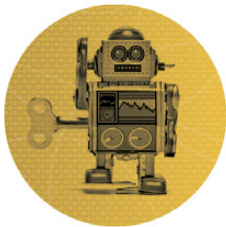
### 1950
Alan Turing publishes *Computing Machinery and Intelligence*, in which he proposes what is now referred to as the Turing Test: an experiment that tests a machine's ability to exhibit intelligent human behavior.[1]

### 1968
The first commercial database management system, or Information Management System (IMS), tracks huge amounts of structured data such as bills of materials for NASA's Apollo Moon mission.[2]

### 1972
Work begins on MYCIN, an early expert system that identifies infectious blood diseases using an inference engine and suggests diagnoses and treatments. Despite high performance, it is not used in practice.[3]
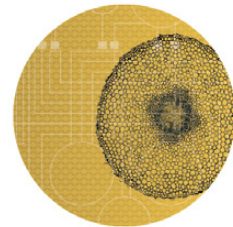
### 1980s
Steady increases in computing power fuel a revolution in natural language processing as early algorithms such as decision trees and neural network models are introduced.[4]

**COMPUTATIONS PER KILOWATT-HOUR[9]**

| | | | |
|---|---|---|---|
| 1e+12 | | | |
| 1e+8 | | | |
| 1e+4 | | | |
| 1950 | 1960 | 1970 | 1980 |

Sources: [1] A. M. Turing, "Computing machinery and intelligence," 1950, *Mind 49*: 433-460, http://www.csee.umbc.edu/courses/471/papers/turing.pdf, accessed December 27, 2013. [2] IBM, "Icons of progress: Information management system," http://www-03.ibm.com/ibm/history/ibm100/us/en/icons/ibmims, accessed December 27, 2013. [3] Edward H. Shortliffe, *A rule-based approach to the generation of advice and explanations in clinical medicine*, Stanford University Knowledge Systems Laboratory, 1977. [4] Joab Jackson, "Biologically inspired: How neural networks are finally maturing," *ComputerWorld*, December 17, 2013, http://news.idg.no/cw/art.cfm?id=213D1459-C657-E067-397E42988ACBFC00, accessed December 27, 2013. [5] IBM, "Icons of progress: TAKMI - Bringing order to unstructured data," http://www-03.ibm.com/ibm/history/ibm100/us/en/icons/takmi, accessed December 27, 2013.

In financial services, cognitive analytics is being used to advise and execute trading, as well as for advanced fraud detection and risk underwriting. In retail, cognitive systems operate as customer service agents, in-store kiosks, and digital store clerks—providing answers to customers' questions about products, trends, recommendations, and support. Another promising area for cognitive analytics involves the concept of "tuning" complex global systems such as supply chains and cloud networks.

## Getting practical

In practical terms, cognitive analytics is an extension of cognitive computing, which is made up of three main components: machine learning, natural language processing, and advancements in the enabling infrastructure.

Machine learning, or deep learning,[4] is an artificial intelligence[5] technique modeled after characteristics of the human brain. A machine learning system explores many divergent concepts for possible connections, expresses potential new ideas with relative confidence

● **Computing** ● **Machine learning** ● **Natural language processing**

### 1997
TAKMI, or Text Analysis and Knowledge Mining, is developed in Tokyo by IBM to capture and utilize knowledge embedded in text files through mining data and metadata in books, journals, emails, audio and video files, etc.[5]
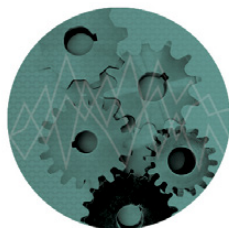
### 2004
The High Performance Computing Revitalization Act sets requirements for the Secretary of Energy for the development of, capabilities for, and access to high-end computing systems for scientific and engineering applications.[6]

### 2009-2010
Content analytics improve capabilities in unstructured data processing; streaming analytics process patient data to identify disease patterns in real time; and predictive analytics forecast the attitudes and behavior of customers.[7]

### Today
IBM, WellPoint, and Memorial Sloan Kettering use Watson to give doctors treatment options in seconds. Streaming analytics process 5 million messages of market data per second to speed up trading decisions.[8]

1990    2000    2010

[6] National Science Foundation, "Department of Energy: High-end Computing Revitalization Act of 2004," http://www.nsf.gov/mps/ast/aaac/p_l_108-423_doe_high_end_computing_revitalization_act_of_2004.pdf, November 30, 2004, accessed January 6, 2014. [7] IBM, "Icons of progress: TAKMI - Bringing order to unstructured data," http://www-03.ibm.com/ibm/history/ibm100/us/en/icons/takmi, accessed December 27, 2013; IBM, "Icons of progress: The invention of stream computing," http://www-03.ibm.com/ibm/history/ibm100/us/en/icons/streamcomputing, accessed December 27, 2013. [8] Memorial Sloan-Kettering Cancer Center, "IBM Watson hard at work: New breakthroughs transform quality care for patients," http://www.mskcc.org/pressroom/press/ibm-watson-hard-work-new-breakthroughs-transform-quality-care-patients, accessed December 27, 2013. [9] Economist, "A deeper law than Moore's?," October 10, 2011, http://www.economist.com/blogs/dailychart/2011/10/computing-power, accessed December 27, 2013.

or certainty in their "correctness," and adjusts the strength of heuristics, intuition, or decision frameworks based on direct feedback to those ideas. Many of today's implementations represent supervised learning, where the machine needs to be trained or taught by humans. User feedback is given on the quality of the conclusions, which the system uses to tune its "thought process" and refine future hypotheses.

Another important component of cognitive computing is natural language processing (NLP), or the ability to parse and understand unstructured data and conversational requests. NLP allows more data from more sources to be included in an analysis—allowing raw text, handwritten content, email, blog posts, mobile and sensor data, voice transcriptions, and more to be included as part of the learning. This is essential, especially because the volume of unstructured data is growing by 62 percent each year[6] and is expected to reach nine times the volume of structured data by 2020.[7] Instead of demanding that all information be scrubbed, interpreted, and translated into a common format, the hypothesis and confidence engines actively learn associations and the relative merits of various sources.

NLP can also simplify a person's ability to interact with cognitive systems. Instead of forcing end users to learn querying or programming languages, cognitive computing allows spoken, natural exploration. Users can ask, "What are the sales projections for this quarter?" instead of writing complicated lookups and joins against databases and schemas.

Finally, cognitive computing depends on increased processing power and storage networks delivered at low costs. That's because it requires massively parallel processing, which allows exploration of different sets of data from different sources at the same time. It also requires places where the massive

amounts of data can be continuously collected and analyzed. Options include the cloud, large appliances and high-end servers, and distributed architectures that allow work to be reduced and mapped to a large collection of lower-end hardware.

## All together now

Cognitive analytics is the application of these technologies to enhance human decisions. It takes advantage of cognitive computing's vast data-processing power and adds channels for data collection (such as sensing applications) and environmental context to provide practical business insights. If cognitive *computing* has changed the way in which information is processed, cognitive *analytics* is changing the way information is applied.

The breakthrough could not have come at a better time. As more human activity is being expressed digitally, data forms continue to evolve. Highly structured financial and transactional data remain at the forefront of many business applications, but the rise of unstructured information in voice, images, social channels, and video has created new opportunities for businesses to understand the world around them. For companies that want to use this information for real-time decision making, cognitive analytics is moving to center stage. It is both a complement to inventorying, cleansing, and curating ever-growing decision sources and a means for machine learning at Internet speed and cloud scale to automatically discover new correlations and patterns.

Cognitive analytics is still in its early stages, and it is by no means a replacement for traditional information and analytics programs. However, industries wrestling with massive amounts of unstructured data or struggling to meet growing demand for real-time visibility should consider taking a look.

# Lessons from the front lines

## Coloring outside the lines

A multinational consumer goods company wanted to evaluate new designs for its popular men's personal care product. The company had sizeable market share, but its competitors were consistently developing and marketing new design features. To remain competitive, the company wanted to understand which features consumers valued.

Thousands of testers filled out surveys regarding the company's new product variant. Although some of the survey's results were quantitative ("Rate this feature on a scale from 1–5"), many were qualitative free-form text ("Other comments"). This produced more text than could be processed, efficiently and accurately, by humans.

The company used Luminoso's text analytics software to analyze the responses by building a conceptual matrix of the respondents' text—mapping the raw content onto subject and topic matters, statistical relationships, and contexts that were relevant to the business. Luminoso's Insight Engine identified notable elements and patterns within the text, and measured the emotional and perceived effects of the product's design and functionality.

The discoveries were impressive, and surprising. The company rapidly identified design features important to consumers, which mapped closely to the numerical ratings testers had assigned. Unexpectedly, the product's color strongly affected how emotionally attached a tester was to his product. When writing freely, testers frequently mentioned color's significance to the product experience—but when faced with specific questions, testers only spoke to the topic at hand. The company also uncovered that the color findings were mirrored in those testers who did not specifically mention color.

The company, able to finally quantify a color preference, conducted a study to select the preferred one. The product is now on the shelves of major supermarkets and convenience stores—in a new color, selling more units.

## Intelligent personal assistants

Some of the building blocks of cognitive analytics have found homes in our pockets and purses. Intelligent personal assistants such as Apple's Siri, Google Now, and Microsoft Cortana use natural language processing, predictive analytics, machine learning, and big data to provide personalized, seemingly prescient service. These are examples of complex technologies working together behind a deceptively simple interface—allowing users to quickly and easily find the information they need through conversational commands and contextual prompts based on location, activity, and a user's history.

Such programs are first steps toward harnessing cognitive analytics for personal enhanced decision making. For example, Google Now can check your calendar to determine that you have a dentist appointment, or search your communication history to know that you are seeing a movie—contextually determining your destination.[8] It can then use GPS to determine your current location, use Google Maps to check traffic conditions and determine the best driving route, and set a notification to let you know what time you should leave. And these systems are only getting better, because the programs can also learn your behaviors and preferences over time, leading to more accurate and targeted information.

## Changing the world of health care

In 2011, WellPoint, one of the nation's largest health benefits companies, set out to design a world-class, integrated health care ecosystem that would link data on physical, financial, worksite, behavioral, and community health. By establishing a singular platform, WellPoint could enhance its ability to collaborate, share information, automate processes, and manage analytics. To do this, WellPoint needed an advanced solution, and therefore teamed with IBM to use the capabilities of Watson—IBM's cognitive computing system.

"We decided to integrate our health care ecosystem to help our care management associates administer member benefits, while providing a seamless member experience and working to reduce costs," said Gail Borgatti Croall, SVP of Care Management at WellPoint. "Cognitive analytics was important in creating a system that could drive effectiveness and efficiencies throughout our business."

Today, WellPoint uses cognitive analytics as a tool for utilization management:[9] specifically, in reviewing pre-authorization treatment requests—decisions that require knowledge of medical science, patient history, and the prescribing doctor's rationale, among other factors. With its ability to read free-form textual information, Watson can synthesize huge amounts of data and create hypotheses on how to respond to case requests. In fact, WellPoint already has "taught" its cognitive engine to recognize medical policies and guidelines representing 54 percent of outpatient requests.

"It took us about a year to train our solution on our business, and the more we taught the faster the Watson cognitive platform learned," said Croall. "Now it's familiar with a huge volume of clinical information and professional literature. This reduces a significant amount of time needed for nurses to track down and assess the variables when making a well-informed decision on an authorization request."

For each case reviewed, the system provides nurses with a recommendation and an overall confidence and accuracy rating for that recommendation. In some outpatient cases, the system already can auto-approve requests, reducing the timeframe for patient treatment recommendations from 72 hours to near-real time. As the cognitive system develops its knowledge database, the accuracy and confidence ratings will continue to rise, and the ability to approve greater numbers and types of cases in real time becomes a reality.

Furthermore, nurses have experienced a 20 percent improvement in efficiency in specific work flows due to the one-stop-shop nature of the integrated platform. The integrated platform will create not only efficiency savings but also enable improvement in speed of response to provider requests.

WellPoint's use of cognitive analytics for utilization management represents the tip of the iceberg. Its integrated health care ecosystem is a multiyear journey that the company approaches with iterative, small releases, keeping the effort on time and on budget. In the future, WellPoint may look into how the system can support identification and stratification for clinical programs or many other applications.

"We'd like to see how our system can support a more holistic, longitudinal patient record—for example, integrating electronic medical record (EMR) data with claims, lab, and pharmacy data," said Croall. "We also see opportunities on the consumer side. Imagine using cognitive insights to create an online, interactive model that helps you, as a patient, understand treatment options and costs. We've barely scratched the surface with our cognitive analytics capabilities. It truly will change the way we perform utilization management and case management services."

## Safeguarding the future— Energy well spent

Each year, thousands of safety-related events occur around the world at nuclear power plants.[10] The most severe events make headlines because of disastrous consequences including loss of life, environmental damage, and economic cost. Curtiss-Wright, a product manufacturer and service provider to the aerospace, defense, oil and gas, and nuclear energy industries, examines nuclear safety event data to determine patterns. These patterns can be used by energy clients to determine what occurred during a power plant event, understand the plant's current status, and anticipate future events.[11]

Curtiss-Wright is taking its analysis a step further by developing an advanced analytics solution. The foundation of this solution is Saffron Technology's cognitive computing platform, a predictive intelligence system that can recognize connections within disparate data sets.[12] By feeding this platform with structured operational metrics and decades of semi-structured nuclear event reporting, the ability to foresee future issues and provide response recommendations for evolving situations is made possible.[13] Ultimately, Curtiss-Wright hopes to improve nuclear safety by means of a solution that not only enables energy companies to learn from the past but also gives them the opportunity to prepare for the future.

# My take

## Manoj Saxena, general manager, Watson Solutions, IBM

In 2011, I was given the opportunity to lead IBM's Watson project and build a business around it. I am passionate about the process of "presentations to products to profits," so this endeavor really excited me. The first decision I had to make was which markets and industries we should enter. We wanted to focus on information-intensive industries where multi-structured data are important to driving better decisions. Obvious choices such as insurance, health care, telecom, and banking were discussed. We chose to first focus on health care: a multitrillion-dollar industry in which our technology could help improve the quality of care delivered, drive toward significant cost reduction, and have a positive impact on society. In 2012, we reduced the footprint of our Watson system—then the size of a master bedroom—to a single server and took our first customer into production.

To be successful with cognitive computing, companies should be able to articulate how they will make better decisions and drive better outcomes. Companies will struggle if they approach it from the "technology in" angle instead of "business out." The technology is no doubt fundamental but should be coupled with business domain knowledge—understanding the industry, learning the theoretical and practical experience of the field, and learning the nuances around a given problem set.

For example, in the health care industry, there are three primary aspects that make Watson's solution scalable and repeatable. First, Watson is being trained by medical professionals to understand the context of the relevant health area and can present information in a way that is useful to clinicians. Second, when building the tools and platform, we created a model that can be reconfigured to apply to multiple functions within the industry so that learnings from one

area can help accelerate mastery in related fields. Third, the delivery structure is scalable—able to tackle problems big or small. The more it learns about the industry, the better its confidence in responding to user questions or system queries and the quicker it can be deployed against new problems. With Watson for contact center, we are targeting training the system for a new task in six weeks with a goal of achieving business "break even" in six months.

However, cognitive computing may not always be the right solution. Sometimes businesses should start with improving and enhancing their existing analytics solutions. Companies considering cognitive computing should select appropriate use cases that will generate value and have enough of a compelling roadmap and potential to "starburst" into enough additional scenarios to truly move the needle.

In terms of the talent needed to support cognitive solutions, I liken this to the early stages of the Internet and web page development when people worried about the lack of HTML developers. Ultimately, systems arose to streamline the process and reduce the skill set required. With Watson, we have reduced the complexity required to do this type of work by 10–15 times where we were when we first started, and recent startups will continue to drive the curve down. So less highly specialized people will be able to complete more complex tasks—PhDs and data scientists won't be the only ones capable of implementing cognitive computing.

There are three things I consider important for an effective cognitive computing solution: C-suite buy-in to the vision of transforming the business over a 3–5 year journey; relevant use cases and roadmap that are likely to lead to a compelling business outcome; and the content and talent to drive the use case and vision. If you approach a project purely from a technology standpoint, the project will become a science project, and you can't expect it to drive value.

# Where do you start?

RATHER than having a team of data scientists creating algorithms to understand a particular business issue, cognitive analytics seeks to extract content, embed it into semantic models, discover hypotheses and interpret evidence, provide potential insights—and then continuously improve them. The data scientist's job is to empower the cognitive tool, providing guidance, coaching, feedback, and new inputs along the way. As a tool moves closer to being able to replicate the human thought process, answers come more promptly and with greater consistency. Here are a few ways to get started:

- **Start small.** It's possible to pilot and prototype a cognitive analytics platform at low cost and low risk of abandonment using the cloud and open-source tools. A few early successes and valuable insights can make the learning phase also a launch phase.

- **Plant seeds.** Analytics talent shortages are exacerbated in the cognitive world. The good news? Because the techniques are so new, your competitors are likely facing similar hurdles. Now is a good time to invest in your next-generation data scientists, anchored in refining and harnessing cognitive techniques. And remember, business domain experience is as critical as data science. Cast a wide net, and invest in developing the players from each of the disciplines. Consider crowdsourcing talent options for initial forays.[14]

- **Tools second.** The tools are improving and evolving at a rapid pace, so don't agonize over choices, and don't overcommit to a single vendor. Start with what you have, supplement with open-source tools during the early days, and continue to explore the state of the possible as tools evolve and consolidate.

- **Context is king.** Quick answers and consistency depend on more than processing power. They also depend on context. By starting with deep information for a particular sector, a cognitive analytics platform can short-circuit the learning curve and get to high-confidence hypotheses quickly. That's why the machinery of cognitive computing—such as Watson from IBM—is rolling out sector by sector. Early applications involve health care management and customer service in banking and insurance. Decide which domains to target and begin working through a concept map—part entity and explicit relationship exercise, part understanding of influence and subtle interactions.

- **Don't scuttle your analytics ship.** Far from making traditional approaches obsolete, cognitive analytics simply provides another layer—a potentially more powerful layer—for understanding complexity and driving real-time decisions. By tapping into broader sets of unstructured data such as social monitoring, deep demographics, and economic indicators, cognitive analytics can supplement traditional analytics with ever-increasing accuracy and speed.

- **Divide and conquer.** Cognitive analytics initiatives can be broken into smaller, more accessible projects. Natural language processing can be an extension of visualization and other human-computer interaction efforts. Unstructured data can be tapped as a new signal in traditional analytics efforts. Distributed computing and cloud options for parallel processing of big data don't require machine learning to yield new insights.

- **Know which questions you're asking.** Even modest initiatives need to be grounded in a business "so what." An analytics journey should begin with questions, and the application of cognitive analytics is no exception. The difference, however, lies in the kinds of answers you're looking for. When you need forward-looking insights that enable confident responses, cognitive analytics may be your best bet.

- **Explore ideas from others.** Look outside your company and industry at what others are doing to explore the state of the possible. Interpret it in your own business context to identify the state of the practical and valuable.

## Bottom line

As the demand for real-time support in business decision making intensifies, cognitive analytics will likely move to the forefront in high-stakes sectors and functions: health care, financial services, supply chain, customer relationship management, telecommunications, and cyber security. In some of these areas, lagging response times can be a matter of life and death. In others, they simply represent missed opportunities.

Cognitive analytics can help address some key challenges. It can improve prediction accuracy, provide augmentation and scale to human cognition, and allow tasks to be performed more efficiently (and automatically) via context-based suggestions. For organizations that want to improve their ability to sense and respond, cognitive analytics offers a powerful way to bridge the gap between the promise of big data and the reality of practical decision making.

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# Industrialized crowdsourcing
## Sometimes more is better

Enterprise adoption of the power of the crowd allows specialized skills to be dynamically sourced from anyone, anywhere, and only as needed. Companies can use the collective knowledge of the masses to help with tasks from data entry and coding to advanced analytics and product development. The potential for disruptive impact on cost alone likely makes early experimentation worthwhile, but there are also broader implications for innovation in the enterprise.

ENTERPRISE adoption of crowdsourcing can allow specialized skills to be dynamically sourced—from anyone, anywhere, as needed—for everything from data entry and coding to advanced analytics and product development. The potential for disruptive impact on cost alone could make early experimentation worthwhile, but there are broader implications for innovation in the enterprise.

Sun Microsystems co-founder Bill Joy said it well in 1990: "No matter who you are, most of the smartest people work for someone else."[1] His intent was not defeatism; it was a rallying cry to tap into the collective experience and enthusiasm outside of organizational boundaries. Today, enterprises are doing just that: harnessing the crowd to help with a wide mix of challenges, from menial tasks and complex needs requiring specialized skill sets to creative endeavors and even strategic planning. The idea of open source talent[2] via crowdsourcing is becoming industrialized—growing in scale, sophistication, and importance as an alternative staffing model. The goal is not just cost savings but also quick access to specialized resources, the ability to dynamically scale up (and down) around workloads, and geographic coverage in quickly changing markets.

Businesses have a rich history of trying to tap into crowds, using consumer surveys, focus groups, and experiential marketing to provoke customer engagement. Product R&D, in particular, has seen significant activity, with open innovation campaigns launched by many large companies, including 3M, BMW, General Mills, and Stanley Black & Decker.[3] More recently, companies have moved to flatten and rewire their structures, making it easier for people *within* the organization to connect with information and specialists to grow ideas and solve pressing problems across a wide spectrum of domains.

## There's a crowd for that

The business applications of crowdsourcing run the gamut from simple tasks to complex solutions. Below is a sampling of the categories and emerging platforms for harnessing the crowd.

- **Simple, task-oriented crowdsourcing.** Companies need arms and legs to execute simple, short, transactional units of work. Language translation services, data entry, photograph tagging, and transcription are popular items that allow large workloads to be split across remote workforces. Routine tasks that require physical presence such

as performing store pricing checks, pulling products during recalls, restocking retail shelves, or serving as data collectors, also fit into this category. Crowdsourcing platforms such as Amazon's Mechnical Turk, Gigwalk, TaskRabbit, Elance, Field Agent, and Quri fill this niche with an on-demand labor force, often global, numbering in the hundreds of thousands and performing millions of jobs.[4] The goal is not just low costs but also speed and scale.

- **Complex, experience-based crowdsourcing.** Complex tasks require abstract thinking, specialized skill sets, and sophisticated problem solving. The crowd is typically made up of diverse, qualified individuals, including software engineers, data scientists, artists, designers, management consultants, and hobbyists with advanced academic degrees or industry experience. Tasks typically require not just scale but also creative problem solving, with the goal of achieving breakthroughs to old problems through innovative thinking. Platforms for this type of crowdsourcing include 10EQS, crowdSPRING, Kaggle, oDesk, and Tongal.

- **Open-ended, idea-generating crowdsourcing.** These applications involve challenges oriented around invention, idea generation, and product and brand innovation. Breakthroughs may come from specialists or, increasingly, from the general public. The challenge becomes one of provoking and harvesting that potential. Corporations are increasingly entering into partnerships with crowdsourcing platforms in this space to focus their efforts. Examples include General Electric's opening of its patent library to Quirky[5] and Qualcomm's Tricorder challenge with the XPRIZE Foundation.[6] IdeaConnection and InnoCentive are other platforms in this space.

- **Funding, consumption, and contribution crowdsourcing.** Large enterprises should be aware of three other models of crowdsourcing that are gaining momentum. The first is crowdfunding, in which entrepreneurs solicit sponsorship from the masses, looking for support or capital to develop ideas, products, and businesses. Indiegogo and Kickstarter are two of many platforms in this space. Collaborative consumption models have also emerged, in which certain assets are available "as a service" to the crowd. Automobiles through Uber and lodging through Airbnb are two examples. Finally, we're seeing platforms where the crowd contributes ideas and information, sharing knowledge that could be useful to others. The open source software movement and Wikipedia are based on this model. Other more recent platforms include Crowdtap and Sourcemap.

## Battalion at the ready

How is this different from outsourcing or temporary agencies that have been around for decades? Industrialized crowdsourcing providers leverage platforms that can match buyers to a much broader base of sellers while reducing many of the administrative hassles, combining cloud, mobile, social, and web technologies to create new marketplaces.

For location-based assignments, individuals carry GPS-enabled devices that provide on-the-spot data entry and performance verification. Others may provide bidding systems, processes for billing and payment collection, performance monitoring, and performance ratings. Platforms can provide easy access to specialists from many walks of life—professionals, freelancers, and hobbyists—who have the motivation, qualifications, and flexibility to create innovative ideas and execute assignments promptly. For temp agencies or outsourcers, the talent pool is constrained by their rosters.

In crowdsourcing, the needle in the haystack comes to you, with skills and interests aligned with your ask.

Buyers can access large pools of people in short order, typically at low transaction costs—a few dollars per store visit or pennies per photo tag, For free agents, these assignments allow them to earn extra money with fewer commitments and more flexibility than traditional employment offers. And individuals qualified for these projects are often attracted by intrinsic rewards beyond just money—prestige, competition, learning, or job opportunities. Many crowdsourcing platforms provide rewards or leaderboards, letting talent be recognized as leaders in their fields.

