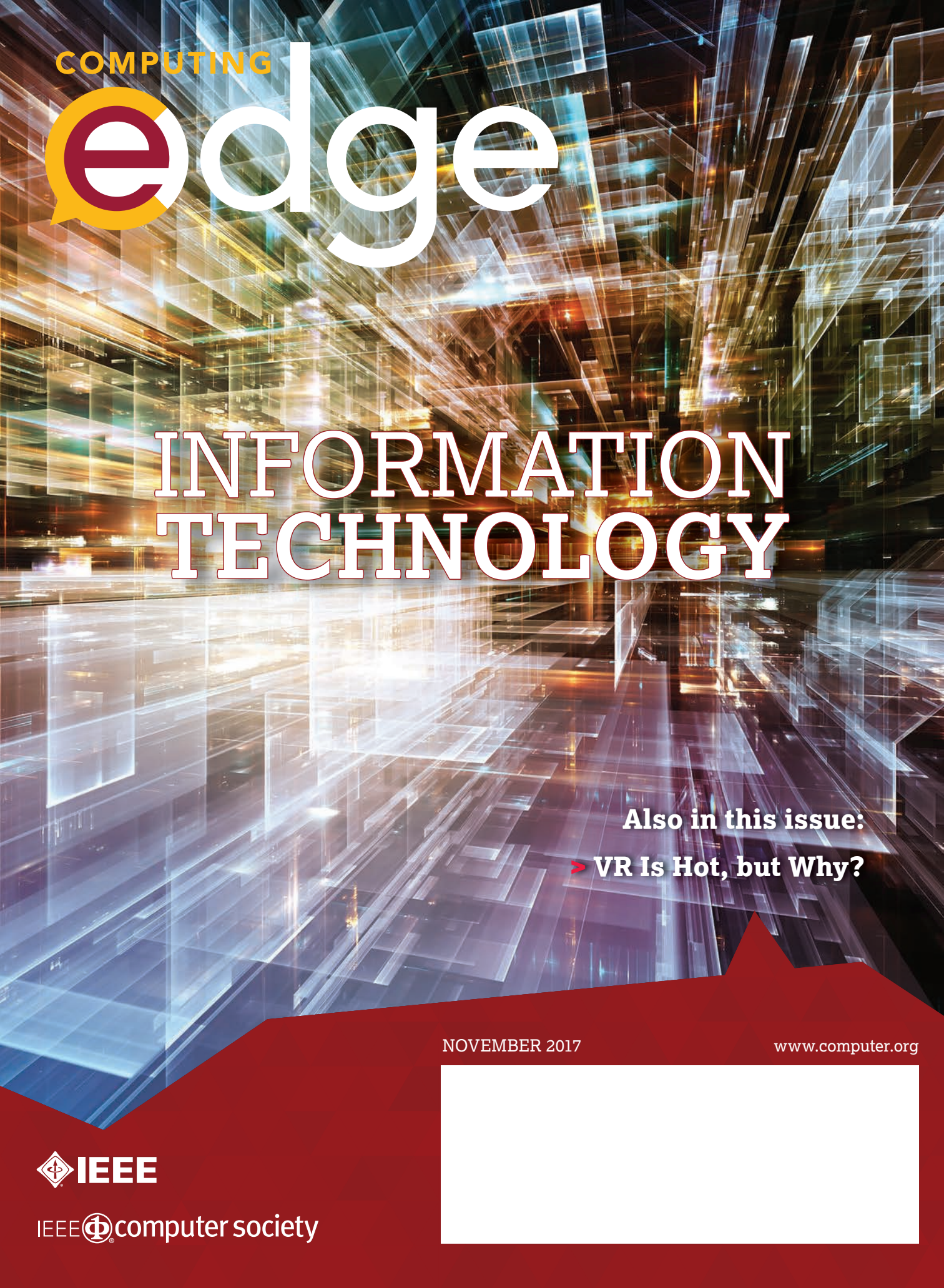

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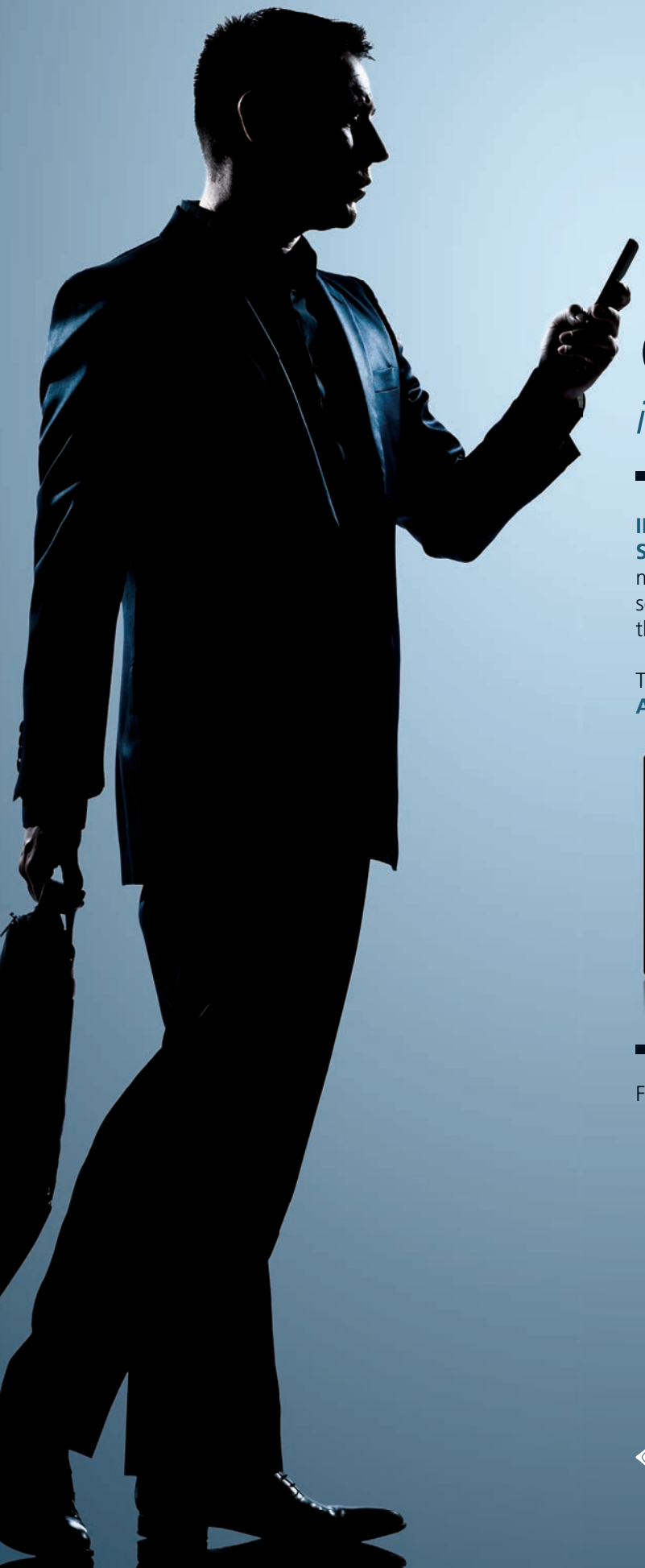

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COMPUTING edge

Departments

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The Role of the Chief Data Officer: Managing Expectations

Magazine Roundup

by Lori Cameron

The IEEE Computer Society's lineup of 13 peer-reviewed technical magazines covers cutting-edge topics ranging from software design and computer graphics to Internet computing and security, from scientific applications and machine intelligence to cloud migration and microchip design. Here are highlights from recent issues.

Computer

Theme Sections on Edge Computing and On-Skin Interfaces

Computer's October 2017 issue has theme sections on two topics: edge computing and on-skin interfaces. Edge computing is a new computing paradigm that places substantial computing and storage resources at the edge of the Internet, near mobile devices, sensors, end users, and Internet of Things devices. This proximity improves latency, bandwidth, trust, and survivability. The convergence of advances in electrical engineering and materials science has created opportunities for using the skin as an interactive device. The on-skin-interface theme section focuses on emerging input capabilities and design.

IEEE Annals of the History of Computing

The Spitting Image of a Woman Programmer: Changing Portrayals of Women in the American Computing Industry, 1958-1985

From the 1960s to the early 1980s, the percentage of the industry workforce that was female almost tripled. In his article "The Spitting Image of a Woman Programmer: Changing Portrayals of Women in the American Computing Industry, 1958-1985," from the April–June 2017 issue of *IEEE Annals*, William F. Vogel argues that the cultural climate of the industry toward hiring women shifted from hostility in the 1960s to one that was more open by the early 1980s. In his research, Vogel drew on a comprehensive study of articles and advertisements in the trade journal *Datamation*; information from sources at

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IBM, Control Data Corp., and Burroughs Corp.; and records of the SHARE Inc. usergroup.

Computing in Science & Engineering

Understanding the Solar Wind–Mars Interaction with Global Magnetohydrodynamic Modeling

For many years, scientists studying Mars have asked what happened to the planet's atmosphere and water. The key lies in understanding how solar wind plasma interacts with Mars' atmosphere. Scientists believe that Mars used to have a strong magnetic core holding its atmosphere together but that the low-density iron core has weakened over time. Now, scientists theorize, charged particles from Mars' upper atmosphere, feeling the pull of the electric field generated by the solar wind, pick up enough energy to escape into space and erode Mars' atmosphere. There have been challenges in testing this theory, mostly because of the wildly uneven distribution of Mars' crustal magnetic fields. "It's computationally challenging to properly model the Martian plasma environment due to the complex nature of the interaction," wrote Yingjuan Ma and her colleagues from UCLA and the University of Michigan in "Understanding the Solar Wind–Mars Interaction with Global Magnetohydrodynamic Modeling," from *CiSE*'s July/August 2017 issue. To address this challenge, Ma and her colleagues have included the effect of crustal fields in a multispecies, single-fluid magnetohydrodynamic model.

IEEE Cloud Computing

Orchestrating BigData Analysis Workflows

Data analytics not only has become an essential part of day-to-day decision making for many businesses and organizations, but it also affects their long-term strategic decisions. Whether it is real-time fraud detection, resource management, the tracking and prevention of disease outbreaks, natural-disaster management, or intelligent traffic management, the extraction and exploitation of insightful information from unparalleled quantities of data is now a fundamental part of many decision-making processes. Success in making smart decisions by analyzing data is possible due to the availability of improved analytical capabilities, increased access to different data sources, and cheaper and improved computing power in the form of cloud computing. However, data analysis is far more complicated than the perception that recent publicity has created, according to "Orchestrating BigData Analysis Workflows," from *IEEE Cloud Computing*'s May/June 2017 issue.

IEEE Computer Graphics & Applications

A Virtual Try-On System for Prescription Eyeglasses

While eyeglasses have improved the lives of millions of people, many wearers are painfully aware of how glasses make their eyes look. Nearsighted wearers' eyes appear smaller through the lenses, while farsighted wearers' eyes appear larger. The problem is "the traditional process of trying on and picking new eyeglasses in a brick-and-mortar shop has a significant shortcoming: eyeglasses on display are equipped with demo lenses that have zero corrective power and thus refraction does not deform the eyes," wrote Qian Zhang and her colleagues in "A Virtual Try-On System for Prescription Eyeglasses" from the July/August 2017 issue of *IEEE Computer Graphics & Applications*. Zhang and her team have developed a system to give users an accurate picture of how glasses will make them look.

IEEE Intelligent Systems

Sentiment Analysis in TripAdvisor

Data analysts who work in marketing are keenly interested in the opinions that consumers have of the products and services they buy. Analysts mine social media and other outlets for "sentiment analysis" and use that information to study which products and services people like and why they like them. Analysts use this information to develop better marketing campaigns. Researchers from the University of Granada, who have studied numerous web platforms, say TripAdvisor is a particularly valuable source for sentiment analysis. They discuss the system they developed in "Sentiment Analysis in TripAdvisor," from the July/August 2017 issue of *IEEE Intelligent Systems*.

IEEE Internet Computing

A Principles-Based Approach to Govern the IoT Ecosystem

The Internet of Things (IoT) has given us greater convenience and more personalized services such as Amazon's Alexa, Google's driverless car, and Fitbit's Flex. IoT is also increasingly being used in applications such as "energy management systems, industrial automation, and in management of urban facilities such as smart grids and smart traffic lights," write Virgilio A.F. Almeida, Benjamin Goh, and Danilo Doneda in their article "A Principles-Based Approach to Govern the IoT Ecosystem," from *IEEE Internet Computing*'s July/August 2017 issue. They say the difference between a good and bad IoT depends on society's ability to construct effective governance models. They propose a principles-based model.

IEEE Micro

Building Maze Solutions with Computational Dreaming

Computational dreaming is inspired by the massively parallel structure and dreaming process of the human brain. Computational dreaming examines previously observed input data during a "dream phase" while normal inputs are shut off. "Combining the virtually unbounded parallelism in the human brain with the need to sleep, we conclude that dreaming is a phase of exploration and optimization during which resources operate in nearly perfect parallelism and are optimized and subset for real-time, awake operation," write Scott M. Jackson and JoAnn M. Paul of Virginia Tech in their article "Building Maze Solutions with Computational Dreaming" from *IEEE Micro*'s July/August 2017 issue. The authors demonstrate that computational dreaming can develop a suitable problem-solving model from scratch during the dream phase and select it for use while awake. They developed a computational-dreaming simulator that solved 15 percent of mazes (ranging from small and simple to large and complex), compared to 2.2 percent solved by random model selection.

IEEE MultiMedia

Beyond 1 Million Nodes: A Crowdsourced Video Content Delivery Network

Fueled by the growth of ultra-high-definition video and Internet-capable portable devices, soaring video traffic is consuming massive amounts of network bandwidth. To alleviate traffic and improve service, some providers are offering users cash rewards to contribute their edge devices' available storage and bandwidth to help distribute video content to other users via a crowdsourced delivery network (CDN). In their article "Beyond 1 Million Nodes: A Crowdsourced Video Content Delivery Network" from the July–September 2017 issue of *IEEE MultiMedia*, researchers from Tsinghua University propose a set of practical strategies to guide CDN implementation and operation.

IEEE Pervasive Computing

An Interactive Telecare System Enhanced with IoT Technology

Tamkang University researchers have designed an interactive system enhanced by Internet of Things (IoT) technology that improves healthcare by enabling direct communication between patients' medical devices and caregivers' smartphones. "Telecare lets mobile devices confirm patient safety through automatic and remote monitoring," write Shih-Jung Wu and his colleagues in their article "An Interactive Telecare System Enhanced with IoT Technology" from *IEEE Pervasive Computing*'s July–September 2017 issue. Their system can remotely activate hardware components of medical devices in real time to access current information and smartphones via a telecare application. Overseas medical institutions have confirmed the system's significant potential value in chronic-illness treatment regimens.

IEEE Security & Privacy

Privacy? I Can't Even! Making a Case for User-Tailored Privacy

E-commerce, smartphones, and social networks provide numerous benefits but require users to disclose personal information and, in some cases, behavior-related activity such as purchases. Users solve the privacy-related concerns that this raises by, for example, providing only some of the requested information. "Past research has

shown that these privacy decisions are inherently difficult, and people aren't very good at them," writes Bart P. Knijnenburg of Clemson University in his article "Privacy? I Can't Even! Making a Case for User-Tailored Privacy," from *IEEE Security & Privacy*'s July/August 2017 issue. Knijnenburg proposes a user-tailored privacy approach that makes privacy decisions less burdensome by giving users the right kind of information and the right amount of control.

