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Predictably inaccurate: The prevalence and perils of bad big data

SPECIAL ISSUE:

Navigating the future of work

Can we point business, workers, and social institutions in the same direction?

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Time for action and experimentation

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HEADLINES attract clicks and sell newspapers, but they don't always provide a nuanced view of the topic at hand. So I've found it to be with the future of work. Most of the media coverage I've seen on the subject focuses on the rise of the robots—everything from "Robots will take our jobs, how terrible!" to (slightly less prevalent) "Robots will free us from drudgery, how wonderful!" Lost in the noise is a recognition that the future of work involves a much broader set of issues. The growth of alternative workforce arrangements, including the freelance economy and crowds, is one. The evolution of talent and customer markets based on "pull" rather than "push" is another. And, yes, the accelerating use of robotics, cognitive technologies, and artificial intelligence in the workplace is still another—though one whose impact will almost certainly be more complex than many foresee.

Given the impact, speed, and pervasiveness of these developments, it's time to move beyond the headlines to a conversation that's less about predicting and more about navigating the future of work. The need goes beyond understanding how jobs and work will change in the future; we should also consider what we can do to manage and, ideally, benefit from these changes today and in the coming years. Questions to ask ourselves as workers, as employers, and as a society include:

- How can we enable people to engage in the lifelong learning that will likely be necessary to remain productive for an extended working lifetime?
- How do we reengineer work and jobs in an era of rapidly advancing artificial intelligence?
- How will we use new tools and technologies, such as augmented reality, to reshape the way we work?
- As industries evolve and converge, how will jobs and work change as well?
- How can an organization manage its culture when a growing proportion of work is done off company premises and/or by freelancers and independent contractors?
- If every company, in some sense, is a technology company, what tech skills will workers need?

At the center of this discussion is a massive transformation agenda for every individual, business, and government at all levels. How can we adapt to create meaningful work, jobs, and careers for ourselves, our employees, and our citizens?

We must surely adapt. The future of work is itself only part of a larger set of transformations on the horizon. These include the growth of the digital enterprise, the emergence of network- and team-based organizations, the deliberate design of customer and employee experiences, and new ways of understanding and managing the risks and costs of labor in business. To deal with the scope of these changes requires a refreshed conversation that starts with understanding how these forces and opportunities interact, not as threads, but as part of a larger fabric.

It's time to focus on aligning priorities and actions in an age of experimentation. Every worker and every leader will need to prepare and make choices about how to act when faced with the new and the uncertain. How will we choose to navigate the future of work in the years and decades ahead?

O robot proofreader, where art thou?

THIS PAST May, I experienced the best conference I never attended. The keynote speech, various presentations, breakout sessions, even side conversations with other attendees—all were streamed directly to my laptop, nestled snugly on my home office's desk. Why the best? Because it was designed to accommodate the way I work: virtually, remotely, with a team whose members are scattered around the world, from New York to Hyderabad. I haven't put in regular appearances at an office for more than a decade (a privilege for which I am fervently grateful). Why should a three-day conference be any different?

There are risks for businesses, of course. Not just the risk that I'll goof off on company time, but the danger that I and other "alternative" workers—which includes everyone from full-time teleworkers like me to gig workers, independent contractors, and crowdsourced talent—will lack the engagement and sense of belonging that depends on a strong organizational culture, and can be so important to financial performance. In this issue of *Deloitte Review*, "Beyond office walls and balance sheets: Culture and the alternative workforce" reminds us of the importance of extending culture to those who may work off-campus or who may not, in the traditional sense, be your employees at all.

Another growing challenge, for both individuals and their employers, is continuous learning. "Catch the wave: The 21st-century career" likens the modern worker's career journey to a surfer's engagement with the ocean: banking on a set of skills until demand for those skills crests and fades, then learning new skills to catch the next "wave" of demand. One constant in this sea of change will likely be the need to know one's way around technology. As "Tech fluency: A foundation of future careers" points out, technology is already integral to almost everyone's daily work, and those who lack a basic understanding of its abilities and limitations—or are unable to smoothly adjust to regular upgrades—will struggle to keep up.

Junko Kaji
Editor-in-chief

Technologies dealing with artificial intelligence often figure into discussions about what the future holds for workers and employers. "The rise of cognitive work (re)design" explores what organizations could accomplish through a revival of '90s-era business process reengineering methods—but with cognitive technologies as the technological enabler. Juxtaposed with this view, "Reconstructing work" posits that organizing work around *problems* rather than processes might allow us to choose a path in which artificial intelligence, far from displacing humans, enables people to take on roles for which human beings are uniquely suited.

Tying all these threads together is the idea that individuals, employers, and governments will need to align their efforts if we are to sustain a stable, just, and productive society as the future of work evolves. As the authors of "Navigating the future of work" describe, individuals face the challenge of continually reinventing themselves through a working lifetime that could last 50 years or more. Employers, while seizing the opportunity to access a global talent pool, will also need to negotiate shifting societal and regulatory expectations around the employer-worker contract. And governments will likely be called upon to develop new ways of providing the social safety nets that can help keep people from being left too far behind.

For many of us, work fills the majority of our waking hours. We have a vested interest in helping the future of work unfold as smoothly as possible. May what lies ahead prove an interesting journey to new ways of working.

Predictably inaccurate

The prevalence and perils of bad big data

By John Lucker, Susan K. Hogan, and Trevor Bischoff
Illustration by Jon Krause

"We're not that much smarter than we used to be, even though we have much more information—and that means the real skill now is learning how to pick out the useful information from all this noise."

—Nate Silver[1]

IS OUR LOVE AFFAIR WITH BIG DATA LEADING US ASTRAY?

SOCIETY and businesses have fallen in love with big data. We can't get enough: The more we collect, the more we want. Some companies hoard data, unsure of its value or unclear if or when it will be useful to them but, all the while, reticent to delete or not capture it for fear of missing out on potential future value. Stoking this appetite is the sheer growth in the volume, velocity, and variety of the data.

Most of all, many business leaders see high potential in a fourth V: *value*. Given our ability to access and (potentially) understand every move our current and potential customers make, coupled with

access to their demographic, biographic, and psychographic data, it seems logical that we should be able to form a more intimate, meaningful relationship with them. Every data point should move the business at least one step closer to the customer.

Yet despite all the digital breadcrumbs, it turns out that marketers might know less about individual consumers than they think. The numbers don't lie—or do they? What if much of this data is less accurate than we expect it to be?