Some of the more compelling results come from harnessing the crowd via contests. These can be offered for entertainment or prestige by applying gamification[7] techniques. Alternatively, top talent can be invited to compete on an assignment by offering financial incentives for the more effective responses. Sponsoring companies pay only for "winning" solutions while gaining access to a wide range of ideas. Talent has the freedom to select projects that match its interests and ambitions and is given a platform to showcase its work. Colgate Speed Stick used this model to spark a Super Bowl ad for the bargain-basement price of $17,000, compared with nine-figure investments associated with traditional agencies.[8] Allstate sponsored a competition in which the crowd created a liability prediction model that was 271 percent more accurate than the original.[9]

Leading companies are blasting through corporate walls with industrialized solutions to reach broader crowds capable of generating answers and executing tasks faster and more cost effectively than employees. Companies are also gaining access to niche, unproven experience that might be hard to find and retain in-house. And with the crowd, you pay only for the task being completed.

The crowd is waiting and willing. How will you put it to work?

## A sampling of crowdsourcing platforms

### Gigwalk[1]
A mobile, flexible workforce for jobs in the field
FOUNDED 2011

### oDesk[2]
A tool for hiring and managing remote freelancers
FOUNDED 2005

### Kaggle[3]
Competitions for predictive modeling and analytics
FOUNDED 2010

### Tongal[4]
Collaborative contests for video production
FOUNDED 2008

### Quirky[5]
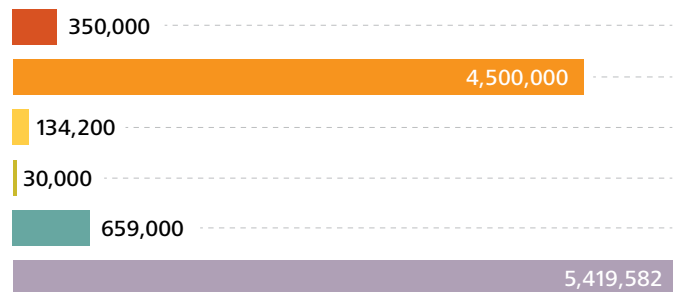A product design incubator and marketplace
FOUNDED 2009

### Kickstarter[6]
A global funding platform for creative projects
FOUNDED 2009

USERS Number of contributors in the community

350,000
4,500,000
134,200
30,000
659,000
5,419,582

JOBS Number of completed projects

4,000,000
897,946
299
150
411
53,728

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# Lessons from the front lines

## Crowd wars: The "fan"tom menace

In 2013, Kellogg's Pringles teamed with Lucasfilm's Star Wars to launch "The Force for Fun Project," a Tongal-enabled contest challenging consumers and fans to design the next Pringles television commercial.[10] By engaging a crowdsourcing platform, Pringles hoped to open its doors to access new ideas and inspire fresh, fan-driven digital content while generating millions of impressions.

The Force for Fun Project was staged in three rounds, with a bonus "wild card" round to identify additional finalists. First, fans were invited to submit a 140-character vision in the "ideas round." The top five ideas advanced to the "pitch round," where filmmakers could present a vision for a video production based on one of the five ideas. The winning pitches, as identified by Pringles and Star Wars executives, advanced to the final "video round," receiving a production budget to bring the pitch to life. In the final round, seven finalists were selected for a chance to win The Force for Fun Project grand prize, which included a $25,000 cash prize and a national television spot.

To drive additional buzz for the video finalists, Pringles and Star Wars solicited 10 die-hard fans and bloggers to feature the videos (with additional, behind-the-scenes content) on their own social platforms.[11]

The six-month initiative generated over 1,000 idea submissions, 154 video pitches, over 1.5 million YouTube views, 6 million social impressions, and over 111 million overall impressions. Furthermore, the contest and winning videos received media coverage across mainstream media and digital outlets. On September 24, 2013, the winning commercial was broadcast to over 12 million viewers during ABC's series premiere of Marvel's *Agents of S.H.I.E.L.D.*

## Civic crowdsourcing

As the budgets for civic organizations continue to shrink, municipalities, nonprofits, and other public organizations are reaching out to the public through crowdsourcing, which allows civic organizations to tap into their constituents for tools and services at a fraction of the cost of traditional sourcing approaches.

One example is the City of Chicago. After Mayor Rahm Emanuel signed an executive order making all non-private data available, the city sought ideas for providing the data to the public in a usable way.[12] Targeting local software engineers, hobbyists, and "hackers,"[13] the city initiated a crowdsourcing effort that yielded a number of app proposals, ranging from a 311 service tracker to a tool displaying real-time subway delays.

Another example is the Khan Academy, a nonprofit organization that provides free educational content online. It uses volunteers to translate the website into different languages—crowd-provided localization services. A Spanish site was released in September 2013, and videos have been translated into more than a dozen languages.[14]

The City of Boston introduced the Citizens Connect mobile app in 2008, encouraging Bostonians to report problems ranging from broken streetlights to missed trash pickups. The reports are connected to the city maintenance tracking system, allowing work crews to be rapidly deployed to fix problems as reports come in and alerting citizens

when work orders are resolved. Since the app debuted, the number of reports has risen from 8,000 in 2009 to more than 150,000 in 2012.[15]

## Have patents, will innovate

Product development and innovation can take years for large companies to develop from initial idea to an item available on retail shelves. Start-up company Quirky is challenging current wisdom by crowdsourcing the product development process, shortening the invention timeline of new products from years to weeks.

In 2012, Quirky caught the attention of GE when it launched 121 new products and sold 2.3 million units.[16] The compressed development schedule impressed GE leadership so much that the company

opened its patent library to the Quirky community to enable development of new consumer products.

Products developed by Quirky begin as one of approximately 3,000 ideas submitted weekly by the Quirky community. As ideas are submitted, community members vote for the ideas they like. Those with the most votes are reviewed by industry specialists and community members who select products for production. During development, the community influences the product roadmap by voting on issues ranging from color and price to engineering. With four products completed,[17] the Quirky and GE team plan to release dozens more over the next five years, with GE already providing $30 million in funding.[18]
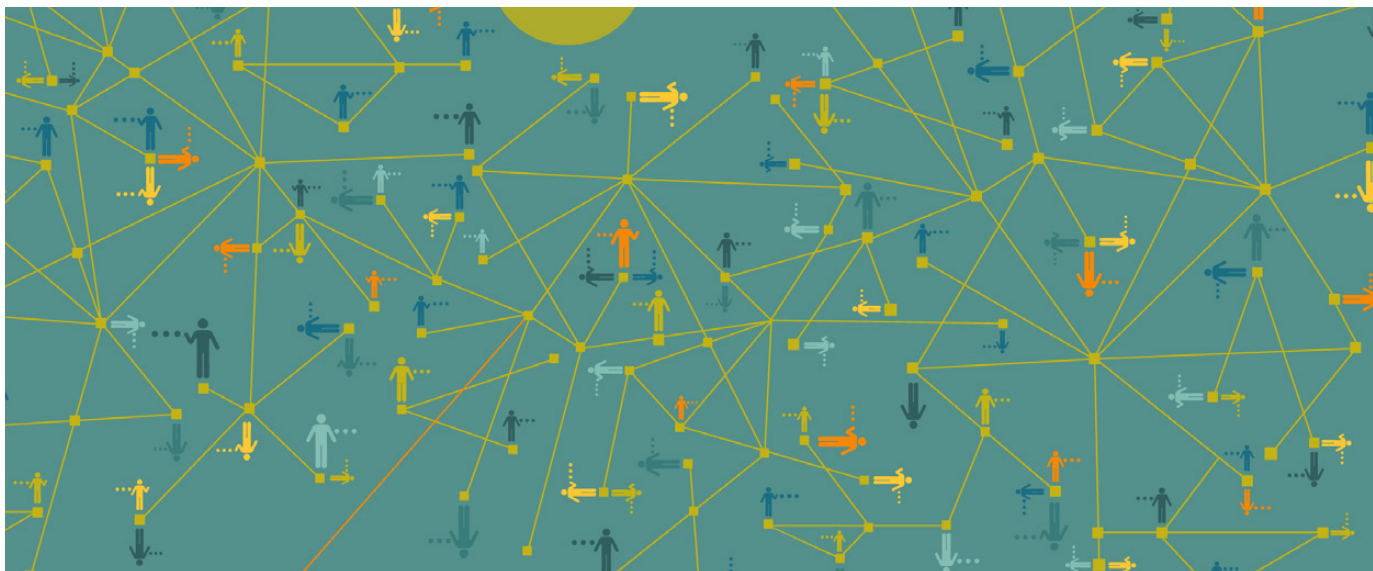
## Crowding store shelves

Innovation is likely at an all-time high in the consumer products industry. Traditionally, new initiatives and technologies took months, or even years, to implement. Today, the timeline can be weeks. Consumer product companies and retailers are finding benefits in rapid experimentation to keep up with the pace of change and stay on the leading edge of innovation.

A leading retailer chose to experiment with crowdsourcing to improve its data collection. It engaged with Gigwalk—a company that taps into the general population to perform micro-tasks for enterprises. Millions of "gigwalkers" use a mobile app that matches them with available jobs, or "gigs," based on their geographical area and skillset. Participants are then promptly paid for executing those tasks.

The company participated in a pilot program to investigate a hunch that stores were missing out on sales because of out-of-stock products. The company set up a series of gigs to monitor and collect data on the stocking of its stores' displays. It was hoping that by collecting and analyzing this data it could identify an opportunity to decrease lost sales.

The company wanted to use new technologies and techniques to tackle age-old industry challenges around out-of-stocks. It started by defining customer scenarios and identifying the specific data to be collected. The crowdsourced team would walk into more than a dozen stores twice a day and identify the missing products. A team member could scroll through a list of the company's products on the mobile app, click the ones that were missing, and use the drag-and-drop menu to enter product information.

The pilot went live a month after conception, but the first week yielded subpar results, with only a 21 percent task adoption rate among the available resources. So the company changed the way the gig was constructed and how the crowd would be incentivized. For example, it realized the term "SKU" was not well understood by many consumers; to aid comprehension, the company more clearly showcased the data that was to be collected. In addition, the company adjusted the pricing structure to reward "gigwalkers" for completing additional store audits. The new model also disclosed the goals and value of the company's crowdsourced data collection initiative. The changes proved to be powerful. In the second week the adoption rate was 84 percent, and in the third and fourth weeks, the rate rose to 99 percent.

The crowdsourcing experiment enabled the retailer to create datasets around its products. By creating a visual heat map, the company was able to view, store by store, which products were out of stock throughout a day across its stores in the pilot group. It was also able to improve the internal processes that corresponded to those products and reduce the number of out-of-stock items. The company estimated it could save millions of dollars if the piloted process enhancements were implemented in stores across the country. The retailer also created a geospatial map to identify routing issues that might be contributing to out-of-stock items, and was able to make changes to its distribution methodologies accordingly.

At a reasonable cost, and in a relatively short period, the company was able to use crowdsourcing to collect data; glean insights about its products, brands, and distribution; and improve processes to reduce its risk of lost sales.

# My take

## Salim Ismail, founding executive director and global ambassador, Singularity University

CIOs have one of the hardest roles in business today: They need to manage reliability, performance, and security while simultaneously guiding innovation and absorbing new technologies. Talent is a massively limiting factor—especially with regard to disruptive technologies like data science. Along with other techniques, crowdsourcing can offer a way to address these challenges.

I see two primary areas where companies can leverage the power of crowdsourcing. The first is in the micro-task world, where a company can create small pieces of work to outsource. The second is in the engagement world, where a company can use a crowdsourcing platform for a defined role such as software development. It's easier to do the latter, but as we atomize processes to smaller and smaller tasks, there is no reason those cannot also be outsourced. The dilemma emerges when you get to mission-critical processes. Outsourcing those can carry enormous risks, but it can also provide incredible scalability. I predict that in the next several years it will become more common, with startups leading the charge and larger organizations following suit to remain competitive. In information-based industries, this is likely to be crucial. Quirky, a consumer packaged goods (CPG) startup, manages a community of 500,000 inventors to submit ideas. Airbnb leverages the crowd to supply rooms for people to stay in.

Regardless of which approach you take, I believe that crowdsourcing is here to stay. The number of people online is projected to increase from 2.4 billion today[19] to 5 billion by 2020.[20] These minds, armed with their ever-more-affordable tablets of choice, will dramatically increase the general availability of intellectual capital. And the technologies and resources now exist for virtually anyone to become skilled in anything very quickly. So the question becomes, "How will you adapt?"

The first step for the C-suite is to gain awareness: Many executives I talk to are unfamiliar with crowdsourcing. To CIOs who think, "That's interesting, but not for me," I would say that if you're only looking for innovation internally, you'll likely find yourself in trouble. There is too much happening outside your company walls for you to risk ignoring it, let alone not leveraging it. Consider the newspaper business, which was disrupted by Craigslist, or the music business, which was disrupted by the iTunes® application.[21] Your business counterparts should expect that they will be disrupted even if they don't yet know in what way. For this reason, I urge traditional businesses to figure out how to cannibalize themselves, or someone else likely will. Yes, there is discomfort and risk involved, but that can be mitigated, and it is ultimately less dangerous than your business failing.

When you tap into the crowd, you sacrifice certainty for breadth of creative input, but as long as the crowd is large, you have the potential for incredible results at fractional costs. We're entering a world where businesses are either the disruptor or the disrupted, and there is no middle ground. I believe that taking advantage of trends like crowdsourcing can help companies keep the upper hand.

# Where do you start?

UNDERSTANDING how to use crowdsourcing to help reach organizational goals may not be intuitive, and the range of potential projects and platforms can add to the confusion, especially as you're educating your business counterparts. Data security, privacy, and compliance risks may be raised as roadblocks. That said, every industry can find acceptable areas in which to experiment, perhaps in unlikely places. Goldcorp is a mining company that shared its top-secret geological data with the crowd, offering $500,000 for finding six million ounces in untapped gold. This $500,000 investment yielded $3 billion in new gold in one year.[22]

Tapping crowd power through an online platform is a low-risk investment with potentially high returns, but only if you choose appropriate projects.

- **Scope.** Focus on a clear and specific problem to solve—one that can be boiled down to a question, task, or request with measurable definitions of success. One of the benefits of crowdsourcing comes from garnering ideas that aren't limited by your organization's preconceptions of how your business or market works. The scope of a task can require deep domain experience but should not be dependent on your own organization's context.

- **Focus on gaps in your organization's own abilities.** Begin your search in areas where your own talent gaps have held back progress. What could you learn or accomplish if you had affordable manpower readily available? What complex problems have confounded your people? What

solutions seem out of reach, no matter what you try? These may be problems worth pitching to a crowd that isn't contaminated by "what's not possible." Crowds are likely to consider data or information that insiders assume is irrelevant.

- **Keep an open mind.** Crowdsourcing is rarely initially championed by a C-level executive, but the CIO may be in a position to help educate business leaders on its potential. A broad perspective across the enterprise, combined with an open mind, may help CIOs recognize unexpected applications that could benefit the organization. Leaders should foster a culture where appropriate crowd experiments are encouraged while minimizing security, privacy, and compliance risks. Employees may feel threatened by crowdsourcing, perceiving it either as a "big brother" tactic or a means to replace the existing workforce. Consider making crowdsourcing a tool *for* your employees. For example, the sales team for a consumer goods company can use a crowdsourcing app to harness cheap labor to perform the mundane parts of their job. By letting your employees orchestrate the crowd, concerns can be alleviated.

- **Get ready for what's next.** Crowdsourcing is in the early stages, but it's not too early to consider long-term opportunities for new ways to get work done. Could a native mobile app that feeds directly into your systems streamline field data collection and reporting in the future? Could the time come when it would make sense to provide access to corporate assets to free

agents? A crowdsourced labor pool will become a legitimate component of many organizations' distributed workforce strategy. Start thinking now about what policies and processes need to be in place. Incentive structures, performance management, operating models, and delivery models may, in some cases, need to be redrawn. Use crowdsourcing as a tangible example of the shift to social business[23]—allowing early experimentation to make the case for more profound investments and impacts.

## Bottom line

Crowdsourcing is still in its early stages, but today's online platforms are sophisticated enough to provide substantial benefits in solving many kinds of problems. The potential for disruptive impact on cost alone makes early experimentation worthwhile. More important are the broader implications for innovation in the extended enterprise. Today you can expand your reach to engage talent to help with a wide range of needs. It's important that your organization has the ability to embrace new ideas that may be generated by your crowdsourcing initiatives. That means industrializing not just for scale and reach but also for outcome.

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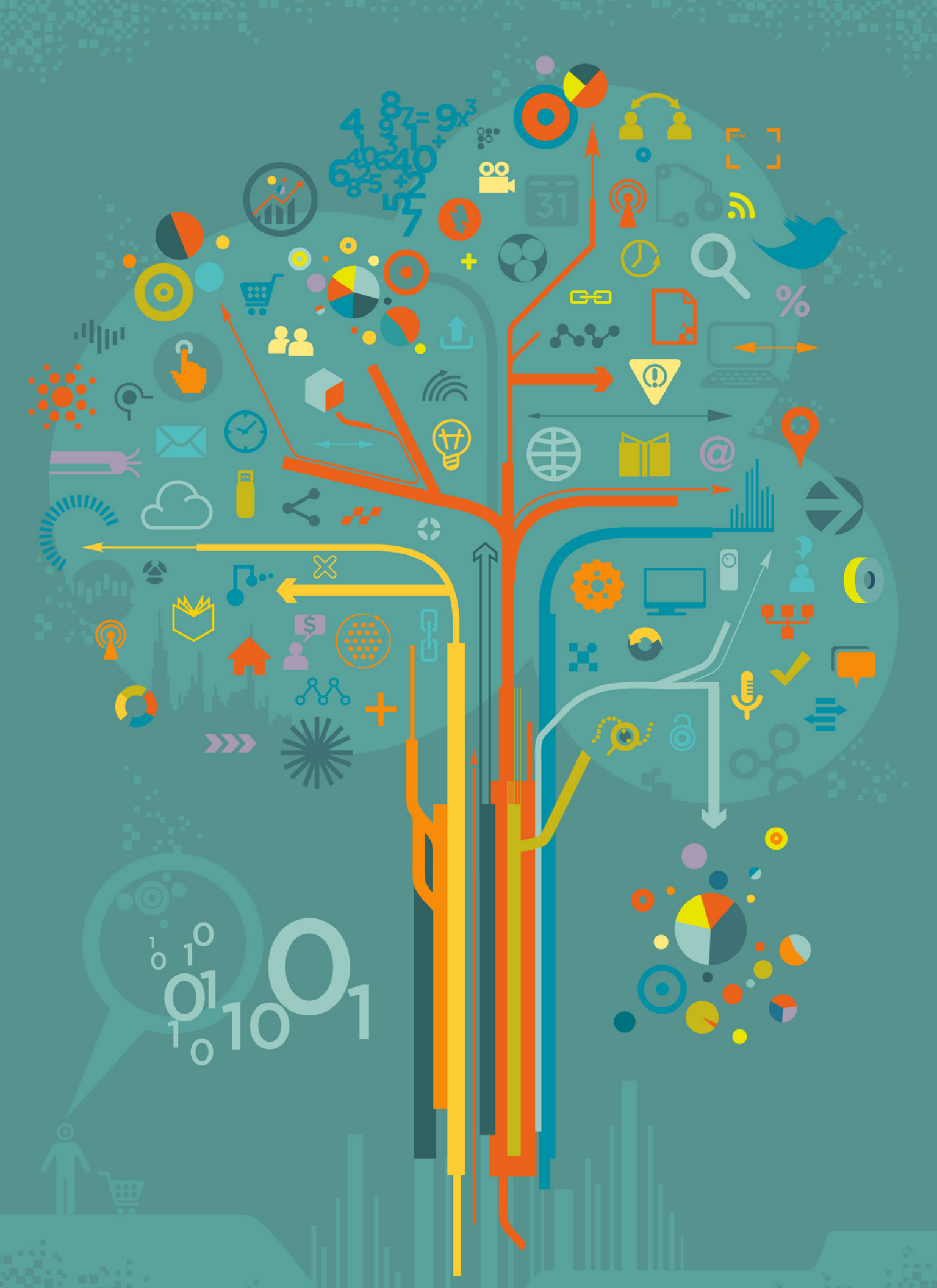
# Digital engagement
## Context + content for marketing . . . and beyond

Content and assets are increasingly digital—with audio, video, and interactive elements—and consumed across multiple channels, including not only mobile, social, and the web, but also in store, on location, or in the field. Whether for customers, employees, or business partners, digital engagement is about creating a consistent, compelling, and contextual way of personalizing, delivering, and sometimes even monetizing the user's overall experience— especially as core products become augmented or replaced with digital intellectual property.

**D**IGITAL is at the heart of business— reshaping customer interaction, rewiring how work gets done, and potentially rewriting the nature of competition in some markets. Today's digital technologies include mobile, social, and the web, but wearables[1] and the Internet of Things could dramatically expand the definition in the years ahead. The underlying intent is simple: using technology to design more compelling, personally relevant, engrossing experiences that lead to lasting, productive relationships, higher levels of satisfaction, and new sources of revenue. Driving digital *engagement*.

## First stop: Sales and marketing

Tapping digital channels to advertise, market, sell, and provide customer care is far from new terrain for many companies. Early efforts have focused on coverage and consistency: Do I have a digital presence where my customers are spending time?[2] Do the various channels provide consistent information, services, and brand experience? Even as some companies struggle with these foundational elements, customers expect new levels of digital engagement.

Today's markets demand intimacy and synchronization across channels—providing seamless, personalized experiences to customers who are time-, place-, and context-aware. Customers want to be able to connect via mobile, web, call centers, kiosks, and emerging technologies–and they expect the experience to pick up where the last interaction left off. Second-screening (providing synchronized, complementary content simultaneously across two channels) has gained popularity in media and entertainment, with other industries following suit. And it doesn't stop with digital. Sometimes dubbed *omnichannel*, digital engagement also looks to connect the digital experience with physical interactions—in-store, on-site, and via customer and field service personnel.

Digital engagement requires a commitment to content as a discipline, backed by a technical and operational backbone. This backbone enables the rapid creation, delivery, and curation of assets, personalized to the individual according to location, activity, historical behavior, and device or service. This enables personally relevant and timely interactions that are "just right" in their level of detail, utility, and privacy.

For CIOs, many of the foundational moves in digital engagement may be happening outside of their direct control. Chief marketing officers and newly minted chief digital officers

## Digital engagement in action

**@JohnSmith**
Need a #magicianskit for Jane's bday present.

The Hobby Shop captures tweets with the tag #magicianskit.

www.thehobbyshop.com
Welcome, John.
magician's kit

The Hobby Shop tracks John's session, checks the CRM system for purchase history and family information, and, with predictive analytics, anticipates John's potential purchase for his daughter.

John uses his smartphone while walking through the mall.

**25% OFF**
For John from the Hobby Shop

John uses the coupon to purchase a Marvelous Max Coins & Cards Magic Kit.

The Hobby Shop app recognizes John's proximity to the store.

The Hobby Shop emails John a receipt and access to a personalized magic trick app.

Try Max's favorite tricks from your new **Coins & Cards Kit**:

Vanishing Coin

Card Levitation

Floating Spoon

Mind Reading

**@MarvelousMagicMax**
@JohnSmith, hope the birthday is magical!

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are likely defining the roadmap for big parts of the digital backbone—content management, web analytics, campaign management, search engine optimization, email optimization, and social listening. Realizing the full potential may require hooks into customer relationship management (CRM), sales force automation, e-commerce, and back-office processes such as order, inventory, pricing, and fulfillment management—areas IT is well-prepared to help drive. The CIO can also provide guidance and stewardship for responsible adoption of these digital technologies, preserving the "-ities" of security, reliability, scalability, interoperability, maintainability, and capacity.

## Let's get digital: New products (and markets)

The implications of digital engagement are even more interesting when you look beyond sales and marketing. It is a universal opportunity, regardless of whether a company's product or service assets are physical or digital. But as more industries' core products and services are replaced or enhanced by digital offerings, the same commitment to digital content, asset, and intellectual property (IP) management moves from marketing enabler to strategic imperative.

The media and entertainment industry has been leading this charge as a significant percentage of revenue continues to move from physical to digital channels across the industry.[3] Financial services, retail, and health plans are also undergoing transitions to digital. And with the advent of embedded sensors and low-cost connectivity, life sciences, consumer, and industrial products companies are increasingly enhancing their core products with digital services—from turbines to soft drink dispensers to toys.

Pharmaceutical companies are creating companion apps to support patients—creating new value beyond the molecules while inspiring brand loyalty. Ball bearing manufacturers are including on-vehicle

sensors to offer adjacent services for fleet management and route optimization. After impressive consumer adoption, fitness trackers are being endorsed by health plans for wellness programs. The broader "quantified self" movement has brought new players into hardware and software markets, from consumer apparel companies to retailers. Users are trading their personal information for enhanced experiences, sometimes even paying for the privilege.