IEEE Software

Earned Business Value: See That You Deliver Value to Your Customer

The order in which a software development team puts its backlog items—its technical tasks—into effect determines when stakeholders can reap benefits from each piece of application functionality. This can substantially impact market timing, enterprise earnings, and a project manager's job security. Industry researchers have developed methods to express business value relative to cost in a company's backlog. In their article "Earned Business Value: See That You Deliver Value to Your Customer" from *IEEE Software*'s July/August 2017 issue, the authors discuss their system for accomplishing this.

IT Professional

Can Blockchain Strengthen the Internet of Things?

Blockchain—a distributed-ledger technology—has been described in the popular press as the next big thing. It is a data structure of cryptographically linked "blocks" of transactions that are virtually impossible to change or remove without being detected. The technology was originally developed for use with cryptocurrencies such as bitcoin. Researchers are now asking whether blockchain could also strengthen the Internet of Things (IoT). "Observers have noted that the blockchain–IoT combination is powerful and is set to transform many industries," wrote Nir Kshetri of the University of North Carolina at Greensboro in his article "Can Blockchain Strengthen the Internet of Things?" from *IT Pro*'s July/August 2017 issue. Kshetri highlights how blockchain-based solutions could be, in many aspects, superior to the current IoT ecosystem, which relies mainly on centralized cloud servers.

Computing Now

The Computing Now website (computingnow.computer.org) features up-to-the-minute computing news and blogs, along with articles ranging from peer-reviewed research to opinion pieces by industry leaders.

Today's Information Technology

Information technology (IT) is critical to the operations of most companies, government agencies, and other organizations today. In addition, many individuals use and depend on IT in their everyday lives. This *ComputingEdge* issue focuses on the state of IT today, the challenges it faces, and where it's heading.

The ability to understand and utilize IT's power, known as digital intelligence, is a critical skill for business and IT managers. "What Is Digital Intelligence?" from *IT Professional*, examines digital intelligence's evolution and describes how it requires an understanding of how to synchronize business and IT strategies and how to execute projects.

Computer's "Low Clearance Ahead: Can Predictable IT Crashes Be Avoided?" discusses the problems, some serious, that occur on the all-too-frequent occasions when organizations launch IT systems despite numerous warning signs that the systems are flawed.

The Open Science Cyber Risk Profile Working Group has created a document that demonstrates how improving scientific projects' IT security reduces the risks to researchers' results. This is addressed in "The Open Science Cyber Risk Profile: The Rosetta Stone for Open Science and Cybersecurity," from *IEEE Security & Privacy*.

IT efforts can address government corruption and inefficiency, but to do so, they must incorporate appropriate investments in reducing regulatory rigidity and strengthening institutions, notes *IEEE Internet Computing*'s "The Curious Case of e-Governance."

The author of "Improve IT, Improve Healthcare," from *Computer*, says that upgrading IT might not solve all healthcare problems but can improve quality and reduce preventable errors that harm patients.

Enterprises moving to the cloud tend to focus on the move itself and not enough on what they need when they get there, such as data integration. This is a potentially serious mistake, according to *IEEE Cloud Computing*'s "Cloud Computing Changes Data Integration Forever: What's Needed Right Now."

In "The Role of the Chief Data Officer: Managing Expectations," from *IT Professional*, the author reviews his interview with Citizens Bank chief data officer (CDO) Ursula Cottone. They discussed the benefits of having CDOs, the roles they play in organizations, and the challenges they face.

Computing in Science & Engineering's "VR Is Hot, but Why?" looks at the latest trends in virtual reality.

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What Is Digital Intelligence?

Sunil Mithas, *Robert H. Smith School of Business*
F. Warren McFarlan, *Harvard Business School*

Digital intelligence—the ability to understand and utilize the power of IT to our advantage, is becoming a critical skill for all managers in today's economy,[1] partly because of significant changes in the business environment in the last 50 years. The IT world has changed remarkably since the 1960s, when IT was largely a back-office function focused on automation and reducing costs, was not well integrated with business functions, and did not matter as much strategically.[2] Much IT work was done in-house at that time by IT departments, and there were few external service providers.

IT Evolution and Digital Intelligence

A lot has changed since then. Around 2010, upward of 50 percent of firms' capital spending was going to IT, compared to less than 10–15 percent back in the 1960s. IT matters a lot today because of its revenue role and strategic potential; it is much more integrated with business functions, with many more options for business and functional units to configure IT themselves rather than rely on an internal IT department. The Strategic Impact Grid, introduced by F. Warren McFarlan in 1983, has been a useful tool in assessing IT changes over time and preparing a firm to respond to them (see the "About the Strategic Impact Grid" sidebar).

Despite significant progress on the technology front since then and a manifold rise in the digitization of business operations, products, and services, many organizations fail to synchronize their IT and business strategies.[3] The tension between the standards and controls that IT departments champion and the fast responses that businesses need still remains. McFarlan's examples of companies such as William Carter, Li & Fung, Otis, Kodak, and Uber explain why digital intelligence should be a part of boardroom discussions in today's information economy.[4]

Digital intelligence is more than being able to work with computers or IT; it involves an understanding of how to synchronize business and IT strategies, govern IT, and execute IT projects and enterprise systems. We next discuss some key elements of digital intelligence to gain competitive advantage and sustain it in the rapidly changing digital age.

Synchronize Business and IT Strategies

Synchronizing business and IT strategies requires that managers envision IT, integrate IT with strategy, and explore new IT on a continuous basis. We prefer the word "synchronization" to "alignment" because alignment implies that either IT or strategy is preordained, whereas synchronization implies a continuous, two-way interaction between IT and strategy. In other words, synchronization better captures a mindset that is open to new possibilities enabled by technology and at the same time ensures that the use of IT is consistent with strategic needs.

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About the Strategic Impact Grid

The Strategic Impact Grid highlights the impact of IT on a firm's competitiveness.[1,2] The vertical dimension represents the firm's exposure to real losses as a result of IT vulnerabilities or security breaches. The horizontal dimension represents the overall impact of the firm's application development portfolio on its competitiveness (see Figure A). The grid can be used to illustrate how different firms, or parts of firms, are affected in different ways by IT. It can also facilitate a dialog among business and IT professionals regarding the position of the company as a whole or that of a firm's business units or IT applications. The grid was originally used to assist with IT planning efforts, and more recently its use was extended to shape IT governance and spending decisions at the board level.

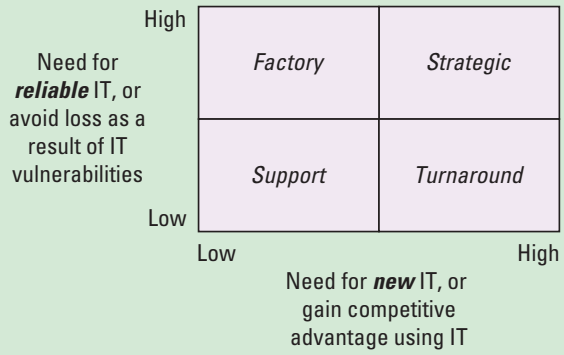

Figure A. McFarlan's Strategic Impact Grid.

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Envision IT

First, all managers need to have a vision for embracing IT's potential and realize that IT can have a significant—even make-or-break—impact on an organization. When we say "all managers," we refer to both business and IT managers. CEMEX, Zara, Capital One, and Amazon all demonstrate how IT and information-based capabilities helped firms create sustainable value in widely differing industries and ways. Conversely, companies such as FoxMeyer Drug, Blockbuster, and Borders had significant difficulties managing IT and dealing with IT-enabled transformations. Xerox's failure to capitalize on the innovations of its PARC lab demonstrates the importance of this point.

Integrate IT

Second, IT should be an integral part of any strategy discussion. It is the responsibility of senior leaders to develop inclusive but robust strategy development processes that are informed by the capabilities of IT but also stretch these capabilities for long-term organizational sustainability. Senior leaders must understand the duality inherent in IT before they can choose an appropriate digital business strategy and an offensive or defensive posture. The dualities of IT refers to the idea that technology can be both sustaining and disruptive; enable adaptation to and shape competition; provide new competitive advantages, even if such advantages are highly visible and replicable; enable aggregation (horizontally) and disaggregation (vertically); and create tremendous digital uncertainties even while providing tools to manage them. Leaders need to question their conventional strategy concepts, which focus on tradeoffs, because IT can, at times, help overcome these tradeoffs altogether. For example, IT can help firms pursue both revenue growth and cost reduction, or higher quality and lower costs—combinations that might not initially be visualized.

An easy way to understand IT's role in creating competitive advantage is to remember the acronym ADROIT. This acronym parses the value created by IT into six components:

- *Add revenues*. IT can help to add revenues through inorganic or organic means that might involve increasing sales to existing or new customers through existing or new channels by selling existing or new products.
- *Differentiate*. IT can help to differentiate or enhance nonprice attributes such as perceived quality or convenience that often increase customer satisfaction.
- *Reduce costs*. IT can help a company reduce its overall costs through selective outsourcing while also investing in internal capabilities. Benchmarking on IT costs alone can be

counterproductive if IT investments can help to reduce non-IT costs substantially.

- *Optimize risks*. IT can help to optimize risks (not necessarily reduce them). Managers must try to reduce downside risks from not investing in IT by engaging in counterfactual reasoning. One way to reduce downside risk is to split IT projects into must-do and may-do components and manage IT projects as having real options to resolve technical or market uncertainties. Managers should consider the effect of IT investments on intangibles such as customer satisfaction that can reduce downside or idiosyncratic risk.
- *Innovate*. IT can help firms pursue IT-embodied or IT-enabled innovations by making R&D more effective and scalable, and by using innovation from outside the firm, as Lego, P&G (through Connect + Develop), and SAP have tried to do.
- *Transform business models and processes*. IT can help transform business models and processes by replacing or complementing atoms with bits. Dealing with transformations requires that managers calibrate their response to the triggers that are causing transformation; protect their current revenue streams to the extent possible while finding ways to develop or grow new ones; and develop capabilities for dealing with change and transformation without being blinded by the rush to outsource key capabilities that might be necessary for future competitive advantage.

This acronym can help managers think about IT's role in a comprehensive manner to synchronize IT and strategy.

IT Pro Welcomes New Editorial Board Members

G.R. Gangadharan is an associate professor in the Institute for Development & Research in Banking Technology (IDRBT), Hyderabad, India. His research interests include energy informatics, cloud computing, and enterprise information systems. Gangadharan received a PhD degree in information and communication technology from the University of Trento, Italy. He is a senior member of IEEE and ACM. For further details, see http://www.idrbt.ac.in/grganga.html. Contact him at geeyaar@gmail.com.

Charalampos Z. Patrikakis is an associate professor in the Department of Electronics Engineering at Piraeus University of Applied Sciences. He has 20+ years' experience in international research projects, having participated in more than 32 national, European, and international programs, in 16 of which he has been involved as a technical/scientific coordinator or principal researcher. Patrikakis has more than 100 publications in book chapters, international journals, and conferences, and has two contributions to national legislation. He is a senior member of IEEE and a counselor of the IEEE student department at Piraeus University of Applied Sciences. Contact him at bpatr@puas.gr.

Explore New IT

Third, managers and entrepreneurs need to repeatedly scan new technologies to assess their significance and use them to stay relevant and transform their organizations. This should not be a one-time exercise; these actions should become part of a manager's routine because exploration of newer technologies can often facilitate new and more effective ways of doing business. Experimentation to gain insight into applications, technology, and change is key. To avoid making sense of newer technologies on an ongoing basis is to avoid change; this rarely pays off, as the failures of Kodak and Borders demonstrate.

Just scanning new technologies and recognizing their significance is not enough. Leadership matters when it comes to transforming organizations. Although frameworks or methodologies such as Baldrige Criteria, Design Thinking, or Agile can act as triggers, unless leaders empower organizations and monitor the progress made on these opportunities for improvement, they are unlikely to achieve success.

Transformations, whether technology-enabled or otherwise, need leadership, management continuity, rigor, discipline, and eschewing of the pursuit of management fads. Sustained performance requires persistence, the refining of technologies, and their integration with incentive systems and business processes to yield desired outcomes. More than relying on the charisma of leaders, organizations must focus on creating processes that focus on long-term

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thinking, where continuous improvement, scanning of newer technologies, and agile transformations to stay relevant become routine.

Govern IT

Fourth, formulating strategy is rarely enough; deployment is equally important. Successful deployment needs attention to the governance of IT decisions, departments, dollars, and delivery in a way that is synchronized with the company's strategy to avoid the "two-culture problem" that business and IT often struggle with. There are no simple solutions, and because of their structures, staff capabilities, and so on, different organizations will come to different answers regarding governance configuration. Not tackling governance issues in a systematic way or following through on them is an abdication of managerial responsibility because solid governance provides a platform for integrating various initiatives, just as an operating system allows a variety of applications to be built by leveraging a common platform. The governance failures at firms such as Blockbuster show that there's significant room for improvement in governance.

Execute IT

Fifth, IT projects need to be managed carefully, with attention to technology evolution, firm strategy, business processes, business value, and bottom-line benefit, while ensuring buy-in and business sponsorship whenever possible. It is the responsibility of business and IT managers to be aware of technology evolution, make informed decisions regarding technology upgrades, and understand how they should help to adopt, diffuse, and exploit IT systems. Managers must also understand what risk-management strategies they should adopt when it comes to implementing various enterprise projects consistent with their broader strategy.

Finally, it is not just IT systems, artificial intelligence, or big data that on their own can provide desirable business outcomes. Analytics and metrics matter; organizations suffer if they do not have metrics, but they also suffer if they focus on the wrong or narrow metrics to measure success. It is the job of managers to ask critical questions related to data definitions, do some upfront thinking about how the data will be analyzed and used to inform business decisions, and then ensure that, over time, such data-driven decision making becomes the norm.

In summary, managers need to care about IT because IT-induced technological advances affect most industries and functional areas. Smart managers can use IT as a lever to enhance their personal and professional competitive advantage. Because IT is so embedded with business processes and new initiatives, sooner or later, most managers will be involved in an IT project. Given how risky and important these projects are, we must invest the necessary effort to understand how to manage them to ensure success. Together, these are good reasons for managers to invest in their own digital intelligence and that of the people or organizations they supervise. IT

Acknowledgments

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Sunil Mithas *is a professor at the Robert H. Smith School of Business at the University of Maryland. His research interests include strategies for managing innovation and excellence for corporate transformation, focusing on the role of technology and other intangibles. Mithas is the author of the books* Digital Intelligence: What Every Smart Manager Must Have for Success in an Information Age *(Finerplanet, 2016) and* Dancing Elephants and Leaping Jaguars: How to Excel, Innovate, and Transform Your Organization the Tata Way *(2014). He is a member of* IT Professional*'s editorial board. Contact him at sunil.mithas@gmail.com.*

F. Warren McFarlan *is the Albert H. Gordon Professor Emeritus of Business Administration at the Harvard Business School. He currently teaches in several short Executive Education programs. McFarlan has had a significant role in introducing materials on management information systems to all major programs at the Harvard Business School since the first course on the subject was offered in 1962. Contact him at fmcfarlan@hbs.edu.*

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Low Clearance Ahead: Can Predictable IT Crashes Be Avoided?

Robert N. Charette, ITABHI Corporation

Knowingly launching a flawed IT system that could harm society's most vulnerable as collateral damage isn't just callous—it's administratively evil. Any IT professional should be ashamed to be part of such a project.