Perils ranging from minor embarrassments to complete customer alienation may await businesses that increasingly depend on big data to guide business decisions and pursue micro-segmentation and micro-targeting marketing strategies. Specifically, overconfidence in the accuracy of both original and purchased data can lead to a false sense of security that can compromise these efforts to such an extent that it undermines the overall strategy.

This article explores the potential adverse consequences of our current love affair with big data. Evidence from our prior[2] and current primary research, supported by secondary research, highlights the potential prevalence and types of inaccurate data from US-based data brokers, as well as the factors that might be causing these errors. The good news is that strategies and guardrails exist to help businesses improve the accuracy of their data sets as well as decrease the risks associated with overreliance on big data in general.

PERSONAL DATA THAT'S BOTH INCOMPLETE AND INACCURATE

"It's pretty scary how wrong data collected about you can be—especially if people make important decisions based on this incorrect information. This becomes more frightening as more and more decisions become information-based."

—Survey respondent

TO better gauge the degree and types of big data inaccuracies and consumer willingness to help correct any inaccuracies, we conducted a survey to test how accurate commercial data-broker data is likely to be—data upon which many firms rely for marketing, research and development, product management, and numerous other activities. (See the sidebar "Survey methodology" for details.) Some of the key findings:[3]

- More than two-thirds of survey respondents stated that the third-party data about them was only 0 to 50 percent correct as a whole. One-third of respondents perceived the information to be 0 to 25 percent correct.

- Whether individuals were born in the United States tended to determine whether they were able to locate their data within the data broker's portal. Of those not born in the United States, 33 percent could not locate their data; conversely, of those born in the United States, only 5 percent had missing information. Further, no respondents born outside the United States and resid-

ing in the country for less than three years could locate their data.

- The type of data on individuals that was most available was demographic information; the least available was home data. However, even if demographic information was available, it was not all that accurate and was often incomplete, with 59 percent of respondents judging their demographic data to be only 0 to 50 percent correct. Even seemingly easily available data types (such as date of birth, marital status, and number of adults in the household) had wide variances in accuracy.

- Nearly 44 percent of respondents said the information about their vehicles was 0 percent correct, while 75 percent said the vehicle data was 0 to 50 percent correct. In contrast to auto data, home data was considered more accurate, with only 41 percent of respondents judging their data to be 0 to 50 percent accurate.

- Only 42 percent of participants said that their listed online purchase activity was correct. Similarly, less than one-fourth of participants felt that the information on their online and offline spending and the data on their purchase categories were more than 50 percent correct.

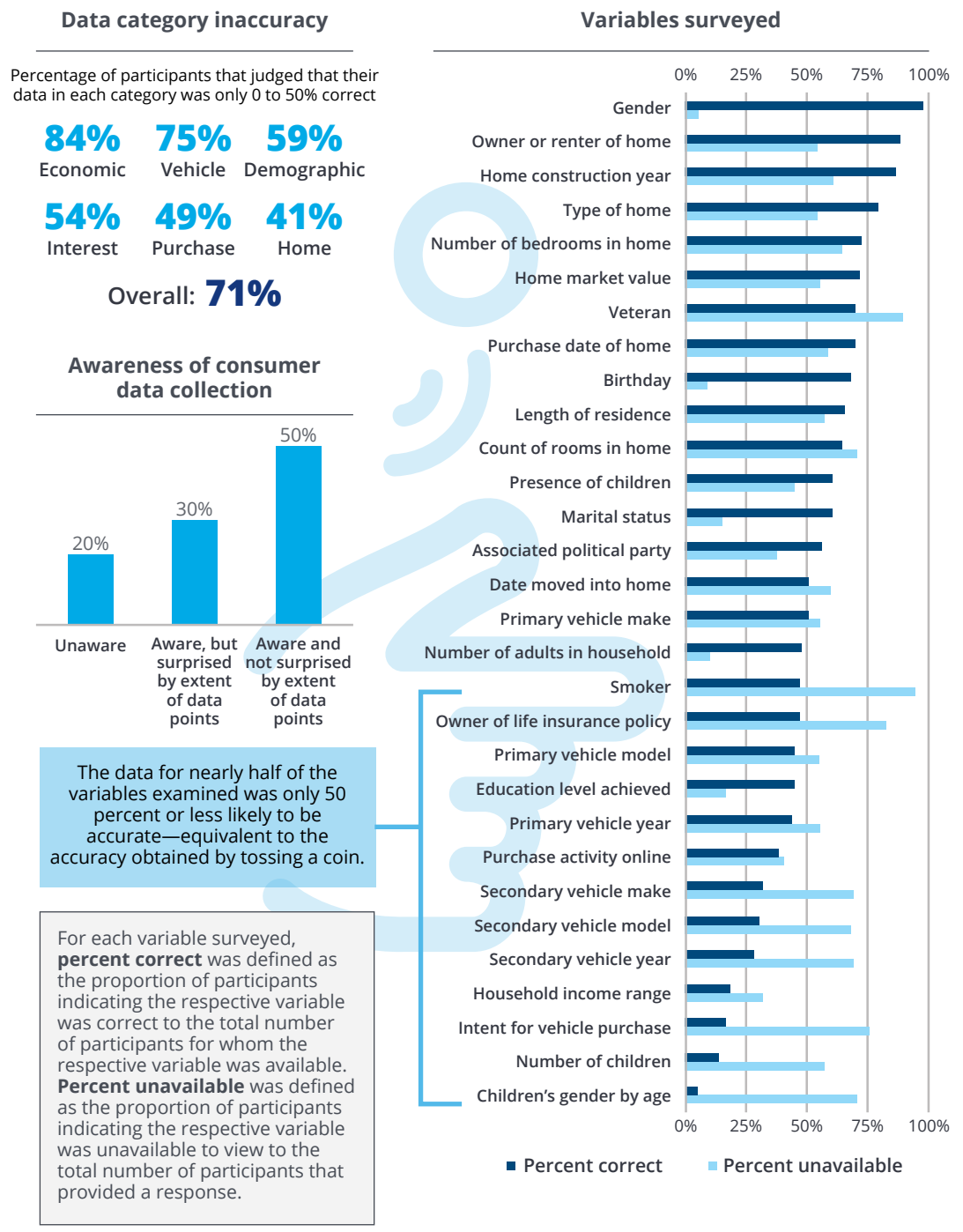
- While half of the respondents were aware that this type of information about them existed among data providers, the remain-

SURVEY METHODOLOGY

Our survey asked 107 Deloitte US professionals to privately and anonymously review data made available by a leading consumer data broker, a broker with a publicly available, web-based portal that presents users with a variety of personal and household data. Respondents, all between 22 and 67 years of age, completed the rapid-response, 87-question survey between January 12–March 31, 2017.

