



A Consumer
Products
Perspective

Deloitte
University
Press

Tech Trends 2014

Inspiring Disruption

Contents

Introduction | 2

Disruptors

CIO as venture capitalist | 7

Cognitive analytics | 19

Industrialized crowdsourcing | 31

Digital engagement | 45

Wearables | 59

Enablers

Technical debt reversal | 73

Social activation | 85

Cloud orchestration | 95

In-memory revolution | 107

Real-time DevOps | 121

Exponentials | 133

Appendix | 145

Introduction

WELCOME 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 exponential technologies, working with Singularity University to 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.

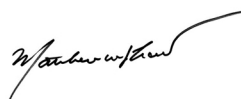
From a Consumer Products lens, we provided industry sector specific perspective on majority of the topics including CIO as a venture capitalist (how to leverage brand categories perspective for portfolio planning), crowdsourcing (specific strategies including crowdfunding, flexible workforce and data analysis contests), wearables (discussing the Empowered Employee and the Persistently Connected Consumer) and digital engagement (Omnichannel Brand Engagement, Ubiquitous Sensors and other topics).

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.



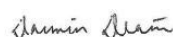
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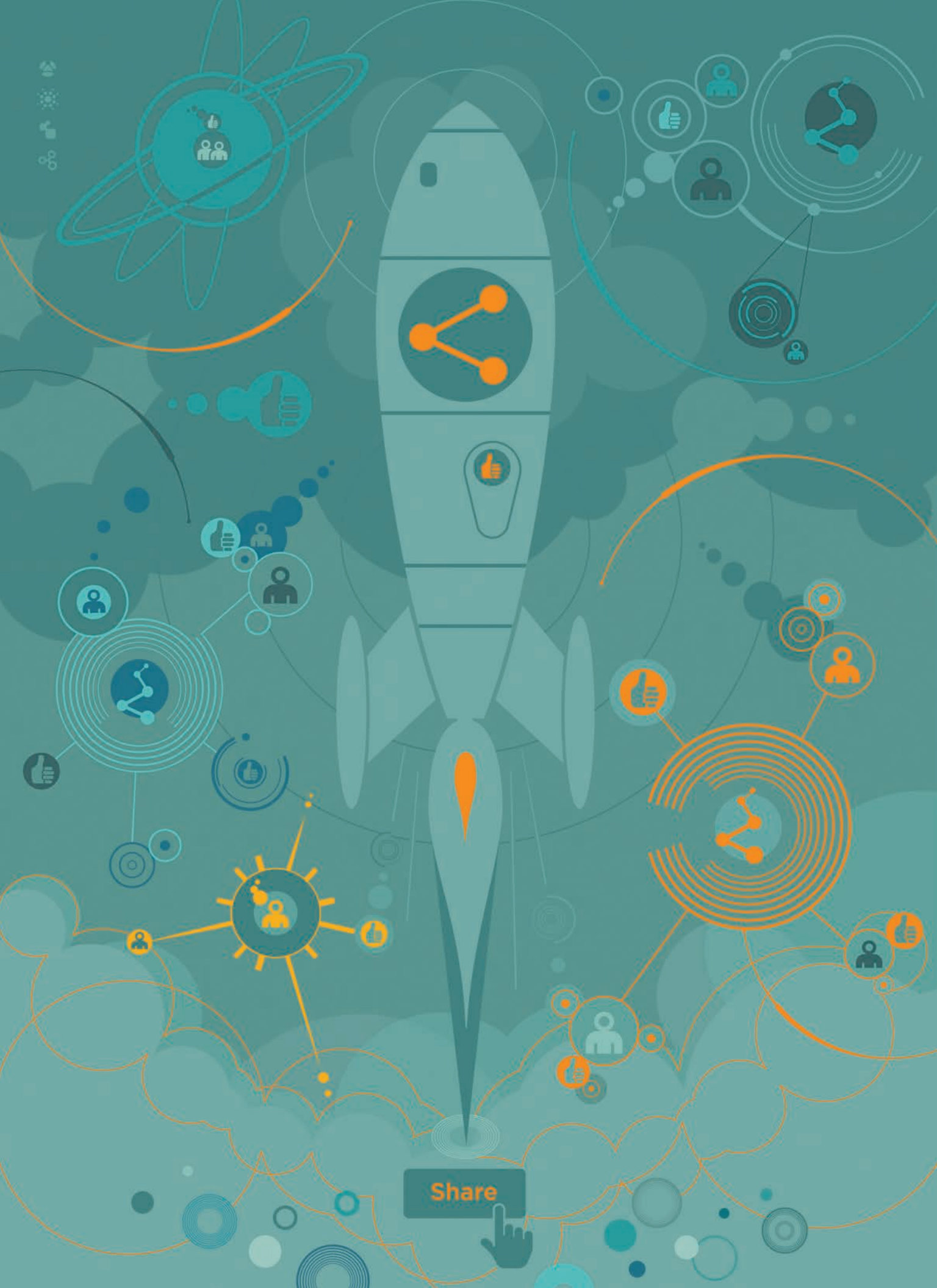