Just how many warnings are needed to prevent an accident? Apparently for many driving trucks and RVs under the Norfolk Southern–Gregson Street Overpass in Durham, North Carolina, multiple low-clearance signs, an LED warning sign, and flashing lights aren't enough. Since 2008, the 11-foot, 8-inch bridge—nicknamed the "Can Opener" for the numerous vehicle tops it has sheared off—has been the site of more than 110 height-related accidents.[1] Drivers who have slammed into the bridge routinely claim they never saw the warnings.[2]

Over the past several years, a steady stream of IT projects, especially in government, have similarly ignored multiple warnings not to launch and have ended up crashing into their own analogous can openers. In some cases, like the Canadian government's new C$309.5 million Phoenix payroll system that went live in February 2016, the costs of repairing the resulting wreckage are exceeding the costs of development.[3] Phoenix has for well over a year managed to botch the payments of more than 150,000 Canadian government workers, or about half.[4] As of the end of July 2017, there was still a backlog of some 228,000 improper payments needing to be sorted out.[5] Eliminating the backlog will take some time, since nearly as many new cases of improper payments are occurring as are being cleared up.

Canadian Prime Minister Justin Trudeau belatedly admitted that his government "didn't pay enough attention to the challenges and the warning signs on the transition we were overseeing."[6] After originally promising that the payroll system would be fixed by October 2016, the government is now expecting—or perhaps hoping—that Phoenix will rise from the ashes sometime in 2019.[7,8]

The Phoenix fiasco is by no means unique. For instance, who can forget the disastrous rollout of HealthCare.gov,

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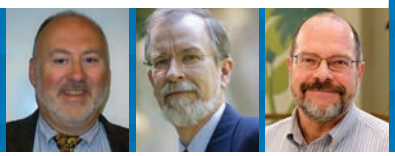
EDITORS
HAL BERGHEL University of Nevada, Las Vegas; hlb@computer.org
ROBERT N. CHARETTE ITABHI Corp.; rncharette@ieee.org
JOHN L. KING University of Michigan; jlking@umich.edu



the US government's health insurance exchange website, in October 2013, despite 18 well-documented warnings over the previous two years that the site wasn't ready?[9]

A perplexing question is why so many decision makers persist in launching an IT system even when (1) there are multiple warning signs that doing so is rash, and, (2) knowing that if the launch doesn't go well, thousands of vulnerable lives are going to be adversely impacted. Unsurprisingly, there's a kaleidoscope of programmatic, socioeconomic, and psychological reasons. Rare public insight into these causes can be found in a recent report by the auditor general of Ontario, Canada, Bonnie Lysyk, detailing the decisions by senior executives in the province's Ministry of Community and Social Services to prematurely launch its Social Assistance Management System (SAMS).[10] The report will make any true IT professional cringe.

A "PRETTY SEAMLESS ROLLOUT" TURNS UGLY

SAMS was launched 11 November 2014 without much fanfare, but within weeks became front-page news across Canada as major operational problems emerged. SAMS was a replacement for a case management system that had been in use since 2002 but was no longer fit for purpose.

The original plan was to roll out SAMS in March 2013, but the go-live date had to be postponed three times because of on-going functionality and reliability issues. Difficulties converting the existing case management system data into a format that SAMS could use were especially vexing. Having correct client-data conversion was obviously vital, as SAMS would be a "big bang" implementation—once it went live, the existing system would be shut off with no going back. The development problems encountered were reflected in escalating project costs, which rose from an initial C$202 million to C$242 million.

The final decision to launch SAMS was made in October 2014, with Ontario's Community and Social Services Minister, Helena Jaczek, confidently telling a provincial legislative committee a week before the launch, "I feel fairly confident that the new system will have a pretty seamless rollout."[11] However, once SAMS went live, it quickly became clear that its seams were unraveling. The vast majority of the 11,000 SAMS caseworkers complained that it was much more stressful to use than the case management system it replaced.[12] Malfunctions were so numerous that social services offices across Ontario lambasted SAMS, with some so frustrated that they even vainly called for it to be shut down until it was fixed.[13]

The ministry tried to downplay the difficulties, claiming that system bugs were being "eradicated quickly."[14] Yet, the technical problems continued to pile up well into 2015, forcing the ministry to commission an outside study focused on identifying ways to fix SAMS's "transitional issues."[15] In October 2015, Jaczek, in releasing the completed transition plan, admitted that some C$52 million had been spent so far on addressing the various problems with SAMS since its launch the previous year.[16] She insisted that only "small fixes" were now needed and that SAMS was "stable and doing the work it's intended to do."

However, the report on SAMS released by Auditor General Lysyk in December 2015 was far less hopeful. It noted that as of 31 July 2015, nine months after SAMS went live, there were still 771 outstanding defects, with many more yet to be identified. For instance, some 11,500 calls to the SAMS help desk hadn't been reviewed, and these calls typically identified where software defects were within the system. More troubling, the report noted, SAMS was fundamentally poorly designed, forcing caseworkers to spend more time struggling with the software than with helping clients. Operability would continue to be a sore point for both caseworkers and clients until the system's design flaws were addressed, for which there was no plan in sight.

A perplexing question is why so many decision makers persist in launching an IT system even when there are multiple warning signs that doing so is rash.

THE LAUNCH DECISION: RATIONALIZING AWAY THE RISKS

Ministry executives knew full well that their big-bang approach to rolling out SAMS was risky, the audit noted. To mitigate the risk, the project plan sensibly called for a thorough testing of SAMS prior to launch to ensure its functionality worked and the converted data was clean, as well as robust training of the caseworkers using the new system. The significant difficulties encountered after SAMS went live obviously showed that the risk mitigation plan failed.

Lysyk understandably wanted to know why the ministry's Executive Committee approved the SAMS launch.

The committee offered four reasons. First, the next available date to do so with minimal disruption was spring 2015, but this was also when contract negotiations were going to be held with the Ontario Public Service Employees Union, which represented many SAMS caseworkers. The rollout, therefore, would probably have to be delayed until those negotiations were completed, which might be summer. Second, the caseworkers were trained on SAMS in spring 2014, and any further delay would likely cause them to forget their training. Third, there was concern that after three aborted launches, any further holdups would make the project—which was costing C$20 million per quarter—vulnerable to being canceled outright and begun anew. Fourth, a risk assessment conducted a few weeks prior to launch recommended going live even with some known deficiencies.

Lysyk found this reasoning "overly optimistic," which is polite government-speak for delusional. Her conclusion is easy to understand given what the audit revealed about the astonishing true state of SAMS at its rollout.

As part of the pre-launch risk assessment, the SAMS project staff had developed a readiness-to-go-live scorecard consisting of 18 criteria against which to measure the system's current performance. The audit found that the committee decided to approve the launch even though SAMS met only one of those criteria. One criterion, for example, was for 100 percent of the test scenarios to be executed using converted data, yet none of these tests were actually performed.

In addition, the audit found that the committee knew 418 serious defects had been identified in SAMS. Workarounds existed for 217 of them but were unknown to the caseworkers, who had been trained on an incomplete version of the system. The committee regarded the other 201 existing defects, for which there no workarounds, as acceptable.

Furthermore, the audit discovered that the SAMS project team had failed to share important information with the committee prior to launch—namely, the discovery of another 319 serious defects—"because they had started developing solutions or fixes for them." The auditors were perplexed why this somehow made the defects exempt from disclosure. The project team also suggested it had performed more thorough SAMS testing using converted data, and uncovered far fewer problems, than it actually had. Nevertheless, the audit concluded, that didn't absolve the committee from its highly dubious decision to go forward with SAMS.

COULD THE BUNGLED SAMS LAUNCH HAVE BEEN PREVENTED?

In response to Lysyk's report, the ministry promised that on future IT projects it would "ensure that all information that is provided to decision makers will include a complete and accurate status of system readiness."[10] But would more information truly have prevented the SAMS launch? The odds are against it, given the programmatic, socioeconomic, and psychological issues involved.

After all, only three options were available to the committee when deciding whether to roll out SAMS that November: cancel, delay further, or launch. Canceling the project was clearly a nonstarter—the ministry had already committed too much time, financial resources, and political capital in SAMS to give up now. A fourth postponement also wasn't financially or politically palatable, as that would've meant explaining the reasons and in turn exposing the system's poor state of readiness to public scrutiny, no doubt leading to calls by the political opposition, media, and other critics for its cancellation. Delaying further was out of the question, therefore, unless there were ironclad technical reasons for not launching.

In fact, there was no defined technical "line in the sand" preventing SAMS from launching. The audit report states, for instance, that the "go-live criteria did not specify [the] overall acceptable number of serious defects." Instead, the Executive Committee was obviously willing to rationalize away the high number of defects and justify multiple launch criteria shortfalls without digging fully into what those shortfalls meant in terms of operational consequences.

Moreover, the programmatic environment wasn't conducive to actively managing risk. The audit took SAMS project managers to task for inadequately overseeing contractors, as well as taking positive internal reports at face value while resisting more circumspect views. For instance, an independent audit of the system's readiness was proposed a few months before the November go-live date, but project managers said it was unnecessary given the expertise of the contractors preparing for launch—expertise that had previously been found wanting.

Socioeconomic factors also influenced the committee's decision to launch prematurely, such as not wanting to pay for both SAMS development and continued operation of the current case management system, which in conjunction with cost overruns was devouring the C$5 million in promised annual savings from implementing SAMS.[17] In addition, the Ontario government's reputation was already severely tarnished by numerous other recent embarrassing IT project failures, like the C$1 billion eHeath fiasco, and it could ill afford yet another one.[18]

The audit report likewise depicts both SAMS project managers and the Executive Committee succumbing to several classic psychological decision traps including escalation of commitment, the sunk-cost fallacy, and confirmation bias.[19] Two in particular predominated.

The first decision trap was plan-continuation bias, also known as "get-there-itis," a fixation on accomplishing an objective regardless of warning signs to the contrary.[20] Just like drivers surprised after slamming

into Durham's "Can Opener Bridge," SAMS project teams and ministry officials didn't seem to register multiple red flags that SAMS was in trouble until it was too late.[21]

The second decision trap was what NASA Inspector General Paul Martin has dubbed "Hubble psychology": the belief by managers that even if a project isn't meeting its cost, schedule, or technical objectives, subsequent success will erase any memory of these earlier problems.[22] This happened with the Hubble space telescope, which was late and over budget and required a costly post-launch repair mission but is considered a spectacular success today. In SAMS's case, Hubble psychology was magnified by its being a "burn the ships" project. Once the system was launched, there was no going back: its shortfalls would have to be fixed, regardless of cost. As with Hubble, who would remember SAMS's deficiencies, especially given that few remembered those of its predecessor?

In such an environment, it's not surprising that the SAMS project team withheld critical launch information from the Executive Committee. And given that no one has ever been disciplined for unprofessional conduct, signaling the ministry's tacit approval that the ends justify the means, it'll likely recur in future IT projects.[23]

ARE THERE ANY REALISTIC SOLUTIONS?

The SAMS audit report, with minor edits, could easily describe most botched IT system launches, as well as highlight the same programmatic, socioeconomic, and psychological justifications. Consider, for instance, recent audit reports on the Los Angeles Unified School District's My Integrated Student Information System (MiSiS),[24] National Grid USA's New York gas companies' back-office support system,[25] and the Australian Queensland Health payroll system,[26] all of which ended up costing significantly more to fix than to develop despite multiple warnings that they wern't ready to go live. Although a full audit of the Phoenix payroll system has yet to be published, it would be highly surprising if the same factors weren't at play, including not learning from prior mistakes launching SAMS.[27]

In the commercial sector, the marketplace rapidly disciplines companies that launch their IT systems prematurely, as British utility Npower,[28] United Airlines,[29] and Avon in Canada,[30] among many other examples, have found out to their cost. The same can't be said of government IT systems. Those dependent on such systems must suffer the consequences of IT failure without recourse, unlike, say, airline customers who can chose another carrier. The SAMS audit report unambiguously documents that the costs of the system's poor performance on those who would be impacted didn't factor into the Executive Committee's launch decision.

In the commercial sector, the marketplace rapidly disciplines companies that launch their IT systems prematurely.

In writing about Hubble psychology at NASA, Inspector General Martin pointed out that warnings of trouble with a project are routinely ignored without much consequence to those managing it. He asserts that government agencies must find a way "to reward managers for good stewardship of [project] resources as enthusiastically as [they do] for successful technological achievements and to hold managers appropriately accountable for mismanagement of resources."[22]

Martin's recommendation is sensible but in practice very difficult to implement in government. NASA has yet to find a way to reward managers for not turning a blind eye to project risks, and decade-plus-long efforts by the UK government against overoptimism in IT projects haven't been encouraging.[31]

However, holding managers and executives accountable for mismanagement of IT project resources could be easier and ultimately more effective. For instance, why not make go/no-go criteria public, along with their ratings and who rated them, several weeks before a planned launch? It's hard to believe the Executive Committee would have approved the SAMS rollout if the project managers had had to defend in a public hearing the absence of prelaunch test scenarios. As distressing audit report after audit report has shown, keeping such criteria and their status hidden from view until an ex post facto accounting isn't an effective deterrent to poor decision making.

Government IT projects also must ditch green-yellow-red reports that measure progress against an imaginary plan for red-yellow-green reports that measure progress against an uncertain reality.[32] Project assessments should convey how well problems are being solved instead of encouraging deceitful assurance that the project is conforming to a plan everyone knows is and always has been flawed.

Finally, all costs, not just financial ones, of a botched launch must be accounted for and published. Proven metrics, such as quality-adjusted life years (QALYs), could be used to assess the potential impacts of an IT system rollout gone bad on those most affected.[33] Such impacts go beyond "inconvenient," a term used by Minister Jaczek when SAMS was badly floundering.[34]

Knowingly launching a flawed IT system that harms society's most vulnerable as collateral damage isn't just callous—it's administratively evil.[35] Any IT professional should be ashamed to be part of such a project.

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ROBERT N. CHARETTE, coeditor of the Aftershock column and founder of ITABHI Corporation, is an internationally acknowledged authority and pioneer in risk management, systems engineering, and the lean development and management of large-scale software-intensive systems. Contact him at rncharette@ieee.com.

The Open Science Cyber Risk Profile:

The Rosetta Stone for Open Science and Cybersecurity

Sean Peisert | Berkeley Lab
Von Welch | Indiana University

A common misconception—one often held even by scientists—is that open science is "open" by definition, so hackers wouldn't target it. The reality is that even open science is rarely *entirely* open at all times. For example, it can often be misleading to the public or even other researchers to publish raw data before it's been verified, validated, and interpreted. Beyond situations in which raw data is published almost immediately, there are certainly many circumstances in which raw data contains valuable intellectual property that could be at risk of theft—both domestically and internationally. Or data might contain personally identifiable information, such as during clinical drug trials.

Moreover, it would be a mistake to ignore security risks outside confidentiality, including integrity and availability. While scientists might not feel anyone wants to interfere with their results, any scientist developing or testing something of commercial value can certainly be at risk of having their work tampered with in a way that causes it to behave unpredictably or to make something look more or less successful than it actually is. Consider the possibilities of tampering with science related to politically sensitive subjects or public safety, such as meteorology or public health.

The reality is that, aside from the "why me?" question, the most important issue is really the "what if" question. Producing scientific results takes months or years of careful labor of many people using expensive and often unique instruments. These results, in turn, are often built upon by others, again over months, years, or even decades. While the scientific process has done a good job of finding errors and inaccuracies in science, there are steps to help this process with regard to errors owing to computer attacks. The goal is to mitigate errors from the outset, or at least spend less time and money to identify them after they do happen.

