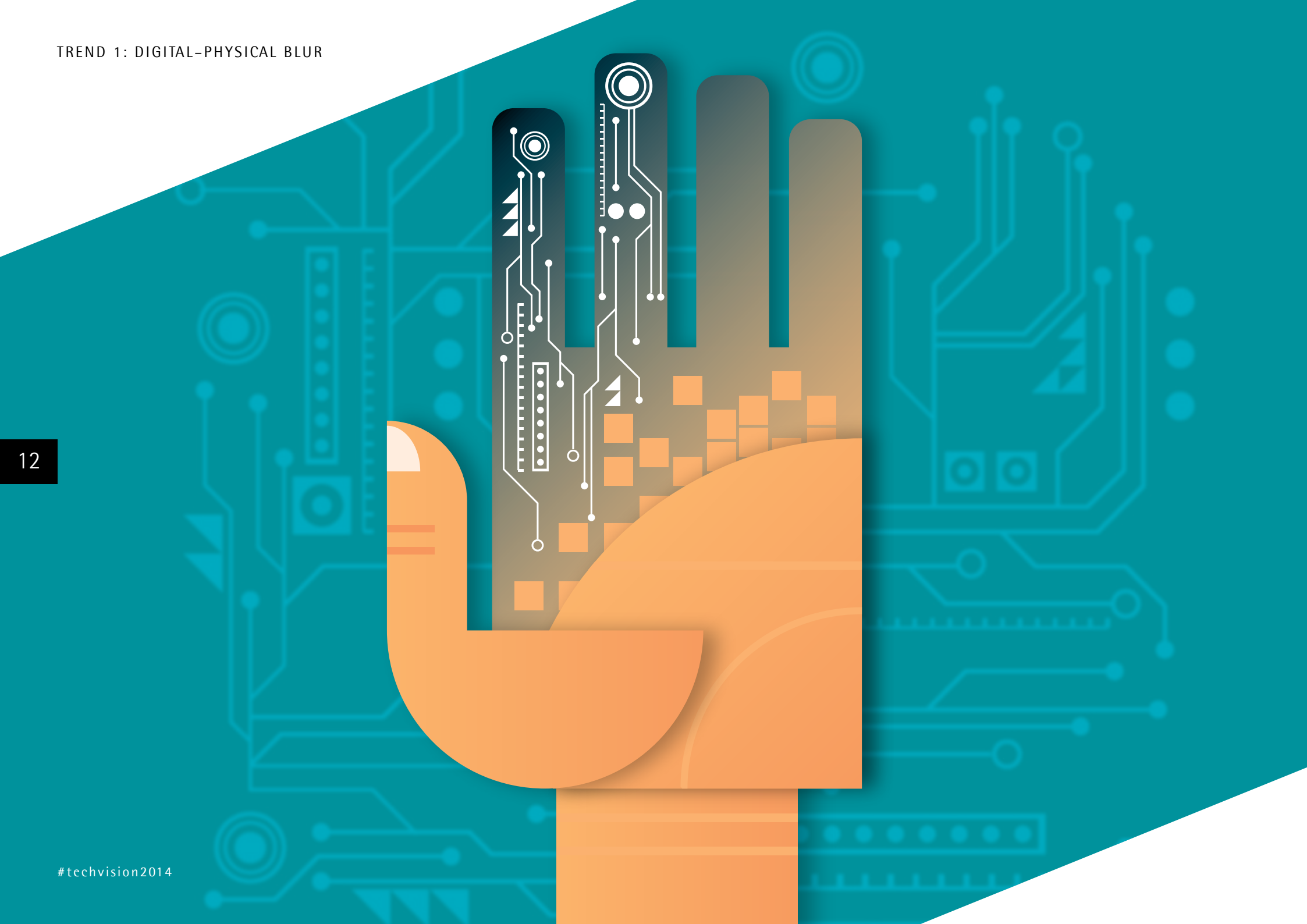

TREND 1

Digital–physical blur: Extending intelligence to the edge

The physical world is coming online as objects, devices, and machines acquire more digital intelligence. What's emerging is more than just an "Internet of Things"; it's a new layer of connected intelligence that augments the actions of individuals, automates processes, and incorporates digitally empowered machines into our lives, increasing our insight into and control over the tangible world. There are benefits for consumers and businesses. Consumers become better informed and better equipped to influence the ways they experience everything around them. And businesses get real-time connections to the physical world that allow machines as well as employees to act and react faster—and more intelligently.