Longer term, the progression of 3D printing may cause a fundamental shift in product strategy, bringing a rise in digital-only products in these traditional industries. When a spare part can be downloaded and produced by customers themselves, effectively protecting, managing, and monetizing the underlying digital IP may become as critical as managing any other product. At a minimum, new approaches for managing digital assets and rights will probably be needed. But the implications may be far more disruptive—requiring rewired sales structures and incentives, reshaped channel partnerships, and new ways to take orders, provision products, monitor usage, bill, settle, service, and support.

## The enterprise awaits

There is tremendous opportunity to apply digital engagement principles within the enterprise to reengineer how your own employees interact, work, and grow. The same digital backbone put in place for external stakeholders can be used to drive internal engagement across almost every process and domain.[4]

Now is the time for CIOs to help their businesses define a digital vision while helping marketing integrate its activities with those of sales and operations. Perhaps more importantly, the CIO can secure IT's role in helping to drive the company-wide transformation behind enterprise digital adoption and in making a longer-term strategic pivot from physical goods to digital services.

# Lessons from the front lines

## Driving new savings, sales, and loyalty

Many global brands have a legacy of semi-autonomous regional marketing teams delivering local solutions—an approach that may not add up to a sum greater than the parts. Instead, they may find themselves paying for the same digital marketing services in multiple regions to multiple agencies with little to no economies of scale. The result can be millions of dollars in duplicate spend, an explosion of inconsistent websites, a fragmented customer experience, and lost opportunities to enrich engagement.

Recognizing that there was a better way, one leading auto manufacturer created a cost-savings business case for a new, global digital marketing organization. The new organization could potentially cut tens of millions of dollars in avoidable spend by consolidating processes, governance, and technology enablers and by reducing the company's dependence on external agencies—all while retaining local differentiation where needed.

The company's global digital marketing approach includes a unified customer experience with regional variations, a governance structure with the authority to direct spending, and a transparent operating model that brings the digital tools and services to the business. With this new approach, digital teams have the opportunity to focus on more ways to engage customers rather than on the daily blocking and tackling of managing websites and e-mail campaigns.

## Reimagining the online experience

In 2010, Intel set out to completely re-architect the existing Intel.com website—hundreds of thousands of pages serving millions of visitors each month—into a consistent, dynamic, and highly relevant digital experience. The effort focused on three primary objectives: use powerful technology with best-in-class capabilities, create an engaging and innovative user experience, and provide a scalable and stable publishing process for the business and its vendors.

To create this new and distinctive digital experience, Intel involved the lines of business, marketers, IT staff, software consultants, creative agencies, and specialty vendors. The cross-functional team worked together to build out the new system following an iterative process with parallel development of user experience, technical implementation, and content creation, migration, and localization.

In less than a year, Intel was able to provide a new online experience that has won multiple user experience and design awards. The company has also seen measurable improvement in visitor ratings and satisfaction. By dynamically delivering rich, relevant content to visitors, Intel.com has seen a total traffic increase of 67 percent per year, an 82 percent site satisfaction rating, and a 55 percent conversion rate of visitors clicking through from Intel's shop out to retailers and OEMs. The solution has also resulted in a 50 percent reduction in publishing costs and the ability to make content updates in hours instead of weeks, allowing Intel to provide a rich, relevant digital experience for its customers, partners, and employees.

## Calling all content

Rapid technological advancements such as mobile and cloud, as well as consumer demand for digital content across multiple channels, are causing rapid changes to the telecommunications landscape. Sensing the positive disruption these changes could likely have on its business, Verizon Communications began exploring ways to monetize the digital landscape.

Traditionally, the digital media supply chain—the process by which digital content (such as news clips, movies, and television shows) is delivered to consumers—has been decentralized across many vendors. When digital content is produced, different entities store, catalog, and distribute the content with manual hand-offs between the companies. With its infrastructure and network already in place, Verizon built on the existing invest-ments to provide an offering for digital content for media and entertainment companies. As a result, Verizon launched its Digital Media Services division, providing customers with a means to deliver content to consumers.

## The one-stop digital shop

Adobe, a global software company focused on creativity and digital marketing solutions, had a product marketing website that was one of the most trafficked sites on the Internet, with more than 35 million unique visitors per week (75 million including download users). But the company wasn't capitalizing on its site traffic for online purchases, and instead directed customers to alternate sources where they could purchase its products.

Adobe wanted to increase its online direct-to-consumer revenue by transforming its website into a seamless product marketing and e-commerce site—one that would not only be functionally richer, but also engage each customer. In the process, it also wanted to leverage its own digital marketing capabilities, especially its online marketing analytics capabilities—which had been bolstered through its acquisition of online marketing and analytics company Omniture—and its digital experience capabilities, enhanced through its acquisition of Day Software. In parallel, Adobe decided to undergo a strategic shift to move from its traditional model of selling boxed software to a subscription-based, cloud-driven software model—a transformation that prepared the company to be almost completely digital.

In pursuit of those goals, Adobe created an engaging, integrated marketing and e-commerce site to showcase and sell its products. Personalized for each customer based on his or her navigation profile and past purchases, it included a customized product carousel with relevant products for each customer and a recommendation engine that allowed Adobe to push related promotions. Responsive design allowed for a seamless experience across browser, tablet, and smartphone—dynamically rendering high-definition visuals, video content, and contextual product and promotion information based on the user's profile and specific channel. And the site allowed customers to explore Adobe's subscription services, the Creative Cloud for digital media and the Marketing Cloud for digital marketing, alongside traditional products—accelerating awareness and adoption of the new products. The site was built using a combination of Adobe's digital marketing capabilities, including Experience Manager for Content Management, Test&Target for improving site functionality, Recommendations for driving cross-sell and up-sell, and SiteCatalyst for driving online analytics and reporting.

In addition to personalizing the customer experience, the website provided an intuitive authoring environment for back-end management of content and workflow—simplifying the process of updating the site and decreasing the time needed to make changes from weeks or months to hours or days. Maintenance complexity dropped as the global page count dropped by 40 percent, and marketing efficiency increased by 78 percent. The self-managed nature of the site also led to decreased operational costs, as built-in intelligence drove promotions and offerings automatically, saving time that would have otherwise been spent on manual intervention.

Adobe achieved significant results from its efforts around digital engagement. Its online revenue has increased 39 percent since the project began three years ago—surpassing the $1 billion mark in 2013. Checkout conversions increased 16 percent, with a 48 percent increase in lead conversion. Revenue per visit increased on targeted content. But perhaps more importantly, Adobe transformed its own digital presence into a leading example of how to put its tool set to use—showcasing the opportunity for digital engagement at a time of dramatic innovation in sales and marketing.

# My take

### Soleio Cuervo, head of design, Dropbox

Consumer technology has evolved significantly in the last decade alone. When I first started in the business at Facebook, we designed products for one environment—the desktop web browser. Today, we find ourselves fully immersed in the post-PC era, where people use technology throughout the day across a growing combination of laptops, smartphones, tablets, and other mobile devices. And the number of devices that people need to access their data will likely only escalate over time. So it's important for businesses to be design-centric and maintain a deep appreciation for how their products and services fit into the cadence of a user's daily life across different devices.

At Dropbox, we focus on how to make things reliably simple for our users. People's stuff is commonly on the brink of disaster—hard drives crash, devices are lost, and phones are accidentally dropped and broken. Safe, reliable online storage is a fundamental building block of our service, but we have ambitions far beyond mere backup. We want to build software that makes people's lives more productive and memorable. I credit the cofounders of Dropbox with being very design-minded. Even in its earliest form, Dropbox was an elegant product—a "magic folder" on the desktop computer that was native to the operating system environment people were already familiar with.

The design organizations I've worked with understand two things. First, in order for a product to have global appeal, it should be conceptually basic and universally intuitive. Conceptual simplicity comes from a deeply empathic and highly iterative approach to design. Second, world-class experiences require technical experience coupled with an understanding of how a product fits into a person's day-to-day life. These two concepts continue to grow in importance as we become an increasingly connected society. Managing a user's attention and transferring context across devices require a multidisciplinary approach to exploration and prototyping.

It is also important for business leaders to understand that great design doesn't happen on the first try, or even on the tenth try. Designers should get in front of consumers, field-test their prototypes, and relentlessly iterate on their work in order to achieve perfection. As products have increasing amounts of access to personal data about their users—names, locations, interests, the people they work and socialize with—software makers have a powerful opportunity to *personalize* product experiences in ways that were previously impossible. We can "roll out the red carpet" and offer a singular experience that makes our customers feel as if the product or service was handmade for them. The true potential of digital engagement is creating experiences rich with empathy and context across multiple touch points—driving customers from being users to loyal advocates.

Simple, elegant, and intuitive design can be a competitive edge for a business, and it begins with executive leadership buy-in, an uncompromising focus on hiring top talent, and a cultural commitment to great design. When designed accordingly, digital engagement can provide seamless, accessible, *personalized* solutions for customers.

# Where do you start?

**M**ANY companies have content management systems to support certain types of information on the web, but few have gone beyond that to tackle the broader range of digital content. That's likely because they're looking at content the wrong way. Content is still isolated or tied to specific business units or geographies when it should be anchored to a customer or product. Complicating matters, the volume of content is out of control—especially with the rise of big data signals. Even the fundamentals need attention. Many companies lack processes and systems to understand the real costs of their activities, and they have no easy way to know which content elements are current, which should be retired, and how they should come together to support business operations. Some companies use third parties to maintain and manage their digital content, thereby delegating what may have easily become a source of competitive advantage. The potential scope is huge, but in practice, attention should be focused on five specific areas:

- **Web, mobile, and social content enablement.** Digital engagement should be seamless across channels. Achieving this will likely require responsive design and digital content that can be dynamically rendered and delivered based on the end user's context—in different formats, with varying granularity, and with different actions exposed. Day-parting, behavioral analytics, and social activation[5] are parts of this drive toward context-rich personalization. As Yahoo! CEO Marissa Mayer said, "The ultimate search is the one where *you're* the query"—taking into account your history and preferences.[6] That starts with a robust content backbone—technically and operationally.

- **Self-service and governance.** Centralizing digital content management can enable more efficient and effective communication. Which tools, skills, and resources are needed to allow the business to create, deliver, and curate the content its customers and other stakeholders need? Managing the platform and campaigns at the core—while allowing for personalization and activation on the edge—enables a mix of global control and localization. Some organizations are looking to build in-house digital supply chains to manage the full lifecycle of web, mobile, social, and on-premise content, allowing real-time experimentation and responsiveness.

- **Ease of access.** Instead of holding content captive in a particular repository, unlock it. Make content easily accessible across multiple channels, countries, and stakeholders—potentially including customers and enthusiasts.

- **Digital IP and asset management.** What information assets are you managing? Who controls them? Where are the assets located? How are they protected today? Are there plans to monetize them? Do you have the resources needed to edit and improve them? Which parts of your business will become digital in the next two years? What competencies and practices should be put into place to make that happen? How do you manage rights for IP usage across and beyond the enterprise? What new revenue streams are possible?

- **Cost reduction.** Take time to inventory digital content across the enterprise. At what rate is new content being developed, and how does it break out by function? Streamlining the distribution and management of digital content, regardless of where it resides, is the first step toward containing costs.

## Bottom line

Digital engagement is a way to drive new investments in marketing, similar to those that have improved finance, supply chain, and customer relationship management over the past few decades. Beyond efficiency and cost savings, digital engagement presents new ways to enhance customer loyalty and competitive advantage—riding the wave of changing behaviors and preferences for contextual interactions. Organizations should "think Big Mother (relevant, useful services) rather than Big Brother (omnipresent, creepy intrusions)."[7] And with more parts of the business becoming digital, the CIO has the opportunity to build a new legacy for IT—a responsive, forward-looking organization, an enabler of innovation, and a driver of digital engagement.

# Authors

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As a leader within Deloitte's Customer Transformation practice, Christine Cutten helps companies reach and connect with customers, build brands, and grow the bottom line. In her 10-year tenure with Deloitte, Cutten has helped many CMOs rethink their marketing strategies and operations.

**Barbara Venneman, principal, Deloitte Consulting LLP**

As the national digital content leader within Deloitte Digital, Barbara Venneman leads a team of talented practitioners that helps clients establish digital strategies, operational models, processes, and emerging technologies to deliver business results.

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# Wearables

## On-body computing devices are ready for business

**Wearable computing has many forms, such as glasses, watches, smart badges, and bracelets. The potential is tremendous: hands-free, heads-up technology to reshape how work gets done, how decisions are made, and how you engage with employees, customers, and partners. Wearables introduce technology to previously prohibitive scenarios where safety, logistics, or even etiquette constrained the usage of laptops and smartphones. While consumer wearables are in the spotlight today, we expect business to drive acceptance and transformative use cases.**

WEARABLE computing technology, dating to the 1960s' helicopter pilot head-mounted displays, is not new.[1] Even the familiar office identification badge is a type of wearable. But with recent materials science advances driving technology miniaturization and battery improvements, we're standing on the brink of widespread adoption.

Wearables are devices worn on the body in items such as watches, glasses, jewelry, and accessories. Or in the body—ingested or surgically implanted. They consist of three modular components: sensors, displays, and computing architecture. A wearable device may include one, two, or all three functions. A smart watch may contain narrowly purposed sensors that gather data about the user and his or her environment, but it may have limited display functionality and no computing power. Computing may occur in the cloud or on a multipurpose device such as a smartphone. The display may be on a nearby screen or in a pair of smart glasses, or it may even use an earbud or pendant for verbal response.[2] Think of wearables as an ecosystem—expanding capabilities that are individually interesting but more compelling when combinations are harnessed. This modularity is allowing new manufacturers to enter the market,

driving demand from both consumers and enterprise users.

The mobile revolution placed powerful, general-purpose computing in our hands, enabling users to take actions in the digital world while moving about in the physical world. By contrast, wearable technology surrounds us with devices that primarily enable other devices with digital information, which in turn support us in taking real-world actions.

## So why move forward now?

Few enterprises have tapped the full potential of smartphones and tablets, and many IT organizations are still learning how to design and build elegant, intuitive mobile apps. Also, the enabling infrastructure required to secure, deploy, manage, and maintain mobile assets is still being developed.[3] And many industries are just learning how to think beyond today's business scenarios: how to, instead of veneering existing processes and systems, come up with new ideas and even business models that were not previously possible. With so many opportunities left to explore using conventional mobile devices—smartphones, tablets, and laptops—why

should business leaders consider another wave of investment?

Wearables' value comes from introducing technology into previously prohibitive environments—where safety, logistics, or even etiquette have constrained traditional technology solutions. Wearables can be the first seamless way to enable workers with digital information—especially where hands-free utility offers a clear advantage. For example, using wearables, workers in harsh environmental conditions can access data without removing gloves or create records without having to commit data to memory and then moving to a sheltered workstation.

The primary goal of wearables is to enable users to take real-world actions by providing relevant, contextual information precisely at the point of decision making. Wearables shine in scenarios where using a laptop, phone, tablet, or other conventional device may not be appropriate[4] as well as in making use of the data gathered by sensors. Meeting this goal requires generating data in real time and intelligently pushing it to a device or devices according to the user's current context—just-in-time digital logistics. These use cases suggest that wearables may be most valuable deep in an organization's operations, rather than in customer-facing applications.

## Making sense of sensing

Wearables can also form a bridge to related disciplines. Augmented reality (AR), for instance, overlays digital information onto the real world. Many smart glasses scenarios feature AR concepts, and overlaying reference images and graphics can be a powerful enhancement to wearables. Likewise, the Internet of Things (IoT) refers to the explosion of devices with connectivity and—potentially—intelligence. Be they motors, clothes on a retailer's shelves, thermostats, or HVAC ducts, IoT is rapidly adding to the context map that will amplify wearables' impact.

Sensors permeate the Internet of Things and are a leading focus of consumer wearables. This is especially true in the "quantified self" movement in which bracelets can gather personal data or sports gear and clothing can help monitor health. Consumer-facing enterprise applications, such as beacons that affect the behavior of wearable displays or smartphone apps, rely on consumers being surrounded by a network of always-on sensors.

Corporate uses of sensors may include temperature readings of an employee's environment or sleepiness indicators for fleet drivers. These sensors are not necessarily smart by themselves; rather, they harvest data that is processed and displayed elsewhere.

## Going to work

The potential uses for wearables are staggering. In Australia, firefighters are being outfitted with a data-transmitting pill that can detect early signs of heat stress.[5] Health care insurance companies may offer policy discounts for members who quantify their healthy lifestyles by wearing fitness-tracking devices, similar to auto insurance companies' in-car efforts to track safe driving habits.[6] On the manufacturing floor, workers may be able to view metrics for nearby equipment on a smart watch. AR overlays in a warehouse can guide a worker who needs to find, move, pick, pack, and ship a particular product. Field installation, service, and maintenance professionals are being outfitted with smart glasses to access documentation, procedural tips, and skilled advice—from the top of a cell tower or beneath a boiler.[7]

Similar potential exists on the consumer side; Gartner predicts that "the worldwide revenue from wearable electronic devices, apps, and services for fitness and personal health is anticipated to be $1.6 billion in 2013 increasing to $5 billion by 2016."[8] But the market is—and will likely continue to be—highly fragmented. This fragmentation is inherent in a modular ecosystem, reflecting the lack of widely adopted technology standards.
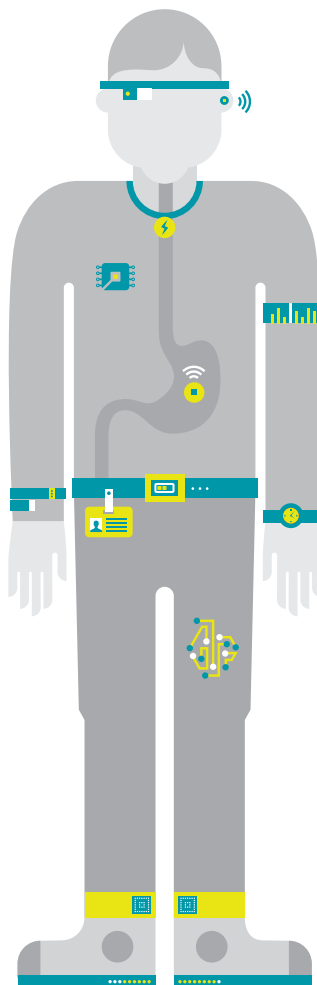
# Design principles of wearables

**CONTENT**

Ascribe to (much) "less is more" for content and its delivery—the design facilitates exceptionally low duration, high frequency use.

**COMMUNICATION**

Focus on communicating rather than simply displaying data— not necessarily visually, and not necessarily via the device generating the notification.

**INFLUENCE**

Do not force new behavior, but allow users to adjust their future behavior by providing new information or capabilities.
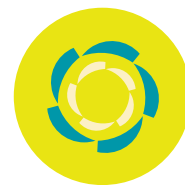
**INTERACTION**

Are careful about requiring response from the user— interaction with the device should be minimal and expedite the user's manual actions.
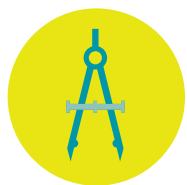
**INTENTION**

Use persistent design elements, alerts, just-in-time information, and notifications with discretion.

**INTELLIGENCE**

Are fueled largely by intelligence from analytics, big data, and sensors, which are often embedded in other devices.

**ENHANCEMENT**

Leverage the digital world to enhance the user's behaviors, actions, and experiences in the real world.

**NETWORK**

Communicate with an expanding community of wearables, data, devices, systems, platforms, services, and software.

More than two dozen manufacturers are aggressively pursuing head-mounted smart glasses. A dozen smart watches are already in the market. And new devices are launching virtually every day—from sensor-rich socks[9] to Bluetooth-powered rings to digital tattoos.[10]

Luckily, although the lack of industry standards in wearables can lead to policy headaches, a number of uses for wearables can be enabled using tools and governance processes similar to those needed for smartphones and tablets: device management, identity and entitlement management, security policies, content management, and app provisioning. Privacy concerns need to be managed—even though wearables are likely to be more readily accepted in the workplace than in public situations. It's important that employees perceive that the tool will help them perform more effectively on the job. Over time, social and workplace tolerance may increase, but during these early days, acceptance is a factor that must be considered.

But enterprises should not wait for consumer markets to settle and conventions to be established. Because the wearables ecosystem can benefit from the proliferation of niche players, companies don't need to hold off until marketplace standards or leaders emerge. The door is open to early experimentation—and to usher in the next wave of mobile innovation.

# Lessons from the front lines

## The doctor is in (your stomach)

For millions of patients with chronic illness, remembering to take a daily dose of medicine can be a difficult task. According to the World Health Organization, approximately 50 percent of patients fail to take medicine correctly and more than 50 percent of medicines are prescribed, dispensed, or sold inappropriately.[11] This may cause doctors to over-prescribe medicine if they do not see the expected results.

Proteus Digital Health has developed a system that includes both a body-worn patch and a small ingestible sensor that supports patients in tracking their medicine usage and health.[12] The ingestible sensor can be embedded into a pill or tablet and consumed with a patient's prescription. It works like a potato battery—dissolving in the stomach to activate. The ingestible sensor communicates with the patch, which in turn transmits the ingestion data, along with activity and rest patterns picked up by the patch, to a secure application that can be accessed from a smartphone, tablet, or PC.[13] With the patient's consent, the data can be automatically shared with health care providers, family members, or other caregivers.

## Wearable wardrobe

2013 saw an explosion of wearable devices in consumer products, with the "quantified self" movement leading the charge. Fitness and activity tracking devices are predicted to top $1 billion in sales in 2014.[14] Athletic consumer apparel brands such as Nike, Adidas, and Under Armour have either launched wearable technology products or publicly shared plans to enter the market.[15]

The trend is being embraced in the broader fashion and consumer goods industries, with a wide range of emerging categories. Heapsylon manufactures Sensoria smart socks, which track how much a user is exercising. The company has plans to expand the platform to help prevent and manage falls and foot injuries and to collect information that health care professionals can use to provide better-quality care.[16] Reebok's CheckLight beanie measures the intensity of blows to the heads of athletes participating in contact sports, sending an alert when a blow is moderate or severe.[17] Huggies announced prototype sensor-laden diapers that can tweet parents when their infants need to be changed.[18] And more products are coming, as demonstrated by the high number of wearables on display at the 2014 Consumer Electronics Show.

## Hands-free patient care

Philips Healthcare brought wearable technology to the operating table through its proof of concept for using a hands-free device to improve the efficiency of surgical procedures. A surgeon typically reviews numerous screens to monitor a patient, requiring the surgeon to turn away from the procedure at hand. Now, by wearing a headset with a display in the field of vision, a surgeon can monitor required information while keeping both eyes on the patient. The prototype allows doctors to interact with an application derived from Philips' IntelliVue Solutions.[19] Using simple voice commands, a surgeon can request to view a patient's vital signs or medical history, which then would be displayed in the surgeon's line of sight.

Additionally, by giving doctors the ability to observe a patient's vital signs remotely, Philips'

prototype allows doctors to virtually be in two places at once. For example, if a doctor performing a routine procedure were called upon to assist with another patient, he or she could review the vital signs of both patients to determine the more critical need.[20]

Other companies are also exploring the possibilities of wearables in health care. Shimmer, a provider of wearable wireless health sensor products, is teaming with research enterprises. Sample use cases include remote monitoring of epileptic seizures and the delivery of biofeedback during resistance training activities.[21] Additionally, an Ohio State University Medical Center doctor recently used a head-mounted device to perform surgery. The device gave medical students the opportunity to watch the surgery in real time from a classroom and allowed the surgeon to communicate with an off-site specialist while operating.[22]

## A new vision for training[23]

CraneMorley, a boutique design firm, creates tools for learning and performance support. Working extensively with clients in the automotive industry, the company has been leveraging technology more and more to drive business performance by creating solutions that target gaps in workers' knowledge and skills.

At a car dealership, salespeople should be well versed in the technology and telematics their cars are equipped with to effectively sell them to their customers. If a salesperson can't demonstrate a car's features, there is a good chance the customer won't buy the car; on the flip side, if the salesperson can demonstrate the technology seamlessly, the customer could love and buy the car and become a long-term advocate of the brand.

Rather than overloading salespeople with information about the cars, CraneMorley designed training workshops to interactively teach them what they need to know about cars' telematics and technology features. Twenty-five salespeople were equipped with tablets and placed around six cars. They established their competency in demonstrating the car's technology features, and if they struggled with one, they could watch a quick lesson on their tablet for help. The instructors were able to see a master view of the salespeople's tablet programs, and could also insert themselves to help them as required.

The program worked wonderfully—except that the salespeople had to hold the tablets while working through the demonstrations. Identifying an opportunity to pilot wearable technology, CraneMorley has developed a discovery learning training program using smart glasses. Through the use of the glasses, the salespeople are now able to interact with the cars while information is overlaid on the hands-free glasses by the augmented reality software. The ability to actively demonstrate the car's features allows the salespeople to better remember how to do it again in front of a customer at the dealership.

CraneMorley is exploring other scenarios to expand the smart glasses-powered discovery learning concept beyond training salespeople. One application for the technology could be servicing: As someone is trying to fix a car, he or she could access helpful information or contact an engineer for real-time support—allowing the specialist to see exactly what the technician is seeing in the repair bay and offer immediate guidance.  Another application is on the sales floor: Many technologies have been deployed to the sales floor to help customers learn more about cars' features, such as kiosks, PCs, and tablets, but none have really been effective. Smart glasses could be a tool to teach customers about the cars that interest them in a more personal way, even allowing them to test drive a car without leaving the dealer's floor.