Bringing cybersecurity to bear on open science often presents both a culture clash and a knowledge gap. Cybersecurity professionals don't have much experience with rare, even unique, scientific instruments, and the sensitivities of their data, unlike say HIPAA (Health Insurance Portability and Accountability Act) regulatory data, aren't defined. Scientists, believing themselves to not be targets, will often see cybersecurity as simply administrative hindrances to their work. The result is that the application of cybersecurity to open science can be off target—an impediment to science and less than optimally effective.

The Open Science Cyber Risk Profile (OSCRP) aims to help improve IT security for open science projects—that is, science that's unclassified and often funded by US government agencies, such as the NSF, the Department of Energy's Office of Science, and the National Institutes of Health. The OSCRP working group has created a document that motivates scientists by demonstrating how improving their security posture reduces the risks to their science, and enables them to have a conversation with IT security professionals regarding those risks so that appropriate mitigations can be discussed.

Given all the potential risks, the OSCRP working group examined a variety of different types of scientific computing–related assets and divided them into key categories, including various types of

- data (for instance, public data, embargoed data, and internal data),

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- facilities (for instance, physical storage, power, and climate control),
- system and hardware assets (for instance, networks, front ends, servers, databases, and mobile devices),
- software assets (including both internal and third-party software),
- instruments (for instance, sensors or control systems), and
- intangible and human assets (ranging from project reputation to human staff to collaborative materials and financial assets).

Note that it's key that the working group focused on *assets*, which are things that a scientist knows and cares about, rather than specific *threat actors*, which are difficult for anyone to predict and whose motivations and tactics change over time (for example, the rise of ransomware over the past few years has greatly changed the threat landscape).

To accomplish this task, we assembled a group of security experts as well as domain scientists running large science projects, including particle physicists, oceanographers, genomic researchers, and more.

This group considered a set of common open science assets as well as how open science projects relied on each—and, hence, the risks associated with each asset's failures. We then mapped possible IT threats to these science risks. Scientists can use the OSCRP document to enumerate all the assets of importance and the risks each brings to their science mission. Using this information, they can prioritize the relevant IT threats. IT security professionals can then design and implement appropriate mitigations tuned specifically for the science risks, and scientists would understand the value of these mitigations.

It's our hope that this document helps scientists better understand reasons why they might be interested in pursuing further discussions with computer security experts and, conversely, help institutional community efforts best convey important messages to domain scientists about the risks to open science.

The OSCRP can be found at trustedci.github.io/OSCRP. It reflects an initial set of assets and the group's early valuation of those assets' risks. Over time, assets will change and so will risks; hence, we envision it as a living document that will evolve over time. To this end, we followed a NIST practice and used the popular GitHub source code repository to author the OSCRP. This allows for the public's submission of proposed additions, changes, and comments on the document. Note that the lists of assets and their risks are not comprehensive; more contributions in either of these areas are welcome. We've already received some great community feedback and hope for not just more feedback but a community sense of ownership.

Although open science is indeed open, it's not exempt from the risks of computer-related attacks, and there are cultural and technical challenges to applying current cybersecurity approaches. We hope the OSCRP serves to bridge the communication gap between scientists and IT security professionals and allows for the effective management of risks to open science caused by IT security threats. ■

Sean Peisert is a staff scientist at Lawrence Berkeley National Laboratory, chief cybersecurity strategist at CENIC, and an associate adjunct professor at UC Davis. Contact him at sppeisert@lbl.gov.

Von Welch is director of the Center for Applied Cybersecurity Research and the NSF Cybersecurity Center of Excellence at Indiana University. Contact him at vwelch@iu.edu.

Editor: Kamal Bhattacharya, kabhatta@gmail.com

The Curious Case of e-Governance

Kamal Bhattacharya • *iHub*

Tavneet Suri • *MIT Sloan School of Management*

A key role of government in developing economies is building institutions that support firms over their lifecycle. However, real politics creates immense regulatory rigidity. IT presents a tremendous opportunity to address corruption and efficiency, yet it must incorporate appropriate investments in reducing regulatory rigidity and strengthening institutions.

What makes a country *developed* or *developing*? Historically, the distinction has been between high-income countries (developed) and middle- and low-income countries (developing). Today, the World Bank classifies countries into four broad categories: high, upper-middle, lower-middle, and low income. Colloquially, we use developed versus developing all the time, as if there's a clear distinction. The notion of developed is a proxy statement for a high-income economy with a gross national income (GNI) per capita above US$12,475, where it's easy to live and do business. One signature of a high-income economy is its strength in developing efficient markets for the private sector to thrive, both locally and across borders. Developing countries are low- and middle-income economies that work off a lower capital base, and assuming political stability, tend to achieve significant returns from capital investments, leading to higher gross domestic product (GDP) growth.

Governments globally play an important role in ensuring market efficiency. How? First, they provide physical infrastructure, such as airports, bridges, and roads, which are essential to economic growth, especially in emerging markets. The World Bank estimates that the elasticity of GDP with respect to infrastructure capital is on the order of 1–2 percent for developed economies versus 15 percent for developing countries. This is exactly the high returns reaped by capital investments in low-resource environments. But, equally if not more important is the second role of governments: creating strong institutional infrastructure and norms. Government regulations support the entire lifecycle of businesses via this institutional infrastructure. It establishes appropriate regulations around key aspects of a firm's lifecycle – such as starting a business, acquiring property, and getting electricity all the way to trading across borders. One popular example, and probably the least disputed one, is the regulation of anticompetitive behavior. A competition authority uses a regulatory framework to determine if, for example, a company has engaged in behavior that purposely undermines another firm in the same market. In general, the more efficient the public sector agencies are at implementing regulations in support of essential business functions, the more that businesses can focus on their core activities. If only it were that easy ...

Delivering Public Goods

Imagine a situation where you want to buy your favorite sneakers online. You select the color and size you want, enter your payment details, and hit the "buy" button. The online vendor now sends the request to procurement, who verifies that the sneakers are in stock and requests a shipment from the warehouse to your address. The warehouse will bundle the shipments with the logistics provider so that you soon enjoy your new sneakers.

Now imagine a different process. The procurement representative calls you and verifies your

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payment details and your order. After verification, the agent will send you a signed procurement form to be co-signed by you. You are now kindly requested to drive to the warehouse and physically drop off the procurement form, co-signed, at an office, which will then take 24 hours to validate it. A day later you get a call that your shipment has gone out and will be delivered to a collection center. You are sent a shipment notification slip, which you will then take to the collection center, with an additional copy of the procurement form. Five days after the day of order, you eventually enjoy your new sneakers.

No enterprise in its sane mind would ever expose a client to such a process. The value-add provided by the seller is that the customer is exempted from all the back office processes. The imaginary example started with what is reality today, a one-click shopping experience that delivers your goods at the right time to the right place. A quick look at the government services that enable businesses, however, makes our imaginary "bad process" look efficient. You do not have to go as far as an African country that you know little about. Starting a business in Germany takes nine procedures, forcing a business owner to interact with more than five different organizations. Even though most other services in Germany are extremely efficient, there are more than 100 countries in the world more efficient than Germany in supporting new entrants to the private sector. This number is not an estimate, but there's proof, and we'll get to that shortly.

Process engineering and the use of IT to automate tedious, manual processes has led to tremendous efficiencies in business operations and client service. In fact, in developing markets, some enterprises have adopted a mobile-only approach to engage with their customer base. It's hard to argue that the emergence of "online at large" has not generated significant improvements in customer experience. If the private sector can do this, what's holding back the public sector?

Real Politics

A private sector enterprise makes up its own rules about how to engage its customer base and how to fulfill services. In an efficient market, an enterprise can decide to automate whatever it deems necessary to increase revenue or profit or both. Equally, private sector firms might decide against efficiency, as the cost of implementation might outweigh the benefits. In short, firms are focused on the customer segment they are serving. They are not concerned about public good.

A government, on the other hand, is elected to serve their citizens and represent national interests. Basic infrastructure as well as services provided under institutional infrastructure are public goods — that is, they must be provided so that no community gets disenfranchised. Governments do this by creating regulatory frameworks that get ratified in an appointed governance body, such as a parliament in most democracies.

It is entirely possible to create a widget that automates the process of starting a business, but it might violate the law. Changing the law to facilitate the deployment of the magic widget could require political will, as the process will likely cut across a variety of government stakeholders. Real politics might require a political stakeholder to engage in a give and take to push the agenda. We are not alluding to money changing hands, but more to members of government agencies trading favors to ultimately benefit their constituencies. Thereby, the question of delivering a public good ultimately becomes a question of personal incentives versus national interest. Reaching consensus requires many political transactions to be completed. This is real politics. And this is how almost all government systems work.

This sounds worse than it is. After all, the foundry of every functional democracy is to come to consensus on a variety of choices that ultimately benefit national interest. Unfortunately, decisions are often based on too little evidence, as generating evidence is costly. Hence, real politics are often less about evidence and more about opinion. Technology in general, and IT specifically, should be agnostic to opinion, but rather prove itself by improving efficiency.

The importance of efficient government services cannot be underestimated. Convoluted processes in economies with weak institutional infrastructure introduce exactly those systemic behaviors that are counterproductive to providing public goods. The weaker the institutional infrastructure and the more client touch points, the greater the opportunity to accelerate processes through bribery. Thereby, process efficiency is introduced for only those who have the means. In other words, providing an inefficient government service in support of delivering a public good might be counterproductive, as it disenfranchises those who either do not have the means or are morally inclined to not engage.

Corruption is an issue across all economies, but especially in emerging economies, it can be a hindrance to economic growth. It's unreasonable to believe that corruption can be fought overnight or that it just takes political will to eradicate it. It's far more complicated than that. However, looking at solutions to address corruption through the lens of efficiencies in institutional infrastructure could ultimately make it harder for corruption to succeed. Regulatory rigidity stands in the way of efficiency, as regulations are usually less prescriptive on inputs but more outcome-based. Every client touch point is prescribed and thereby non-negotiable at implementation time.

The perfect world, or the "consultant's dream," is one where the government describes the required outcomes and service-level agreements for the delivery as a mandate to the implementing

agencies. That is, the average waiting times for process *x* cannot be longer than *y*. The reality in government is not like that and there's work to be done to improve the institutional infrastructure, especially in emerging markets. However, before we can improve institutional infrastructures and reap regulatory efficiency, we need to know how to measure it in the first place.

Measuring the World's Regulatory Efficiency

The ease of doing business (EODB) index of the World Bank Doing Business project (www.doingbusiness.org) is one globally used measure of business regulations. Established in 2003, the index is a global ranking of countries, based on each country's performance on 11 indicators that measure the efficiency of service delivery processes and the strength of regulatory and judiciary institutions. Each of these indicators measures, from a client perspective, the efficiency of a part of the lifecycle for establishing and managing key functions of a business, from services as basic as starting a business to more complex functions such as trading across borders. For each of the 11 indicators, the index measures the time taken, the process steps, and (through sub-indices) regulatory strength. The client is assumed to be at least a small or medium enterprise with sufficient starting capital.

For example, the indicator "starting a business" measures the number of procedures needed to start a business, the time it takes to complete all the necessary procedures, and the cost associated with the process. "Enforcing contracts" measures the ability of the judicial system to resolve commercial disputes and includes the quality of judicial processes, in addition to the time to resolve disputes and the costs of resolution. The quality of judicial processes is a sub-index that, broadly speaking, categorizes the regulatory support provided to get disputes resolved expeditiously. For example, are there regulations dictating service-level agreements, is it possible to file an initial complaint electronically, and are judgments publicly gazetted? All of these measures are collected through surveys and the final index is translated into a relative rank.

How are low-income economies faring against high-income economies? Figure 1 is a visualization of all the indicators and total rank for two regions: high-income Organization for Economic Cooperation and Development (OECD) countries shown in blue and countries in sub-Saharan Africa shown in brown, the latter of which are almost all low-income economies. In general, the EODB rank correlates positively with GDP per capita, indicating that developed country governments are more efficient and exhibit better institutional strength than developing countries.

What Happened in Azerbaijan?

Chances are you have to look up Azerbaijan unless you are from the area. Azerbaijan is an upper-middle-income economy that has completed its post-Soviet-era transition into an industrialized oil- and gas-producing country. In terms of GDP, the country had double-digit growth, at times almost doubling GDP year to year during the oil boom 2003–2007 (see http://data.worldbank.org). As in many countries with oil, diversification of the economy is essential to continued growth. Azerbaijan had started to address issues with its ability to enable entrepreneurship. Figure 2 shows the time it takes to start a business against the number of procedures it requires in a given year. Between 2005 and 2006, the government of Azerbaijan reduced the time taken without reducing the number of procedures. Reduction of time is a matter of reducing process inefficiencies and might not necessarily require regulatory changes. The regulatory framework, however, sets a natural limit to what can be achieved without such regulatory changes and hence, pure process improvements are likely to have diminishing returns.

Between 2007 and 2008, we observed a reduction in the number of procedures. A procedure is typically a single implementation of a regulatory requirement. As government processes are spread over multiple agencies (think the Ministry of Tax, the Judiciary, and so on), the law dictates the rules by which each agency must support the process of starting a business. Changing the number of process steps thereby implies a regulatory reform, or as in the case of Azerbaijan, a presidential decree that mandated a one-stop shop for everything related to starting a business. However, this came on the heels of some already significant changes. Think about it as an organization just realizing that exposing the client to every backend decision might not be such a good idea after all, just as in our imaginary sneaker-buying example.

The one-stop shop approach has become quite popular in many countries. Instead of asking an entrepreneur to go to every single government agency and fill out a form specific to the agency and the regulation it is implementing, a client fills out one form, submits all relevant material to one window in a single, typically newly formed organization. This approach separates the client from the backend processing of a request.