Why now?

Explosion of connected devices: The installed base of the Internet of Things is estimated to reach approximately 212 billion in 2020. This will include 30 billion "connected (autonomous) things" that same year.[1]

Increased bandwidth: Global IP traffic is expected to nearly double between 2013 and 2016, and broadband is expected to speed up more than twofold.[2]

Advanced robotics: From agriculture to oil fields, advances in robotics are empowering human-robot collaboration in industries beyond the factory floor. Several leading car manufacturers have committed to bringing autonomous car technologies to market by 2020.

Rise of real-time analytics: Data sources are growing at an unprecedented velocity, and the ability to loop insights immediately back into the decision process is supporting automating responsive actions like never before. By 2017, more than 50 percent of analytics implementations will make use of event data streams generated from instrumented machines, applications, and/or individuals.[3]

Wearing a smartwatch yet? Tracking your workouts with your phone? Noticed a driverless car in your neighborhood?

From wearable computers to autonomous drones, the ways in which we experience the world are changing fast. Intelligent interfaces are emerging that allow decisions to be made "on the edge"—at the point where digital and physical worlds converge—rather than in a centralized manner. These decisions can be made exactly when they're needed in informed, social, easy-to-use ways, allowing companies and governments to reimagine the possibilities for engaging with their customers and citizens.

Smartphones have turned their owners into digitally augmented versions of themselves—able to catalog and quantify actions throughout the day and access, create, and share an astonishing array of pertinent information that can enable faster, better decisions. Several car models can now self-park with ease—making "edge" decisions about available space, proximity to the curb, and more. Google and Nissan claim their driverless cars are just five to six years away.[4] And autonomous drones—once the sole province of the military—are being used by police precincts across the United States.

But what does the average smartphone subscriber have in common with the person riding in a driverless car? They are both using "edge devices"—devices whose edges border other devices in that they have unprecedented capabilities to connect with other devices. These "cyber physical" systems sense their environments and respond—appropriately—in real time, making possible better-informed decisions within windows of opportunity that can create competitive advantage. The pivotal point is that the sheer quantity of these edge devices is increasing as dramatically as their prices are dropping. At the same time, their ability to sense environmental variables, share data with other edge devices via the cloud, and have deep analytics performed by the cloud adds up to create rich user experiences that inform much more intelligent, real-time decision-making.

As the line between the digital and the physical continues to blur, a vast new window of opportunity is opening for the enterprise. By leveraging and enhancing their physical assets, traditional companies are looking at this opportunity as a way to leapfrog online competitors, create immersive real-world experiences for consumers, and gain market share. In addition, every company now has the opportunity not just to gather insight to make smart business decisions but to turn those decisions into actions, in real time, in the real world. The enormous expansion in intelligent capabilities is rapidly reshaping established operations, paving the way for industry disruption on a massive scale.

But to chase these new opportunities, business and technology leaders alike must rethink how they both engage customers and run their businesses in a digital-physical world. For industrial Internet leaders like GE, this means pushing sensing technologies outside of industrial applications and further to the edge of operations. For companies such as Cisco, which predicts that the industrial Internet market will be worth $14.4 trillion over the next decade, this means focusing on the "Internet of Everything"—or, as Cisco describes it, "bringing together people, process, data, and things to make networked connections more relevant and valuable than ever before."[5]

A world of new user experiences

The way people interact with the world around them is changing. Digital technologies offer new decision-making experiences—from selecting a restaurant in a new neighborhood to making a critical maintenance decision on a gas pipeline. The power of these decision spaces is that they give users real insights, not just information; by providing valuable insight, users are one step closer to taking action.

Technology has been evolving to enable this for the last decade. The ubiquity of network connectivity and the proliferation of smart devices (such as sensors, signs, phones, tablets, lights, and drones) have created platforms upon which every enterprise can innovate. In terms of creating new consumer experiences, this is perhaps most visible in the surging popularity of the "quantified self" movement. Consumer wearables such as Nike's FuelBand, Adidas's miCoach, and Fitbit track exercise and physical activity in ways that allow users to easily gain insight into their performance—often in real time—giving them the information necessary to make decisions about picking up the pace, going for another lap, or pushing for a personal best.