Respondents viewed their third-party data profiles along a number of specific variables (such as gender, marital status, and political affiliation), grouped into six categories (economic, vehicle, demographic, interest, purchase, and home). To calculate the "percent correct" for each individual variable, we took the number of participants who indicated that the third-party data point for that variable was correct, and divided it by the total number of participants for whom third-party data were available for that variable. To determine respondents' views of the accuracy of the data for each *category*, we asked them to indicate whether they felt the category data was 0 percent, 25 percent, 50 percent, 75 percent, or 100 percent accurate.

Figure 1. Reported accuracy of third-party consumer data from our respondents



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ing half were surprised or completely unaware of the scale and breadth of the data being gathered.

Figure 1 outlines other inaccuracies or omissions related to date of birth, education level, number of children, political affiliation, and household income. Clearly, all of these types of data are potentially important to marketers as they target different consumer segments.

Can we count on individuals to correct their own data?

"While I wasn't surprised by the extent of the data collected, it was interesting to see it. I was actually surprised at how little data there was about me (I am an avid online shopper), and how incomplete the 'cyber me' picture is. I'm not complaining about it, though."

—Survey respondent

Survey respondents were provided with the opportunity to elaborate on why they thought their data might be wrong or incomplete. Most commonly, the available information was outdated—especially vehicle data. Many others saw the data as characterizing their parents or other household members (spouses or children) rather than themselves. The most-mentioned feeling among respondents was surprise—not at the amount of correct data available, but rather that the information was so limited, of poor quality, and inconsistent. In essence, for many respondents, the data seemed, as aptly put by one respondent, "stale."

"There was lots of information that didn't exist about me. And of the data that did exist, much seemed inconsistent with other data."

—Survey respondent

Interestingly, even after being offered the opportunity to edit their data via the data broker's online portal, few respondents chose to do so. While approximately two-thirds of respondents reported that at least half of their information was inaccurate, only 37 percent opted to edit their data.

The most common best reason for the decision to edit (given by 31 percent of respondents who chose to edit) was to improve the information's accuracy. The second most common response was a decision to edit only what seemed relevant (provided by 17 percent of respondents opting to edit). Another 11 percent of respondents who opted to edit cited privacy and nervousness about their data being "out there." Other respondents noted the desire to reduce or avoid targeted messaging and political mailings, as well as the hope of improving their credit rating (even though, presumably unknown to them, this type of marketing data has no direct connection to how credit scores are derived). The most commonly edited categories were demographic data and political party data.

Why did so many respondents elect not to edit their data? Most often, people cited privacy concerns. Other reasons included no perceived

value in editing and ambiguity regarding how third parties might use the data. Table 1 gives an overview of the most common reasons for the decision to edit or not.

"I'm skeptical and cautious about what could be done with this data. Even assuming the best of intentions and integrity by people who might consume this data, I cannot imagine a scenario that would also be in my or my family's best interest. I would actually prefer less personal information about me to exist publicly. So, obscure, inaccurate, or unreliable data is what I consider to be the next best thing."

—Survey respondent

THE PERILS OF RELYING ON BAD DATA

OUR survey findings suggest that the data that brokers sell not only has serious accuracy problems, but may be less current or complete than data buyers expect or need. Given that a major US marketing data broker hosts the publicly available portal used for our survey, these findings can be considered a credible representation of the entire US marketing data available from numerous data brokers. The impacts of inaccurate or incomplete data are many, ranging from *missed opportunities* to just plain *misses*.

Table 1. Common reasons driving decisions to edit or not to edit data

Why did you edit your data?	Why didn't you edit your data?
• To make data more accurate/better	• Privacy
• Corrected only where I perceived that it was valuable/worth the effort	• No perceived value/not worth the time and energy
• Privacy/nervous that this data is even out there	• Not interested/don't care what data they have on me
• To reduce/avoid targeted ads/offers	• Cautious/unclear how the information will be used
	• Lack of time to edit
	• Not my job to do their work/fix errors
	• Against targeted marketing

Source: Deloitte analysis.

Missed opportunity 1: Underestimating customer worth and not capitalizing on the power of habit

"I wish I spent only that much. My purchasing data seems significantly understated from what I know I spend in the categories indicated."

—Survey respondent

Understanding the spending behavior and power of current and potential customers is very important to firms. Many marketers extrapolate this information based on three key categories: current income, modeled net worth, and prior purchasing behavior. Consumers are creatures of habit—our past spending behavior is one of the best indicators for marketers to determine not only how much we will spend in the future, but what types of items we are likely to purchase. This can guide predictions on how much revenue a company can expect to see in the coming year, as well as any cross-selling or up-selling efforts.[4] Given this information's importance to marketers, and the incredible number of digital breadcrumbs that consumers leave behind, we were surprised to find such a high level of inaccuracy. More often than not, respondents indicated that the household income data provided by the broker was incorrect, with purchasing data often underestimated, suggesting that marketers relying on this information to guide their targeting efforts may be leaving potential revenue on the table.