The one-stop shop also has become a precursor to online registration. Azerbaijan, and other countries like it, have moved toward automation and online registration of businesses, thus minimizing the number of procedures. The benefit of using IT at this point is usually on the cost side. The cost of delivery will be marginal for an online system, as compared to setting up offices and requiring your clients to come to a physical office. This is the true benefit of IT. For example, many African countries are sparsely populated and establishing effective and accessible government services for people will be extremely costly. Mobile-delivered government services could lead to inclusion, just as mobile money

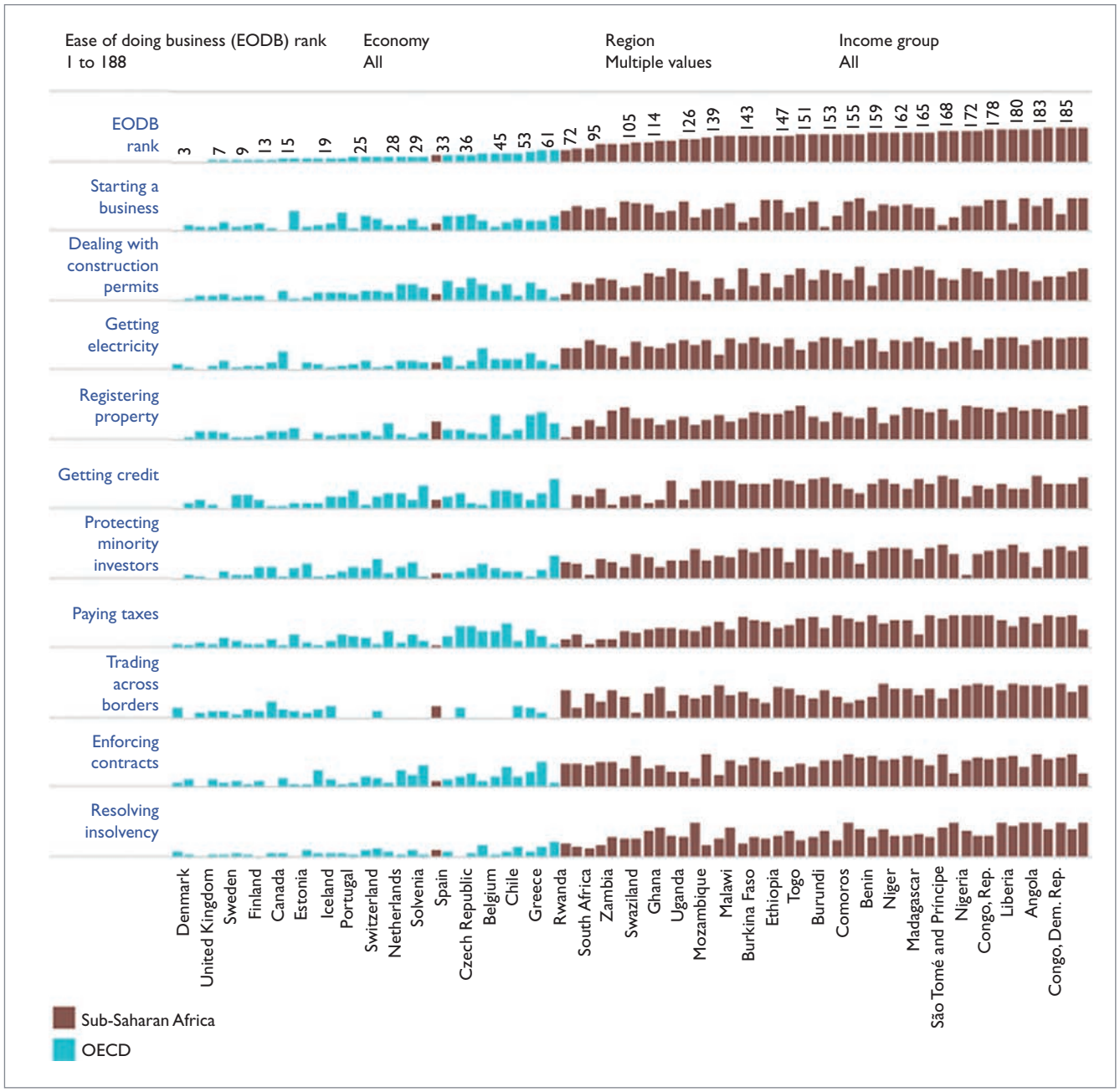

Figure 1. Visualization of ease of doing business (EODB) indicators comparing Organization for Economic Cooperation and Development (OECD) countries with sub-Saharan African Countries. (Source: http://blogs.worldbank.org/opendata/visualizing-world-business-regulations.)

has resulted in the financial inclusion of remote clients.

However, creating efficient institutional infrastructures does not necessarily guarantee the effects that someone desires. The incentives for the president of Azerbaijan in 2007 were clear. The end of the oil and gas boom was foreseeable and improving the business regulatory environment seemed an essential first step to diversifying the economy. That hasn't materialized yet; the country's GDP still depends predominantly on crude oil exports and has risen and fallen with the price of oil. Institutional infrastructure is necessary, but clearly it is not sufficient for economic growth. The latter requires the willingness of economic institutions to take the necessary steps toward diversification by, for example, providing support for entrepreneurs in areas outside of the core machinery.

The Importance of e-Governance

Azerbaijan is just one example of many economies that have improved

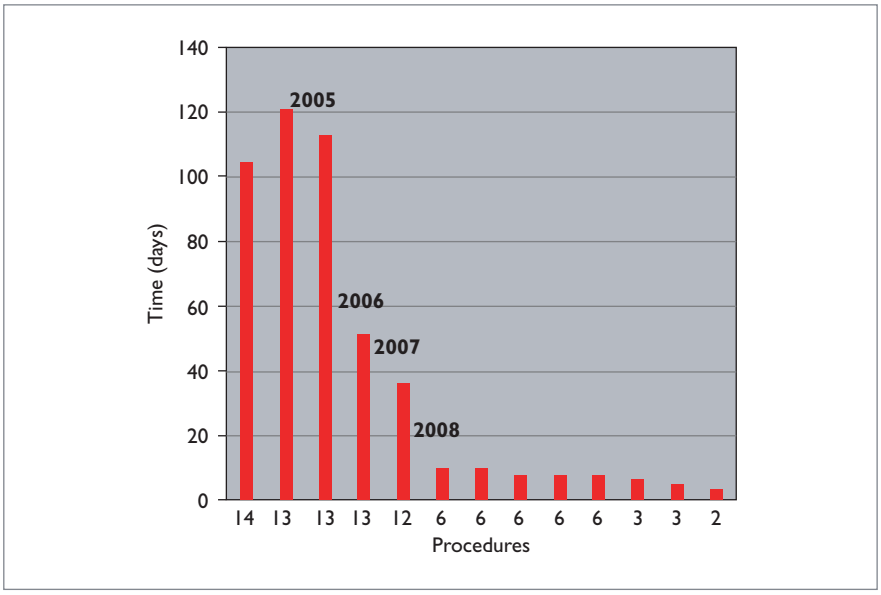

Figure 2. Time needed for completing the steps to start a business in Azerbaijan, given the number of procedures required. In the first part of Azerbaijan's transformation, the time to completion changed without changing the number of procedures. In 2007, the number of procedures were reduced significantly, implying regulatory changes to drive higher efficiency.

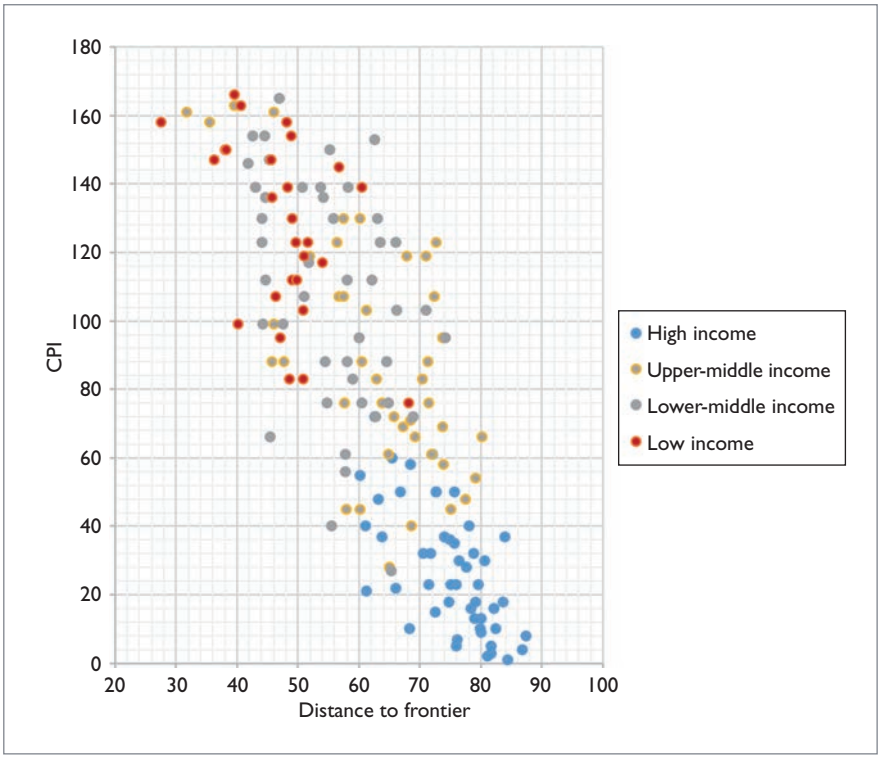

Figure 3. Corruption perception index (CPI) rank against the distance to frontier for a given country. A low CPI rank indicates a less-corrupt country. A lower distance to frontier implies weaker business regulations and a higher perception of being corrupt.

or are improving significantly. Most success stories today are of countries that were growing economically due to their resources or strategic position. A few African countries, such as Rwanda or Kenya, are starting to embark on the same path with significant, albeit initial, success. A presidential decree declaring what needs to be done, even if it is in a country's best interest, is not necessarily how most democratic nations work. The tedious process of consensus building is what often inhibits the timely completion of reforms. However, it builds one truly important part of the institutional infrastructure: the political process. Regardless of whether you think presidential interventions are efficient, the question is where do you draw the line? The EODB framework does at least provide guidance on where interventions might be necessary. For Azerbaijan, it did not happen overnight and, in fact, a number of improvements had already taken place to even make the decree useful.

Basic infrastructure is another important aspect that influences the strength of firms and is a part of the EODB indicators. For example, many developing economies face challenges in reliable energy distribution. These countries are limited in how much they can improve on the EODB rank when it comes to indices that include basic infrastructure measures. This ranking does not take into account that businesses in areas with unreliable energy supply find workarounds, such as diesel generators, uninterruptible power supply (UPS) systems, and so on. As with so many things in life, what starts out as a workaround often becomes the norm and part of the cost of doing business. That said, the EODB ranking sets the tone of the discussion around improvement and provides a way for economies to reason about progress.

Introducing e-government is not as much a technology challenge as one that requires patience and a strategic approach by first reducing process

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inefficiencies; second, driving regulatory change; and third, IT automation — in that order. Dropping the widget is not an option. The World Bank Doing Business project's index is very far from perfect, but it serves as a useful framework to set goals. The more developing economies strive toward improving their ranking by focusing on specific indicators, the better the institutional infrastructure becomes. The better the institutional infrastructure becomes, the fewer client touch points will be required. The more optimized the processes, the easier it will be to automate back offices and transform front office experiences through IT.

The more removed the citizen is from the delivery of government services, the harder it becomes to bribe and be asked for a bribe. IT can do its part in creating the right level of transparency. Figure 3 shows the corruption perception index (CPI) rank, released every year by Transparency.org, for a given country against the "distance to frontier" rating for the same country. Distance to frontier is a measure that describes the distance of any given country to a perfect EODB performer. A low CPI rank indicates a less-corrupt country. Being careful not to compare apples to oranges, it's fair to say that the trend indicates that high-income countries (blue dots) that have better institutional infrastructure tend to be perceived as less corrupt. A lower distance to frontier implies weaker business regulations and a higher perception of being corrupt.

Corruption is rampant in the developing world, and it is not only a government issue: as they say, it takes two (or more). It's also not only corruption at the highest level that holds economies back, but also the everyday corruption. Government processes might be inefficient, but a plethora of agencies may help a business for a small "administrative" fee. Fighting corruption quickly becomes personal, as "administrative" fees quickly become essential to people's livelihoods. Similarly, for processes that are more involved, especially when it comes to land rights, the exchange of bribes might become proportional to the value at stake.

Seeing Figure 3, a person might hypothesize that countries with better and more efficient business regulations are better prepared to fight corruption. Obviously, there are other factors that come into play in high-income economies — for example, pay structures in the government that allow people to live decent and secure lives and provide for their children.

The role of IT presents a bit of a conundrum for the industry. There is a tremendous focus on back-office automation with no doubt that this is required. Ensuring efficiency in the back office is an important step in the process to get significant transparency. The challenge, of course, is that back-office automations are usually large systemic transformations, which require skills to manage and maintain the infrastructure and applications. In emerging markets, these skills have yet to be developed. Skills are scarce, as those who have them vie for higher-paying jobs in the private sector. However, there is even less in the innovation space that targets government. In high-income economies, leading edge tech is often funded by the government and used for its own purposes. This is not the case for emerging markets.

The other challenge is that entrepreneurs tend to have less focus on innovation that could be relevant to governments. For example, there is tremendous scope for mobile-enabled, cloud-delivered innovations in the government sector for emerging markets, especially in countries that are geographically vast. The Blockchain could provide the necessary transparency in various government agencies beyond the boundaries of the government. This not only holds in the context of processes relevant to institutional infrastructure, but also beyond. We believe that independent of the regulatory challenges described in this article, there is always a way for IT to lead the way and put pressure on regulatory change.

Nevertheless, driving change in governments requires an appreciation for the complexity of government operations, the constraints posed by regulations, and the time to value for reaching consensus to overcome hurdles. This is true for all economies. Private sector business operations are distinctly different from running government operations. In developing economies, the complexities of everyday corruption make it even harder. We believe strongly in the power of IT to accelerate the creation of institutional infrastructure. However, the IT industry often falls prey to the "drop a widget" fallacy and needs to build in mechanisms to address regulatory rigidity as a first-class design principle. The IT industry frequently underestimates the challenges that new technologies pose from a regulatory perspective, as well as the immaturity of policy makers in emerging markets to understand how to act on new technology. There is no silver bullet, but IT is essential to institutional infrastructure and, thereby, to the equitable delivery of public goods in emerging markets.

Kamal Bhattacharya is the CEO of iHub, Nairobi and the Country Director of the International Growth Center, Kenya. His interests include entrepreneurship and policy research in emerging markets. Bhattacharya has a PhD in theoretical physics from Goettingen University, Germany. Contact him at kabhatta@gmail.com.

Tavneet Suri is an associate professor of applied economics at the MIT Sloan School of Management. Her interests include research in development economics, focusing on mobile money and agriculture. Suri has a PhD in economics from Yale University. Contact her at tavneet@mit.edu.

Improve IT, Improve Healthcare

Harold Thimbleby, Swansea University

While not a magical solution to healthcare problems, improving IT will improve quality and reduce preventable errors that cause patient harm.

Cars were dangerous in the 1960s, but thanks largely to Ralph Nader's powerful book *Unsafe at Any Speed*,[1] car safety has since improved dramatically. Nader's 1966 bestseller motivated changes in automotive safety legislation and a cultural shift in the industry from "drivers have accidents so safety isn't our problem" to "drivers have accidents so cars must be engineered to be safer." For instance, seat belts alone reduce the risk of front-seat deaths by 45 percent,[2] and automakers now invest in and promote many new technologies that make cars and driving safer.

A similar cultural transformation is required for health IT. We need at the least passive safety technologies—the equivalent of seat belts and air bags—to detect errors and limit their harm. Furthermore, we must promote designed-in safety, now integral to the automotive and aviation industries. We also need a lever to help effect this cultural shift—evidence-based labeling—to develop and evaluate IT in healthcare safety as rigorously as in other safety-critical areas.

HEALTH IT AS MAGIC

Healthcare is in trouble. Costs are rising, transparency is lacking, and care is often badly managed, resulting in unnecessary and harmful procedures. Many people enthusiastically promote health IT modernization as a means to magically eliminate these problems. Going paperless, using mobile medical devices and apps, leveraging big data and AI to gain new health insights—such changes, it's argued, will improve both efficiency and patient satisfaction.[3–5]

Unfortunately, just investing in "better" IT to improve healthcare oversimplifies some critical issues.

First, most highly successful companies built on cutting-edge IT like big data, cloud computing, and machine learning have very different business models than healthcare organizations. Everyone with an Amazon account, for example, follows a similar and fairly simple process—search for an item, make a payment, and track the order—that's ideally suited for automation. In contrast, healthcare is a complex, often messy process that requires all sorts of workarounds.[6] Patients also are much more diverse than consumers: nobody's medical history or treatment is the same. In these circumstances, IT might amplify, rather than simplify, a problem.

Second, the stakes are much higher in healthcare than in most other industries. If I make a mistake

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ordering something online or post a message I regret, it might cause some inconvenience but does no physical harm and is usually easily corrected. If a hospital makes a mistake, however, I could suffer irreparable harm or even die.