In the urban context, the Copenhagen Wheel, a replacement bicycle wheel, is able to augment the cycling experience by sensing the pressure and effort exerted on the bike's pedals and adding motorized help when the rider needs it; in doing so, it's able to quantify physical activity for the rider.

These quantified measurements are not isolated to athletes or individuals. Osakidetza, the public health system in the Basque region of Spain, is using Microsoft Kinect devices to enable telemedicine treatment of chronic patients. Using the Kinect devices, patients are given not only a more natural way to interface with technology but also new ways to experience medical care. Using insights from the Kinect devices, physical therapists get access to a wealth of granular data that can be used to offer remote consultations and to quantifiably gauge progress. In doing so, therapy sessions can be more frequent, more targeted, and shorter, thus reducing costs, improving outcomes, and reducing patients' recovery times.[6]

More and more, these experiences are expanding beyond a user's personal set of devices. Embedded intelligence isn't limited to smartphones and tablets. Everyday objects are becoming smart and expanding the definition of what it means to experience the real world. In London, British Airways has unveiled two digital billboards that actively track flights in real time, animate an image of a child pointing to the plane, and display the flight number and information about its destination or origin—inspiring onlookers to dream about where they could be escaping to on a British Airways flight.[7] In San Francisco, parking meters are smart and connected; drivers see a color-coded map denoting varying levels of parking difficulty. Once a car is parked, the system can alert the driver when his meter time has nearly expired and allow him to "feed the meter" virtually, from his smartphone. The technology doesn't allow drivers to reserve a parking spot, but it does give them an interface to make a decision on the edge.[8]

Similarly, Waze, a mobile phone app, allows drivers to make decisions at the point of action. It does this by enabling users to use their phones to share insights on current road conditions and offering suggestions about alternate routes around traffic obstacles. In short, Waze users share rich, unstructured insights that create actionable decision spaces.

These decision spaces are not the exclusive domain of digital companies. Brick-and-mortar retailers can differentiate themselves from their online-only counterparts by mastering the digital–physical blur. Retailers such as Tesco, Neiman Marcus, and Staples are continually experimenting with new ways to deliver unique and meaningful consumer experiences. Tesco and Staples are transforming their in-store technology and service offerings to better align with consumer lifestyles: Tesco is rolling out face scanning digital signage at all 450 of its UK petrol stations to tailor engaging and on-screen content to the audience of five million-plus adults who pass through its stations each week; Staples is piloting stores with less merchandise, more kiosks (with free next-day delivery), and meeting spaces for busy small-business owners.[9] For its part, Neiman Marcus has piloted digital-physical solutions that provide both sales associates and customers with actionable intelligence—in the form of store events, product arrivals,

and even personal touches such as the knowledge of when a favorite sales associate is working.[10] With Apple's introduction of iBeacon indoor positioning technology and competitors such as Estimote, brick-and-mortar retailers will find abundant opportunities to incorporate digital transformations on the retail floor that cascade throughout their operations.

What all of these examples have in common are the ways they enhance users' experiences of the world, improving their ability to share insights and take action. There's a powerful secondary effect at work here too: the more that users have access to such amplifying technology, the more they want access to real-time analytics to inform their next experiences, everywhere.

Capabilities at the edge refresh traditional industries

Having access to instantly actionable decisions has served the industrial world well. Over the last two decades, industrial companies have enjoyed radical efficiency improvements by integrating digital technologies throughout their operations—from RFID tags in supply chains to robotics and remote monitoring and control in oilfield and pipeline operations.

What's changing to put digital-physical systems on boardroom agendas today is their infiltration into more industries and their ability to disrupt so many sectors of global economies. The same improvements that manufacturers have made to drastically improve safety and operational efficiency and, in some instances, to augment the ability to scale are now expanding to every industry. Today's digital-physical systems range from chef robots that can serve a custom gourmet burger every 10 seconds to smart grid technologies that are able to identify individual appliances and their discrete energy consumption—by simply installing a single device on a smart meter that can read, analyze, and decipher complex electrical frequencies.[11]

