A Consumer Products Perspective

Tech Trends 2014

Inspiring Disruption

Deloitte University Press

Contents

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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Disruptors

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.

FOR 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

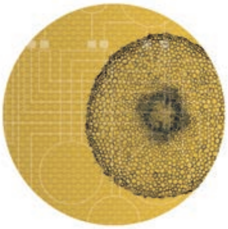
Alan Turing publishes *Computing Machinery and Intelligence*, in which he proposes what is now referred to as the Turing Test: an experiment that tests a machine's ability to exhibit intelligent human behavior.[1]

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]

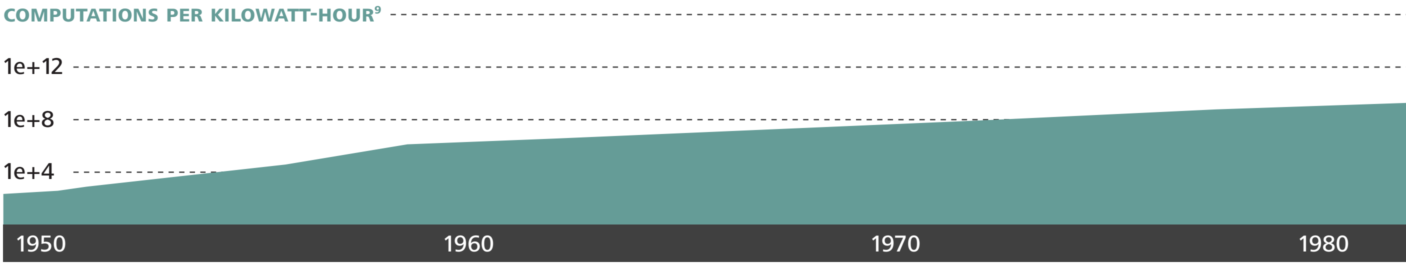
1972

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]



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

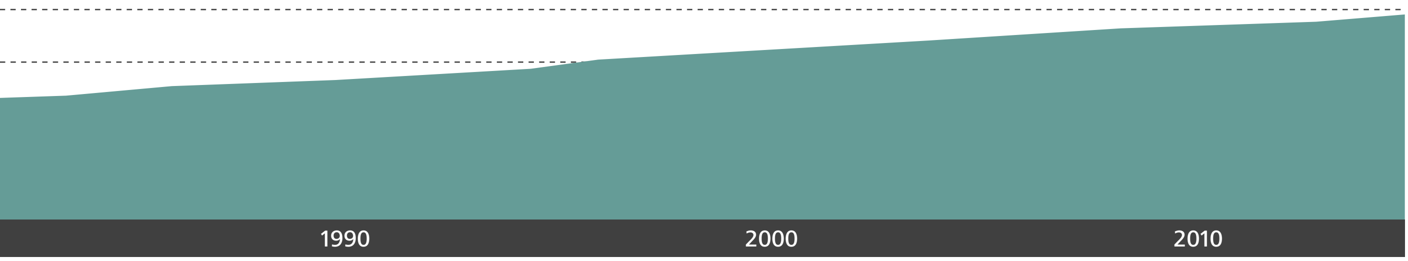
The High Performance Computing Revitalization Act sets requirements for the Secretary of Energy for the development of, capabilities for, and access to high-end computing systems for scientific and engineering applications.[6]

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]



[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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Endnotes

1. Sam Roweis, "Boltzmann machines," lecture notes, 1995, http://www.cs.nyu.edu/~roweis/notes/boltz.pdf, accessed December 19, 2013.
2. Andrew Carlson, Justin Betteridge, Bryan Kisiel, Burr Settles, Estevam R. Hruschka Jr., and Tom M. Mitchell, "Toward an architecture for never-ending language learning," http://www.cs.cmu.edu/~acarlson/papers/carlson-aaai10.pdf, accessed December 19, 2013.
3. *Tech Trends 2014* is an independent publication and has not been authorized, sponsored, or otherwise approved by Apple Inc.
4. Robert D. Hof, "Deep learning," *MIT Technology Review*, April 23, 2013, http://www.technologyreview.com/featuredstory/513696/deep-learning/, accessed December 19, 2013.
5. For more information on AI, see Deloitte Consulting LLP, *Tech Trends 2014: Inspiring disruption*, 2014, "Exponentials."
6. HP Autonomy, *Transitioning to a new era of human information,* 2013, http://www.autonomy.com/html/power/sem/index-human_information.html, accessed December 19, 2013.
7. Steven Hagan, "Big data, cloud computing, spatial databases," Geospatial World Forum, Amsterdam, The Netherlands, April 25, 2012.
8. Google, "How Google Now works (iOS app)," https://support.google.com/websearch/answer/2841497?hl=en, accessed January 7, 2014.
9. Utilization management is the case-by-case assessment of the appropriateness of medical services against evidence-based quality guidelines.
10. Paul Hoffman, "Cognitive computing," April 2013, slide 31, http://www.slideshare.net/paulhofmann/automation-of-cognitive-thinking-associative-memories-saffron-technologies, accessed January 7, 2014.
11. Saffron Technology, "Big data exchange conference," http://saffrontech.com/event/big-data-exchange-2013/, accessed January 7, 2014.
12. Saffron Technology, "All source intelligence for anticipatory sensemaking," http://saffrontech.com/wp-content/uploads/sites/4/2013/01/Saffron-Executive-Summary-2013.pdf, accessed January 7, 2014.
13. Saffron Technology, "Big data requires cognitive computing for model-free machine learning," September 18, 2013, http://saffrontech.com/2013/09/18/big-data-requires-cognitive-computing-for-model-free-machine-learning/, accessed January 7, 2014.
14. Deloitte Consulting LLP, *Tech Trends 2014: Inspiring disruption*, 2014, chapter 3.