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Enablers



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

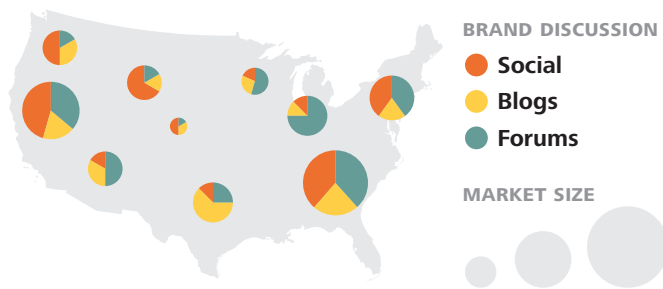
Social businesses³ ideally rally around well-defined business problems, supported by committed communities with well-defined incentives for participation. To take full advantage of this potential, age-old organizational constraints need to be identified and rewired. Hierarchies, biases, standardized 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

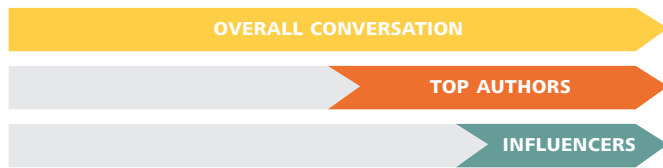
destination, commanding 27 percent of global time spent on the web.⁴ Not surprisingly, social monitoring and listening were some of the earlier investments companies made in the social arena. Social efforts leaned on the enabling tools that allowed passive data collection, tracking the volume of surface-level 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

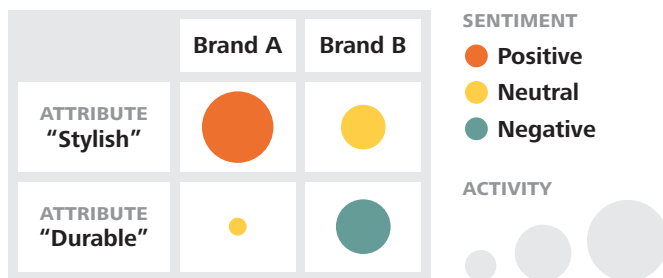
1 Focus: Map the audience



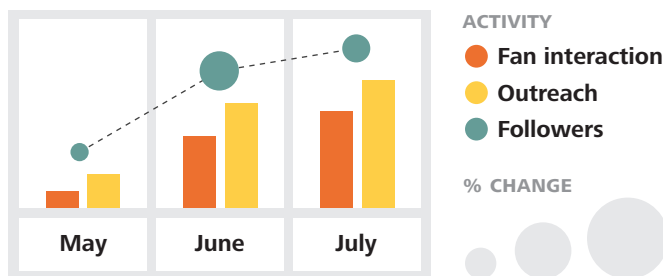
2 Insight: Identify influencers



3 Perception: Use brand analysis to identify target areas



4 Audience: Distribute content through advocates, enable audience contribution



5 Campaigns: Inject new energy



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?

THERE 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.

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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.

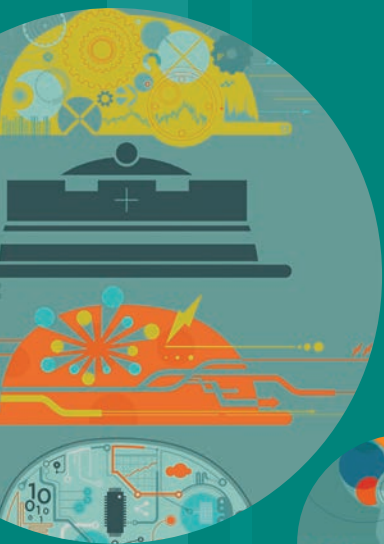


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Alicia Hatch is one of the leaders of Deloitte Digital's social offering. She joined Deloitte Digital in October 2013 with the acquisition of Banyan Branch, a leading social media agency where she led new business for the firm, introduced new strategic offerings, and built a broad client portfolio of Fortune 500 brands.

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Exponentials

One more thing . . .

EACH 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—undefinable 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 second¹¹ to heterogeneous networks of small cells (micro-, pico-, and femtocells¹²) to terahertz radiation¹³ 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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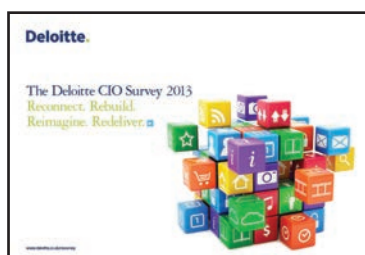
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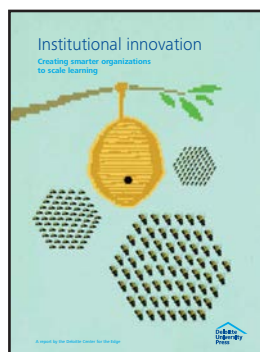
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