Building owners, property managers, and industrial equipment vendors are benefiting from the reduced cost and increased capabilities of digital-physical systems to drive new experiences with building operations. They are adopting integrated solutions such as continuous

commissioning systems that make use of sensors throughout a building's workspaces and mechanical equipment to collect data with millisecond resolution on building performance. Four years ago, Microsoft relied on a team of reactive operations staff traversing the enormous corporate campus in trucks responding to hot and cold calls. Today, the company uses a software overlay which visualizes the existing 500 million data transactions every 24 hours and is managed by a staff of highly skilled engineers who is harnessing big data and using it to improve Microsoft employees' experience and drive down energy costs.[12] Schneider Electric is going one step further by incorporating some of the world's most advanced weather modeling data into its building automation systems, allowing facilities managers to factor external climate conditions into their decisions and making it easier to automate many of those decisions.[13]

Industries from warehousing to agriculture are seeing similar advances. With robotic systems for order fulfillment enabling big reductions in shipment times, warehouses can process more orders in less time with fewer employees. Taking robots to the skies, the use cases for autonomous drones are abundant and are disrupting

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a diverse group of industries. Agricultural applications use infrared cameras to pinpoint crops that are receiving too much or too little water, first responders use drones to detect survivors of accidents and natural disasters and to deliver supplies to those emergency zones, and road surfaces and traffic congestion are monitored by drones. The EU has identified robotics as a high-growth industry and is committing resources to ensure a strategic leadership position. Together with a consortium of ten European companies led by Shell, the European Commission has committed €3.7 million to a €6.2 million project to develop robots which can replace humans in inspections of pressure vessels and storage tanks used extensively in the oil, gas, and petrochemical industries. When deployed, these robots will increase worker safety, reduce exposure to hazardous conditions, and increase economic development by creating new jobs and opening new markets for the European robotics industry.[14]

Individuals are seeing the benefits of augmentation as well. Philips is piloting the use of Google Glass to allow physicians wearing the display to simultaneously monitor a patient's vital signs and react to surgical procedural developments without having to turn away from the patient or procedure.[15] Gartner predicts that the field service industry alone stands to save $1 billion annually by 2017 by using smartglasses—the field now being pioneered by Google Glass. The research firm notes that smartglasses will enable field service technicians to "diagnose and fix problems more quickly and without needing to bring additional experts to remote sites."[16]

Disruptions ahead

Supported by their abundant resources and their ability to scale, large companies can now use digital-physical systems to disrupt their industries—and other industries too. To act disruptively, they must not simply use digital-physical systems to improve today's processes and services; they have to re-imagine the end-to-end delivery and experience of those processes and services. In doing so, there's ample opportunity not only to disrupt existing industries but to define new markets.

Etihad Airways has reimagined what it means to operate an airline in a digital world. Working with Taleris, a provider of intelligent operations services, Etihad Airways will tap the industrial Internet and use sophisticated software to harvest and analyze data generated by

hundreds of sensors working inside its planes. The tools will allow Etihad to monitor planes in real time, reduce fuel costs, manage plane maintenance, and even spot problems before they happen.[17]

Enabling many of these advances is the concept that data can be acquired, analyzed, and acted upon in real time. The underlying concept is hardly novel: it applied to the earliest anti-lock brake systems on cars, and it's true of many more complex systems today. The difference, however, is that today's digital-physical systems often have orders of magnitude more data to help make more informed decisions within a window of opportunity that matters.

This "iteration capital" is a force multiplier at Ford Motor, where 3-D printers radically reduce iteration cycles in the design process, saving an average of one month of production time for new engine parts, for instance.[18] At motorcycle maker Ducati, design cycle time has been halved by leveraging 3-D printing.[19] And the U.S. Army is experimenting with 3-D printers to eliminate the need to carry so many spare parts. The precision enabled by today's additive manufacturing technologies is leveraged by GE to make parts that were simply not possible with previous manufacturing technologies.[20] In all of these examples, companies are pushing decisions to the edge in ways that were never before possible.

The entire transportation ecosystem is ripe for disruption by digital-physical systems. When driverless cars become common, not only will they change commuters' experiences, they are expected to reduce the incidence of traffic accidents, improve the density of road use, smooth subsequent planning for maintenance and new road construction, ease long-term planning for other transportation systems such as light rail, and much more. Overall, driverless cars will radically disrupt the shipping and logistics industries, fleet services, public transportation, taxicabs, rental cars, agriculture, and mining industries. What's more, insurance liability markets will likely undergo dramatic changes as car manufacturers move to self-insure, offsetting their distributed risk via reinsurance markets.