# My take

**Brian Ballard, CEO,
APX Labs**

At APX Labs, we are dedicated to changing the way people use wearable displays, specifically through the use of smart glasses. This new class of devices can provide people with relevant information to achieve tasks hands-free. In the United States, there are 17 million "desk-less" workers—people whose jobs take them away from offices and cubicles into the heart of where business gets done. Think manufacturing, logistics, service technicians, or medical professions. This alone is a $20 billion market for wearable technology—and only a part of the bigger opportunity.

Wearables are a crowded, and growing, ecosystem. We've focused on building a platform to lower the barrier of entry for users across multiple markets and form factors of smart glasses. We see the market in two broad categories: heads-up displays (HUDs) and true augmented reality glasses—both of which act as new tools to solve old problems.

With heads-up displays, contextually relevant information is presented via an accessible, but secondary, out-of-eye display. Think Kopin Golden-i and Google Glass. Status, workflow, and supplemental data look-ups are dominating early uses, but more are coming as the development kits have become generally available.

With augmented reality displays, smart glasses are used to present real-time information and services in the user's view of the world—ideal for the heads-up, hands-free worker. One of our first applications was for the defense industry. "Terminator Vision" was an effective initial use case—using facial recognition and background check services to visually highlight potentially hostile parties as a soldier scans a crowd. Medical use cases are also leading the charge—with the goal of giving practitioners a view of vital signs, electronic health records, procedural guidance, and simple administrative support. Applications for manufacturing, logistics, and in-stadium entertainment are targets for future adoption where large numbers of people are engaged in similar tasks that require access to the same information. More important, companies control and operate the ecosystem surrounding the business processes—simplifying funding and integration challenges.

As the wearables market begins to take off, there's a bit of a chicken-and-egg phenomenon playing out. In the consumer space, developers won't get behind a new platform unless there is a substantial market for it, and users have been hesitant to enter the wearables market before there is a defined use case for the product, which is dependent on compelling apps. This is the driving reason that we think enterprises are going to lead the charge—tackling well-defined problems to drive the required volumes to propel developers to opt in en masse.

But we're still in the early days. Some enterprise customers flock to the technology simply because it's "cool"—and then try to determine what they can use it for. A better path is for companies to holistically look at the business issues they face, evaluate their options, and determine if smart glasses are the required tool for solving specific problems. We try to help our customers identify what some of those burning issues are—and figure out how the technology will revolutionize the world around us.

# Where do you start?

**W**E expect to see an escalating number of wearable computing devices, platforms, and applications that can enable and transform business operations. Now is the time to begin exploring the possibilities that wearables hold for improving supply chains, workflows, and processes to drive down costs and increase competitiveness.

- **Imagine "what if."** Think about how your business's effectiveness could improve if workers had the information they needed at the moment they needed it. What current processes could be discarded or refined? What could people accomplish if a photo or video could replace a paper report? What critical processes—for example, emergency procedures—are difficult for workers to master because they are rarely needed? What if employees could have specific instructions for those procedures delivered at the point of impact? What if a worker had ready access to equipment manuals while repairing an oil rig or bridge cable? What if a worker in the field could show a remote colleague real-time video from his or her point of view—while leaving his or her hands free?

- **Kick the tires.** As new wearable devices and software applications appear, experiment with various platforms and evaluate the organizations behind them. Do they fit your business operations? Is the vendor viable for the long term? Do you have a pool of early adopters who will likely embrace the technology? Remember that wearables are a modular ecosystem, so if one component doesn't measure up, the system can adapt to accommodate other players. Experimentation is the name of the game.

- **Become an early adopter.** Connect with wearable manufacturers and software developers to share your business's operational needs and explore the possibilities of working together to develop solutions. As companies are looking for beachheads in this new world, there are opportunities for teaming.

- **Simplify. Simplify. Simplify.** In design, wearables need to be treated as their own beast. Just as the design patterns from desktop, laptop, and the web were not well-suited for smartphone and tablet use, a completely different experience should be designed for wearables. Simplicity is the ultimate form of sophistication, and transparency is the ultimate form of simplicity. User interaction should be kept to a minimum. If a use case requires an explicit user response, it should be limited to spoken commands, gestures, or a gloved knuckle tap. Minuscule displays require discipline in not only what information should be displayed but how to present it; a two-tone simplified graphic can be more effective than a detailed photo. Time sensitivity becomes important, so create "glanceable" awareness of information in the applicable context. The information displayed should be curated to precisely fit the immediate situation or task, with no extraneous data. This extends to the purpose for which a device is used: Don't design a wearable experience for a function that's more effectively done on a smartphone, a tablet, or a piece of paper.

- **Anticipate data and device management.** Data generated by wearable devices could exponentially increase the quantity of

information that your IT organization should store, manage, and analyze. The volume of unstructured data, including pictures and videos, could also escalate. Also, consider how these new devices will be repaired and managed. Assume that bring-your-own-device (BYOD) will happen whether policy supports it or not and that new classes of devices will likely become smart before IT can redefine policies to manage them individually. Strive for simple rules that can govern ever-more-complex behaviors.

- **Engage the workforce.** Ask frontline employees to participate in the imagination process. What persistent problems would they like to solve? What opportunities could be created? Likewise, ask them what concerns they have about the devices, and develop plans to address those concerns. Talk with trade unions and other worker groups to understand and address concerns they may have about using wearable devices. Over time, social and workplace tolerance may increase, but during these early days, focus on employee education and constrain your use cases to those that provide demonstrable benefits to the user.

## Bottom line

Wearables targeted at the consumer market are today's media darlings. Google Glass Explorer parties and Samsung's Dick Tracy-style watches make for interesting copy. But unlike tablets, which were introduced to the enterprise by consumers, we expect businesses to take the lead in building acceptance and demand for wearable computing devices. As consumer devices, wearables represent a very personal buying decision in which aesthetics and fashion are almost as important as function. But in the workplace, experience and engagement matter. Function can trump form—as long as a wearable is perceived as unobtrusive, safe, and not "creepy." The challenge is easy to articulate: Rethink how work could get done with the aid of an ever-present computing device that delivers the desired information when it's needed. Organizations that get a head start could gain an advantage over their wait-and-see competitors.

# Authors

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# Enablers

# Technical debt reversal
## Lowering the IT debt ceiling

**Technical debt is a way to understand the cost of code quality and the impacts of architectural issues. For IT to help drive business innovation, managing technical debt is a necessity. Legacy systems can constrain growth because they may not scale; because they may not be extensible into new scenarios like mobile or analytics; or because underlying performance and reliability issues may put the business at risk. But it's not just legacy systems: New systems can incur technical debt even before they launch. Organizations should purposely reverse their debt to better support innovation and growth—and revamp their IT delivery models to minimize new debt creation.**

TECHNICAL debt is not a new term, but it's gaining renewed interest. Originally coined by Ward Cunningham in 1992, the phrase describes the "not quite right" code typically introduced with initial software releases because of an incomplete understanding of how the system should work.[1] Organizations that regularly repay technical debt by consolidating and revising software as their understanding grows will likely be better positioned to support investments in innovation. And like financial debt, organizations that don't "pay it back" can be left allocating the bulk of their budgets to interest (i.e., system maintenance), with little remaining to develop software that can support new opportunities.

Technical debt is often the result of programmers taking shortcuts or using unsophisticated techniques. It's typically misfeasance, not malfeasance. For example, a developer may copy and paste code blocks without thinking through the longer-term consequences. If the code ever needs to be updated, someone will have to remember to fix it in each instance.

But sometimes, technical debt is simply the result of dealing with complex requirements. To meet a project deadline, complicated proprietary code may be developed, even though simpler alternatives may have been available. With each such action, technical debt proliferates. This is like high-interest, short-term borrowing. If you don't pay off the debt promptly, compounding kicks in.

The impact of accumulated technical debt can be decreased efficiency, increased cost, and extended delays in the maintenance of existing systems. This can directly jeopardize operations, undermining the stability and reliability of the business over time. It also can stymie the ability to innovate and grow.

Articulating technical debt is the first step in paying off its balance. With new tools for scanning and assessing software assets, CIOs can now gauge the quality of their legacy footprint—and determine what it would cost to eliminate the inevitable debt. A recent study suggests that an average of $3.61 of technical debt exists per line of code, or an average of more than $1 million per system.[2] Gartner says that "current global IT debt is estimated to stand at $500 billion, with the

# $3.61
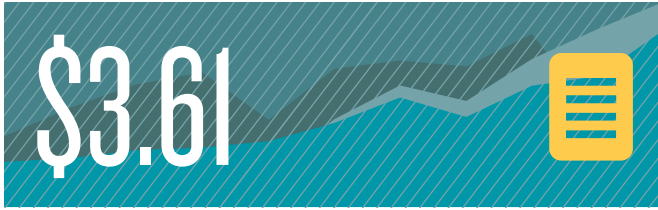
Technical debt per line of code within a typical application.[1]

# 35 PERCENT

The defect removal efficiency of most forms of testing.[2]

# $312 BILLION

Estimated global annual expenditure on software debugging in 2012.[3]

# 52 PERCENT

Portion of total effort spent repairing architecturally complex defects, though they account for only 8% of all defects.[4]

potential to rise to $1 trillion by 2015."[3] While the idea of debt doubling in a year's time may seem astonishing, we're in the midst of unprecedented investments in disruptive technologies—often with deep hooks into core systems. The push for rapid innovation in unproven domains is also leading to compounding debt.

These estimates address only the literal definition of technical debt—how much it would cost to fix the exposed code quality issues. But there's also another dimension, which we call "architectural debt." Architectural debt refers to the opportunity costs associated with system outages or the inability to deliver new capabilities. In some cases, architecturally complex defects can absorb as much as 52 percent of the total effort spent repairing defects.[4] They can also derail new initiatives.

Technical debt is not limited to legacy systems; every new project has the potential to add to the backlog. With that in mind, you should incorporate the cost of technical debt into project management processes and portfolio reporting. This kind of transparency can not only raise awareness of quality among development teams, but can also provide a foundation for talking to the business about the hidden cost of IT delivery. By documenting your debt-decreasing efforts, you can account for those efforts—important progress that

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would likely not otherwise be visible (or appreciated).[5]

The ability to quantify technical debt can provide a common point of reference for the C-suite when you are deciding how to prioritize IT projects for an organization. Typically, technical debt should be paid down within the context of delivering against business priorities by incrementally refactoring existing solutions and using improved development processes to minimize new debt accumulation. Incorporating techniques described in our *Real-time DevOps* chapter[6] can help reduce waste generated when software is developed.

Some organizations may also need to spur projects that address especially messy issues such as bolstering performance, preventing production issues, or preparing for future strategic investments. The goal is a sustained, prioritized reduction of the balance sheet, where each project systematically improves on the baseline.

For most organizations, technical debt comes with the territory, an unavoidable outcome of decades of technology spend. The big question is: How will you manage the liability? Understanding, containing, and mitigating technical debt can be a platform, not only for a stronger IT foundation, but for a renewed level of trust and transparency with the business.

# Lessons from the front lines

## Express delivery of quality

To keep up with the over 150 billion pieces of mail delivered each year,[7] the United States Postal Service (USPS) depends in large part on the quality and effectiveness of its IT systems. So when quality concerns became apparent during one of its IT modernization projects and the USPS was facing budget concerns, USPS leadership proactively took action to manage the organization's technical debt.

First, USPS used the SQALE[8] method for assessing the quality of its technical debt across four software dimensions: reliability, performance, security, and changeability. With a clearer picture of how much technical debt existed and where, USPS developed a roadmap to remediate the critical software issues and transition to long-term sustainment following CISQ[9] standards. For example, USPS instituted automated unit test scripts, minimum code coverage testing levels, and static analysis of the source code. These changes improved application quality and performance.

Going forward, USPS is also applying these same measurable standards to other projects by including them as standard oversight and acceptance criteria in their statements of work. And because incorrect project estimates can introduce technical debt, USPS is revamping its project estimation techniques by requiring the use of both parametric and bottom-up estimating techniques. With these changes, USPS is starting to see both improved quality and more accurately planned IT costs across its portfolio.

## Cleaning up shop

DB Systel, a subsidiary of Deutsche Bahn, is one of Germany's leading information technology and communications providers, running approximately 500 high-availability business systems for its customers. In order to keep this complex environment—a mix of packaged and in-house–developed systems that range from mainframe to mobile—running efficiently while continuing to address the needs of its customers, DB Systel decided to embed processes and tools within its development and maintenance activities to actively address its technical debt.

DB Systel's software developers have employed new tools during development so they can detect and correct errors more efficiently. Using a software analysis and measurement platform from CAST, DB Systel has been able to uncover architectural hot spots and transactions in its core systems that carry significant structural risk. DB Systel is now better able to track the nonfunctional quality characteristics of its systems and precisely measure changes in architecture- and code-level technical debt within these applications to prioritize the areas with highest impact.

By implementing this strategy at the architecture level, DB Systel has seen a reduction in time spent on error detection and an increased focus on leading-practice development techniques. The company also noticed a rise in employees' intrinsic motivation as a result of using CAST.[10] With an effective technical debt management process in place, DB Systel is mitigating the possibility of software deterioration while also enriching application quality.

## Countdown to zero technical debt

NASA's Mars Science Laboratory project was classified as a "flagship mission"—the agency's first in almost a decade. It was a $2.5 billion project to land a car-sized, roving science laboratory, Curiosity, on Mars. The rover launched in 2011 and landed on Mars on August 5, 2012, with the continuing objective of determining whether Mars ever contained the building blocks for life.

Building a roving science lab is an immense challenge. Curiosity is an order of magnitude larger than any rover that had previously landed on Mars: It weighs almost a ton, stands seven feet tall, contains a robotic arm that could easily pick up a person, and includes a laser that vaporizes rocks. Curiosity's software is essentially the brain of the rover—integrating its many hardware functions to provide mission-critical functionality such as the descent and landing sequence, autonomous driving, avionics, telecommunications, and surface sample handling.

The software initially developed for Curiosity was inherited from previous rover missions. The core architecture was developed in the 1990s on a shoestring budget. The Curiosity project put approximately four years of work into building on top of that architecture for NASA's most complex mission to date. As the launch date approached, NASA started to see that the project wasn't coming together: The software had bugs and inexplicably failed tests; there were issues with the hardware and the fabrication of key components.

The project faced a difficult question: Do we push on towards a 2009 launch or delay the mission? The unique aspect of launching a mission to Mars is that the opportunity only exists once every 26 months, when Earth and Mars align. If they delayed the launch two years, there was a risk that the project might be cancelled altogether.

The project team decided to postpone the mission and began an incredible regrouping effort. The software team had to quickly decide whether to fix the current software or to start over completely from scratch. Given the existing software's technical debt, it was unlikely they could determine the magnitude of the lurking issues, or confidently plan for new project milestones. The decision was made to tear down the foundation and rebuild using the old code as a reference.

The team started from the beginning: revisiting the requirements, software design, coding, and reviews, and testing and implementing standard processes. The team instituted what they called the "Power Ten," a set of 10 basic rules each developer followed. The team developed coding standards, implemented multiple automated code analyzers and testing tools, and established a cadence of releases—one every four months. They unit tested every line of code and instituted code reviews early in the development lifecycle. Two hundred code reviews produced 10,000 peer comments and 25,000 tool comments—each one reviewed and resolved.

The results were staggering: 3.5 million lines of code, over 1 million hand-written, across 150 different modules. But this time, the numerous bugs and unexplained failures were gone. The standards, though they required additional work, added stability and quality. And with the fresh start, the team were adamant that technical debt be minimized—building a new foundation for future missions.

Though NASA's approach required a remarkably difficult decision, the results were worth the effort. The world can now watch as Curiosity tells us more than we ever dreamed we might know about Mars. And the achievements of the mission led to the announcement of a new $1.5 billion mission to Mars in 2020.

## Combating system complexity

Military Health System (MHS), a unit within the United States Department of Defense, provides billions of dollars' worth of health services to over 9 million beneficiaries.[11] Facing enterprise-wide budget cuts, MHS began looking for ways to provide the same level of care with reduced resources. With dozens of IT systems built over 20 years ago, including clinical systems, supply chain, and billing, MHS recognized that reducing its technical debt was one way the organization could reduce its IT budget and improve business efficiency.

MHS embarked on a transformation with portfolio rationalization at the forefront in an effort to streamline its investments. Using an application health grid that removed potential subjectivity, MHS measured the business value, technical maturity, and cost of each of its systems. Business value was determined by how many business processes are supported. The technical maturity analysis focused on four areas: external stability (an evaluation of third-party software, hardware, and associated vendors); internal stability (an architectural evaluation); system availability; and security. The rationalization effort helped MHS identify over a dozen systems with high levels of technical debt that could be decommissioned—saving the organization over $50 million in ongoing operating costs within the first phase of the transformation.

MHS continues to use data-driven analytics implemented through SEMOSS.[12] The transformation that began with portfolio rationalization has now moved into optimization and dynamic portfolio planning. Reviewing a system's technical composition in combination with functional capabilities allows MHS to protect itself against future technical debt and make informed decisions about its overall IT portfolio.

# My take

## Larry Quinlan, global chief information officer, Deloitte Touche Tohmatsu Limited

Technical debt doesn't just happen because of poor code quality or shoddy design. Often, it's the result of a series of good or necessary decisions made over time—actions individually justified by their immediate ROI or the needs of a project. There are many examples: skipping a software update or infrastructure upgrade because there wasn't a clear business benefit; building point-to-point interfaces into a small departmental app to get it into the business's hands more quickly; choosing a product you already own to build a prototype in order to avoid a drawn-out vendor selection and procurement process.

The path to technical debt can be paved with good intentions, but when combined, can lead you to quality and architectural issues.

But good intentions don't give you a pass to ignore technical debt. Leading IT organizations can, and should, actively manage and reverse technical debt. These organizations have a vision for robust platforms ready to fuel growth and use nimble business-aligned delivery models to innovate, fulfill unexpected business-driven requirements, and ultimately solve business problems.

There are two aspects that are important to technical debt management. The first is to know where you stand. Reversal starts with visibility—a baseline of lurking quality and architectural issues. Develop simple, compelling ways that describe the potential impact of the issues in order to foster understanding by those who determine IT spending. Make technical debt a metric that your IT organization is conscious of—not just in planning and portfolio management, but in how projects get delivered.

The second is with the actual management of technical debt. There are a couple of ways to approach it: a big bang approach that fixes everything at once (which almost never works) or a selective approach to systematically reduce the backlog. Consider what is needed in the next year or two to assist with achieving your

strategic goals. This will allow you to identify the parts of your portfolio that should be upgraded to achieve those goals. When it comes to each of your platforms, don't be afraid to jettison certain parts.

At Deloitte, we deliberately separate our IT budget into core and business-driven investments so business users can choose investments driven by their priorities. A server upgrade rarely trumps a functional requirement when battling for fixed investment funds. That's why architecture, platform, and technical debt investments are part of our core investment bucket—with priorities set by the IT organization. My philosophy is: What's the point of having a CIO if I need a committee to approve every upgrade? By keeping the core investments separate from the business-driven investments, we are able to avoid the technical debt we might otherwise accrue.

Preventing technical debt requires a philosophy that addresses the known and expected requirements with an underlying, agile platform. CIOs need the courage to make the investments that reduce technical debt—and the knowledge and the team to know where and when to make those investments.

# Where do you start?

Technical debt calculation can begin when you have clear visibility to the quality of code for legacy systems as well as projects on the horizon. Only with both sets of information can you make the trade-offs necessary to manage technical debt effectively. For companies eager to get ahead of the technical debt curve, here are some important steps:

- **Assess the status of code for all significant investments.** Calculate your technical debt. Know the size of the hole you're in—and whether or not it's getting deeper. Evaluate the importance of each system to understand whether the technical debt has to be addressed—and in what timeframe. Aim for surgical repairs when possible, but recognize that some aging systems may be beyond incremental fixes. Prevention is preferred, but early detection at least allows for a thoughtful response.

- **Find out how future investments are dependent on your legacy systems.** Is your architecture ready for new initiatives? Can it scale appropriately? How well are back-end complications understood and fed into planning efforts? Should you launch legacy modernization efforts now to get ahead of impending business demands?

- **Think through the availability of talent to support debt remediation.** For some aging systems, your resources may not be sufficient for cost-effective updating. Talent should be factored into your analysis. Think of it as a multiplier on top of the raw technical debt calculation—and use it to define priorities and timelines.

- **Hold developers accountable.** Consider rating and rewarding developers on the quality of their code. In some cases, fewer skilled developers may be better than volumes of mediocre resources whose work may require downstream reversal of debt. Regularly run code complexity reviews and technical debt assessments, sharing the results across the team. Not only can specific examples help the team improve, but trends can signal that a project is headed in the wrong direction or encountering unexpected complexity.

- **Spread the wealth (and the burden).** Communities are great ways to identify and address technical debt. Peer code reviews are leading practices for informal spot checks. Formal quality assessments by seasoned architects can find issues that would be undetectable with standard QA processes. Learn from open source communities, where quality is continuously refined by the extended pool of developers poring over each other's code.[13]

- **Determine your debt repayment philosophy.** Companies have different profiles when it comes to debt for the various parts of their asset pools. Debt is not inherently bad; it can fuel new investments and accelerate product launches. But left unchecked, it can be crippling. There's no single right answer for the appropriate amount of technical debt, but its accumulation should be a conscious, transparent decision.

## Bottom line

When CIOs operate like venture capitalists,[14] technical debt is a big part of the financial picture. Without a clear view of the real cost of legacy systems, CIOs lack the information required to make effective decisions about new initiatives and investments. While it's important not to get obsessed with technical debt, it's also critical to understand and plan for it. Every new project automatically comes with technical debt as a cost of doing business. Reversing technical debt is a long-term investment, but if left unaddressed, it can bankrupt your ability to build for the future. Capers Jones, a long-term technical debt specialist, once said: "If you skimp on quality before you deliver software, you end up paying heavy interest downstream after the software is released for things you could have gotten rid of earlier, had you been more careful."[15] He was right.

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Share

# Social activation
## From passive to active tense

**Over the years, the focus of social business has shifted from measuring volume to monitoring sentiment and, now, toward changing perceptions. In today's recommendation economy, companies should focus on measuring the perception of their brand and then on changing how people feel, share, and evangelize. Companies can activate their audiences to drive their message outward—handing them an idea and getting them to advocate it in their own words to their own network.**

ORGANIZATIONS have spent the last several years chasing the tantalizing prospect of "social." Within the enterprise, social represents a bastion of hope for productivity and collaboration—a chance to effectively navigate who knows what, who knows whom, how work gets done, and how decisions get made. We're still in the opening frames of a broad wave of social-driven enterprise transformation,[1] as a recent study by *MIT Sloan Management Review* and Deloitte confirms. That study revealed that 69 percent of executives thought social business would be critical to their organizations in the next three years.[2]

Social businesses[3] ideally rally around well-defined business problems, supported by committed communities with well-defined incentives for participation. To take full advantage of this potential, age-old organizational constraints need to be identified and rewired. Hierarchies, biases, standardized operating procedures, rigid job descriptions, and other embodiments of institutional inertia can stunt progress.