Missed opportunity 2: Decreased customer loyalty and revenue

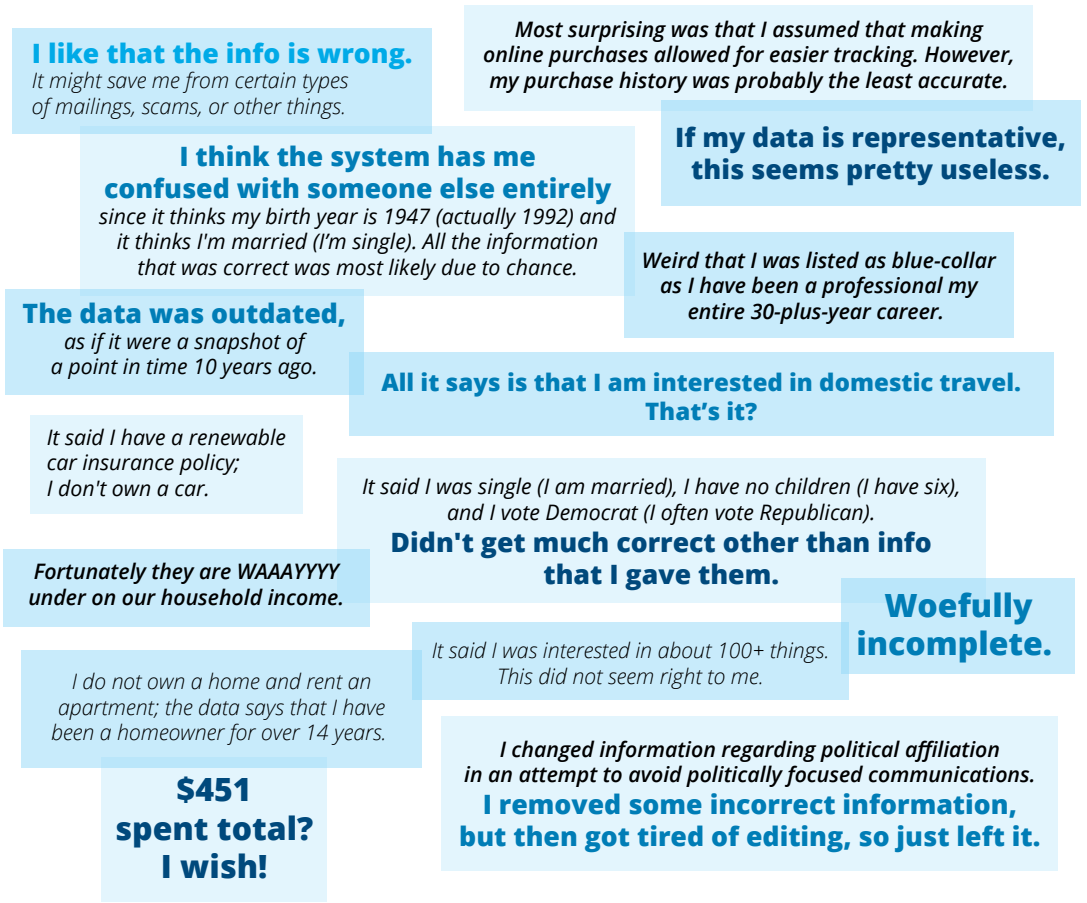
"[The data] stated that I own a property that is actually owned by my parents, and at the same time, it failed to list the property that I currently do own."

—Survey respondent

Another area of significant inaccuracy was home residence and vehicle ownership, which was quite surprising given the readily available public records for each. As stated previously, home data was more accurate than auto data, but still considerably inaccurate overall. Respondents suggested that the data in these two categories was often outdated—potentially by five to ten years.

One of the highest-expenditure periods in an individual's life is when she makes a household move. Not only are these moves expensive—households incur significant ancillary spending as well, even with local moves. When moving from one geography to another with a different climate, the consumer often starts from scratch in numerous product categories (new wardrobe, home furnishings, outdoor equipment, and so on). A marketer wouldn't want to miss this transitional moment, in which consumers spend more money than they typically would as well as form new behaviors—including purchasing routines and loyalties. Without a timely and relatively accurate picture of a consumer's residence changes, the marketer could miss out on influencing momentary pur-

Figure 2. What do people think about their own big data profiles? A sampling of comments from our respondents



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chases, subsequent add-on purchases, and, potentially, building long-run customer loyalty.

Corroborating our findings, a third-party data quality study found that 92 percent of financial institutions rely on faulty information to better understand their members, a rate likely attributable to human errors and flaws in the way multiple data sources were combined. Fully 80 percent of credit unions believe the inaccuracies have affected their bottom line, causing an average 13 percent hit on revenue. Additionally, 70 percent of financial institutions blame poor data quality for ongoing problems with their loyalty efforts.[5]

Miss 1: Moving the customer relationship along too fast

"I'm annoyed that nothing is private anymore. I rarely use advertisements for purchasing decisions anyway, and I wish I could stop receiving them altogether."

—Survey respondent

It should go without saying that micro-targeted messaging is full of pitfalls—regardless of the accuracy of the data on which it is based. Take, for example, the father who learned about his daughter's pregnancy through retailer offerings that came in the mail after the retailer detected purchasing behavior correlated with pregnancy.[6] While evidence suggests that consumers are becoming more receptive to personalized marketing, marketers still need to be thoughtful and tread lightly in this area.[7] This word of warning is consistent with recent research identifying similarities between interpersonal relationship development and business and customer relationships,[8] as well as existing theories regarding healthy relationship development. Particularly, self-disclosure of personal information is meant to follow a reciprocal and progressive course, with initial mutual sharing of surface-level personal information over time evolving to a more intimate level of exchange.[9] Too much, too soon from either party can come across as invasive and creepy—and disrupt the relationship that has developed so far. This means that demonstrating a ballpark knowledge of your customer early on may be more beneficial than demonstrating an intimate or precise knowledge. Recent research has corroborated this idea, suggesting that semi-tailored or customized advertising can lead to a 5 percent increase in intent to purchase. However, advertising that gets too specific, by seeming to zero in on one individual as opposed to a general demographic group profile, may be viewed as invasive and a little too close for comfort. This latter situation can lead to a 5 percent *decrease* in intent to purchase.[10]

Miss 2: Delivering the wrong or inappropriate micro-targeted message

"Some of the misses were really bad, like my political party and my interest in tobacco!"
—Survey respondent

Probably worse than getting too close is getting it wrong. When a marketer tries to make a personal connection through messaging using wrong or inappropriate information, the effects can range from humorous—such as a twentysomething receiving AARP membership invitations[11]—to sad. The latter was the case with a recently mailed discount offer that, while sent to a live person, included an (accurate) reference to not only a recently deceased family member but the way this person died—embedded into the recipient's mailing address. The firm that had given the offer, which didn't believe it could have sent out this mailing until receiving the physical proof, claimed this blunder was the result of a rented mailing list from a third-party provider.[12] While reported cases such as this last example are rare, basing a personalized message around wrong or inappropriate information, and subsequently delivering the wrong micro-targeted message to customers, can not only diminish the effect of marketing efforts, but do more damage than good. This adverse reaction is often referred

to as a boomerang effect: causing a customer to move from a neutral, nonexistent, or positive attitude toward the company to a negative one.[13]

Miss 3: Assessing risk inaccurately

Both private and public health care institutions often create and rely on big data models to understand their patients' future needs and potential life spans. Such risk models, however, go beyond managing an insurer's bottom line by helping identify high-risk clients.[14] Inaccurate data can prompt inaccurate assessments such as determining financial risks,[15] life expectancies,[16] and medical care needs, which can lead to inappropriate insurance payments at best.[17] At worst, if public health groups that use these risk models to guide strategic decisions around global public health initiatives miss the mark, it can contribute to deaths. These deaths could be due to misidentification of vulnerable or at-risk populations, which could be avoided if the right treatments were made available to them.[18]

Miss 4: Predicting inaccurate outcomes

While most us have learned to cut weather forecasters some slack, we are fixated on the many "scientific" and "statistically significant" crystal balls: models used to predict the outcomes of our elections,[19] football games, and horse races. Yet models meant to determine precautions to be taken have often been off the mark. For example, in 2013, a search engine-based flu-tracking model forecast an increase in influenza-related doctor visits that was more than double what the Centers for Disease Control and Prevention (CDC) predicted.[20] While the CDC based its predictions on various laboratory surveillance reports collected from across the United States, the culprit behind the social media tracking tool's wildly different result was what some researchers have called "big data hubris": the mistake of assuming that big data can substitute for, rather than supplement, traditional methods of data collection and analysis.[21]

HOW DID THE DATA GET SO BAD?