In case there is any doubt that such technologies are in our future, public policy—often the biggest laggard in innovation economies—is keeping pace. In the U.S., California, Nevada, Michigan, and Florida have already passed legislation allowing driverless cars on the roads.[21]

"Organizations that understand the potential of behavior shaping and respect its privacy implications will enjoy consumer loyalty and employee engagement."

The U.S. federal government has instructed its Federal Aviation Administration to publish rules that will permit drones to use public airspace by September 2015. Nearly a dozen EU member states have no laws preventing small drones from flying below 150 meters.[22]

Decisions on the edge are powering innovations for consumers and businesses alike. To lead, companies need to identify the decisions they would like to shape and the places where they can build decision spaces to inform those decisions. From there, companies will have new opportunities to shape behaviors in new ways.

Shaping consumer behavior

What's perhaps most intriguing about digital's amplification effect is that it's directly allowing businesses and the enterprise to identify and replicate productive behaviors. Furthermore, it's creating the expectation that every experience can and should be optimized. There is significant potential to shift employee behaviors away from preparing for every permutation of

an experience and toward developing new and simpler experiences altogether. These experiences prove to be better for the end user and to be more cost-efficient for the enterprise to implement.

Royal Caribbean International cruise line has shown its grasp of technology's ability to empower travelers and optimize customer experiences. Eager to ease long lines for shipboard restaurants—a perennial complaint from passengers—Royal Caribbean uses sensors to relay to passengers the real-time seating availability at each of the restaurants on its ships. In other words, Royal Caribbean moved dining decisions to the edge by giving its passengers the data they need to decide where and when to have a meal. Passengers are happier and the cruise line was able to discard cumbersome scheduling processes, making it a win-win situation for everyone.[23]

This behavior-shaping capacity can be tuned by the ways in which information is presented to a user. For example, if a city wants to reduce its collective carbon emissions, it might offer a transit planning app that provides route planning guidance on the least carbon-intense mode or route in addition to the quickest.

Organizations that understand the potential of behavior shaping and respect its privacy implications will enjoy consumer loyalty and employee engagement. The key is to notify individuals about how their activities are being monitored, give them the choice of opting in, and explicitly share with them the choices of actionable information at the decision point.

These aspects are crucial. Privacy issues are likely to keep making headlines as privacy watchdogs jump in to defend against unauthorized tracking of citizens and consumers. The company that can build a reputation for providing valuable services while using consumers' personal data in trustworthy ways will have big advantages over competitors. Its brand will be more valuable, it will have more opportunities to attract and retain lifetime customers, and it can become a preferred partner in a larger value chain of goods and services.

Next steps for businesses

Are consumers already buying smartwatches? They are. Is there a long waiting list for Google Glass? You bet. It's fair to say that there will always be individuals who are eager to acquire technology to become better informed and to be able to enjoy different and hopefully better user experiences.

Businesses are likely to be more circumspect about the migration of decisions to the edge. Accenture expects that business-to-consumer organizations will be quite quick to respond to consumers' eagerness for and openness to new experiences, offering everything from new mobile couponing opportunities to new ways to monitor and improve their health.

In the broader business world, there are enormous opportunities to move employees' decisions closer to where they can take action. That much is apparent when so many employees keep their mobile phones close to them in the workplace. But businesses' embrace of the next generation of automation will be cautious.

Accenture anticipates three phases of uptake. The first impact will be on making current ways of doing things much more efficient. The second phase will see digital-physical systems start to create industry disruptions. Disruption will begin as it always does—by changing users' expectations of what is acceptable, normal. The businesses that proactively alter users' experiences will be the disrupters. The third phase will be in how organizations respond. They will need to ask questions about how truly intelligent automation will change interactions with and expectations of their customers and other stakeholders. Will it open up new business opportunities? Will it change the productivity equation in the workplace? Will it materially change how we plan our use of resources? Will it simplify our organization's structure?

The businesses that arrive at the best answers—and that can properly leverage the strengths of machines (precision and scale) alongside the strengths of people (insight and decisions)—will be setting themselves up with market-leading advantages.