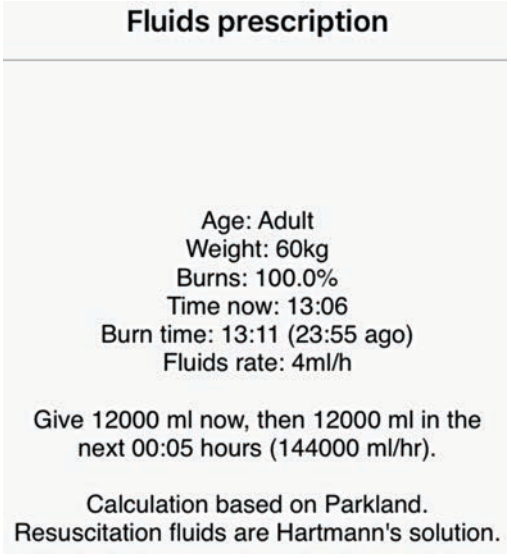
Third, when healthcare errors occur, we're often too quick to blame caregivers and not the IT system upon which they rely.[7,8] This unfortunate scapegoating is encouraged by typical health IT contracts that hold vendors harmless.[6] Consequently, many IT-related problems aren't addressed through, for example, needed software upgrades or policy changes, let alone avoiding them in the first place through proper design and careful procurement.

HEALTH IT AS A SOURCE OF ERROR

Human error is a major killer in healthcare. In hospitals, fatalities from preventable error are on a scale comparable to that of cancer and heart disease.[9] Reducing error will improve healthcare outcomes better than any medical intervention, including breakthrough treatments for diabetes and other deadly diseases. Unfortunately, stakeholders underestimate the frequency of errors and often don't recognize them until it's too late. Indeed, if we ever noticed errors before it was too late, we'd do our best to fix them!

But many errors result from system design flaws. In particular, errors in calculations—which are ubiquitous in healthcare—are a common source of preventable error. This might be somewhat surprising given that one of IT's main benefits is the ability to carry out a high volume of calculations quickly and more reliably than humans can, but when the stakes are as high as they are in healthcare, there's no room for error. The system must be extremely dependable—a wrong result could be the difference between life and death.

(a)



(b)

(c)

Figure 1. Examples of flawed medical device designs. (a) CareFusion's Alaris patient-controlled analgesia (PCA) modular syringe driver has a confusing display that makes it unclear how much drug the device is delivering. (b) Despite earning numerous awards and having CE marking, the Mersey Burns app recommends a dangerously high infusion rate of resuscitation fluids for burn victims; it miscalculates the burn time as well. (c) Many features of Abbott's XceedPro handheld blood glucometer, including its "lock-out technology," do not work as advertised.

Consider, for example, the delete function, which is designed to correct an input error but is often implemented incorrectly. Suppose that, on a calculator, you try entering 0.5 but accidentally enter an extra decimal point. To correct the error while typing, you press the delete key after the

second decimal point. However, the calculator interprets what you typed, 0 • • DEL 5, as 5—your "correction" has actually caused an error ten times higher than the intended number.

More generally, most medical devices fail to comply properly with the Institute for Safe Medication Practices' guidelines on number entry.[10] Astonishingly, this problem is widely ignored despite the potentially serious consequences.[11,12]

Figure 1 shows some typical examples of other often-overlooked medical device design problems. These examples were chosen to be easy to visualize, but unfortunately many other problems are complex and hard to visualize.[13]

Figure 1a shows the display area of CareFusion's Alaris patient-controlled analgesia (PCA) modular syringe driver. The device's fixed label is contradicted by the programmed display: is it delivering the drug at a rate of 9 mL/h or 9 mg/h? This dangerous confusion is the result of inadequate testing combined with poor programming practices.

Figure 1b is a screenshot from the award-winning Mersey Burns app, which is designed to calculate the amount of resuscitation fluids to give a burn patient. In this case, the recommended infusion rate is an average 144 L/h, after giving 12 L in the first 5 minutes. However, the initial infusion is much more than an adult's typical blood volume of 5 L.[12] This faulty calculation is due to poor programming and reveals inadequate (or no) sanity checking on the part of the designers. Nevertheless, Mersey Burns is self-certified CE marked, which means it can be used in the EU. Unfortunately, self-certification won't reveal developers' own blind spots. Clearly, the numerous awards Mersey Burns received didn't assess whether the app was well engineered.

Figure 1c is an Abbott XceedPro handheld blood glucometer, as used in hospitals. Abbott claims that it provides "lock-out technology" to help ensure compliance with mandated procedures for device use. However, as revealed in a much-publicized UK criminal trial of nurses accused of fabricating patient blood-glucose readings, this feature, among others, failed to work properly because the device was poorly programmed with no end-to-end checks. The court case highlighted IT management errors as well as problems with the device's design, as Abbott itself deleted critical data uploaded to a centralized system.[8]

Another example of health IT as a source of error is "alarm fatigue," which occurs when a system emits so many warnings or alarms that clinicians stop paying full attention to them. Not only can this lead to mistakes when critical alarms are ignored, it can also result in blame improperly being assigned to users rather than designers. Alarm fatigue can also waste staff resources: one UK study of 360,000 hours of infusion pump logs at a hospital found that 5 percent of infusion time was spent monitoring the system's alarms—a cost of about £1,000 per year per pump.[14] Alarm fatigue is often seen as a hospital, not a design, problem,[15] yet the root cause lies in manufacturers' lack of liability: it's easier to design a device to beep than to think of a solution.

These and other basic problems are surprisingly widespread. Poor system design induces and exacerbates errors that are then inadequately investigated, with doctors and nurses too often blamed for the consequences. When the causes of errors aren't properly identified as design flaws, patients, staff, and overall healthcare quality suffer.

Anyone familiar with modern software engineering and formal methods in particular knows that many IT problems are avoidable[16–18]—in fact, we've known this for decades.[19,20] The bottom line is that medical device manufacturers discount the importance of safe, dependable programming, and the best cure for this self-delusion is a liberal dose of formal methods.[21]

TRANSPARENCY BENEFITS

Health IT links together all stakeholders in the healthcare system including patients, caregivers, hospitals and clinics, insurers, device and drug manufacturers, and medical researchers. Improving IT is therefore the most efficient way to improve healthcare systems and processes and to reduce errors that cause harm. However, this requires transparency: we must be able to recognize an improvement before we can implement it. Without knowing all the facts, we might be easily seduced by IT solutions that promise magical results but that aren't truly effective.[4]

Healthcare critics like Eric Topol point out that lack of financial transparency leads to inefficiencies and high costs.[3] But also missing is transparency with regard to health IT quality and safety. Without safety transparency, there's little incentive for manufacturers to improve their devices or for hospitals and clinics to switch vendors. In fact, there are numerous contractual impediments to sharing information about device quality and safety.[6]

Nevertheless, many IT quality measures exist, and others can be specified for healthcare safety. For example, in my own research I've evaluated the safety of number-entry user interfaces—such as those that use a knob or pair of chevron keys to advance numbers as well as traditional numeric keypads—so that hospital and clinics could preferentially buy the safer products.[22,23]

EVIDENCE-BASED LABELING

Figure 2 shows a selection of consumer rating schemes from different industries about product quality and safety. None of these schemes impose any particular regulations or mandate how manufacturers should make their products. In the relatively transparent consumer market, the idea is to provide basic information about goods to consumers so that they can make more informed choices. This in

Figure 2. Examples of consumer rating schemes for product quality and safety: (a) UK Food Standards Agency food hygiene ratings; (b) EU tire label for fuel efficiency, wet grip, and noise; (c) EU energy efficiency label for most appliances, light bulbs, and vehicles; (d) European New Car Assessment Programme (Euro NCAP) safety ratings.

turn creates market pressure to make better products and can even result in new ratings to reflect market improvement. For example, EU energy efficiency ratings for most appliances, light bulbs, and even cars originally spanned from A (most efficient) to G (least efficient), but as Figure 2c indicates, improved energy efficiency has led to new official A+, A++, and A+++ ratings for many products.

Likewise, every health IT product should have a simple, visible quality/safety rating. Such ratings would empower patients to be more proactive in their own care: "I don't want to be hooked up to an infusion pump with such a low rating!" Clear labels would also motivate hospitals and clinics to purchase higher-quality goods to earn patient confidence and to attract new customers: "We use only AAA+++ certified medical devices." When errors do occur, visible device ratings would help ensure that potential system failure is properly considered. Over time, then, incidence reporting will increasingly highlight the role of system design in errors and the fact that caregivers aren't necessarily at fault.

Of course, health IT labeling assumes we know how to rate such products. It's

FURTHER READING

See the CHI+MED (Computer–Human Interaction for Medical Devices) project website (www.chi-med.ac.uk) for a manifesto, a large bibliography, many insights, and research results.

widely recognized in healthcare that all clinical interventions should be based on evidence, as they might have many different side effects for different patients. Health IT is no exception: ratings of medical device safety and quality must also be evidence-based, reflecting documented estimates of the risk of using such devices and the severity of potential side effects.

Although IT is often naively proposed as "the" solution to healthcare's problems, the reality is that improving health IT quality and safety is a long-term cultural and regulatory challenge that requires overcoming centuries of medical tradition and a lack of technological maturity. Today's medical device market isn't transparent, and hospitals and clinics can't choose safer systems even if they want to. At the same time, health IT vendors clearly aren't using modern software engineering techniques, let alone formal methods. These techniques are routine, indeed required, in the aviation industry and have produced very reliable software. Applying formal methods to health IT would likewise produce dramatic improvements in medical device and system software.

As a first step, unbiased system designers, medical and behavioral researchers, and computer scientists must work together to integrate modern software engineering techniques and computational thinking[24] with health IT practice. Ironically, despite calls for big data in healthcare, that's exactly what's lacking. We need better data on how health IT systems work, the protocols clinicians follow, and their impact on patient care. How many and which preventable errors are induced by poor IT? Why aren't accurate error logs routinely collected? What design innovations would minimize errors?

Just like prescription drugs, medical devices should be properly evaluated before they can enter the market. Once we have sufficient information to rate health IT systems for quality and safety, regulations are needed to mandate that all devices have easy-to-understand rating labels so that healthcare stakeholders can make more informed decisions.

Healthcare's problems aren't unsolvable; all that's needed is the right approach and a commitment to fix health IT and improve patient safety.

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HAROLD THIMBLEBY is a professor of computer science at Swansea University. Contact him at harold@thimbleby.net or visit www.harold.thimbleby.net.

Cloud Computing Changes Data Integration Forever: What's Needed Right Now

DAVID S. LINTHICUM

Cloud Technology Partners
david.linthicum@cloudtp.com

TWENY YEARS AFTER WRITING "ENTERPRISE APPLICATION INTEGRATION,"[1] DATA INTEGRATION IS STILL AN AFTERTHOUGHT WHEN IT COMES TO THE CLOUD DEPLOYMENTS I SEE. Enterprises moving to cloud tend to focus on the move itself, and not as much on what they need when they get there. While this may be a common practice, it's not a best practice.

Data integration is needed because we just re-hosted some of our data on a remote cloud service. Thus, the inventory system that's still running on a mainframe in the data center needs to share data with the sales order system that's now on Amazon Web Services (AWS). In other words, our data integration problem domain just got bigger and more complex.

Traditional approaches to data integration, including traditional data integration technology providers, are typically no longer a fit. Even data integration technologies that I've built in the past as Chief Technology Officer (CTO) would no longer be on my short list of data integration technologies that I would recommend. So, what are enterprises to do? Let's look at how we got here.

What's Changed?

Enterprise applications and the data landscape are undergoing dramatic change. The growth of the cloud, the dramatic rise in the value of Internet of Things (IoT) data, more empowered business users, and the increasing pace of business are all placing pressure on data and application integration.

New data from the Synergy Research Group shows that, across six key cloud services and infrastructure market segments, operator and vendor revenues for the four quarters ending September 2016 reached $148 billion.

This means that cloud has grown by 25 percent on an annualized basis. Infrastructure as a Service (IaaS) had the highest growth rate at 53 percent along with Platform as a Service (PaaS). Note that PaaS is a much smaller portion of that figure, and we've noted that it's declining. This is followed by hosted private cloud infrastructure services at 35 percent, and enterprise SaaS at 34 percent. What was most notable is that 2016 was a year in which spending on cloud services overtook spending on cloud infrastructure hardware and software. Aggregate cloud service markets are now growing three times more quickly than cloud infrastructure hardware and software (see Figure 1).

The forces that caused the change are now systemic. It's possible to define new criteria for data integration that was once not well understood.

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In this article, I'll take you through what I think is changing, and, more importantly, patterns that you need to address to make data integration a success within your cloud deployments.

New Patterns

In working with many of my cloud computing clients, I've come up with 8 new patterns, or requirements, that enterprises should consider when they approach data integration within cloud-based domains. They are:

- Support a Hybrid Cloud
- Support Big Data
- Centralized Integration Platform
- Ability to Empower End User
- No-Code Approaches
- Maximize Reuse
- Provide Security, Governance and Data Management
- Analytics and Predictive Intelligence

Support a hybrid cloud is the big one. Your data integration solution needs to support both on premises-based systems, perhaps traditional systems such as mainframes, as well as systems residing in public clouds. While they need to support private clouds as well, for the most part it will be a mix of traditional and cloud-based systems that make up your hybrid. I call these pragmatic hybrid clouds.

At issue is that the data moving from existing to cloud-based systems needs to be much lighter weight than traditional systems. As such, they need to support native Internet protocols such as TCP/IP.

If you think that's already built into most traditional systems, you're dead wrong. Either you redo your traditional systems to deal with systems on the open Internet, or you approach this by leveraging data integration technology that can mediate the differences. In other words, the technology must speak mainframe on one side, and REST-based APIs on the other.

So, the idea of hybrid within the world of data integration is the exchange of data between cloud-hosted and traditional systems, and doing so using a mediation layer within the data integration software. That software itself could be hosted on premises, or within a public cloud.

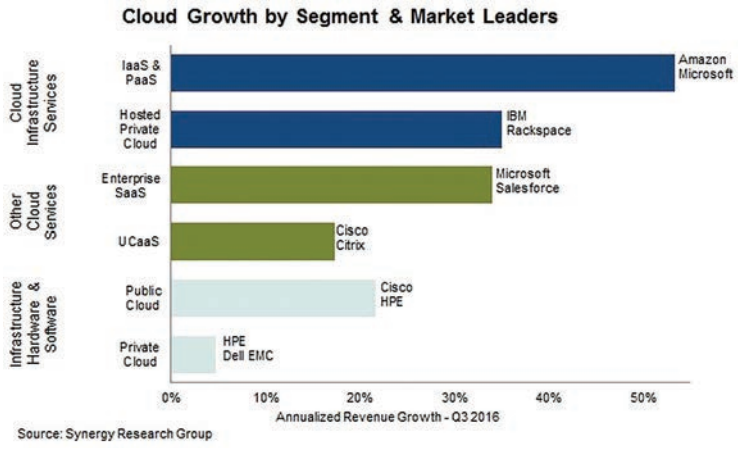

FIGURE 1. Over the period Q4 2015 to Q3 2016, total spending on hardware and software to build cloud infrastructure exceeded $65 billion, with spending on private clouds accounting for over half of the total, but spending on public cloud grew much more rapidly.

Support Big Data means that modern cloud-enabled data integration solutions need to support large volumes of data. This includes the ability to leverage the data where it rests, finding the meaning between silos using abstracted views.

What's changed is that the data needs to be seen in real time. Data warehousing and data marts are so 1995, where data analyzed was typically well over a month old. That type of latency is unacceptable in 2017.

These days, not only do you need access to data for analysis, but the ability to abstract both the data, as well as predictive metrics that can be placed within APIs, such as REST-ful Web Services. Using this approach, we can locate any piece of data, hosted on any system, at any time, for any reason, and placed in the proper context. The ability to leverage your own data in effective ways makes all the difference.