UNFORTUNATELY, our primary research findings are not unique but, rather, a glimpse into the general state of affairs: Big data is often inaccurate,[22] and companies relying on inaccurate big data can suffer significant consequences. Since we reviewed only the fields available to us, it's important to note that inaccuracies almost certainly extend beyond the fields and attributes highlighted in this article, especially the less common or more esoteric fields, such as whether an individual is a veteran.

So how does this information wind up so far off the mark? There are many possible causes, such as human error, collection or modeling errors, and even malicious behavior. To make matters worse, a data set is often victim to more than one type of error. Some examples of how errors can arise:

Big data is often inaccurate, and companies relying on inaccurate big data can suffer significant consequences.

- Outdated or incomplete information may persist due to the cost and/or effort of obtaining up-to-date information

- An organization that uses multiple data sources may incorrectly interweave data sets and/or be unaware of causal relationships between data points and lack proper data governance mechanisms to identify these inconsistencies

- An organization may fall prey to data collection errors:

  - Using biased sample populations (subject to sampling biases based on convenience, self-selection, and/or opt-out options, for instance)[23]

  - Asking leading or evaluative questions that increase the likelihood of demand effects (for example, respondents providing what they believe to be the "desired" or socially acceptable answer versus their true opinion, feeling, belief, or behavior)

  - Collecting data in suboptimal settings that can also lead to demand effects (for example, exit polls, public surveys, or any mechanism or environment in which respondents do not feel their responses will be truly anonymous)

  - Relying on self-reported data versus observed (actual) behaviors[24]

- Data analysis errors may lead to inaccuracies due to:

  - Incorrect inferences about consumers' interests (for example, inferring that the purchase of a hang-gliding magazine suggests a risky lifestyle when the purchaser's true motive is an interest in photography)[25]

  - Incorrect models (for instance, incorrect assumptions, proxies, or presuming a causal relationship where none exists)

- Malicious parties may corrupt data (for example, cybercrime activity that alters data and documents)[26]

Understanding the causes of these errors is a first step to avoiding and rectifying them. The next section explores the next steps companies can take along the path to utilizing big data in the right way.

A BIG DATA PLAYBOOK: PRESCRIPTIONS FOR SUCCESS

THERE is growing recognition that much big data is built on inaccurate information, driving incorrect, suboptimal, or disadvantageous actions. Some initial efforts are under way to put in place regulations around big data governance and management.[27] Regulatory agencies, such as the Federal Trade Commission and the National Association of Insurance Commissioners, are beginning to consider more oversight on data brokers as well as how models utilizing their data are used. However, savvy firms already engaged in big data should not wait for agencies to act, especially given the uncertainty around how effective or restrictive any eventual regulations will be. Based on our market experience and observations, here are some guidelines, advice, and remedies to consider to help you avoid shooting yourself in the foot when utilizing big data.

Increase the likelihood that more of your big data will be accurate

"If they were more clever, they could cross-reference the home data with household income data to find major discrepancies."
—Survey respondent

Ask and expect more from big data brokers. Perhaps our expectations for big data are too high—but it's possible that we are asking too little of data brokers, especially given the study results we describe here. The role of data brokers has evolved over time. Traditionally, firms looked to data brokers to provide mailing lists and labels for prospective customers and, perhaps, to manage mailing lists and track current customers' purchasing behavior. However, the information that brokers provide now plays a much more integral role in our strategies, digital interactions, and analytic models. Consequently, we should be asking for more accountability, transparency, and continuous dialogue with these organizations. (See the sidebar, "What to ask your data brokers.")

Know the data sources. While you certainly want to understand where your own data come from, knowing the source and lineage is particularly important for information you source through data brokers. However, our research suggests data brokers fall on a spectrum when it comes to revealing their sources. Not all brokers organically generate the data they sell; rather, many license information to each other, as different brokers cater to various data use cases and business niches.

Put steps in place to verify that the brokers from which you source have adequate control over their data's accuracy, including control over and transparency regarding their data sources. Understand the surveillance proce-

WHAT TO ASK YOUR DATA BROKERS

Demand transparency regarding:

- Data source(s): the lineage of the data fields and values, timing of maintenance, update processes
- Data collection, validation, and correction methods
- Any relationships and interdependencies—for instance, interrelatedness between data sources and model inputs
- Model inputs and assumptions

Ensure ongoing communications with data sources in order to be kept abreast of any:

- Inaccuracies found in existing data sets
- Changes to models and/or assumptions and the rationale for such changes, as well as transparency to model logic and metadata
- Changes to categories and the rationale for such changes

Verify the appropriateness of the manner in which you are using their data:

- Explain to the broker how you are using data, and verify that their information is appropriate and sufficiently accurate for your context

Consider specifying accuracy and performance standards in your data broker contracts.

dures they have in place with these sources to track changes, measure accuracy, and ensure consistency. Develop and maintain processes to be notified of inaccuracies in the data, and understand how often information is validated or updated. Consider the significance of a five-year age difference: 20-year-olds are buying different products than those aged 25, just as those who are 25 are at a different stage in life than 30-year-olds.

Explore the data yourself. Before you use any big data (especially externally sourced) to guide your decisions and marketing strategies, do an exploratory data analysis yourself. If possible, test a sample for inaccuracies or inconsistencies against data fields you already have or can validate. On your own, consider digging into the data and doing validity checks, exploratory analysis, and data mining against individual and industry information. Does what

you are seeing make sense? For example, one of the authors of this very article was labeled as having an old-fashioned dial-up Internet connection rather than the actual broadband connection.

Alternatively, hire an expert to look at this data. Also, realize that internally gathered information often relies on a combination of sources—which could be external or outdated—and is also prone to human error, so the same verification tests should be performed here as well. A proper data governance framework can go a long way in helping to ensure your information is accurate, timely, and valuable.