Meanwhile, the flurry of activity around external social channels continues. Social media has become a frequent online destination, commanding 27 percent of global time spent on the web.[4] Not surprisingly, social monitoring and listening were some of the earlier investments companies made in the social arena. Social efforts leaned on the enabling tools that allowed passive data collection, tracking the volume of surface-level activity and broad-stroke awareness—followers, likes, mentions, and click-throughs to their own corporate channels. As the numbers grew, premature victory was announced. But volume doesn't tell you much—good, bad, or indifferent.
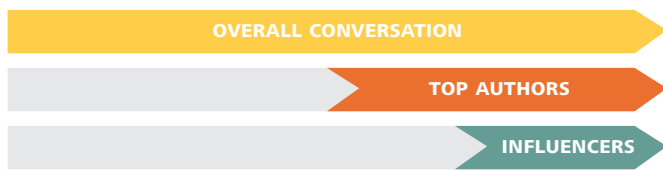
Monitoring gave way to sentiment analysis. Raw quantitative counts were replaced by happy and sad faces in an attempt to glean what the social masses were thinking about brands, products, services, and campaigns. Once again, out-of-the-box tools were often used to drive sentiment calculations, but they often lacked the nuance and context needed in business. The aggregated sentiment was a general measure of positivity, but it lacked subject-matter specificity. The sentiment camps ignored so-called "neutral" conversation—the lion's share of dialogue and the place where opinions are formed through exploration and discussion. Sentiment analysis was difficult
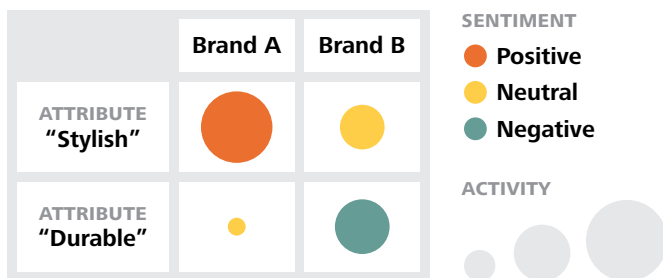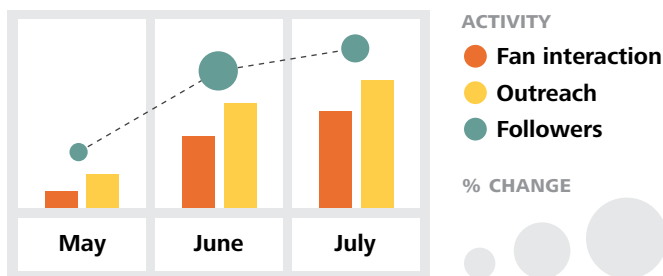
## 1 Focus: Map the audience

**BRAND DISCUSSION**
- Social
- Blogs
- Forums

**MARKET SIZE**
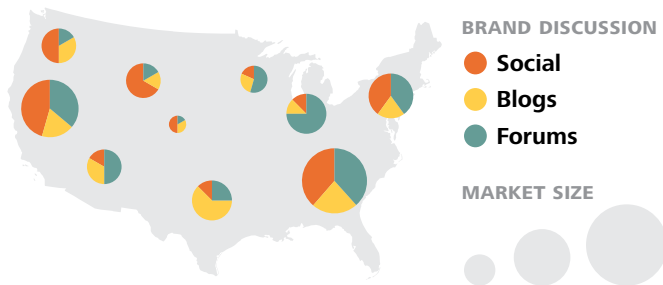
## 2 Insight: Identify influencers

OVERALL CONVERSATION

TOP AUTHORS

INFLUENCERS

## 3 Perception: Use brand analysis to identify target areas

|  | Brand A | Brand B |
|---|---|---|
| ATTRIBUTE "Stylish" |  |  |
| ATTRIBUTE "Durable" |  |  |

**SENTIMENT**
- Positive
- Neutral
- Negative

**ACTIVITY**

## 4 Audience: Distribute content through advocates, enable audience contribution

| May | June | July |

**ACTIVITY**
- Fan interaction
- Outreach
- Followers

**% CHANGE**

## 5 Campaigns: Inject new energy

Promotions and special features

Regular content

J F M A M J J A S O N D

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to take action on, though the possibility nonetheless sparked a wave of investments in social command centers.

The thought process was that we need to do *something*, now that we've shone the light on what people are saying about us. So companies rolled out social-based customer service, communications, broadcast marketing, and crisis communications. These applications use social as another channel and are largely a means to distribute mass messaging or to pull customers back to a company's own websites and call centers.

The business potential of social technologies is real. But that potential lies in moving from monitoring sentiment to influencing perception—and helping customers become advocates for marketing, for sales enablement, and for servicing.

## The recommendation economy

Social activation is based on the new recommendation economy—where customers have tuned out anything that smells like traditional advertising, seeking instead the contextualized recommendations of peers. We have seen the rise of informed, passionate audiences who are ready to engage—willing co-creators who are actively sharing what they are interested in, buying, and using. They are participating in their own words, on their own turf, with personalized messages on social networks, blogs, community forums, and other locations where those with shared interests

congregate. They are inspired to share why they made a decision, what they considered along the way, and why others should follow suit. A recent Nielsen study confirmed that 84 percent of global respondents trust word-of-mouth recommendations from friends and family—the most highly rated among digital and traditional methods.[5]

Social activation involves new tactics. Audiences and influencers need to be understood at a granular level—who they are, what they care about, and how they spend their time. Then campaigns can be designed to empower and engage specific communities for tangible, expected results. Content should be rapidly created, tailored, monitored, and refined—according to the context of the audience, the outcome, and the campaign. It should be designed so that consumers feel motivated to add context to brand content with their individual insights for friends and readers. Content supply chains are often put in place, allowing core collateral to be pushed through internal and external ranks—in formats that encourage regional social teams and end consumers to localize, personalize, and enhance it.

Finally, digital outreach can—and should—be paired with traditional in-store or on-site campaigns, delivering on the potential of seamless, omni-channel digital engagement.[6] The goal is not to divert social activity onto corporate assets; instead, it is to influence outcomes and promote advocacy.

# Lessons from the front lines

## The social TV experience

Recognizing that the Internet and social media have started changing the way people watch TV, the FOX Broadcasting Company identified an opportunity to both enrich the TV viewing experience of its existing fans and generate a new fan base through an engaging second screen experience using social media and the voices of its dedicated viewers.

FOX's approach combines the live television viewing experience with a parallel online experience specifically designed for each show and the preferences of its audience. For one reality show, FOX let fans vote for the winner via Twitter. Another show uses social media for a "fan of the week" contest where individuals publicly share why they are a fan and winners are given "shout-outs" on-air during the broadcast.[7] When FOX News started letting viewers agree or disagree in real time with speakers on one show, they saw its audience grow by 21 percent among a key demographic.[8]

By designing separate social business strategies for each show and enabling viewers with compelling content, FOX has activated a large, online fan community that is driving the conversation and helping amplify its message to reach new viewers.

## Unleashing the power of social

Four years ago, Hartz, one of the nation's largest providers of pet products, was not engaged in social media. Recognizing the need to have a social presence to remain competitive in the marketplace, Hartz launched a multifaceted social media strategy designed to educate and foster relationships with pet enthusiasts.

The company listened to the online conversations of pet owners and developed content in response—having detailed conversations with owners and breaking down the company's products for specific audiences such as small dog or short-haired cat owners. It conducted online contests and engaged industry influencers, largely bloggers, with relevant pet care topics and products to test. Hartz also used social media to educate pet owners on which pest control products were best suited for their companions through the interactive "Flea and Tick Education Center" on its Facebook page.

Hartz was able to tap into the widespread positive conversations about animals that were already happening in social media, positioning itself as an advocate for an existing online community passionate about pets and their overall well-being. As a result, Hartz has built an affinity between its brand and the "pet lifestyle," creating stronger relationships with its customers.

## Community outreach

Parallels, a desktop virtualization and hosting and cloud services enablement company, sells Parallels Desktop for Mac, which allows users to run Windows applications on a Mac® computer,[9] side by side, without rebooting. Several years ago, Parallels faced competitive pressure and wanted to improve its online reputation. The company decided to engage with its customers across multiple social media channels and share the insights with its engineering and marketing teams to incorporate the customers' voice into its product.

The virtualization engine is complex software—running two or more operating systems on the same piece of hardware and making them act as if they are one. The product team had a roadmap for performance improvements and sophisticated new features, but the company launched a listening study to see what other ideas might come from social media followers. The study found that one out of three recommendations to buy a competitor's product was based on its "prettiness." By polishing the product—rounding the corners on message boxes, creating more natural translations of error messages originally written in another language, shifting the color palette of the menus and headers—Parallels had the opportunity to convert new customers. This was new feedback not previously shared in direct customer input or focus groups—but in the world of open purchase recommendations, the company was able to directly address the perceived gap in usability. Social activation helped reshape the company's product roadmap and drive new revenue.

Parallels also created two separate programs to build its online reputation: an "influencers program," in which a group of power users were encouraged to write content for a Parallels blog highlighting their own uses of the program; and the "advocates program," which leveraged customers who were avid social media users and positive supporters of the product and brand to help increase positive sentiment via social channels. Both programs activated passionate users—giving them access to beta software and encouraging them to share their perspectives to shape future product releases.

A few years later, when an updated version of the software was two weeks away from being released, an employee of a big box retailer accidentally shelved it early, and a customer took a picture of the packaging exposing the product's specifications, features, and marketing messaging. Parallels had planned massive media coverage announcing the product release, but it was scheduled to be launched two weeks later. The company decided instead to go to market with the product at the time of the leak solely with social media and public relations communications. Members of its influencer and advocate programs were core pillars of the roll-out. Due to the strong, engaged online community that Parallels had built, that online messaging alone drove sales of the new product equivalent to those of the previous year's release.

The company's realization of the importance of cultivating, appealing to, and rewarding a passionate community of customers transformed its brand. Especially with strong competition, customer perception can change quickly, and maintaining customer loyalty is fundamental to maintaining sales. Today, Parallels Desktop has 90 percent market share in Mac desktop virtualization software.[10]

# My take

## Peer Schneider, executive vice president and co-founder, IGN Entertainment

Social is the glue that holds together our IGN site experience. We've been a web property for over 16 years—before Facebook, YouTube, and Twitter. Facilitating a social experience between our users has consistently been at the core of what we do. We morphed from exclusively trying to pull visitors to our website to proactively pushing content to where gamers live through social channels like Facebook, Twitter, YouTube, and Google+. The crux of that strategy is our premium content delivered by recognizable online personalities, intended to resemble the person on the couch next to you playing a video game.

Opinion is the basis of our social interaction. But opinion can be a two-edged sword. People sometimes talk about games two years before their release, and it's almost as if they're "willing" games to be good. If highly anticipated games earn negative reviews, that generates heated conversation; for our users, it can sometimes be about satisfying expectations or justifying purchase decisions rather than about the game itself. The editorial team has to actively participate in discussions to make sure the audience doesn't place blame on the messenger. The openness of voice we strive for can also be challenging for our relationship with the industry. But, we believe authenticity is at the core of engagement—especially via social channels. Game developer Peter Molyneux signed on our wall, "Thank you for all the reviews, both the good ones and the bad ones." The bad reviews give him an added push to improve his upcoming products.

IGN went public right before the dot-com crash and started looking for alternate revenue streams. At that time, we had a vibrant community on our message boards, accounting for approximately 50 percent of our page views. Experimenting with how to monetize our users, we moved a large portion of that community behind a paywall. Though the short-term gain was beneficial, this ultimately stunted our growth and created a love-hate relationship with the most vocal segment of our user base. Shortly thereafter, we moved the paywall back and reintroduced free forums. Two years ago, we created the subscription service, Prime, which lets subscribers behind the "velvet rope"—an ad-free experience, free games, and access to our editorial team—without keeping other users out. The moment we pivoted, we saw the site's growth return.

I recommend four steps for getting started with social channels. First, understand your baseline audience. We run an annual segmentation study to determine our audience. Second, identify, and activate, your social influencers. We labeled this segment our "All Stars." We have someone dedicated to interface with them because, while they are influential enough to run their own blogs and cultivate their own Twitter followers, we also want them to keep using our tools and share our content. To this end, we provide rewards in the form of social currency, such as highlighting their commentary on IGN's homepage. Third, execute on your plan. For example, facilitate giveaways and contests that encourage your audience to share comments and content. Lastly, appropriately measure your outreach—different content is appropriate for different social channels. Some channels are better suited for traffic referrals and others for starting conversations and getting the word out. Don't get caught up in "vanity metrics" like how many followers you have. Focus on what matters: true engagement, quality content sharing, and commentary.

# Where do you start?

**T**HERE are many beneficial social listening, sentiment, and analytics products on the market—and likely many already within your organization. But social activation shouldn't start with tools. Instead, it should begin with well-defined business objectives and measurable, attributable metrics that can guide your efforts. Your objective may be to increase the number of leads or sales, boost your share of voice on a strategic topic, or reduce call volume to your call center.

Once the call to action is clear, the following areas of emphasis can help you fast-forward to social activation:

- **Focus.** Avoid the temptation to overload initial efforts across too many desired outcomes. There will be opportunities to extend the reach and effect of campaigns, but initially you should opt for focused results.

- **Insight.** Gain understanding about existing communities, channels, and content. Community insight involves understanding the various relevant constituencies within regions and groups, as well as the influencers and their relationships across the market. Channel intelligence measures the impact that programs make across various digital platforms and sites. Content reviews look to understand the health of social assets and how aligned they are to community and channel preferences.

- **Perception.** Perception involves uncovering what conversations are taking place, where they're happening, and how people really think and feel about the company or product. Counting Facebook "likes" or how many tweets contained positive words such as "good" or "happy" only skim the surface. Instead, engage in a perception study and let today's conversations inform how you, your competitors, and your partners are perceived. You will likely need to deal with negative perceptions, amplify positives, and design strategies to seed and grow your aspirational perceptions.

- **Audience.** Gather, monitor, and enlist targeted pockets within the community over time. Create plans to motivate and shape perceptions—including the build-out of content supply chains to manage, govern, and enhance digital content worldwide. Launch hyper-targeted ambassador or consumer VIP programs, fostering a community of passionate and connected users to help drive messaging, promotions, and—perhaps—even product innovation.

- **Campaigns.** Focus on the ideation, creation, execution, and monitoring of social experiences that engage audiences and shape perceptions. These may be tied to external events such as seasons and holidays, conference schedules, or industry milestones. Or they may be linked to internal happenings such as product launches, new content releases, or media events. Content, promotions, games, mobile applications, and microsites that harness the power of social media to achieve business objectives are possible tools. Either way, look to create natural links to e-commerce platforms—allowing activation to actually influence sales.

## Bottom line

     Effective social engagement is no longer about consumer loyalty to the brand; it's about a company's ability to nurture loyalty from the consumer.[11] The goal is not just passive monitoring, but active influencing. In today's recommendation economy, educating and empowering your audience can lead to impactful, long-lasting results. Social is neither a passive distraction nor a dangling modifier. It can drive real business performance through measurable, sustainable results. But it requires a shift in mindset—with a focus on perception, engagement, and activation.

# Authors

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Dave Hanley is one of the leaders of Deloitte Digital's social offering. In his career as a web marketer, he has specialized in creating and marketing viral social applications. Hanley joined Deloitte Digital in October 2013 with the acquisition of Banyan Branch, a leading social media agency which he co-founded.

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# Cloud orchestration
## From cloud to clouds (to core)

**Cloud adoption across the enterprise is a growing reality, but much of the usage is in addition to on-premises systems—not in replacement. As cloud services continue to expand, companies are increasingly connecting cloud-to-cloud and cloud-to-core systems—in strings, clusters, storms, and more—cobbling together discrete services for an end-to-end business process. Tactical adoption of cloud is giving way to the need for a coordinated, orchestrated strategy— and for a new class of cloud offerings built around business outcomes.**

CLOUD adoption across the enterprise is a growing reality. Forrester predicted that "by the end of 2013, enterprises will use an average of 9.6 software-as-a-service (SaaS) applications."[1] Yet much of the cloud usage is not in lieu of on-premises enterprise systems. Forrester also found that "only 18 percent of the enterprises that were first-wave adopters and less than 9 percent of the second-wave adopters have used SaaS as a full replacement."[2] As a result, these cloud services increasingly require integration back to core internal systems—linking edge offerings to legacy financials, order management, inventory, HR, manufacturing, and other enterprise systems. Companies are connecting clouds—in strings, clusters, storms, and more—and cobbling together discrete services to create end-to-end business processes. Tactical adoption of cloud is giving way to the need for a coordinated, orchestrated strategy.

As cloud services continue to expand in number and sophistication, gaps in managing cloud-to-cloud and cloud-to-core portfolios are beginning to appear, leading to new and smarter ways to operate in this hyper-hybrid[3] IT environment. It is also opening the door for a new category of offerings: pre-integrated and orchestrated cloud offerings delivering higher-order business outcomes-as-a-service.

## All together now

Integration, data management, and enterprise architecture have long been aspirations for IT. With cloud, these practices have become more complex. And they've shifted from leading practices to critical core disciplines. Integration stability and reliability was the number two challenge in a recent survey on cloud adoption, trailing only security concerns.[4] Virtually every enterprise should be developing a strategy on how to integrate, aggregate, and orchestrate its collection of cloud and on-premises assets. Understanding the extensibility, portability, and reliability of a cloud service should begin at the sourcing stage.

- Extensibility refers to the ability to get information into and out of the service— the availability of data and transactions to be invoked by other parties and the ability to trigger external events from within the cloud service. Many cloud providers offer lightweight web services and RESTful[5] interfaces, but it's important to review the assets around APIs and data structures—documentation, toolkits, testing harnesses, backward compatibility, and deprecation policies.

- Portability represents the ease of migrating your business from the cloud service. Can data be exported? What about customized business logic? Are there contractual terms associated with intellectual property ownership?

- Reliability addresses performance of the service—not just the core cloud offering, but the surrounding stack. For an orchestrated process, the integration layer and dependencies on legacy systems should be able to scale dynamically to take advantage of the elasticity of cloud services. The end-to-end business process is only as strong as its weakest link.

Cloud orchestration can build from a mature enterprise integration and architecture footprint. The underlying tenets are familiar: service orientation, data correlation, security services (especially authentication, entitlement management, and encryption), and a separation of business logic. Several integration platforms have emerged from the cloud, offering cloud-based deployment options as well as preconfigured connectors and integration patterns for popular cloud services. Providers include Boomi, CastIron, MuleSoft, and TIBCO's Cloud Bus.

## New beginnings

The cloud provider market is starting to address the desire for higher-level, pre-integrated cloud orchestration services. For example, consider the example of a health plan's recruiting and HR service. Today, health plans contract with separate cloud providers for résumé sourcing, background checks, on-boarding, benefits, payroll, and performance management—which means they need to develop and maintain point-to-point interfaces between the various players to enable the full prospect-to-employee lifecycle. They are waiting for an end-to-end "hire to retire" service to emerge, which could provide contracting, configuration, and handoffs across various systems. The enterprise could subscribe to a single service, priced based on usage or, in an ideal world, on outcomes.

Traditional ERP players are acquiring and integrating cloud applications to supplement core offerings. Established cloud providers are

## Tracking a business transaction in the cloud and core



**ON-PREMISES**
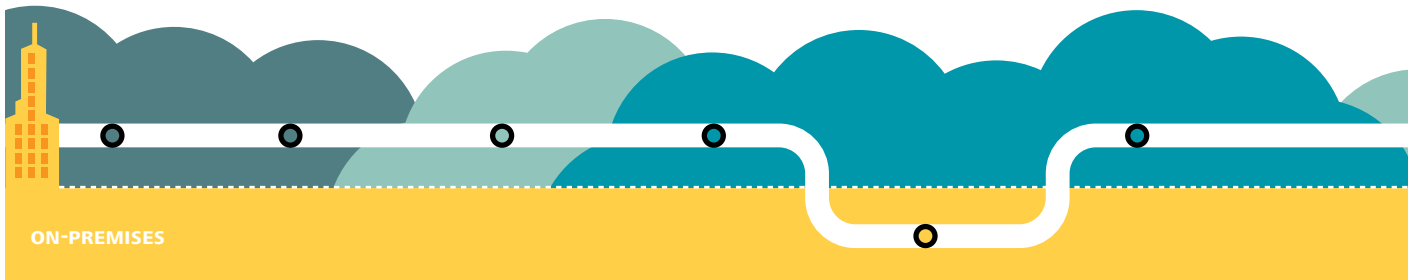
**INTEREST**
A tweet in a new marketing campaign elicits a customer response.

**LEAD**
The customer requests a demo and receives an email from the company.

**OPPORTUNITY**
A marketing rep assigns the lead to a sales rep for review.

**QUOTE**
The sales rep creates a quote and converts the lead to a new account.

**CREDIT**
A collections agent performs a credit check and assigns a credit limit.

**CONTRACT**
With approval from the sales manager, the sales rep creates a contract.

creating storefronts of complementary cloud solutions, which make choosing and buying an expanding inventory of services easier. But we are still in the early days of this expansion, and integration often remains the buyer's problem. Over time, technical compatibility within a vendor's stack should become less challenging. ERP and cloud providers are also planning improved interoperability between their products[6]—an encouraging development, to be sure, but of little help in the immediate term.

Others may yet enter the cloud orchestration market. Systems integrators and professional services firms that specialize in integrating diverse systems could expand and formalize their roles by pre-integrating the components of an end-to-end bundle. For such organizations, this may offer a way to monetize intellectual property around industry and process experience while diversifying from consulting to a product revenue stream. Several high-tech players looking to expand their offerings could emerge, such as Amazon, Google, HP, and Microsoft.

## A brave new world

The initial market for effective cloud orchestration is likely to be startups and small- to medium-sized businesses. They could receive the benefits of one-stop access without the hassle of navigating vendor contracts, integrating systems, and managing data. Larger businesses in emerging markets are also natural targets. Like startups, their circumstances may not justify a full enterprise solution. Finally, serial acquirers could gain agility and advantage from being able to integrate diverse platforms more efficiently. In each case, IT's mission should be to create integration, data management, and security services to guide cloud adoption.

But the majority of the Fortune 1000 will be living with the reality of a mix of cloud and core offerings, even as sophisticated cloud orchestration emerges. IT's charter to own cloud integration, data, and security is even more important in this case—especially as businesses are increasingly dependent on hybrid operating environments. Build the components to orchestrate the cloud today, and you'll be ready to adopt more compelling services as the market develops.

● **Marketing Cloud**  ● **Sales Cloud**  ● **Billing Cloud**  ● **Core**
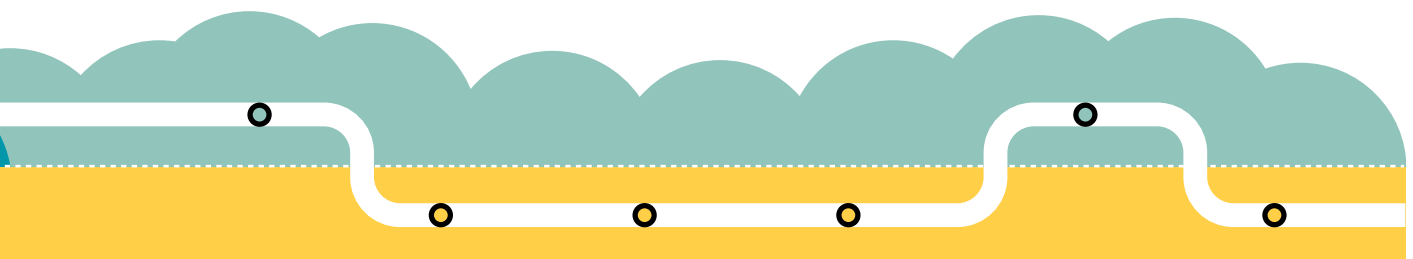
**ORDER**
The sales rep closes the opportunity and initiates order fulfillment.

**PROVISIONS**
The provision manager creates license keys for the customer.

**BILLING**
The customer receives an invoice and serial keys from the collections agent.

**PAYMENT**
The collections agent follows up with the customer about payment.

**REQUEST**
The customer has a customer service request.

**SERVICE**
A service rep responds to the request and then resolves the case.

# Lessons from the front lines

## Linking the network[7]

LinkedIn, a social networking website, has three main enterprise lines of business: talent solutions, marketing solutions, and sales solutions. As Andres Bang, LinkedIn's head of global sales and operations systems, described recently: The company adopted cloud services to support sales and CRM functions, but found that its business was outgrowing standard out-of-the-box capabilities and that its processes increasingly required integration to ERP and proprietary systems for generating sales leads.

To address its immediate lead-to-cash process requirements, and to build a scalable solution for future orchestration, LinkedIn adopted a cloud-based integration platform. Bang explains that by using the integration platform, LinkedIn was able to connect multiple systems, including its lead generation tool, CRM system, financial system, data warehouse, and proprietary applications. Integrating both its cloud-based and on-premises systems created a "single pane of glass" for the company's salespeople to access the information they need to perform their jobs.

## Orchestrated banking[8]

SunTrust Banks, a leading US financial services holding company, found that its relationship managers were encountering issues with accessing customer information in a timely manner, threatening their ability to provide quality customer service. The root of the issue was the company's reliance on an assortment of back-end systems for loan origination, underwriting, servicing, and CRM. SunTrust's architecture was a mix of cloud services, on-premises packaged software, and on-premises custom solutions. The company sought an integrated, scalable solution to expedite the delivery of services to customers—and pave the way for future cloud adoption.

The bank decided to adopt a cloud-based integration platform to address these challenges. By connecting SunTrust's back-end enterprise application and shared services to the cloud, SunTrust was able to eliminate its complex back-end business processes. Furthermore, the cloud enabled seamless integration with the bank's enterprise service bus and provided preconfigured connectors to cloud services.

Today, SunTrust maintains a scalable solution supporting its broader business process transformation. Furthermore, relationship managers are empowered with the tools and resources to access important customer information in a timely manner, reducing the time it takes to provide service to customers.

## Hybrid high tech

A global hardware and software company was undergoing rapid change stemming from acquisitions, organic growth, and divestitures. The company's goal? To maintain its core hardware and product businesses while expanding its software and services offerings. The company's expansion introduced complexity in many areas, such as marketing, sales and incentive management, product configuration, pricing, and project and workflow management. Speed to market was a driving force, since the organization wanted to engage with customers from dozens of countries in a consistent and coordinated manner. The company also recognized that its strategy was built around continual transformation of its offerings—and that required flexibility and agility in the enabling systems.

The organization was vexed by decades of what it called "lumpy" expenditures—costly IT infrastructure refresh cycles, with a history of overspending for capacity because of unpredictable demand. But the concern was about more than cost and scale. The company also sought shorter time to market and the ability to more efficiently assimilate new ventures. This was important, given its recent wave of acquisitions.