Centralized integration platform refers to an approach where we leverage data integration technology as a central hub. Hubs got a bad name in the post EAI days, as enterprises understood them to be limiting.

However, with the advent of cloud computing and cloud-based platform delivery, centralization is a smart choice. Those who leverage integration engines as a cloud service typically find that they can

Table 1. Important Attributes for Your Project.

Support a Hybrid Cloud	15%
Support Big Data	15%
Centralized Integration Platform	15%
Ability to Empower End User	15%
No-Code Approaches	10%
Maximize Reuse	10%
Provide Security, Governance and Data Management	10%
Analytics and Predictive Intelligence	10%
Sum	100%

place all of their integration logic, flows, adapters, etc., within a single abstract entity. Thus you don't deal with the complexities of a distributed integration architecture, which is difficult to manage and not as reliable.

Ability to empower end users. We no longer expect IT to do everything with data integration. Non-technical workers who exist in non-IT departments can leverage data integration as needed, when needed, using tools that are easy to understand and use.

An example would be somebody from the accounting department setting up feeds out of the sales system. These feeds would drive predictions as to sales for the next 10 to 100 days, and the accounting department can do this without the latency of dealing with IT, which once took months for them to meet a simple request such as this.

No-code approaches. This is the ability to leverage programmatic approaches to data integration without code. In the early days of data integration, all data integration occurred within one-off programs purpose-built for integrating data.

While moving to EAI engines made this much easier, in many cases, programming was still a requirement. This added cost, risk, and, again, added latency.

These days, when leveraging modern cloud-aware integration tools, we're taking more of a configuration approach to setting up integration flows. Thus code is basically non-existent.

Maximize reuse, which is related to the previous point. Now we can easily reuse things such as adapters, data flows, transformation routines, etc.. This requires automated mechanisms to discover components, understand the components, and leverage them within your own integration project. Moreover, we have the ability to check the updated components back into the repository for others to leverage as well.

Provide Security, Governance and Data Management means just that. Ensure that your data integration engines are secure, as well as controlled, using centralized policies that can be updated as needed.

Finally, analytics and predictive intelligence refers to the ability to make sense of the data in flight and at rest. We can understand the data that exists moving through the data integration engine, or at a source or target systems, and place that data in context, as well as create analytical abstractions.

For example, the ability for accounting to see sales data, and place that data within an analysis engine that can take an educated guess as to how the data will change over time, based upon existing patterns found in the data. Or, the ability to integrate external data sources, for example, the ability to mash up sales data with weather data to determine correlations.

Where to from Here?

Understanding the patterns laid out above, you need to determine which ones are important to you. For instance, perhaps it's a good idea to create a table such as Table 1 below. You should assign a percentage to attributes that are more important to your project than others.

Note that your problem domain will rank these very differently. However, the purpose of this exercise is to determine which things are more important than others.

We can also draw this as shown in figure 2.

Using this as a jumping off point you can begin to evaluate data integration technology providers. Essentially, rank what the provider brings to the table using the criteria we defined above. From there you should be able to determine a mathematical probability as to which data integration technology is likely to provide the best services for the requirements you've defined.

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THE PURPOSE OF THIS ARTICLE WAS NOT TO REDEFINE DATA INTEGRATION AS A TECHNOLOGY, BUT UNDERSTAND THAT DATA INTEGRATION IS CHANGING AND NEEDS TO CHANGE AROUND THE USE OF CLOUD-BASED SYSTEMS. Enterprises will still attempt to force fit their existing (legacy) integration technology. Although, that will be more of a square peg in a round hole.

As so many things that need to be changed, including security, governance, management, monitoring, etc., data integration is just something else to put on your list. But be aware that, out of all approaches and technologies that must change around the use of cloud computing, data integration is the most systemic.

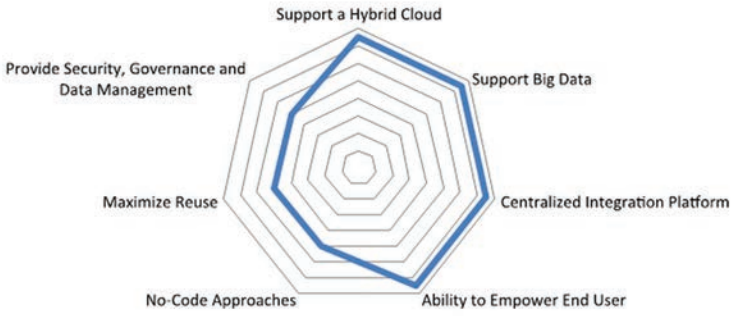

FIGURE 2. Using a spider diagram to understand the importance of each attribute.

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DAVID S. LINTHICUM *is senior vice president of Cloud Technology Partners. He's also Gigaom's research analyst and frequently writes for InfoWorld on deep technology subjects. His research interests include complex distributed systems, including cloud computing, data integration, service-oriented architecture, Internet of Things, and big data systems. Contact him at david@davidlinthicum.com.*

EDITOR: Seth Earley, Earley Information Science, seth@earley.com

The Role of the Chief Data Officer

Managing Expectations

Seth Earley, *Earley Information Science*

This article is one in a series that examines the evolving role of the *chief data officer* (CDO) and how the CDO interacts with other members of the C-suite. For this installment, I interviewed Ursula Cottone, CDO of Citizens Bank, about a journey that began not with data, but with people. We discussed how projects had to be justified not by direct ROI, but through understanding the process, transparency along the journey, and ongoing expectations management.

Why a CDO?

Cottone began at Citizens Bank in 2015, taking on the bank's new CDO role after having been the first CDO at her prior job. A long-time banking professional, she has held many roles throughout her career: she managed branches, was on the credit team, was part of the investment bank, and led a large-scale Siebel implementation for the enterprise from the business side. She acquired a deep knowledge of the banking business, and found that the technology side was more about understanding business requirements than it was about data or technical functionality.

Citizens Bank determined that a dedicated executive role was necessary, due to several factors. The bank was about to go public and had embarked on an enterprise data management plan a number of years earlier, but was finding it challenging to realize the expected benefits from technology investments. The business went through the pain of deploying new tools, but was not yet seeing the payoff. It became clear that the heavy technology focus of prior data programs needed to be adjusted to connect more strongly to business results. After engaging with a consultancy, the bank signed off on the recommendation to hire a CDO, whose mandate would be to get greater business value from data and technology investments.

The first step in any new environment is to get to know the enterprise's people and culture. "The initial relationship-building process is critical—understanding what people care about and how they do business," said Cottone. "It may seem that banking is the same across every bank, but it's not. There are cultural differences and process differences. The people make a huge difference."

Starting at the CEO

Understanding the needs of stakeholders took time. Cottone began meeting with the CEO and his direct reports—the heads of business units and critical functions. Some were chief operating officers for individual business lines. Some were heads of business lines—for example, the heads of everyday consumer banking, business banking, and wealth. She also met with CFOs and finance heads.

These meetings with top executives provided a high-level understanding of pains and priorities. Meeting with executives' direct reports provided an understanding of the needs of key influencers, operational executives, centers of innovation, and the people who were building value in the enterprise by finding gaps in capabilities and actively building new ways of serving customers and improving efficiencies.

Over a period of five to six months, Cottone met with more than 50 executives, and members of her team

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met with those people the executives recommended. As these discussions progressed, themes and issues emerged that were tracked along with the names and departments of stakeholders, the key takeaways, and people who were suggested for additional interviews.

While Cottone was gaining an understanding of people and issues, a parallel process was in progress to understand what the bank already had in place for managing enterprise data and the history of those tools, applications, and platforms. This technical review sought to determine what technologies had been built, what had been purchased, why they were purchased, who owned them, what functions they were supporting, and what was working or not working. The goal was to understand the landscape of the technology, the data, and the processes that existed within the institution at that time.

What Do Those Data People Do Again?

For Cottone, another critical piece in the learning process was understanding the team that she inherited and what skills they brought to the table. The enterprise information service team, as it was called, consisted of 72 dedicated and talented people. Cottone quickly found, however, that due to the way the team had evolved, much of the work was siloed, and there was little cross-team collaboration. This was because teams served different functions and, due to how those functions operated, there was not much need to collaborate. The systems that were supported were siloed. There was also little visibility into the details of how each team's work supported the business. This is not an unusual situation. Technical teams often work in esoteric areas. Data modelers in particular deal in abstractions, and it is sometimes difficult to understand the downstream processes and value to the customer.

One of my own experiences highlights this issue. I was at a conference on metadata, and because I am considered an expert in the space, a team from a Fortune 500 company asked me to meet with them. The challenge, they said, was that they could not get enterprise support for their work. They were having trouble getting attention, funding, and resources. I said, "Okay, I can help with that. Tell me what you do and who you serve." They explained what they did for the next 45 minutes. I kept asking, "So who's the customer? What's the business value? What are you achieving? What are you doing for customers?" After digging and digging and digging, I had no idea what these people did. And I'm an expert.

Focusing on Business Value

After a good deal of investigation, Cottone identified the team members and activities from which the majority of the business value was being derived. In some cases, business stakeholders' priorities had not been addressed to the extent that they had hoped. In addition, some of the work did not focus on the strategic priorities of Citizens Bank. Collaboration was difficult because of a widely dispersed staff, some of whom were not tuned into overall objectives. Rather than continue to invest in activities that were not moving the bank toward its larger goals, Cottone selected the staff and tasks that were productive from that viewpoint, and downsized the team significantly.

She recognized that the issue did not come from the staff but from how workers were organized and the structure of the work. The enterprise information services team was passionate about what it was doing, and really loved the work. "They cared. They were looking for a home and somebody to help—it was just that they were not aligned with the organization's business problems." Cottone's solution was to stop many of the group's activities and then await a response. In fact, no one in the organization ever objected to these changes, which was a good indication that the streamlining had not removed any critical activities.

Strategy should relate back to stakeholders' pain points and be presented as clearly as possible.

One key lieutenant whom she retained was an individual who had worked for the bank for a very long time and had a great deal of institutional memory. "This type of person is an invaluable asset in a project like this," Cottone continued. "She has a lot of relationships in the organization, and helped me tackle issues from all different angles inside the company. I also had a key technical resource who similarly had deep knowledge of the enterprise technology landscape." These were key members of her team whose tacit knowledge of the organization was relied on heavily.

Developing the Strategy

After building a foundation consisting of an understanding of the company, stakeholders, and their pain points; building relationships

to learn about the data environment; and developing her team, Cottone was ready to develop a strategy. That strategy now needed to be socialized with the people with whom she had spent time gaining understanding. Strategy can sometimes be theoretical or too high level. It should relate back to stakeholders' pain points and be presented as clearly as possible.

"I had to be honest with the executive committee and point out that the organization faced a choice. It was at a crossroads," said Cottone. It had spent money already, and the question was whether to stop, or to make the next round of investments to deliver business value. The committee was willing to make that investment, taking a leap of faith. Getting to that stage required honesty about what was going well and what was not going well and setting expectations appropriately about when the payoff would be seen from the time, money, and organizational resources spent on the effort.

The team also had to take that leap of faith.

Balancing Oversight, Communication, and Collaboration

Many large-scale initiatives have a steering committee to ensure the correct level of oversight and executive communication. In the case of Citizens Bank, the group required broad participation from marketing, analytics, lines of business, and technology. This advisory group (which grew to approximately 15 people) was also tasked with taking messages back to their businesses and keeping their stakeholders updated. This structure was actually in place almost from the start of Cottone's tenure, with participation growing as a wider group of stakeholders were engaged.

The challenge in setting up a group like this early in the process is keeping stakeholder interest while conducting the foundational work. It requires setting the right expectations at the outset—if the group believes there will be quick fixes, this expectation needs to be reset. Agendas need to be relevant, and though there was not a lot to report, it was important to communicate to the steering committee as well as extended stakeholder teams that it would be a "together" journey. In one-on-one meetings with these stakeholders, it was possible to spend time in more of a collaboration mode, rather than the reporting mode that is the typical steering committee group dynamic. The extended advisory group included approximately 25 participants, including people from Cottone's team who needed to be completely fluent in the message, along with some steering committee members who brought their lieutenants.

The challenge in setting up a group like this early in the process is keeping stakeholder interest while conducting the foundational work.

A second group was formed last year, about 18 months into the project. These were customer data stewards who helped design and test the customer master. A third group formed was the source data stewards. Citizens has 75 data sources that had customer accounts or transaction data for the master data management (MDM) system that went live in 2016, and for the data lake that began its rollout the same year. A steward or subject matter expert (SME) was named for each data source, and the advisory committee reviewed every name to make sure the right source systems were included.

The Role of Data Trustee

In mid-2016, another role was added. This role is between data stewards and the advisory committee; the individuals are referred to as *data trustees* for each business unit. Data trustees prioritize issues that their business stakeholders identify—for instance, identifying details of data sources that are planned for the data lake, including ownership, rights, downstream usage, provenance, privacy and security issues, quality measures, and other characteristics such as data standards and structures.

This group is a linchpin in the structure that connects business and technical considerations. The advisory group gives advice, but the bank needs business-directed feedback. There are about 25 in this group. The trustees are aligned with business units and lending segments including student, mortgage, auto and home lending, banking, wealth and commercial, treasury, middle market, capital market, tech, risk, compliance, and anti-money laundering.

Including these liaisons, advisors, subject matter experts, stewards, and extended group members brings the total to 150 stakeholders across the various teams. With all these stakeholders and extended team members, the challenge was getting and keeping them aligned and aware of initiatives. This does not mean that everyone needs to know about all of the program details—they need to understand what impacts them and how they can contribute to the program's success.

Getting the 360-Degree View

The bank developed a customer master so it could stop maintaining

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multiple customer mastering processes and customer counts. "The customer master is to be the cornerstone of data work," said Cottone. "All of the other applications depend on an accurate, complete, and up-to-date customer master."

Much of the data maintained by Citizens Bank was in application silos, and would require a great deal of effort to consolidate or identify trends across businesses. Rather than build a warehouse, Cottone preferred to develop warehouse-like functionality along with more advanced data ingestion and analytic capabilities in one place. This approach became the driver for building out a data lake for the organization. The bank did not have to buy more technology, but could instead focus on getting the data into the data lake and creating a customer master to be the foundation for advanced capabilities.

Since the approval of the project at the end of 2015, the team has hit every goal that it set out to achieve.

Tracking Benefits

The challenge of a program of this scale and scope—as well as starting from a clean slate—is that it takes some time to achieve a clear payoff. People know they need good data, but it takes discipline, resolve, and a longer-term planning horizon than quarterly earnings to go down the right path to get there. Laying out an achievable set of milestones with a realistic budget provided initial objectives that could indicate the program was on track.

When laying out the business case and projecting benefits, leadership thought that the strategy would specify when the bank would start getting benefits and what those benefits would mean in terms of ROI. This traditional line of thinking is difficult to apply in this kind of initiative. The older business case models are based on the idea that a certain level of spending provides a multiple of the investment back, for example, in the form of cross-selling that generates new revenue or reducing capital hold for regulatory purposes; these models could not be applied here. In fact, it would be impossible to tie specific benefits to the initiative, given that many other initiatives also have the goal of cross-selling. How does a foundational capability contribute to the outcome? Direct, quantifiable attribution is not possible because so many other programs are contributing to the same goal.

This less quantifiable business case, along with plans for addressing challenges, was presented in the summer of 2015. At the end of the year, Cottone was able to show leadership a view of the path that illustrated the business benefits through linkages to other business-driven projects.