Consider big data to be one more tool in the toolkit, not a replacement toolkit

Keep expectations for big data in check. It is often the case that big data might be directionally correct but still inaccurate at an individual level. The good news for firms and marketers is that big data analytics built on such "semi-accurate" information can provide predictive power overall. However, it is a mistake to expect individual micro-predictions to carry the same level of accuracy.[28]

Use and draw conclusions from big data judiciously. Big data is a great tool for marketers, but it should be thought of as a tool in the decision-making and marketing toolkit, not a replacement for the already existing toolkit. Consequently, don't rely too heavily on a limited number of data points, especially if accuracy is a potential peril. If you decide to do any micro-messaging, consider limiting its geographies and scope to avoid some of the perils we discussed earlier. Additionally, soliciting customer feedback on the data not only improves the prospect of more accurate data—it increases transparency within the relationship. However, as our findings suggest, you can't count on your customers to fill in the gaps adequately and accurately.

Complement big data with other decision-making tools. While big data is and will remain a powerful tool for firms and marketers when used appropriately, we've already explored the dangers of overreliance on it—which could also result in marketers losing faith in their own experience and intuition to help guide decisions.[29] Therefore, executives should complement the decisions derived from big data with their own insights based on experience and other research methods and sources (such as small-sample qualitative research). Regardless of the data quality, a good rule of thumb is to not over-rely on the data and outsource too many decisions.[30]

Continually connect with customers

Be nimble and responsive. Continually assess data sources and appropriateness of methodologies, models, and assumptions; frequently revisit and assess questions and category fit with changing target demographics and categories. Also, measure how successful target marketing efforts have been since incorporating insights from big data. Beyond quantitative

or objective measures, create feedback opportunities within your micro-targeting. After collecting feedback, spend time reviewing, incorporating, and adjusting your strategies based on this feedback. When appropriate, respond directly to those providing feedback—recent research suggests this may not only increase the likelihood of additional feedback, but also make the customer feel more valued and encourage an ongoing dialogue.[31]

Reward customers for correcting their data. While our study suggests that consumers are unlikely to correct information provided by a big data source, it's worth exploring their willingness to take corrective action for their own data if the request comes from a firm with which they have a relationship—and for which they see more direct value from such an action. Additionally, in an effort to thank customers for not only their patronage but for updating personal information, firms can offer incentives for their corrective efforts. The benefits could be many: accurate customer data; an active, direct line of communication; and, ultimately, a deeper connection with customers.

Regardless of our current infatuation with big data, we must remember that data should never take center stage at the expense of the customer. Firms that understand big data's limitations (and advantages) can add it to their marketing and analytical arsenal, aiming to foster and preserve customer relationships and the trust that they work so hard to develop and maintain.

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Navigating the future of work

Can we point business, workers, and social institutions in the same direction?

By John Hagel, Jeff Schwartz, and Josh Bersin
Illustration by Tim Marrs

"The future is already here"

What images does "the future of work" conjure up for you? In his 1930 essay, *Economic possibilities for our grandchildren*, John Maynard Keynes foretold a future of "technological unemployment" and 15-hour workweeks.[1] We've long since given up on early 20th-century utopian visions of a leisure society in which machines do almost everything for us. But there's no question that what we actually do these days is changing fast, and will continue to change.

MAYBE in your particular future of work, you imagine factories full of robots, automating commonplace tasks, while human beings orchestrate the work's ultimate goals and intent. Perhaps you think of the working population's shifting demographics, with the workforce growing older in developed nations, while emerging economies struggle to assimilate record numbers of young workers. Or you may envision a global gig economy in which most individuals work for themselves, lending their labor—physical or intellectual, online or in person—to a variety of employers on their own time and terms.

The future of work could involve all of these scenarios and more, as disparate forces act and interact to drive the way we behave in the pursuit of a comfortable living, a reasonable profit, and a stable and just society.

It's a big subject, and small wonder that pundits in the business and popular press have tended to narrow their focus, studying one or another of the dimensions of the future of work: automation, demographics, the growth of the contingent workforce, or something entirely different. While this narrowing of scope is understandable, the result is that we sometimes lose sight of the connections and interdependencies across all of these dimensions. We can't grasp where we are and where we're headed without seeing the full picture of this transformation in our lives, our businesses, and our society—and we can't see the whole thing unless we take a step back and let all the elements come into view.

The outlines of the picture are already emerging. Indeed, it may be misleading to explore all this under the heading of "the *future* of work," which suggests that the changes are not yet here, and will occur in an indeterminate number of years. The truth is that many of these changes are already playing out, driven by forces that have been underway for decades. As science-fiction novelist William Gibson reminded us, "The future is already here—it's just not evenly distributed."

The biggest challenge in understanding the future of work comes in surfacing the implications for three broad constituencies—the individual, businesses and other employers, and social and governmental institutions—and getting all three pointed in the same direction. Unless all three of these constituencies manage to align in their understanding and actions to address emerging opportunities and challeng-

We can't grasp where we are and where we're headed without seeing the full picture of this transformation in our lives, our businesses, and our society.

es, the road to the future of work will be bumpy at best.

Under the best of circumstances, everyone—individuals, businesses, and public institutions—will find this fundamental evolution in the nature of work challenging and stressful. But if our organizational and public policy leaders understand more fully how this complex landscape is evolving, they can target their moves in ways that will help workforces around the world—and societies in general—anticipate and prepare for the coming challenges.

A FRAMEWORK FOR UNDERSTANDING THE FUTURE OF WORK

WHAT are the components that collectively constitute "the future of work"? Perhaps the logical place to begin is with the forces that are driving these changes (figure 1). Based on our experience and research, we have identified three forces that are shaping the nature of future work and the future workforce:

Technology. Technological advances—for example, in the areas of robotics, artificial intelligence (AI), sensors, and data—have created entirely new ways of getting work done that are, in some cases, upending the way we use and think about our tools and how people and machines can complement and substitute for one another.