The company's vision is to move to a 100 percent cloud-based infrastructure for the enterprise. As a first step in fulfilling this vision, and to continue to provide seamless, end-to-end business processes, the organization orchestrated a complex integration between multiple cloud services and its on-premises systems. A new sale requires smooth interaction between separate cloud systems for many processes: calendaring and messaging; materials development; lead and campaign management; opportunity, sales, and support management; configuration, pricing, and quoting services; sales and support management; and compensation and incentives. The integration enabled these systems to communicate with each other, and it also included hooks into on-premises systems for human resources and order and billing management. Recognizing that the glue to bring together the various services was as important as the individual functionality being delivered, the company created disciplines around cloud-to-cloud and cloud-to-core integration: tools, architectural standards, and a dedicated team to drive growth and adoption.

Through the company's efforts, maintenance costs have gone down: Instead of heavily funding incremental software improvements, the company is taking advantage of enhancements being rolled out by the cloud services. System performance has improved; outages have become shorter and less frequent. The company's global teams have enjoyed greater browser and device compatibility, as the cloud offerings have a wider footprint than was historically allowed. And the business feels better served by IT: IT's responsiveness has improved, as has the business's understanding of associated costs. Finally, the company has started to take the next step toward the overall vision by shifting to cloud hosting of traditional ERP to "rightsize" the underlying infrastructure—a solution that can scale up (or down) based on the company's circumstances.

## Espresso with a shot of cloud[9]

Online distribution channels have transformed Nestlé Nespresso S. A. from a traditional, coffee-shop-and-boutique-store business model to a household brand in the single-serving coffee machine category. But in order to meet growing global customer demand, Nespresso needed to replace its home-grown, complex ERP system with a more scalable architecture and integrated cloud solution.

The business began enhancing its enterprise architecture by launching the Nespresso Open Architecture (NesOA) platform, a tool designed from service-oriented architecture (SOA) principles. With NesOA, Nespresso's IT department could support new distribution channels, manage increased consumer traffic, and introduce new applications and services to the business. Furthermore, by using a cloud-based integration platform, Nespresso could easily integrate a variety of systems, including the Nessoft ERP system, an interactive voice response system, an automated warehouse management system, and an emergency ordering tool.

As a result, Nespresso's NesOA transformed its home-grown enterprise into a scalable, automated, and more efficient solution to meet business needs. Furthermore, it mitigated the risk of disruption from a single point of failure with a solution based on clustering and redundancies. Nespresso is now poised to leverage cloud and traditional solution offerings to support future growth of its IT system landscape.
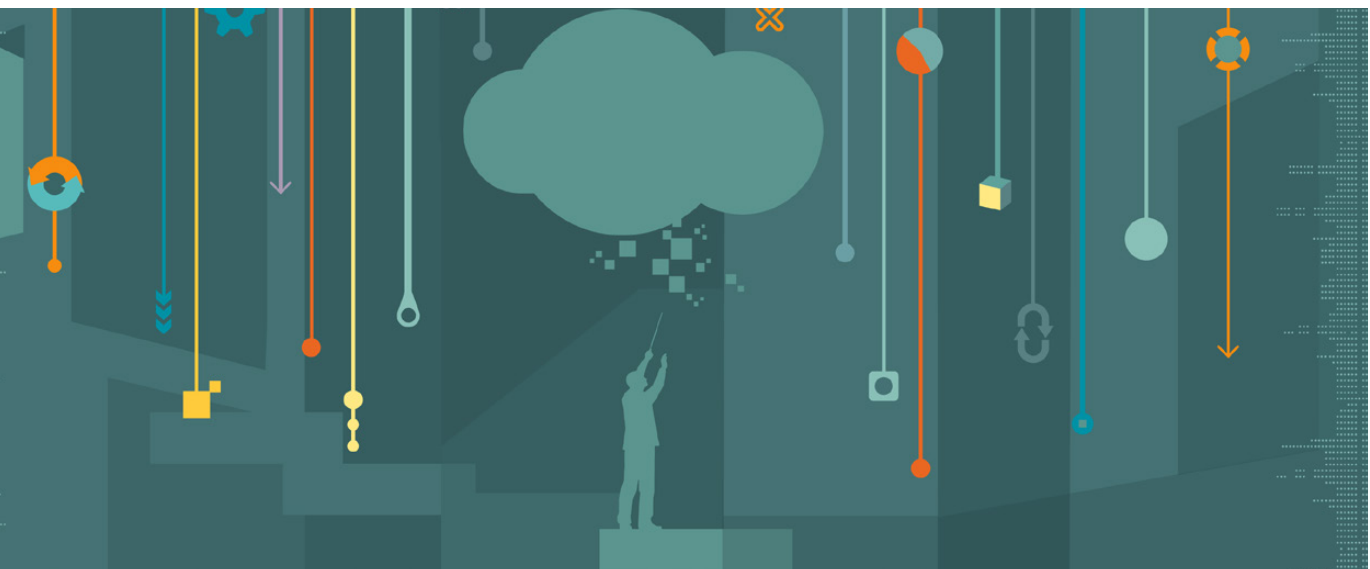
# My take

## Dounia Lievan, former banking executive
## Director, Deloitte Consulting LLP

I formerly worked for a regional bank that generated the majority of its revenue from mortgage banking. The bank looked to diversify by focusing on both the retail and commercial banking lines of business. We recognized that we could drive immediate revenue in retail by elevating the customer experience at the point of sale. The longer-term goal was an integrated omnichannel experience driven by online and mobile capabilities, but initially the case for change was to better serve our customers in the branch—knowing that the technology we implemented could provide a solid foundation for our "connected customer" vision.

Previously, the process for opening an account with related services was lengthy and inefficient. Employees accessed multiple systems and entered duplicative data. In addition, we didn't provide bankers with tools or insight to identify customer needs, and we lacked an automated way to manage the ongoing customer relationship. To improve the experience for both the customer and banker, and with an eye toward the broader vision, we invested in a customizable cloud solution with native customer relationship management (CRM) capabilities. It provided one delivery system for branch bankers with increased flexibility, support for process improvement, and the option for future expansion across channels.

We chose to go to the cloud for several reasons: to generate revenue, to increase efficiency, to be agile enough to respond to changes in the marketplace, and to differentiate ourselves from our competitors—while reducing the burden on the IT organization. Cost factored into, but didn't dominate, the investment decision.

Our legacy systems didn't provide the functionality needed to solve the business problem, so we used the cloud and SaaS to connect multiple core and ancillary systems. Integration isn't a new concept, but with the cloud, a balance has to be struck between traditional methodologies and the flexibility that the cloud can introduce. Looking back, there are a few things we might have done differently,

such as creating more real-time APIs versus batched transfers. But, overall, the project laid the groundwork for the longer journey.

During the course of the project, and especially after go live, the cloud changed how IT and the business work together. It drove collaboration and created a new team with an enhanced skill set and a different mindset. They're no longer completing a stand-alone project and moving on, but dedicated to driving continuous improvement and evolving the platform to deliver business results.

As you take the cloud integration journey, executive sponsorship and building enterprise support are key success factors. Create a strategic roadmap, and articulate your plans two to three years out. Upon completing the first phase, showcase the solution and use the roadmap to sell the vision to the C-Suite and across business lines. Provide regular updates on adoption metrics, user feedback, progress toward change, and—more importantly—return on investment. This keeps the platform top of mind and makes it easier to gain support to grow the platform and enhance its value.

As business leaders, we look for ways to drive revenue and efficiency, continuously creating value. At the heart of the banking business is the relationship we have with our customers, and building trust is the foundation of that relationship. What I love about this technology is that we used it to remove compliance and operational obstacles and gave bankers the tools they need to be effective and efficient. We used technology to enable bankers to be present, listen, ask questions, and help people—to make a stronger human connection.

# Where do you start?

**E**VEN with the more sophisticated cloud offerings that span end-to-end processes, the challenge of integrating cloud-to-core remains. How does the CIO manage the definition of standards for cloud adoption? Establish architecture to support integration? Handle data correlation, retention, and migration? These are important questions to answer now—and they'll be even more important as cloud services spread across the enterprise. CIOs should be making deliberate investments in developing advanced integration and data management capabilities to support a cloud-to-cloud-to-core model.

- **Petition for a new cloud business model.** Many companies could save money if cloud pricing was based on usage and outcomes rather than licensing fees. If this is true for your organization, let the cloud providers know. And if your company is ready for an orchestrated cloud option now, connect with others who share your need. Let your voices be heard by the software vendor community.

- **Build an integration foundation.** Even if your organization doesn't operate in a cloud-to-core environment, it's likely you eventually will. Laying the groundwork now will make integration easier later. If you've already invested in middleware to link legacy systems, build from there. However, you may find that a cloud-based model requires new approaches.

- **Connect the dots.** Definitions of customer, product, employee, and other data elements vary from one cloud solution to another— and need to be mapped to your business's semantics and taxonomy. Understand how each application defines its dataset, and develop a strategy for funneling data from various cloud systems to support your organization's reporting and analytic objectives.

- **Read the fine print.** Develop a healthy skepticism of cloud provider contracts. Understand your rights to data ownership, portability, and migration. If you change providers, can you be confident that your data is protected? Negotiate terms where possible to maintain your flexibility.

- **Build a strong chain.** Overall business performance is limited by the weakest cloud solution in the process chain. Understand the performance variability your business will tolerate, and weigh whether each individual cloud service can meet those demands. And remember: The scalability and performance of the interconnected whole is only as strong as its weakest link. Cloud's elasticity could stress (and break) legacy solutions built around more modest, predictable requirements. Cloud-based integration platforms ramp up (or down) to meet your needs—similar to the cloud offerings you are looking to orchestrate.

- **Explore edge architecture.** Borrowing from the days of SOA, consider describing business capabilities and processes as services. The goal is to connect enterprise core, private, and public cloud offerings— which can be broken into a common set of services used to deliver on business needs. This will lead to deliberate identification and management of business rules, APIs, identities and personas, entitlements, workflow items, and interfaces. The goal is to promote reuse, standards adoption, and architectural integrity—from a business-driven mindset. A revamped IT delivery model will likely be needed, as will support from both IT and business executives for a new governance mindset.

## Bottom line

As enterprises use disparate cloud offerings to handle critical business processes, the desire to link these offerings to core legacy systems and data grows. IT organizations will be asked to provide that orchestration. A recent Gartner survey shows that "over 70 percent of organizations that are using or planning to use cloud services expect internal IT organizations to assume the role of cloud services broker."[10] That need has generated challenges that extend beyond integration to include security, data integrity and reliability, and business rules for managing a hybrid state. It is also creating demand for cloud orchestration to link multiple cloud services to each other—and to the core. CIOs who have the disciplines of data management and integration architecture in place will be positioned to create harmony out of the existing landscape and to leverage orchestration services when they arrive.

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# Endnotes

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# In-memory revolution
## An answer to big data

As in-memory technologies move from analytical to transactional systems, the potential to fundamentally reshape business processes grows. Technical upgrades of analytics and ERP engines may offer total cost of ownership improvements, but potential also lies in using in-memory technologies to solve tough business problems. CIOs can help the business identify new opportunities and provide the platform for the resulting process transformation.

**D**ATA is exploding in size—with incredible volumes of varying forms and structure—and coming from inside and outside of your company's walls. No matter what the application—on-premises or cloud, package or custom, transactional or analytical—data is at its core. Any foundational change in how data is stored, processed, and put to use is a big deal. Welcome to the in-memory revolution.

With in-memory, companies can crunch massive amounts of data, in real time, to improve relationships with their customers—to generate add-on sales and to price based on demand. And it goes beyond customers: The marketing team wants real-time modeling of changes to sales campaigns. Operations wants to adjust fulfillment and supply chain priorities on the fly. Internal audit wants real-time fraud and threat detection. Human resources wants to continuously understand employee retention risks. And there will likely be a lot more as we learn how lightning-fast data analysis can change how we operate.

## An evolution of data's backbone

Traditionally, data has been stored on spinning discs—magnetic, optical, electronic, or other media—well suited for structured, largely homogeneous information requiring

ACID[1] transaction processing. In-memory technologies are changing that core architecture—replacing spinning discs with random access memory (RAM) and fueling a shift from row-based to column-based data storage. By removing the overhead of disc I/O, performance can be immediately enhanced. Vendor claims vary from thousand-fold improvement in query response times[2] to transaction processing speed increases of 20,000 times.[3] Beyond delivering raw speed, in-memory responses are also more predictable, able to handle large volumes and a mix of structured, semi-structured, and unstructured data. Column-based storage allows for massive amounts of data of varying structures to be promptly manipulated, preventing redundant data elements from being stored.

While the concept of in-memory is decades old, the falling price of RAM and growing use cases have led to a new focus on the technology. CIOs can reduce total cost of ownership because the shift from physical to logical reduces the hardware footprint, allowing more than 40 times the data to be stored in the same finite space. That means racks and spindles can be retired, data center costs can be reduced, and energy use can be slashed by up to 80 percent.[4] Operating costs

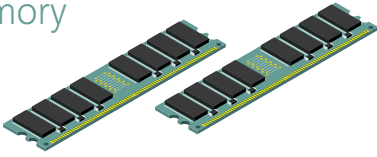|  | Infrastructure | Finding data |
|---|---|---|
| **Disc-based** | **DISK STORAGE** Data is mechanically recorded on a spinning disk—often on a large array of networked storage appliances. | **INDIRECT** For data to be read or written, the correct address must first be found on the physical disk, which is divided into cylinders, blocks, and sectors. Overhead for input/output (I/O) activities causes delays to large and/or complicated jobs. |
| **In-memory** | **MAIN MEMORY** Data is stored in the machine's main system memory, allowing in-line processing and manipulation. | **DIRECT** Streamlined data retrieval and processing; with no mechanical parts, no movement or alignment is involved. |
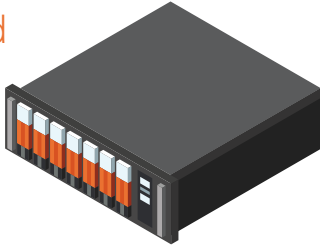
can also be cut both by reducing maintenance needs and by streamlining the performance of employees using the technology.[5] In addition, cloud options provide the possibility of pivoting from fixed to variable expenses. The bigger story, though, is how in-memory technology shakes up business processes.

## Beyond the technology

CIOs should short-circuit market hype and determine which areas of their business can take advantage of in-memory technology. In last year's *Tech Trends* report, our "Reinventing the ERP Engine"[6] chapter asked a specific question: What would you do differently if you could close your books in

seven seconds instead of seven days? Today, with advances in in-memory technology, that "what if" has become a reality that is driving companies to consider both the costs of ERP upgrades and the breakthrough benefits of real-time operations.

Operational reporting and data warehousing are easy targets for in-memory, especially those with large (billion-plus-record) datasets, complex joins, ad hoc querying needs, and predictive analytics. Core processes with long batch windows are also strong candidates: planning and optimization jobs for pricing and promotions, material requirements planning (MRP), and sales forecasting. The sweet spot is where massive amounts of data, complex operations, and business challenges demanding

|  | Efficiency | Structure |
|---|---|---|
| **Relational** | **OLTP[1]** Row-based structure suited for transactional integrity and SQL-based querying. Complex queries and joins require tiered processing, with staging of intermediate results, leading to more I/O overhead. | (diagram) |
| **Columnar** | **OLAP[2]** Data is organized by attributes (what would be columns in relational structure), allowing compression, eased aggregation and analytics, and faster complex queries across large data sets. | (diagram) |

**Relational structure:**

| | Name | Product | Status | ID |
|---|---|---|---|---|
| **Record 1** | Customer 1 | Product A | Open | #111111 |
| **Record 2** | Customer 2 | Product B | Closed | #222222 |
| **Record 3** | Customer 3 | Product C | Closed | #333333 |
| **Record 4** | Customer 4 | Product B | Open | #444444 |

**Columnar structure:**

| Record 1 | Record 2 | Record 3 | Record 4 |
|---|---|---|---|
| Customer 1 | Product A | Open | #111111 |
| Customer 2 | Product B | Closed | #222222 |
| Customer 3 | Product C | | #333333 |
| Customer 4 | | | #444444 |

Footnotes: [1] online transaction processing. [2] online analytical processing.

real-time support collide. Functions where the availability of instantaneous information can improve decision quality—telecommunications, network management, point-of-sale solutions—are good candidates for an in-memory solution. Over the next 24 months, some of the more important conversations you'll have will likely be about in-memory technologies.

Not every workload will be affected equally, and the transition period will see a hearty mix of old and new technologies. We're still in the early stages of businesses rewiring their processes to take advantage of the new engine. Analytics will continue to see the lion's share of investment, with in-memory–fueled insights layered on top of existing legacy processes. Point technical upgrades will offer incremental benefits without the complexity of another round of process transformation. And ERP vendors are still in the midst of rewriting their applications to exploit the in-memory revolution.

And while benefits exist today, even more compelling scenarios are coming soon. The holy grail is in sight: a single data store supporting transactions and analytics. This is great news for CIOs looking to simplify the complexity of back-end integration and data management. It's even better news for end users, with new experiences made possible by the simplified, unified landscape.

# Lessons from the front lines

## Reinventing production planning

When a large aerospace and defense company sought to uncover and overcome challenges in its ability to deliver products on time, the company turned to an in-memory-based analytics platform.

By using descriptive statistics to determine the root causes of the performance issues, they discovered that only a small number of the more than 50,000 assembly parts delivered performance within 10 percent of the company's plan, uncovering the need for more accurate data to fuel the planning process. Additionally, performance variation among component parts was high. By splitting the bill of materials into delivery segments, more advanced statistics could be generated, allowing performance to be evaluated at the individual part level.

Predictive models were then used to determine the factors contributing to the longer lead times. Subsequently, 35 unique parts were identified as representing significant risks to meeting delivery timelines. Clustering analytics assigned these high-risk parts into 11 groups of performance improvement tactics. Finally, predictive models were again run to align performance targets and financial goals with each of the tactics identified.

As a result of the diagnostics and actionable insights generated by this analytics platform, benefits valued in excess of $100 million were achieved. In addition, reduced product lead time, reduced inventory holding costs, and a 45 percent increase in on-time delivery were attained.

## Drilling for better performance

Pacific Drilling, a leading ultra-deepwater drilling contractor founded in 2008, grew aggressively in its first few years. As a result, IT was tasked with providing a state-of-the-art platform for measuring company performance. Additionally, Pacific Drilling's ERP system—implemented early on in the company's life—was due for an upgrade. The company selected an approach that addressed both projects, allowing it to keep pace with expansion plans and gain a strategic edge with its information system.

Pacific Drilling implemented a single in-memory data platform for both advanced analytics and its upgraded ERP system. On this platform, the company was able to more effectively run maintenance, procurement, logistics, human resources, and finance functionalities in its many remote locations. It also could perform transactional and reporting operations within one system in real time. Business leaders are gaining insight, while IT delivers reports and dashboards with reduced time-to-value cycles.

With an in-memory solution, Pacific Drilling can more effectively measure performance and processes across the enterprise, and is better positioned to expand its business and competitiveness in the industry.

## Communicating at light-speed

In the telecommunications industry, the customer experience has historically been defined through a series of disconnected, transactional-based interactions with either a call center or retail store representative. Customers have likely witnessed frustrating experiences such as service call transfers that require repeated explanations of the problem at hand; retail store interactions conducted with little understanding of their needs; and inconsistency of products and offers across different channels. While some companies may see this as a challenge, T-Mobile US, Inc. recognized an opportunity to innovate its customer experience.

The challenge many companies face is a "siloed" view of customer interactions across traditional marketing, sales, and service channels, as well as across emerging channels such as mobile devices and social media. T-Mobile recognized the potential in connecting the dots across these interactions and creating a unified customer experience across its channels, both traditional and emerging. By shifting its customer engagement model from reactive to proactive, T-Mobile could understand, predict, and mitigate potential customer issues before they occur and drive offers based on an individual's personal history (i.e., product usage, service issues, and buying potential). This was certainly a tall order, but it was a compelling vision.

T-Mobile's approach was to create a single view of customer interactions across channels. Each time a customer interacts with T-Mobile, the company records a "touch," and each time T-Mobile corresponds with a customer, the company also records that as a touch—creating a series of touches that, over time, resemble a conversation. The next time that T-Mobile and a customer interact, there are no awkward exchanges: The conversation starts where it left off. And the collection of touches can be used in real time to drive personalized pricing and promotions—through the web, on a mobile device, or while talking to a call center agent.

The situation T-Mobile faced when getting started: Two terabytes of customer data, created just in the last three months, stored in 15 separate systems with 50 different data types. Producing a single, consumable view of a customer's interaction history with the company's existing systems was likely impossible. Add the desire to perform advanced analytics, and it was clear the existing systems could not support the effort. To address these technical limitations, T-Mobile implemented an in-memory system that integrates multichannel sales, service, network, and social media data. The powerful data engine, combined with a service-oriented architecture, allows T-Mobile to capture customer interactions in a dynamic in-memory data model that accommodates the ever-changing business and customer landscape. The in-memory capabilities enable the integration of advanced customer analytics with a real-time decision engine to generate personalized experiences such as a discount for purchasing a new device the customer is researching or an account credit resulting from network issues impacting the customer.

T-Mobile's multichannel customer view takes the guesswork out of providing "the next best action" or "the next best offer" to customers. Data integration across traditional and emerging channels allows T-Mobile to see the full picture of a customer's experience so its employees can proactively engage customers with the appropriate message at the appropriate time. The importance of the customer experience has never been greater, and T-Mobile is shaking up the wireless industry by eliminating customer pain points. Customers can take advantage of its no-annual-service-contract Simple Choice Plan, an industry-leading device upgrade program, as well as unlimited global data at no extra charge. By implementing an in-memory platform to better understand its customers, T-Mobile continues to extend its competitive advantage with its differentiated customer experience.

## Next-generation ERP

With customers demanding reductions in time-consuming workloads and better performance of transactional and informational data, ERP providers are looking for ways to improve existing products or introduce new ones. In-memory capabilities, often used for analytics in the past, can give vendors a way to address such concerns and create core business offerings that were previously unachievable. Both SAP and Oracle provide technical upgrade paths from recent releases.

To this end, Oracle announced the release of 13 in-memory applications with a performance improvement of 10- to 20-fold.[7] Seven of these applications are new, intended to make possible several business processes previously deemed too intensive. Changes to the algorithms of six legacy applications will also allow in-memory versions to be created.[8] Additionally, an in-memory option, intended to double the speed of transaction processing, has been added to the core 12c database.[9]

Similarly, SAP has shifted its core business applications to an in-memory database and has gained the participation of more than 450 customers as of October 2013.[10] For these customers, this shift could make real-time financial planning possible, including interactive analysis of vast amounts of data.[11] The outcomes of immediate data-driven decision making may soon be seen as adoption of in-memory business applications continues.

# My take

## Jason Maynard, software and cloud computing analyst, Wells Fargo Securities

The in-memory movement is upon us and a bevy of approaches are emerging to solve new and existing business problems. So with the goal of doing things "faster, better, cheaper," in-memory databases help to get you the "faster"—with an opportunity for "better" and "cheaper" when you use in-memory to tackle business, not technical, problems.

From my perspective, mass-market in-memory adoption is still in the early stages but poised to gain momentum. While in-memory database systems aren't new per se, they are gaining in popularity because of lower cost DRAM and flash options. I think it has greater potential than many recognize—and more known use cases than many believe. The available products still have room to mature in their development lifecycles, and I think customers are looking for pre-packaged, purpose-built applications and platforms that show concrete benefit. I think there is opportunity, however, for early-adopting customers to lead the charge and gain competitive advantage.

In-memory databases are database management systems that use main memory for computer data storage instead of disk storage. This brings benefits such as faster performance, faster response time, and reduced modeling. Many industries, such as financial services, telecommunications, and retail, have used in-memory for trading systems, network operations, and pricing. But as new modern systems such as SAP's HANA, Oracle's Exalytics, and a number of startups appear, the market should expand in size. Moving in-memory from specialized markets to mainstream adoption means that many applications may need to be rewritten to take advantage of the new capabilities. SAP's HANA database engine supports analytic applications and transactional systems. Oracle has released a number of in-memory apps across its application product portfolio.

My advice for companies is to start small. Identify a few bounded, business-driven opportunities for which in-memory technology can be applied. Budgeting, planning, forecasting, sales operations, and spreadsheet-driven models are good places to start, in my view. Their massive data volumes and large numbers of variables can yield faster and more informed decisions and likely lead to measurable business impact. The idea here is to reduce cycles and increase planning accuracy. By allowing a deeper level of operational detail to be included within the plan, users can perform more what-if scenario modeling iterations in the same budgeting window. This means insights can be put to use without reengineering the back-end core processes and existing transactions can be run with more valuable, timely input. Among others, Anaplan has released a cloud-based planning and modeling solution that was built with an in-memory engine.