Your 100-day plan

In 100 days, promote decisions at the edge by completing the following:

- Take an inventory of devices at the edge of your network; segregate them by those used by humans and those that act on their own, such as sensors and embedded intelligence.
- Catalog how data is currently being collected in your organization to drive business decisions. Understand how having more data about daily operations could improve business outcomes.
- Define and prioritize both the ways in which consumers engage with your products or services and the locations where they engage. Brainstorm ways to deliver compelling user experiences that offer new insights into their decision making.
- Consider how you can influence behaviors or decision making to help consumers arrive at a favorable outcome for your mission or business.
- Look to early adopters to learn what businesses in different industries are doing to enhance consumer experiences, enable field workers, and embed intelligence into their physical assets.
- Organize a cross-functional mobility team between your IT and business organizations. Their objective will be to pilot relevant hardware innovations and test new consumer and employee digital-physical experiences.
- Collaborate with your customer-facing business units to capture the types of edge decisions they often make. Determine how they will benefit by adding data with real time analytics at the point of action and create a strategy to deliver that solution.
- Reevaluate your corporate privacy policy to address the new digital-physical interactions for your business. Data collection, usage, transparency, and user control (opt in/opt out) guidelines should be clearly addressed.
- Uncover the types of decisions that can alleviate oversight obligations from middle management and start to build decision spaces for front-line workers to take autonomous actions.

This time next year

In 365 days, you should step up your business agility by pushing decisions to the edge:

- Develop a portfolio of pilots to deliver actionable insights to employees and customers and that considers hardware and software solutions. Aim for increased data resolution over what is provided today. Monitor outcomes related to those decisions, and consumer experiences.
- Extend your infrastructure to support enterprise mobility for core business functions.
- Develop a real-time data analytics infrastructure to support the data velocity and insight needs of digital–physical projects.
- Develop a governance strategy to act on real time feedback loops to enhance decisions at the edge.
- Proactively address potential data privacy issues as new pilots and projects are developed. Urge leaders to go beyond compliance, giving end users transparency and control in an effort to mitigate corporate risk and liability.
- Start planning for known technology disruptions coming down the pipeline. Example: your business will make use of autonomous vehicles and aerial drones. Be disruptive. Plan on aerial drones being available for use in late 2015 and driverless cars in 2020.

SIDEBAR

Digital augmentation makes every worker an information worker

To-date, corporate technology investments have focused on improving the efficiency of only certain staff: high-cost knowledge workers. That is changing. Intelligent devices are now sufficiently abundant, inexpensive, and connected, empowering workers at every level to perform their jobs with greater efficiency, productivity, and safety. Front-line workers are becoming information workers with some of the same augmentation technologies that improve the performance of knowledge workers.

These new information workers are able to make informed decisions in real time, acting in the tangible world with the right information at the right time—often using their own mobile devices rather than technology supplied by the organization, yet interacting with the organization's back-end IT systems.

For example, paramedics in Champaign, Illinois, and Grand Rapids, Michigan, are using their own smartphones and tablets to increase access to medical information, find drug dosages and interactions, and share insights

with the destination hospital while a patient is in transit. In the past, if this research happened at all, it would happen when the paramedics arrived at the hospital or returned to their depots. Now, the research can happen in near real-time and have meaningful impact on the course of treatment.[24] The paramedics are newly enabled by information that provides critical insights within a narrow window of opportunity; those insights can spur a decision "on the edge" that can possibly save a life.

In similar ways, developments with wearable technology, such as Google Glass, may provide field-service professionals in the oil and gas industry with access to real-time information and deep expertise—improving their effectiveness at fixing remote pipelines and maintaining highly sensitive infrastructure.

As front-line workers have their capabilities augmented by digital technologies, they are emboldened to make more informed, real-time decisions and encouraged to become more engaged with the organization. This drives operating efficiency and revenue growth. Studies have shown that companies with high employee engagement frequently demonstrate higher levels of operating income and growth in earnings per share than those found to have low levels of employee engagement.

The implications of digital workforce transformations go beyond updating bring-your-own-device (BYOD) policies. Realizing the efficiencies from digitally augmented workforces will require business leaders to fundamentally rethink how employees do their jobs and reassess the back-end systems that support them. Leaders will also need to be comfortable with decentralized decision-making as business decisions get pushed closer to the edges of their business. Chief information officers (CIOs) will need to be more cognizant of potential risks associated with data privacy and security. Real-time information systems will become a higher priority. Getting information to workers as they need it will allow businesses to uncover a workforce that is more productive, eager for new challenges, and more effective and efficient at making and sharing decisions by collaborating with others. The benefits can rise above quantity and quality of work output by contributing to the flattening of organizations—meaning that a smaller number of supervisors and middle managers can manage larger and more dispersed teams.