The plan identified six projects with several smaller subprojects that would provide cost-avoidance benefits in areas that included risk, compliance, consumer, commercial, sales, and marketing. By October 2016, more than 20 projects were projected to directly benefit from leveraging enterprise data. Those benefits are expected to emerge with the full rollout, which is scheduled to occur throughout 2017 and into 2018.

Managing Expectations through Transparency

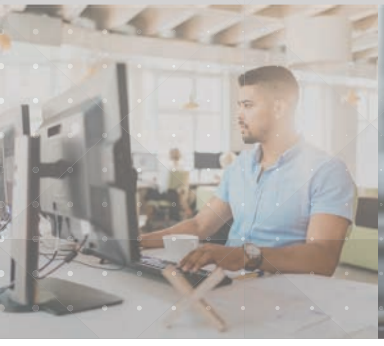
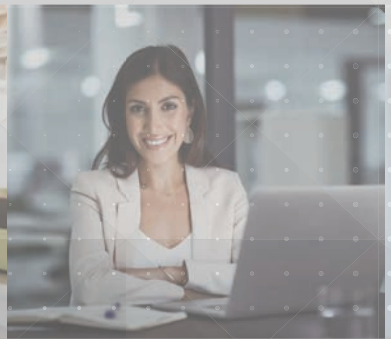
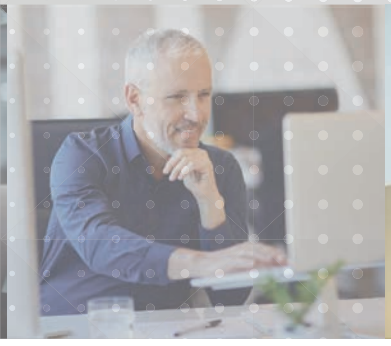
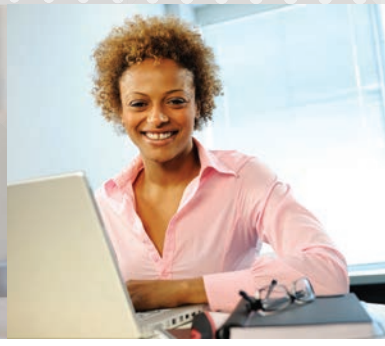
One key to a successful journey is to be transparent about the timing of achieving goals as well as about expected benefits. "Transparency does a lot for people to be willing to keep going on the journey with you, as long as you're honest and tell them where the program stands, and where, when, and how they will be getting the benefit." It's important not to over-promise. Some organizations might not have the resolve to stay the course without more clearly linked benefits and faster timelines. The challenge is that it takes time to change culture and processes, get alignment and buy-in, understand the organization, and make the needed adjustments in how people do their jobs and—along the journey—maintain focus and the attention and support of leadership.

Cottone provides an update every six months to the executive committee, the CEO, and the CEO's direct reports, who have been extremely supportive of the strategy and approach for achieving benefits. She is able to show that the team is achieving what it set out to do and building long-term value through data capabilities. The businesses are also seeing that value, and the approach is beginning to generate results in terms of better serving customers and driving operational cost savings as a result of this new environment.

It's a long journey, but a necessary one if an organization is going to optimize the abundance of data that is its lifeblood. Good data habits, processes, and governance enable adaptability while speeding information flows by removing friction caused by data challenges. While intangible, these approaches to the enterprise data ecosystem are essential to serving customers, adapting to competitive threats, and maximizing shareholder value. IT

Seth Earley *is CEO of Earley Information Science (www.earley.com). He's an expert in knowledge processes, enterprise data architecture, and customer experience management strategies. His interests include customer experience analytics, knowledge management, structured and unstructured data systems and strategy, and machine learning. Contact him at seth@earley.com.*

PREPARE TO CONNECT

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ACCESS TO SKILLSOFT IS AVAILABLE WITH

VR Is Hot, but Why?

by Jim X. Chen
George Mason University

Virtual reality, or VR, means different things to different people. Anything that isn't real but feels like it is can be called VR. In this sense, a lot of electronics and social media can be called VR as well. However, strictly speaking, VR provides a sense of immersion—it's about stereoscopic displays for our vision, haptic devices for our touch or body feeling, and spatial sound for our hearing. In short, VR is about covering our senses with equipment and immersing ourselves in an interactive virtual environment.

VR has been around for quite some time now, and for approximately 25 years, IEEE VR has been the field's premier international conference and exhibition (I happened to serve as IEEE VR conference chair 15 years ago). A wide range of participants—computer scientists, mechanical engineers, knee surgeons, psychologists, museum mangers, and school teachers, to name a few—gather at the annual event. Computer scientists and engineers develop the hardware and software that allow stereoscopic displays, the tracking sensors that report head or body motion, the force feedback devices (haptics) that enable hand or body feeling, and so on. It's an integration of multiple computing and engineering disciplines, including electronics, physics, optics, and mechanics. At the same time, surgeons, psychologists, museum managers, educators, and others exploit or envision VR for all sorts of applications.

Frankly speaking, even though it's thrilling to be immersed in a head-mounted display (HMD) or CAVE (virtual environment with multiple walls of stereoscopic display; see Figure 1) for the first time, VR sensors aren't always spontaneous or accurate. In addition, motions are often reflected in virtual environments with significant time lags, with real body and head motion displaying either significant time delay or position offset. Many research developments, such as virtual surgery, have remained more in the research realm than in physical application—some VR research even focuses on human sickness in VR environments caused by incoherence.

However, VR is extremely trendy right now, with numerous reports touting its growth. Figure 2 shows a recent reports statement that the VR market will grow 20-fold by 2020 (www.rt.com/business/378767-virtual-reality-market-growth).

Such bullish expectations are thought-provoking, but are they real? I've asked several experts, and nobody can pinpoint a significant or revolutionary VR technology break through. The big story is that Facebook bought Oculus VR for $2 billion in

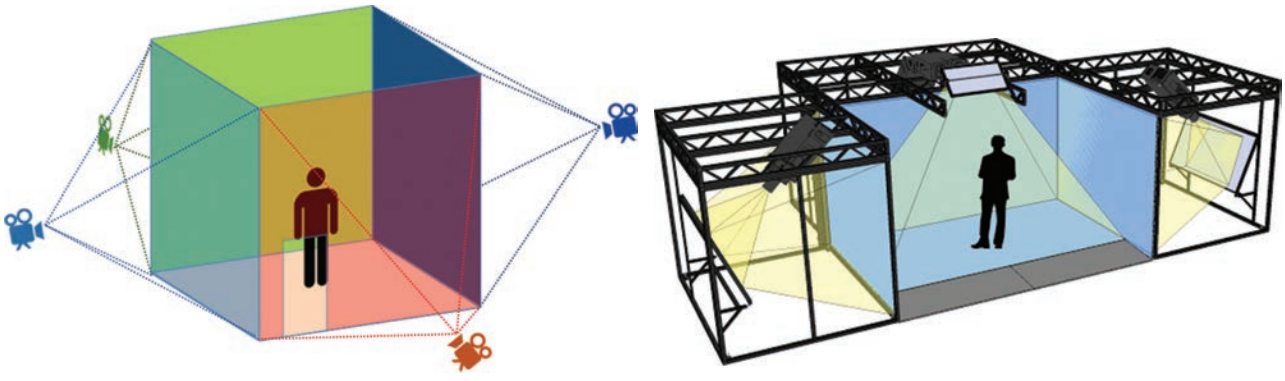

Figure 1. Stereoscopic displays of a seamless environment (CAVE) with the viewer immersed in the room.

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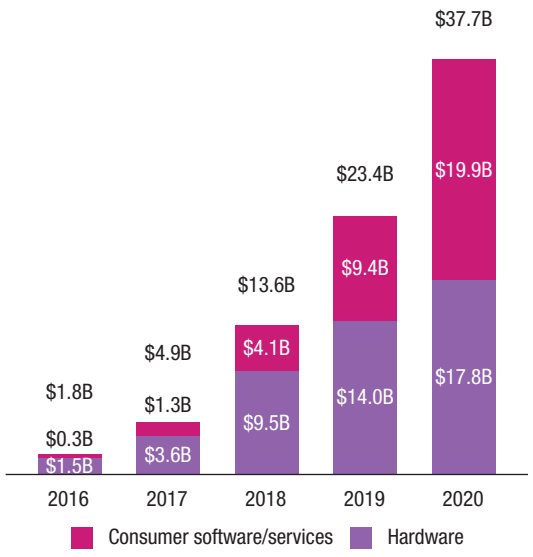

Figure 2. Virtual reality revenue growth projection.

Figure 3. Oculus Rift and Touch, stereoscopic vision, stereo sound, and touch input for $598.

2014, and Google, HTC, HP, Samsung, Sony, and Microsoft are all developing VR devices, primarily stereoscopic display HMDs (see Figure 3). Many industry watchers believe ever-improving smartphone capabilities are at the point of allowing immersive add-ons. The industry is targeting a potentially huge market—gaming with a sense of immersion.

Smartphones are equipped with proximity sensors, orientation sensors, GPS, and so on. The fact is that sensor size and accuracy, chip speed, refresh frequency, display resolution, and their ultimate cost are improving to the point that anybody can experience a decent sense of immersion at a consumer-affordable price.

VR is a world that everybody should enter and experience. But from the present buzz, it's hard to see exactly what killer applications will last. However, we're at least at the point of implementing our imagination and we've only just scratched the surface. Just look at a recent hot VR-enabled toy, remote-controlled drones. This promising tool expands human viewing and outreach for such tasks as movie making and remote delivery. It's the dawning of a new era for VR, and for its associated computing and engineering. ■

This article originally appeared in Computing in Science & Engineering, *vol. 19, no. 4, 2017.*

Careers in Information Technology

For this *ComputingEdge* issue, we asked Thomas N. Theis—professor of electrical engineering at Columbia University and executive director of the Columbia Nano Initiative—about career opportunities in information technology. His research interests include emerging types of devices and computer architectures for energy-efficient computing. He coauthored the article "The End of Moore's Law: A New Beginning for Information Technology" from *Computing in Science & Engineering*'s March/April 2017 issue.

ComputingEdge: What information-technology-related careers will grow the most in the next several years?

Theis: We'll see continued growth in digital and analog circuit design, in software design and development, and in computer science and architecture. Dramatic progress in information technology will be driven less by advances in the underlying device technology, which is maturing, and more by progress in circuit and system architecture. Dedicated architectures for machine learning are hot right now, but other new and specialized architectures will be developed and integrated into tomorrow's information-processing systems.

Advances in device technology will continue—introduction of new memory devices, silicon nanophotonics for on-chip communication, increasingly sophisticated schemes for 3D integration, and more—and will generate career opportunities. But we're in the "build-out" phase of the information technology revolution, with investment increasingly focused on the new goods and services that can be based on the maturing device technology.

ComputingEdge: What would you tell college students to give them an advantage over the competition?

Theis: You have to pick a field of specialization, of course, but learn as much as you can about related fields. For example, the most sought-after circuit designers will have a good understanding of software and system architecture, and will be able to work with specialists in those areas.

ComputingEdge: How can new hires make the strongest impression in a new position from the beginning?

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Theis: First, solve the problems you're assigned. Once you've proven that you can do that, start identifying problems and opportunities that your bosses haven't seen yet. Don't be too discouraged if your suggestions aren't immediately accepted.

ComputingEdge: What is one critical mistake young graduates should avoid when starting their careers.

Theis: If you join an established team or business, don't push for change until you have some understanding of how it currently works.

ComputingEdge: Do you have any learning experiences that could benefit those just starting out in their careers?

Theis: When I joined IBM Research, I had no interest in becoming a manager. I said "no thanks" when first asked, explaining that I wanted to establish myself as a hands-on researcher. After a few years, however, I said "yes" to an offer that seemed to mesh well with my evolving research interests. However, I soon found that the department I joined and the group I was managing had severe morale problems, so I had to spend a lot of time and effort wrestling with those issues. I also found that my established research interests were of little relevance to my new department's goals.

However, I began to identify and address problems of greater interest. After a year or so of struggle, morale was much better, the new research results were exciting, and my bosses were appreciative. I had made the right decision by accepting the management position but for the wrong reason—furthering my established research interests. I found that I enjoyed coaching others to be more effective within an organization. And I learned that the willingness to drop an ongoing research program and set off in new directions is highly prized in industry.

ComputingEdge's Lori Cameron interviewed Theis for this article. Contact her at l.cameron@computer.org if you would like to contribute to a future *ComputingEdge* article on computing careers. Contact Theis at tnt2122@columbia.edu..

TECHNOLOGY

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currently has multiple openings in **Menlo Park, CA** (various levels/types):

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Openings in **Austin, TX** (multiple openings, various levels/types):

Internal Solutions Engineer, Business Integrity (8156J) Develop compelling analyses to execute data-informed initiatives that will improve customer experience and drive growth of Facebook Pages, advertisements, and consumer-to-business and business-to-business commerce surfaces.

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Must reference job title & job code shown above, when applying.

32nd IEEE International Parallel and Distributed Processing Symposium

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ANNOUNCING 23 PLANNED WORKSHOPS

IPDPS Workshops Monday 21 May 2018

HCW	Heterogeneity in Computing Workshop
RAW	Reconfigurable Architectures Workshop
HiCOMB	High Performance Computational Biology
GABB	Graph Algorithms Building Blocks
EduPar	NSF/TCPP W. on Parallel and Distributed Computing Education
HIPS	High Level Programming Models and Supportive Environments
HPBDC	High-Performance Big Data, Deep Learning, and Cloud Computing
AsHES	Accelerators and Hybrid Exascale Systems
PDCO	Parallel / Distributed Computing and Optimization
HPPAC	High-Performance, Power-Aware Computing
APDCM	Advances in Parallel and Distributed Computational Models
ParLearning	Parallel and Distributed Computing for Large-Scale Machine Learning and Big Data Analytics

IPDPS Workshops Friday 25 May 2018

CHIUW	Chapel Implementers and Users Workshop
PDSEC	Parallel and Distributed Scientific and Engineering Computing
JSSPP	Job Scheduling Strategies for Parallel Processing
iWAPT	International Workshop on Automatic Performance Tunings
ParSocial	Parallel and Distributed Processing for Computational Social Systems
GraML	Graph Algorithms and Machine Learning
CEBDA	Convergence of Extreme Scale Computing and Big Data Analysis
MPP	Parallel Programming Model: Special Edition on Edge/Fog/In-Situ Computing
PASCO	Parallel Symbolic Computation
PMAW	Programming Models and Algorithms Workshop
ROME	Runtime and Operating Systems for the Many-core Era

IPDPS Workshops are the "bookends" to the three-day conference technical program of contributed papers, invited speakers, student programs, and industry participation. They provide the IPDPS community an opportunity to explore special topics and present work that is more preliminary or cutting-edge than the more mature research presented in the main symposium.

Each workshop has its own website and submission requirements, and the **submission deadline for most workshops is after the main conference author notification dates**. When a workshop announces its Call for Papers, the link on the IPDPS Workshops webpage is activated, and the call for papers submission due date is posted. Proceedings of the workshops are distributed at the conference and are submitted for inclusion in the IEEE Xplore Digital Library after the conference.

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This event will include traditional poster presentations by PhD students enhanced by a program of mentoring and coaching in scientific writing and presentation skills and a special opportunity for students to hear from and interact with senior researchers attending the conference.

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For details, visit www.ipdps.org

IMPORTANT DATES

• Conference Preliminary Author Notification	December 8, 2017
• Workshops' Call for Papers Deadlines	Most Fall After December 8, 2017

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