The extended ecosystem of ERP vendors, independent software vendors (ISVs), systems integrators, and niche service providers are working hard to close the gap between in-memory's potential and the current state of the market. It will take time, and the full potential is unlikely to be realized until application stacks are rewritten to take advantage of the new data structures and computational scale that in-memory computing provides. But—in-memory computing has the potential to transform business.
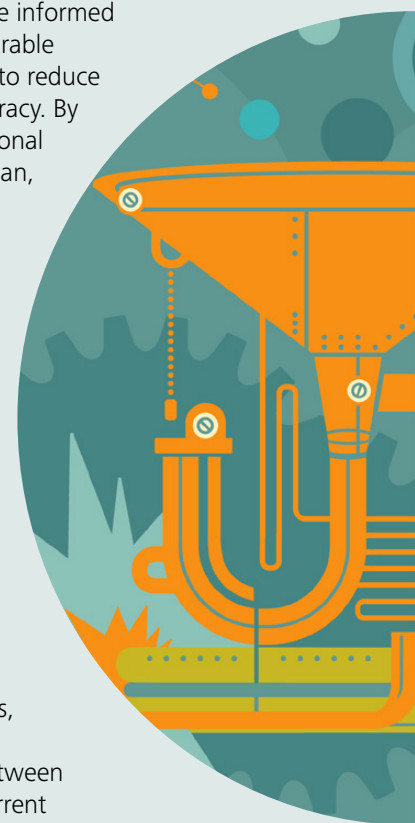
# Where do you start?

**V**ENDORS are making strategic bets in the in-memory space. IBM and Microsoft have built in-memory into DB2 and SQL Server. A host of dedicated in-memory products have emerged, from open source platforms such as Hazelcast to Software AG's BigMemory to VMWare's SQLFire.

But for many CIOs, the beachhead for in-memory will come from ERP providers. SAP continues to heavily invest in HANA, moving from analytics applications to its core transactional systems with Business Suite on HANA. SAP is also creating an ecosystem for developers to build adjacent applications on its technology, suggesting that SAP's HANA stack may increase over the next few years.[12]

Oracle is likely making a similar bet on its latest database, 12c, which adds in-memory as an option to its traditional disc-based, relational platform.[13] While there will be disruption and transition expenses, the resulting systems will likely have a lower total cost of ownership (TCO) and much higher performance than today's technology offers.

In addition, Oracle and SAP are pressing forward to create extensive ecosystems of related and compatible technologies. From captive company-built applications to licensed solutions from third parties, the future will be full of breakout opportunities. Continuous audits in finance. Real-time supply chain performance management. Constant tracking of employee satisfaction. Advanced point-of-sale solutions in retail. Fraud and threat detection. Sales campaign effectiveness. Predictive workforce analytics. And more. Functions that can benefit from processing crazy amounts of data in real time can likely benefit from in-memory solutions.

Vendors are pitching the benefits of the technology infrastructure, with an emphasis on real-time performance and TCO. That's a significant start, but the value can be so much more. The true advantage of an in-memory ecosystem is the new capabilities that can be created across a wide range of functions. That's where businesses come in. Vendors are still on the front end of product development, so now is the time to make your requirements known.

- **Start by understanding what you've already bought.** In-memory is an attractive and invasive technology—a more effective way of doing things. You may already have instances where you're using it. Assess the current benefits and determine what more you may need to spend to capitalize on its real-time benefits.

- **Push the vendors.** Leading ERP vendors are driving for breakthrough examples of in-memory performance—and are looking for killer applications across different industries and process areas. Talk with your sales reps. Get them thinking about—and investing in—solutions you can use.

- **Ask for roadmaps.** Move past sales reps to senior product development people at vendors and systems integrators. Ask them to help create detailed roadmaps you can use to guide the future.

- **First stop: analytics.** You'll likely find more immediate opportunities around your information agenda—fueling advanced analytics. In-memory can be used to detect correlations and patterns in very large data sets in seconds, not days or weeks. This allows for more iterations to be run, drives "fast failing," and leads to additional insights and refined models, increasing the quality of the analysis. These techniques used to be reserved for PhD-level statisticians—but not anymore.

- **Focus on one or two high-potential capabilities.** No company wants to conduct open-heart surgery on its core ERP system. Instead, pick a few priority functions for your business to gain buy-in. Your colleagues need to see the potential upside before they'll appreciate what a big deal this is. Analytics is a good starting point because it's fairly contained. Customer relationship management (CRM) is another good match, with its focus on pricing agility and promotion. After that, consider supply chain and manufacturing.

- **Watch competitors.** Experimentation will take place in many areas over the next two years. If a competitor develops new capabilities with demonstrated value in a particular area, the dam will break and the adoption curve will take off. Be ready for it.

## Bottom line

Some technology trends explode onto the scene in a big way, rapidly disrupting business as usual and triggering an avalanche of change. Others quietly emerge from the shadows, signaling a small shift that builds over time. The in-memory revolution represents both. On the one hand, the technology enables significant gains in speed, with analytics number-crunching and large-scale transaction processing able to run concurrently. At the same time, this shift has opened the door to real-time operations, with analytics insights informing transactional decisions at the individual level in a virtuous cycle. The result? Opportunities for continuous performance improvement are emerging in many business functions.

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Doug Krauss is a specialist leader within Deloitte's Information Management practice. He has over 20 years of experience in the business intelligence and data analytics space. He also leads the SAP HANA innovation platform to support client pilots, proof of concepts, and demonstrations.

# Endnotes

1.  ACID is an acronym for four rules for database transactional integrity: Atomic (ability to guarantee either the completion of a unit of work, or roll back the system upon failure), Consistent (ensure updates are applied everywhere—without violating any constraints or dependencies), Isolated (transactions execute independently without interference), Durable (transactions are persistent once committed).

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# Real-time DevOps

## Empowering the business of IT

**IT organizations need to better respond to business needs with speed and agility. IT can likely improve the quality of its products and services by standardizing and automating environment, build, release, and configuration management—using tools like deployment managers, virtualization, continuous integration servers, and automated build verification testing. Popular in the agile world, DevOps capabilities are growing in many IT organizations with either waterfall or agile methodologies.**

**W**HEN it comes to application development (Dev), the business cares about speed and quality. How fast can I get what I want? How close will it be to what I need? Contrast that with IT operations (Ops), held accountable for response times, stability, and efficiency, and focused on how to reduce business disruptions at the lowest cost. These are very different core missions that yield very different behaviors. Dev is looking to compress delivery cycles and adopt "experiment and learn" mentalities. Ops is looking to institute controls and more tightly govern change. The fact that the "build" and "run" shops are typically separate organizations only adds to the divide.

Further complicating matters, both Dev and Ops could each benefit from investments in enabling technology—creating automated capabilities in the business of IT akin to what finance, manufacturing, and the supply chain have invested in over the past decades.[1] But even as requirements management, system maintenance, and other disciplines are upgraded, incremental investments in disconnected activities will go only so far.

The real goal is to bridge the gap between development and operations, supercharging the investments that currently exist in siloed automation by integrating the end-to-end delivery model. Simply stated: *real-time DevOps.*

Some companies have been using automation to accelerate and improve steps in their development processes for a while. But many more have not. In fact, a recent survey of 1,300 senior IT decision makers revealed that only 39 percent had already invested in pieces of DevOps.[2] Complacent about their time-tested, over-the-wall approaches to software development, many IT organizations have settled for manual, disjointed processes that have rightly earned a reputation for ineffectiveness and inefficiency.

## It's complicated

Complexity surrounds DevOps. From basic design principles and defect tracking to release management, configuration management, and more, the interdependencies of the software development lifecycle are real and complicated. All the more reason to automate and integrate the process.

The rise of agile is one of the factors driving increased interest in real-time DevOps. What was once seen as an experiment is now mainstream, with more than 70 percent of companies reporting at least partial agile adoption.[3] At its core, agile is about "test, experiment, learn, and repeat." It's based on
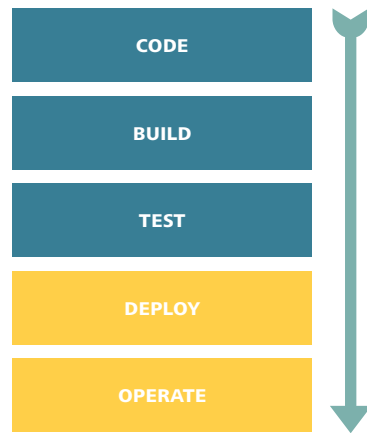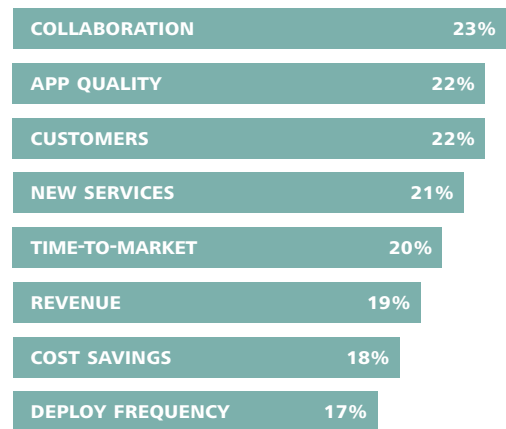
## The Dev

Innovates and creates applications.

## The Ops

Keeps infrastructure running smoothly.

## DevOps disciplines

Integrate and automate processes.

- CODE
- BUILD
- TEST
- DEPLOY
- OPERATE

## The benefits of DevOps[1]

Percent improvement in business areas.

| Business Area | Percent |
|---|---|
| COLLABORATION | 23% |
| APP QUALITY | 22% |
| CUSTOMERS | 22% |
| NEW SERVICES | 21% |
| TIME-TO-MARKET | 20% |
| REVENUE | 19% |
| COST SAVINGS | 18% |
| DEPLOY FREQUENCY | 17% |

Sources: [1] Computer Associates, "TechInsights report: What smart businesses know about DevOps," https://www.ca.com/us/register/forms/collateral/techinsights-report-what-smart-businesses-know-about-devops.aspx, accessed January 3, 2014.

short sprints—typically one or two weeks—to get to a potentially releasable product. That's instead of development cycles that last many months or years.

Accelerated time to market is one possible benefit, but just as important are the side effects of better managing changing priorities and improved alignment with the business. Agile backlogs represent potential work to be completed—stemming from new ideas, unmet requirements, or enhancements and fixes coming back from operations. Each sprint sees the business sponsor (or product owner, in agile parlance) re-establish priorities. Development teams then tackle those items on the top of the list.

Contrary to popular misconceptions, agile development often requires a more disciplined approach than traditional software development methods. It can also provide more transparency in the development process—and real-time visibility into progress. Iterative, rapid development begs for structure and rigor, which are available through

the automated, integrated capabilities of real-time DevOps.

Continuous build and continuous integration are big parts of real-time DevOps. Code is constantly being fed back into configuration management and validated via testing automation suites, giving developers affirmation that quality is continuously monitored, with dependencies managed automatically in the background. Companies gain the ability to automate technical compliance and structural correctness, as well as a continuous measure of how requirements are being met.
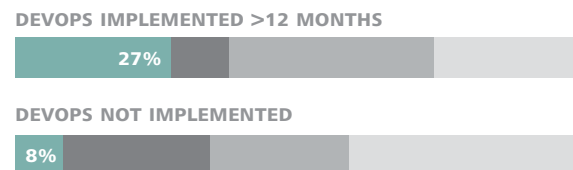
Environment provisioning and management is another opportunity area. Traditionally, projects had to accept up-front capital spend and ramp-up delays while hardware and software were ordered, installed, and configured. With the rise of virtualization, cloud, and software-defined data centers, this process can be largely automated: not only procurement, but also configuration of servers, networks, storage, operating systems, platforms, applications, transactions, and

## Production failure recovery time[2]

**0-30 MINUTES**

| DEVOPS | 41% |
|---|---|

| TRADITIONAL | 30% |
|---|---|

**31-60 MINUTES**

| DEVOPS | 30% |
|---|---|

| TRADITIONAL | 22% |
|---|---|

**60+ MINUTES**

| DEVOPS | 22% |
|---|---|

| TRADITIONAL | 40% |
|---|---|
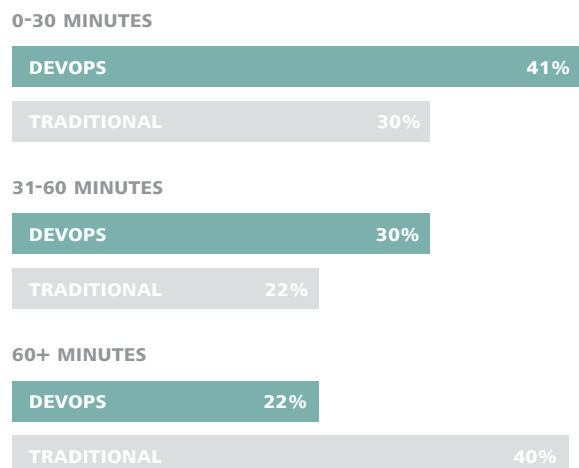
## Deployment frequency[3]

● **On demand**   ● **Once daily to once weekly**
● **Weekly to monthly**   ● **Monthly or longer**

**DEVOPS IMPLEMENTED >12 MONTHS**

27%

**DEVOPS NOT IMPLEMENTED**

8%

## Deployment duration[2]

| DEVOPS | 36.3 MINS. |
|---|---|

| TRADITIONAL | 85.1 MINS. |
|---|---|

[2] ZeroTurnaround, "Rebel Labs IT ops & DevOps productivity report 2013," April 9, 2013, http://zeroturnaround.com/rebellabs/rebel-labs-release-it-ops-devops-productivity-report-2013, accessed January 6, 2014. [3] Puppet Labs, "2013 DevOps report,"March 2013, http://info.puppetlabs.com/2013-state-of-devops-report.html, accessed January 6, 2014.

data—including the automated provisioning of user accounts based on profile types.

Real-time DevOps also includes test automation. When coupled with requirements management, functional, user, and even behavioral scenarios can be scripted for automated quality assurance (QA). This benefits development cycles and also serves as the benchmark for regression scripts—accelerating break/fix and maintenance processes. For areas such as web and mobile development, this might also include build-verification services across devices and operating systems—analyzing across an increasingly fragmented landscape.

## Where there's a waterfall, there's a way

While agile is helping to showcase the need for real-time DevOps, these concepts are just as relevant for waterfall shops. Handoffs and manual steps typically waste time in the development process. Collapsing the time it takes to develop software, and creating more thoughtful linkages to operations, are universal benefits.

Also, real-time DevOps does *not* mean that existing Information Technology Infrastructure Library (ITIL) and governance processes need to be scuttled. Indeed, IT service management should have a more explicit link to software development across the lifecycle, with identified issues fed into the backlog for prioritization. Ongoing patching and infrastructure upkeep should still be done, and with real-time DevOps, it will likely be better coordinated with development. Improving outage recovery and minimizing release fail rates are expected outcomes from real-time DevOps—as well as expedited code deployments and improved developer throughput.

Real-time DevOps is not a tool, though tools make it workable. And it's not only about agile, though agile practices have brought the benefits to light. Instead, real-time DevOps is a process shift that changes the cadence of how much can be done—and in how much time.

# Lessons from the front lines

## Moving at the speed of commerce

John Lewis PLC, a UK-based retailer with 40 department stores, replaced its customer-facing e-commerce platform in early 2013. This was a complex project involving a team of over 100 employees and consultants working across multiple systems: web storefront, web management, product management, and delivery management. To support this project, multiple development environments were used. Each one was carefully managed to support its respective development stream. Code was then deployed across many additional environments: system testing, integration, performance, training, and ultimately production.

To meet the project's pace and flexibility demands, John Lewis focused on DevOps and took measures to increase the frequency and richness of communications between the development and project operations teams, resulting in a prioritized list of DevOps-related enhancements. Many of these took the form of process automation in order to improve reliability, repeatability, and speed.

Since the go-live in early 2013, the company has continued to develop and refine its DevOps processes, focusing on efficiency and reliability. Automation has continued to be a main theme: Automated browser-based functional tests have been adapted so that they can be used on larger, fully integrated environments as both smoke and regression test suites. With real-time DevOps practices in place, John Lewis can now deliver one complete (back- and front-end) release per month. Previously,

releases were only carried out every six to eight weeks.

With the positive results from using real-time DevOps practices on the e-commerce project, John Lewis is now expanding these practices to other projects, scaling the operation and creating a clear delivery and project operations team for the enterprise. Additionally, the company is looking to orchestrate its automated processes, enabling an end-to-end, "one click" deployment across multiple systems.

## Supporting IT's health and well-being

The state of West Virginia's Department of Health and Human Resources (DHHR) administers programs that benefit its citizens, such as cash assistance, food stamps, and Medicaid. In support of this mission, the department depends on an integrated solution made up of more than 30 subsystems providing case management, eligibility determination, and benefits issuance functionality.

Given the breadth of business functionality, the size of the solution, and ongoing changes resulting from federal mandates, DHHR wanted an application development and maintenance process that could efficiently support multiple, parallel initiatives. To meet this objective, the organization implemented a schedule of weekly patches and monthly enhancement releases supported by an automated build and deployment process.

DHHR's DevOps program included multiple integrated, automated components such as defect and change request tracking, build and deployment, smoke testing,

and regression testing. Additionally, the organization created an administration dashboard to schedule, manage, and track builds throughout the release cycle. By integrating its defect and change request tracking with automated build and test utilities, DHHR is able to build only those components tied to tested defect fixes or enhancements— preventing untested components from being migrated to higher environments.

As a result of implementing real-time DevOps, DHHR has increased the success rate of software builds by 58 percent. Additionally, the processes have improved the software quality, which means DHHR's production rollback plan is gathering dust on the shelf.

## A healthy dose of collaboration

For a leading health plan, history seemed to repeat itself whenever the company adopted new technologies: The lack of communication across its enterprise resulted in significant delays in delivering new business solutions. Collaboration between operations and testing didn't occur until the late stages of implementation, and development often proceeded without a holistic view of business requirements. To make matters more challenging, the core implementation teams—operations, requirements, delivery, and testing—were geographically dispersed across multiple locations, both onshore and offshore. As a result, the health plan sought a real-time DevOps and agile/Lean IT approach to streamline communication across the enterprise and accelerate delivery of new business solutions to its users.

The transition to real-time DevOps and agile/Lean IT began by integrating the business functions into a single enterprise environment, creating cohesion from the initial stages of requirements gathering through final deployment. The organization introduced automated processes to build, test, and deploy systems, allowing users to see material progress in four- to six-week release cycles. The process resulted in an efficiency gain of over 50 percent by reducing unproductive wait times throughout the project life cycle, such as by enabling a reduction in the test execution window. There was an increase in overall delivery effectiveness, providing a higher degree of business consistency, flexibility, quality, and satisfaction. When talking about deployment, teams now look at their watches, instead of the calendar.

## A new policy for IT

A leading insurance company with a highly distributed IT organization comprising both internal and external resources started a journey to centralize its infrastructure, creating a services company construct. As part of that effort, the company internalized resources, created a more direct reporting structure to the CIO, and implemented a centralized application development group (ADG) of approximately 5,000 people.

One of the goals of implementing the ADG was to jump-start the company's transition to an agile development organization. As development projects transition into the ADG, they are implemented using an agile methodology. Organization-wide, about 25 percent of development at the company is currently delivered by the ADG using agile. The transition to the ADG has enabled a renewed focus on DevOps and on the goals of standardization, automation, and integration.

Each of the company's key infrastructure platforms was at varying stages of automation and integration. Real-time DevOps first took hold in two separate virtualized environments that already shared many common elements. As applications were built into those environments, their configurations were standardized. This allowed the company to automate more of its DevOps processes—environment provisioning, release management, system monitoring, and others. Efforts are underway to expand the standardization and automation of the company's platforms and processes—and to integrate the various capabilities.

One of the ADG's goals is to continually improve its delivery of what the business wants, which can drive heavy application complexity. With the IT organization moving from a catalog of distinct and separate parts to a service-based model, its approach to building applications has changed accordingly. The ADG is standardizing infrastructure components and applications and is working to automate even more of the work that comes in the door. The company is also looking into which service levels are needed by classifying applications into gold, silver, and bronze categories.

For the company's leadership, engaging its in-house workforce is a priority. DevOps had a strong, positive impact on relationships within the IT department—in particular, the infrastructure team and the ADG. The intangible benefits of improved collaboration and teaming are valued as much as increased quality of work, cost reduction, or reduced development times. DevOps is also a building block for better partnering between the business and IT.

In this effort, the company realized that the IT organization could not get to a service-based relationship with the business if it didn't have a service-based model in place. Leadership knew that it was important to map what it did in IT to what the business actually does for its customers. By getting that foundation in place, IT and the business could start having conversations at a higher level.

# My take

### Ben Gerst, senior vice president of platform and product development, FOX Sports

I'm an unapologetic DevOps geek. As vice president of technology in the PTA at my son's school last year, I built its website and set up real-time monitoring and automated management processes on a virtual machine the site lived on. It was total overkill for such a small website, but I had fun doing it. With the ease of use and price point of tools, even a kindergarten class can take advantage of real-time DevOps.

At FOX Sports, we are actively building out DevOps and continuous integration. We use Jenkins for the automated build process, which is essentially the beginning of continuous integration for us. We're also working on quality assurance automation so we can arrive at the point where we are creating an environment that has been tested and deployed—automatically. The next step will be broader testing automation starting with unit and regression testing. We'll draw a line somewhere; you risk automation overkill if you go too far. But we're not there yet.

In my role, DevOps is about having the information needed to make informed decisions. A large part of that is the combination of real-time monitoring approaches and mechanisms for teams to communicate. Monitoring can tell you a lot. If you see a spike in website traffic, you can easily pinpoint it and figure out what's going on. It might be a good thing like a surge in user activity or it could be because of a defect from a recent build or infrastructure maintenance. Early indicators let me take action—hopefully before the business is affected.

Enabling DevOps was driven by both business and technical needs for us. We needed to make process improvements in order to meet our goals for creating leading, timely content. We're driven by the sports calendar—it makes for lots of hard deadlines and constant activity. This year, the Super Bowl and the Winter Olympics opening ceremony fall within the same week—and we'll be up for the challenge.

Our strategy for DevOps is ever-changing here at FOX Sports as technologies grow and we learn. Bettering the number of features delivered, turnaround time to get a new environment provisioned, and mean time to repair defects are examples of expected outcomes. Currently we can support a build every 30 minutes, and we're taking lessons from our current processes to inform our next steps.

My advice for others is to employ DevOps. Look at the data. Get started with continuous integration. Look at your current deployment process—and consider the hours your team is spending to deploy and test code. DevOps requires an investment up front, but pays dividends in the long run. Over time, you can simply make tweaks to the process and keep rolling out code and testing in an automated fashion.

Not only do I recommend it, but I think it has become the rule, not the exception. A little work up front can save significant effort across the board.
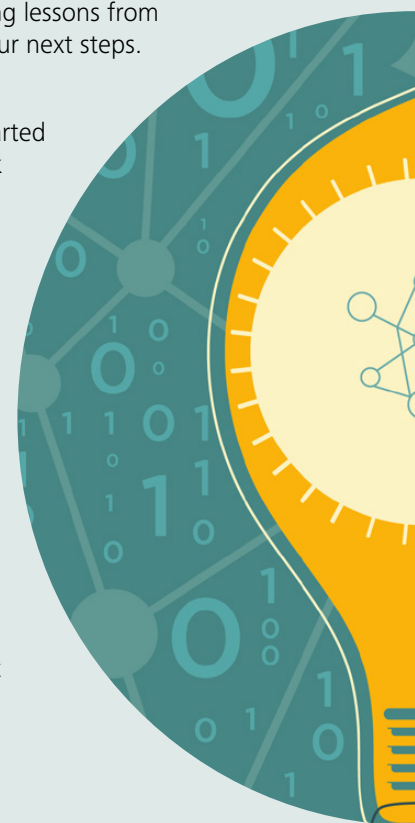
# Where do you start?

While there are many opportunities to make a shift to real-time DevOps, there are some places where you likely can't live without it: mobile, social, and big data. In these fast-growing spaces, disjointed, bottleneck-ridden development processes can undermine your efforts. Unless you can find a way to accelerate without sacrificing quality—and real-time DevOps is likely that way—you'll find yourself out of the loop as the business bypasses IT by going directly to the marketplace.

- **Establish the need.** Conduct your own benchmarking to identify delays and waste in the software development process. Uncover how much time is spent on manual document capture, build management, build verification, release planning, and test script development. These are opportunities for action.

- **Build new skills.** Tool configuration and scripting skills are a part of the equation, used to drive version control, configuration management, test harnesses, ticketing, environment provisioning, and system maintenance and monitoring. But soft skills are just as essential for real-time DevOps to take hold. Team members will be collaborating with the business, program and project managers, developers, testers, and the operations teams. Make sure your core team isn't simply making the new technologies adhere to how things have historically been done.

- **Employ services thinking.** For real-time DevOps to be viable with legacy ERP and large-scale custom solutions, break down complex systems into components and modular services. This allows for rapid incremental changes within monolithic code bases—and sets up the organization for a broader modernization play.

- **Lay down the bases.** Once you understand the pain points within your organization, begin automating individual components. Establish a continuous integration build server for your developers, create a small "smoke test" suite of cases to validate builds, and implement a release automation tool. Also, look to add automation within your development, test, and infrastructure tracks in parallel with similar, discrete steps.