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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

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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 microelectromechnical 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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Endnotes

1. Economist, "The last Kodak moment?," January 14, 2012, http://www.economist.com/node/21542796, accessed January 24, 2014.
2. *Tech Trends 2014* is an independent publication and has not been authorized, sponsored, or otherwise approved by Apple, Inc.
3. Babson College, "Welcome from the dean," http://www.babson.edu/program/graduate/Pages/dean-message.aspx, accessed January 24, 2014.
4. Doug Gross, "Google boss: Entire world will be online by 2020," *CNN*, April 15, 2013, http://www.cnn.com/2013/04/15/tech/web/eric-schmidt-internet/, accessed January 20, 2014.
5. Andrew Myers, "Stanford's John McCarthy, seminal figure of artificial intelligence, dies at 84," *Stanford News*, October 25, 2011, http://news.stanford.edu/news/2011/october/john-mccarthy-obit-102511.html, accessed January 24, 2014.
6. Lucas Mearian, "World's data will grow by 50X in next decade, IDC study predicts," *Computerworld*, June 28, 2011, http://www.computerworld.com/s/article/9217988/World_s_data_will_grow_by_50X_in_next_decade_IDC_study_predicts, accessed January 24, 2014.
7. J. Craig Venter Institute, *Venter Institute scientists create first synthetic bacterial genome*, January 24, 2008, http://www.jcvi.org/cms/research/%20projects/synthetic-bacterial-genome/press-release/, accessed January 24, 2014.
8. Singularity Hub, "An inside look into the Amazon.com warehouses (video)," April 28, 2011, http://singularityhub.com/2011/04/28/an-inside-look-into-the-amazon-com-warehouses-video/, accessed January 24, 2014.
9. Aviva Hope Rutkin, "Report suggests nearly half of US jobs are vulnerable to computerization," *MIT Technology Review,* September 12, 2013, http://www.technologyreview.com/view/519241/report-suggests-nearly-half-of-us-jobs-are-vulnerable-to-computerization/, accessed January 24, 2014.
10. Marc Goodman, "What business can learn from organized crime," *Harvard Business Review*, November 2011, http://hbr.org/2011/11/what-business-can-learn-from-organized-crime/ar/1, accessed January 24, 2014.
11. Phys.org, "One petabit per second fiber transmission over 50 km," http://phys.org/news/2012-09-petabit-fiber-transmission-km.html, accessed January 27, 2014.
12. Scott Reeves, "Pros and cons of using femtocells," *TechRepublic*, November 11, 2013, http://www.techrepublic.com/blog/data-center/pros-and-cons-of-using-femtocells/#., accessed January 24, 2014.
13. Tim Wogan, "New tuner could bring terahertz to the masses," *PhysicsWorld*, June 12, 2012, http://physicsworld.com/cws/article/news/2012/jun/12/new-tuner-could-bring-terahertz-to-the-masses, accessed January 24, 2014.
14. Google, Inc., "What is Project Loon?," http://www.google.com/loon/, accessed January 24, 2014.

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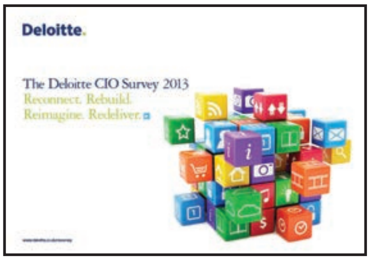

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