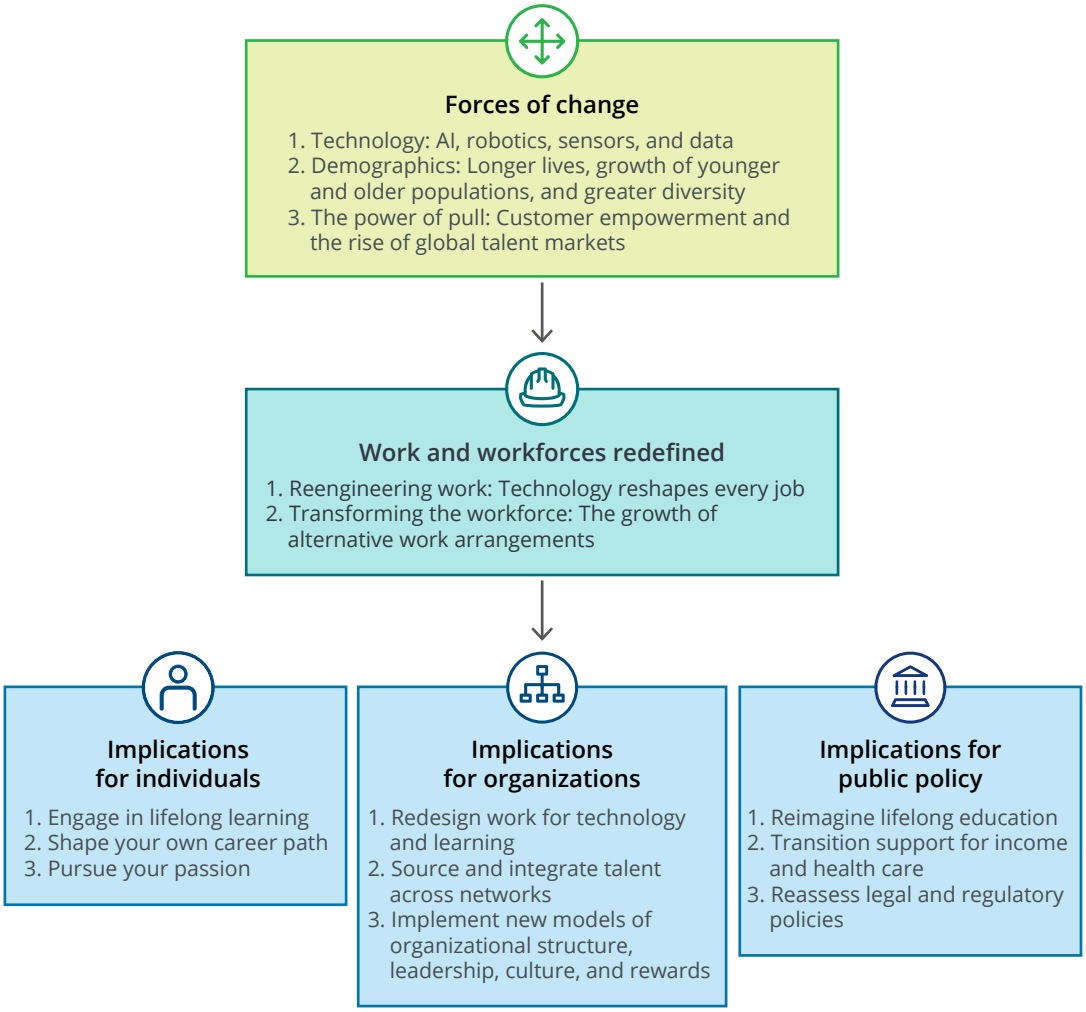
Demographics. Demographic changes are shifting the composition of the global workforce. In most places, people are living longer than ever, and overall, the population is becoming both older and younger, with individual nations becoming more diverse. Even more challenging, the younger generations will be increasingly concentrated in developing economies, while the developed economies (and China) get ever older.

"The power of pull." Largely thanks to digital technologies and long-term public policy shifts, individuals and institutions can exert greater "pull"—the ability to find and access people and resources when and as needed—than ever before. Institutions and prospective workers alike now have access to global talent markets, enabled by networks and platforms opening up new possibilities for the way each interacts with the other. The demand for these platforms will likely be enhanced by increasing customer power and accessibility of productive tools and machines, opening up opportunities for more creative work to be done in smaller enterprises and by entrepreneurial ventures.

While there are other forces shaping the future of work, we believe that they are part of the broader economic landscape or integrated with the forces identified above. For example, globalization is a long-term trend, which is reinforced by the technological, demographic, and "power of pull" forces discussed above.

These three driving forces are having two significant effects on work and the workforce.

Figure 1. A framework for understanding the future of work



Source: Deloitte analysis.

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First, technology is transforming the nature of work and forcing organizations to redesign most jobs. One result, we anticipate, will be the reconfiguration of jobs to leverage uniquely human skills: empathy, social and emotional intelligence, the ability to set context and define business problems. Another, due to the accelerating rate of technological change, will be the need for individuals to continually learn new skills to remain employable.

Second, the relationship between employer and worker is shifting. Where once most workers were full-time, on-balance-sheet employ-

ees with benefits and defined salaries, employers of the future will also execute a significant proportion of their activities through individuals engaged in alternative work arrangements, from freelancing to crowdsourcing to contract-based work.

These alterations to the nature of work and the workforce will have profound implications for individuals, organizations, and public policy makers—all three of which face imperatives for change driven by the need to adapt to the new realities of work in the future.

FORCES OF CHANGE

Technology: Artificial intelligence, robotics, sensors, and data

PAST technological revolutions—mechanization, electrification, computerization—radically reshaped work, jobs, and the organization of business and society. What is different this time is that today's advances in digital technologies are remaking not just manufacturing and low-skilled labor, the focus of past revolutions, but *every* sector of the economy and society.

Indeed, exponentially improving digital technology and infrastructures are reshaping the economics of work across the spectrum. On the one hand, automation is dramatically lowering the cost of certain routine tasks, as is expanded geographic access to low-wage labor. On the other, organizations can significantly augment the value of other tasks by leveraging technology capabilities and the increased ability to access deep specialization, wherever it is located.

Consider how today's technologies are beginning to augment human workers' capabilities. As just one example, by helping us "see" much more richly the evolving world around us, applications based on augmented reality (AR) can help us focus our curiosity, imagination, and creativity on early signals of the potential changes ahead that really matter.[2] Already, AR technology is helping workers out in the field, far from their desktop computers, to assess unexpected developments and focus their effort on the actions that could have the greatest impact.[3] And it's hardly just cognitive technologies such as AR: In the robotics space, prosthetics and other augmentation devices are helping technicians and others to perform operations unimaginable a decade ago.

More broadly, an expanding array of technologies, ranging from 3D printing to biosynthesis, are making productive tools accessible to smaller and smaller businesses, thereby eroding some of large companies' traditional advantages in developing and producing new products and services. This has the potential to create more viable job opportunities for workers in smaller enterprises over time.