- **Connect the dots.** Once you have some of the automation components in place, look for ways to link them into a single stream that can shorten cycles. Not just integration between requirements, but continuous integration—linking to build, to defect tracking, to configuration management, and to release management. In this model, the handoffs and touch points happen seamlessly in the background.

- **Get vendors on board.** The opportunity to learn from and build on vendor successes in real-time DevOps is an important way to accelerate your own improvements. You may want to avoid outsourcing agreements with vendors who aren't using automation as an accelerator.

- **Make the leap to test-driven design—or even behavior-driven design.** Real-time DevOps enables you to move from build-to-run to build-to-verify. This natural evolution leads to design for end-user engagement. That's where contractors and vendors that provide application development and maintenance (ADM) and/or application management services (AMS) can help you improve.

- **Look beyond cost and speed.** Embrace the lower costs and greater speed that come

with real-time DevOps, but recognize that more substantial benefits are also possible. If you believe that your technology delivery model can benefit from real-time DevOps, it's time to get teams delivering against your priorities with a much more compressed cadence.

- **Commit.** Too many companies dabble in this world—acquiring tools and adopting some of the terminology, but without making hard changes to their operating and delivery models. If there is a case for real-time DevOps, don't fall for one-off, surface-level investments. Or if you do, don't be surprised if you get unremarkable results.

## Bottom line

Individual tools for automating the software development lifecycle, maintenance, and monitoring have been available for years, and many companies have been taking advantage of them effectively. Yet few have taken the next step to integrate the pieces and commit to a new cadence of development and operations. That's because the concept of real-time DevOps is only partially understood. In a recent survey, Gartner "found that only one-third of companies surveyed were either in-process or planning to implement DevOps, and close to 44 percent of respondents were still trying to figure out what DevOps means."[4]

Early adopters have the opportunity to profoundly improve their IT shops—accelerating IT delivery, improving quality, and better aligning with their businesses. Arm IT with the tools to automate and integrate their core disciplines, and the cobbler's children will finally have new shoes.

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# Endnotes

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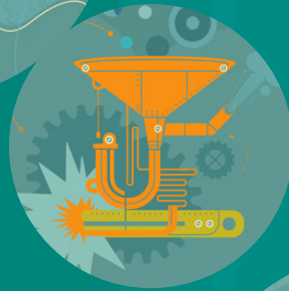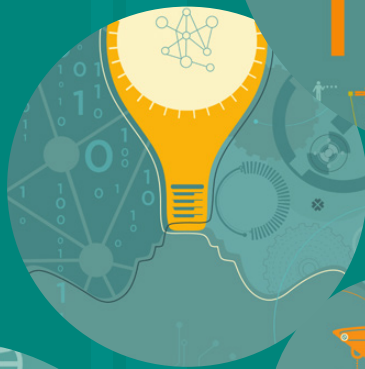
# Exponentials

## One more thing . . .

**E**ACH year, this report analyzes trends in technology put to business use. To be included, a topic should clearly demonstrate its potential to impact businesses in the next 18 to 24 months. We also require a handful of concrete examples that demonstrate how organizations have put the trend to work—either as early adoption of the concept or "bread crumbs" that point toward the fully realized opportunity. Our criteria for choosing trends keeps us on the practical side of provocative, as each trend is relevant today and exhibits clear, growing momentum. We encourage executives to explore these concepts and feed them into this year's planning cycle. Not every topic warrants immediate investment. However, enough have demonstrated potential impact to justify a deeper look.

Because we focus on the nearer-term horizon, our *Technology Trends* report typically only hints at broader disruptive technology forces. This year, in collaboration with leading researchers at Singularity University, we have added this section on "exponential" technologies, the core area of research and focus at Singularity University. The fields we chose to cover have far-reaching, transformative impact and represent the elemental advances that have formed technology trends both this year and in the past. In this section, we explore five exponentials with wide-ranging impact across geographies and industries: artificial intelligence, robotics, cyber security, additive manufacturing, and advanced computing.

In these pages we provide a high-level introduction to each exponential—a snapshot of what it is, where it comes from, and where it's going. Each exponential stems from many fields of study and torrents of research. Our goal is to drive awareness and inspire our readers to learn more. Many of these exponentials will likely create industry disruption in 24 months or more, but there can be competitive opportunities for early adoption. At a minimum, we feel executives can begin contemplating how their organizations can embrace exponentials to drive innovation. Exponentials represent unprecedented opportunities as well as existential threats. Don't get caught unaware—or unprepared.

# My take

**Peter H. Diamandis, MD**
**Co-founder and executive chairman, Singularity University**
**Chairman & CEO, XPRIZE Foundation**
**Author, *Abundance: The future is better than you think***

In 2012 the world experienced what I call "the new Kodak moment." A moment in time when an exponential technology put a linear thinking company out of business. Kodak, the company that invented the digital camera in 1976, and had grown to a 145,000-person,[1] 28-billion-dollar global company at its peak, ultimately filed for bankruptcy in 2012 as it was put out of business by the exponential technology of digital imagery. In stark contrast, another company—also in the digital imagery business—called Instagram, was acquired in that same year by Facebook for $1 billion. Instagram's headcount: 13 employees.

These moments are going to be the norm as exponentially thinking startups replace linear businesses with unprecedented products and services. Although a daunting challenge, exponential technologies offer extraordinary opportunities to the businesses that can keep pace with them.

The lessons learned from Kodak are the consequences of failing to keep up with what I call the "six Ds." The first D is digitization. Technology that becomes digitized hops on Moore's Law and begins its march up the exponential growth curve. Like many companies, Kodak was blindsided by the next D—deceptive growth. When a product, such as imagery, becomes digitized, it jumps from a linear path to an exponential trajectory. The challenge is that early exponential doublings are deceptive. The first Kodak digital camera was only 0.01 megapixels. Even though it was doubling every year, when you double 0.01, to 0.02, 0.04, 0.08, 0.16, this doubling of small numbers near zero looks to the mind like linear growth, and is dismissed. It's only when you continue forward past what is called the "knee of the curve" that it begins to change. Double seven times from "1" and you get to 128. Twenty-three more doublings (a total of 30) gets you to 1 billion. Business leaders often perceive the early stages as slow, linear progress. Until, of course, the trend hits the third D—disruption.

By the time a company's product or service is disrupted, it is difficult to catch up. Disruptive growth ultimately leads to the last three Ds—dematerialization, demonetization, and democratization, which can fundamentally change the market. The smartphone in your pocket has *dematerialized* many physical products by providing their virtual equivalents—a GPS receiver in your car, books, music, and even flashlights. Once these equivalents gain market traction, the established product's commercial value can plummet. It becomes *demonetized*. iTunes®,[2] for example, is impacting the value of record stores. eBay is doing the same to specialty retailers. Craigslist has stripped newspapers of classified advertising revenue. Once products become dematerialized and demonetized, they become *democratized*—spreading around the world through the billions of connected devices we carry around.

Many business leaders confront exponentials with a stress mindset. They realize that the odds of survival aren't great. Babson College noted that 40 percent of the Fortune 500 companies in 2000 didn't exist 10 years later.[3] However, the other side of the coin is an abundance mindset—awareness of the limitless opportunity. Between now and 2020, the world's population of digitally connected people will jump from two to five billion.[4] That growth will also add tens of trillions of dollars in economic value.

To land on the opportunity side of the coin and avoid shocks down the road, companies can take two immediate steps:

- **Conduct an impact assessment:** Identify the top five strengths that differentiate your company. Then look at which exponentials could potentially erode those strengths. Also look at the flip side. What are the top five pain points that exponentials could eliminate? How?

- **Evaluate the threat:** Determine how your company's products or services could be dematerialized or demonetized. Exploiting market adjacencies is a key part of the equation. Google, for example, is focusing on autonomous cars and Microsoft continues to make forays into gaming. The goal is to not only figure out who might disrupt your business's pond but whose pond your company can disrupt.

Your competition is no longer multinational powerhouses in China or India. Your competition now is the hyper-connected startup anywhere in the world that is using exponential technologies to dematerialize and demonetize your products and services. Someone in New York can upload a new idea into the cloud, where a kid in Mumbai builds on it and hands it off to a Bangladeshi company to handle production and marketing. Companies need to make sure their plans are in sync with this world and its dynamics.

Lastly, companies should consider their strategy in the context of leveraging two types of exponentials: First, pure exponential technologies such as artificial intelligence, synthetic biology, robotics, and 3D printing; and second, what I call "exponential crowd tools": crowdsourcing, crowdfunding, and prized-based competition incentive models. If companies then marry this portfolio of exponential assets with the understanding that today's grandest societal and planet challenges are also today's most promising commercial market opportunities, it can truly be a formula for abundance.

# Exponential snapshots

## Artificial intelligence

Computer science researchers have been studying Artificial Intelligence (AI) since John McCarthy introduced the term in 1955.[5] Defined loosely as the science of making intelligent machines, AI can cover a wide range of techniques, including machine learning, deep learning, probabilistic inference, neural network simulation, pattern analysis, decision trees and random forests, and others. For our purposes, we focus on how AI can simulate reasoning, develop knowledge, and allow computers to set and achieve goals.

The ubiquity and low-cost access to distributed and cloud computing have fueled the maturity of AI techniques. AI tools are becoming more powerful and simpler to use. This maturity is the first part of the story: how AI is becoming democratized and can be applied across industries, not just in areas such as credit card processing and trading desks, where AI has been gainfully employed for 45 years. The next part of the story focuses on our desire to augment and enhance human intelligence.

We are increasingly overwhelmed by the flood of data in our lives—1.8 zettabytes of information are being created annually.[6] But we are saddled with an ancient computing architecture that hasn't seen a major upgrade in more than 50,000 years: the brain. We suffer from cognitive biases and limitations that restrict the amount of information we can process and the complexity of calculations we can entertain. People are also susceptible to affectations and social perceptions that can muddy logic—anchoring on first impressions to confirm suspicions instead of testing divergent thinking.

AI can help solve specific challenges such as improving the accuracy of predictions, accelerating problem solving, and automating administrative tasks. The reality is that with the right techniques and training, many jobs can be automated. That automation is underway through many applications in several fields, including advanced manufacturing, self-driving vehicles, and self-regulating machines. In addition, the legal profession is availing itself of AI in everything from discovery to litigation support. DARPA is turning to AI to improve military air traffic control as automated, self-piloted aircraft threaten to overrun air-spaces. In health care, AI is being used in both triage and administrative policies. The world's first synthetic bacterium was created using AI techniques with sequencing.[7] Energy firms are using AI for micro-fossil exploration in deep oil preserves at the bottom of the ocean. AI can also be leveraged for situational assistance and logistics planning for military campaigns or mass relief programs. In sum, AI represents a shift, a move from computers as tools for executing tasks to a team member that helps guide thinking and can do work.

Despite these successes, many of today's efforts focus on specific, niche tasks where machine learning is combined with task and domain knowledge. When we add biologically inspired computing architectures, the ability to reason, infer, understand context, develop evolving conceptual models of cognitive systems, and perform many different flavors of tasks becomes attainable.

In the meantime, AI faces barriers to its widespread adoption. Recognize that in developed nations, its use may encounter obstacles, especially as labor organizations

fight its increased use and its potential to decrease employment. The ethics of AI are also rightly a focus of attention, including the need for safeguards, transparency, liability determination, and other guidelines and mechanisms that steer toward responsible adoption of AI. But these realities should not curb the willingness to explore. Companies should experiment and challenge assumptions by seeking out areas where seemingly unachievable productivity could positively disrupt their businesses.

*Inspired by lectures given by* **Neil Jacobstein**, *artificial intelligence and robotics co-chair, Singularity University*

Neil Jacobstein co-chairs the artificial intelligence and robotics track at Singularity University. He served as president of Singularity University from October 2010 to October 2011 and worked as a technical consultant on AI research for a variety of businesses and government agencies.

## Robotics

Mechanical devices that can perform both simple and complex tasks have been a pursuit of mankind for thousands of years. Artificial intelligence and exponential improvements in technology have fueled advances in modern robotics through tremendous power, a shrinking footprint, and plummeting costs. Sensors are a prime example. Those that guided the space shuttle in the 1970s were the size of foot lockers and cost approximately $200,000. Today, they are the size of a fingernail, cost about 10 cents, and are far more reliable.

Robotics is fundamentally changing the nature of work. Every job could potentially be affected—it's only a matter of when. Menial tasks were the early frontiers. Assembly lines, warehouses, and cargo bays have been enterprise beachheads of robotics. But that was only the beginning. Autonomous drones have become standard currency in militaries, first for surveillance and now with weapon payloads. Amazon fulfillment centers are

largely automated, with robots picking, packing, and shipping in more than 18 million square feet of warehouses.[8] The next frontier is tasks that involve gathering and interpreting data in real time. Eventually these tasks can be replaced by a machine, threatening entire job categories with obsolescence. Oxford Martin research predicts that 45 percent of US jobs will be automated in the next 20 years.[9]

On the not-so-distant horizon, for example, gastroenterologists won't need to perform colonoscopies. Patients will be able to ingest a pill-sized device with a camera that knows what to look for, photograph and, potentially, attack diseases or inject new DNA. Boston Dynamics is rolling out Big Dog, Bigger Dog, and Cheetah—robots that can carry cargo over uneven terrain in dangerous surroundings. Exoskeletons can create superhuman strength or restore motor functions in the disabled. Remote health care is coming. It will likely arrive first with robotics-assisted virtual consultation, followed by surgical robots that can interpret and translate a surgeon's hand movements into precise robotic movements thousands of miles away. Companies are also pursuing autonomous cars. Personal drone-based deliveries could disrupt retail. The limits are our imaginations—but not for long.

Robotics should be on many companies' radars, but businesses should expect workplace tension. To ease concerns, companies should target initial forays into repetitive, unpleasant work. Too often robotics is focused on tasks that people enjoy. Equally important, companies should prepare for the inevitable job losses. Enterprises should identify positions that aren't likely to exist in 10 years, and leverage attrition and training to prepare employees for new roles. The challenge for business—and society as a whole—is to drive job creation at the same time that technology is making many jobs redundant. Ideally, displaced resources can be deployed in roles requiring creativity and human interaction—a dimension technology can't replicate. Think of pharmacists. After as much as eight years of education, they spend the majority of their

time putting pills into bottles and manually assessing complex drug interactions. When those functions are performed by robots, pharmacists can become more powerful partners to physicians by understanding a patient's individual situation and modifying drug regimens accordingly.

At the end of the day, there are two things robots can't help us with. The first is preservation of the human species, a concern more civic and philosophical than organizational. But the second is more practical—indefinable problems. For example, robots can't find life on Mars because we don't know what it might look like. Everything else is fair game. Be ready to open the pod bay doors of opportunity—before your competition does.

*Inspired by lectures given by* **Dan Barry**, *artificial intelligence and robotics co-chair, Singularity University*

Dan Barry is a former NASA astronaut and a veteran of three space flights, four spacewalks, and two trips to the International Space Station. He is a licensed physician and his research interests include robotics, signal processing with an emphasis on joint time-frequency methods, and human adaptation to extreme environments.

## Cyber security

A few hundred years ago, a robbery consisted primarily of a criminal and an individual victim—a highly personal endeavor with limited options for growth. The advent of railroads and banks provided opportunities to scale, allowing marauders to rob several hundred people in a single heist. Today, cyber criminals have achieved astonishing scale. They can attack millions of individuals at one time with limited risk and exposure.

The same technological advances and entrepreneurial acumen that are creating opportunities for business are also arming the world's criminals. Criminal organizations are employing an increasing number of highly educated hackers who find motivation in the challenges of cracking sophisticated cyber

security systems.[10] These entrepreneurial outlaws are a new crime paradigm that is reaching frightening levels of scale and efficiency.

A few examples illustrate the daunting landscape: Hackers are available for hire online and also sell software capable of committing their crimes. A few years ago, for example, INTERPOL caught a Brazilian crime syndicate selling DVD software that could steal customer identities and banking information. The purveyors guaranteed that 80 percent of the credit card numbers pilfered through the software would be valid. Its customers could also contact a call center for support.

Cyber criminals are also leveraging the crowd. Flash Robs, for example, are becoming a new craze where social media is used to bring individuals to a specific store to steal goods before police can arrive. Another crowdsourced crime looted $45 million from a pre-paid debit card network. Hackers removed the card limits. Thieves then bought debit cards for $10 and withdrew what they wanted. In just 10 hours, the crowd made more than 36,000 withdrawals in 27 countries.

What looms on the horizon is even more daunting. With the Internet of Things, every car, consumer appliance, and piece of office equipment could be linked and ready for hacking. As fingerprints become the standard means of authentication, biometrics will become a powerful source of ingenious theft.

The experience of the US Chamber of Commerce portends the future. The organization's photocopiers, like many, are equipped with hard drives that store printed documents. In the past, industrial criminals disguised as repairmen removed the devices. However, when the chamber installed thermostats connected to the Internet, hackers could breach the copiers. Officials only discovered the attack through a defect that inadvertently sent the hackers' documents to the copiers.

There are steps that companies can take to combat cybercrime. The first is to establish risk-prioritized controls that protect against

known and emerging threats while complying with standards and regulations. Companies should also identify which of their assets would likely attract criminals and assess the impact of a theft or breach. Organizations should then become vigilant and establish situation risk and threat awareness programs across the environment. Security and information event management capabilities can be enhanced and new functionality can be mined from tools including endpoint protection, vulnerability assessment/patch management, content monitoring, data loss prevention, intrusion prevention, and core network services. The final step is building resilience: the ability to handle critical incidents, quickly return to normal operations, and repair damage done to the business.

Companies can also turn to the crowd. Security professionals have knowledge that can help investigations and warn of potential threats. The legal environment is also important. Business leaders should advocate for laws and policies that seek to contain cybercrime and also avail themselves of resources provided by federal agencies.

Cybercrime is accelerating at an exponential pace. In the not-so-distant future, everything from our watches to the EKG monitors in hospitals will be connected to the Internet and ready to be hacked. Companies should be prepared to survive in an environment where these threats are commonplace.

*Inspired by lectures given by* **Marc Goodman**, *chair for policy, law, and ethics and global security advisor, Singularity University*

Marc Goodman is a global strategist, author, and consultant focused on the disruptive impact of advancing technologies on security, business, and international affairs. At Singularity University, he serves as the faculty chair for policy, law, and ethics and the global security advisor, examining the use of advanced science and technology to address humanity's grand challenges.

# Additive manufacturing

The technology that supports additive manufacturing, or 3D printing, is more than 30 years old. Its recent popularity has been fueled in part by patent expirations which are driving a wave of consumer-oriented printers. Prices have fallen, putting the technology within the reach of early adopters. 3D printing is democratizing the manufacturing process and bringing about a fundamental change in what we can design and what we can create.

But the story goes much deeper than hobbyists and desktop models. The cost of a 3D printer ranges from a few hundred to a few million dollars. The machines can print with hundreds of materials, including nylons, plastics, composites, fully dense metals, rubber-like materials, circuit boards, and even genetic tissue. Breakthroughs in speed, resolution, and reliability demonstrate potential not only for scale but also for unlocking new possibilities.

The real exponential impact, however, is in the simplicity of the supporting tools. They provide a means to digitize existing objects, customize and tweak open source designs, or create brand new designs based on structural and industrial engineering know-how. Intuitive, easy-to-use tools allow "things" to be created, manipulated, and shared.

In essence, 3D printing makes manufacturing complexity free of charge, allowing otherwise impossible designs to be realized. Objects are built one layer at a time, depositing material as small as 100 nanometers exactly where and when needed. Mechanical items with moving parts can be printed in one step—no assembly required. Interlocking structures mimicking nature's design laws are possible with nearly unlimited geometrical freedom—no tooling, set-ups, or change-overs. Moreover, objects can be built just in time when and where they are needed. The capability unlocks business performance in a highly sustainable manner by reducing inventory, freight, and waste. 3D printing's value is not limited to complex objects.

On-site creation of investment castings or construction molds can supplement traditional manufacturing techniques.

3D printing is not just for prototypes and mock-ups. Many sectors already use the technology for finished parts and products. The aerospace industry, for example, has led the charge on additive manufacturing. Jet engine parts such as manifolds require more than 20 pieces that are individually manufactured, installed, welded, grinded, and tested into a finished product. The 3D printed alternative is easier to build and service and also reduces overall system weight. Medical devices use 3D printing to customize and personalize everything from dental crowns to hearing aids to prosthetics.

The potential doesn't end there. More fantastical use cases are starting to become a reality, such as mass customization of consumer goods, including personalized products ranging from commodities to toys to fashion, with "print at home" purchase options. Even food printers are entering the market, starting with chocolates and other sugar and starch staples, but moving toward meats and other proteins. Organs, nerves, and bones could be fully printed from human tissue, transforming health care from clinical practice to part replacement—and even life extension. Leading thinkers are exploring self-organizing matter and materials with seemingly magical properties. One example is already here: a plane built of composites with the ability to morph and change shape, ending the need for traditional flaps and their associated hydraulic systems and controls.

The enterprise implications are many—and potentially profound. First, organizations should take an honest look at their supply chain and market offerings—and identify where the technology could enhance or replace these offerings. As we discussed in the *Digital engagement* chapter, intellectual property and rights issues will emerge, along with new paths to monetize and disrupt. Finally, business leaders should embrace the

democratized creativity the technology is unleashing. Companies can use 3D printing to drive faster product innovation cycles, especially where it can push the boundaries of possibilities based on materials science and manufacturing techniques.

*Inspired by lectures given by **Avi Reichental**, co-chair for nanotechnology and digital fabrication, Singularity University*

Avi Reichental currently serves as faculty co-chair of the additive manufacturing program at Singularity University. He has been the president and chief executive officer of 3D Systems since September 2003.

## Advanced computing

Advances in raw computing power and connectivity are frequently the building blocks of our annual tech trends report. Core lessons that have guided us through the Internet revolution remain true today, and are steering us toward exponential advances in the future of computing.

The first lesson is the importance of early adopters and how they personally and commercially kick-start industries and adoption. Early adopters have an insatiable demand for improvement and for the doubling of performance. Moore's Law forecasts how many transistors per dollar could be put onto a chip wafer. Engineering curiosity and scientific prowess have fueled many advances in the field. Nonetheless, to build growth and feed customer demand, companies continue to invest in seismic performance improvements because they know there is a demand for products that are twice as good.

The second lesson is an open, hackable ecosystem with a cost contract that encourages experimentation through its lack of incremental accounting for network usage. From the system kits of the PC revolution to the open source movement to today's Arduino and Raspberry Pi hobbyists, a culture of innovation and personal discovery is driving

advances in open groups instead of proprietary labs. Lessons and learnings are being shared that accelerate new discoveries.

The third lesson is that the magical ingredient of the Internet is not the technology of packet switching or transport protocols. The magic is that the network is necessarily "stupid," allowing for experimentation and new ideas to be explored on the edges without justifying financial viability on day one.

On the computing side, we are at a fascinating point in history. Rumblings about the end of Moore's Law are arguing the wrong point. True, chip manufacturers are reaching the theoretical limits of materials science and the laws of physics that allow an indefinite doubling of performance based on traditional architectures and manufacturing techniques. Even if we could pack in the transistors, the power requirements and heat profile pose unrealistic requirements. However, we have already seen a shift from measuring the performance of a single computer to multiple cores/processors on a single chip. We still see performance doubling at a given price point— not because the processor is twice as powerful, but because twice the number of processors are on a chip for the same price. We're now seeing advances in multidimensional chip architecture where three-dimensional designs are taking this trend to new extremes. Shifts to bio and quantum computing raise the stakes even further through the potential for exponential expansion of what is computationally possible. Research in the adjacent field of microelectromechanical systems (MEMS) and nanotech is redefining "hardware" in ways that can transform our world. However, like our modest forays into multi-core traditional architectures, operating

systems and software need to be rewritten to take advantage of advances in infrastructure. We're in the early days of this renaissance.

The network side is experiencing similar exponential advances. Technologies are being developed that offer potentially limitless bandwidth at nearly ubiquitous reach. Scientific and engineering breakthroughs include ultra-capacity fiber capable of more than 1 petabit per second[11] to heterogeneous networks of small cells (micro-, pico-, and femtocells[12]) to terahertz radiation[13] to balloon-powered broadband in rural and remote areas.[14]

Civic implications are profound, including the ability to provide education, employment, and life-changing utilities to the nearly five billion people without Internet access today. Commercially, the combination of computing and network advances enable investments in the Internet of Things and synthetic biology, fields that also have the ability to transform our world. Organizations should stay aware of these rapidly changing worlds and find ways to participate, harness, and advance early adoption and innovation at the edge. These lessons will likely hold true through this exponential revolution—and beyond.

*Inspired by lectures given by* **Brad Templeton**, *networks and computing chair, Singularity University*

Brad Templeton is a developer of and commentator on self-driving cars, software architect, board member of the Electronic Frontier Foundation, Internet entrepreneur, futurist lecturer, and writer and observer of cyberspace issues. He is noted as a speaker and writer covering copyright law, political and social issues related to computing and networks, and the emerging technology of automated transportation.

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