We also should not lose sight of the impact of the accelerating pace of technology evolution and the proliferation of data on the skills required to do work. More and more knowledge

is being created—with other knowledge becoming obsolete—at an accelerating rate, making it necessary to update our skills and job descriptions ever more rapidly to keep up.[4]

Demographics: Longer lives, growth of younger and older populations, and greater diversity

The supply of workers is rapidly evolving globally as a result of shifting demographics, enhanced longevity, and increased focus on the inclusion of marginalized segments of the population.[5]

The workforce in many economies—especially the developed economies and China—is rapidly aging, as figure 2 illustrates. This demographic trend is further amplified by both low birth-rates and enhanced longevity made possible by advances in public health and medicine. For a variety of reasons, ranging from financial need to a desire to continue to make a difference, many older workers are extending their careers well beyond traditional retirement age.[6]

The prospect of older generations working for longer periods as their physical capability to

Figure 2. OECD labor participation rate, by age group

Source: Organisation for Economic Co-operation and Development, "Labour market statistics: Labour force statistics by sex and age: indicators," OECD Employment and Labour Market Statistics (database), DOI: http://dx.doi.org/10.1787/data-00310-en, accessed April 21, 2017; United Nations Department of Economic and Social Affairs, *The world population prospects: 2015 revision*, 2015, http://www.un.org/en/development/desa/publications/world-population-prospects-2015-revision.html.

The prospect of older generations working for longer periods as their physical capability to remain employed improves could affect the pace at which younger talent and ideas renew organizations.

remain employed improves could affect the pace at which younger talent and ideas renew organizations—and potentially intensify the intergenerational competition for jobs. It could also lead to a substantial increase in seniors participating in the "gig economy," out of post-retirement desire or necessity.

In parallel, developing economies are supplying a growing share of younger workers to the global workforce. Digital technology infrastructures are making a growing number of these workers available—as full-time or gig workers—to developed economies that are confronting an aging population, not to mention giving them access to each other across the developing world.

More generally, women and many marginalized population segments are slowly gaining ground in employment spheres around the world. As population growth in developed countries slows, organizations will be under increasing pressure to deepen the talent pool by including workers from more backgrounds. There's growing evidence that more diverse workgroups and teams generate more creative and higher-impact results[7]—an even more important reason for organizations to become more aggressive in drawing in diverse segments of the global population. The likely net effect of all of this will be the workforce expanding to historically underrepresented populations, as well as organizations needing to change work practices to accommodate a more diverse employee base.

The power of pull: Customer empowerment and the rise of global talent markets

Market trends will also play a role in shaping the future of work. In responding to both changing customer demand and the ability to address labor needs more flexibly, the power of pull will likely lead to much tighter alignment of work with customer needs.

Why are customers acquiring more power relative to vendors? Because of their new ability to choose from an expanding array of product and service options globally, to access more information about these options, and to switch from one vendor to another if their needs are not being met.

With buying options expanding, customers are becoming less satisfied with standardized,

mass-market products and services, instead seeking creative, tailored niche products, services, and experiences. This dynamic is playing out in digital product markets such as music, video, and software, but it has the potential to rapidly extend into physical products and services, as the technology trends outlined above make it far more feasible for niche vendors to access the means of production. The result is likely to be a growing fragmentation of product and service businesses, with small companies employing more of the overall labor force.[8]

On the supply side, labor markets are evolving in ways that enhance organizations' ability to access and work with talent when and where needed. The global digital infrastructures discussed earlier are making it possible for employers to connect with, combine, and leverage talent wherever it resides. A growing array of digital platforms is making it easier for potential employers (and customers directly) to find the most appropriate talent anywhere in the world and to pull that talent together to perform specific tasks. Conversely, the same digital platforms are making it possible for workers to exert pull of their own. Online communities such as Glassdoor offer workers a great deal of insight into prospective employers' operations and culture, narrowing employers' historical informational advantage; individuals operating in the gig economy can find, contract with, and work for employers worldwide using the Internet and other digital technologies.

The "power of pull" forces described above can spur growing demand for more creative work as customers shift away from mass-market products and services, as workers in smaller businesses gain greater access to the means of production, and as platforms help to connect niche product and service providers with smaller segments of customers globally.

WORK AND WORKFORCES REDEFINED

THESE three forces of change are leading to a profound shift in the nature of work. Employers and workers will no doubt find this shift challenging in the near term but, ideally, a growing number of people over time will be able to achieve more of their potential. Routine tasks will be increasingly automated, while technology-aided creative work expands and evolves in response to a growing array of unmet needs.[9]

Reengineering work: Technology reshapes every job

The industrial era defined work largely in the form of highly specialized and standardized tasks that became increasingly tightly integrated. This applied not only to factory jobs and manual work, but also to a broad range of white-collar and knowledge-worker jobs such as HR staff, legal staff, and even salespeople and marketers. And it is precisely components of these types of work that are vulnerable to disruption by robots and AI. Law firms are beginning to automate a significant number of

more routine tasks, news websites are beginning to use AI to write stories, and many of us use intuitive software to complete our taxes.

As technology accelerates its replacement of tasks once executed by humans, will it oust humans from performing work altogether (except for the work needed to build and maintain the machines)? Many conversations about the future of work quickly devolve into discussions of the potential of robotics and AI technology to cut costs, automate tasks, and displace human beings altogether. The anxiety is understandable, given these technologies' continuing exponential price/performance improvement and the impact they are already having on the elimination of jobs.

However, this narrow view misses much of the larger opportunity regarding future work and productivity. While perhaps a useful starting point, disassembling work into a set of tasks and orchestrating capabilities (people and machines) is not necessarily the goal. The greater opportunity to enhance productivity may lie in reinventing and reimagining work around solving business problems, providing new services, and achieving new levels of productivity and worker satisfaction and passion.[10] The growing availability of cognitive technologies and data also presents an opportunity to radically reengineer business processes leveraging the breadth and unique capabilities of people, machines, and data to achieve desired outcomes. We expect to see multiple approaches to redesigning jobs emerge: from a narrow focus on identifying tasks to automate, to the radical reengineering of business processes, to the reimagining of work around problem-solving and human skills.

In this view, employers should become much more focused on exploring opportunities to create work that takes advantage of distinctively human capabilities such as curiosity, imagination, creativity, and social and emotional intelligence. Research suggests that more than 30 percent of high-paying new jobs will be social and "essentially human" in nature.[11] Increasing diversity in the workforce will likely enhance the shift from routine tasks to more creative work, and we will see the emergence of hybrid jobs that increasingly integrate technical, design, and project management skills. The specific skills will likely come from diverse domains and evolve rapidly, increasing the need to accelerate learning for both individuals and employers to stay ahead of the game.

Research suggests that more than 30 percent of high-paying new jobs will be social and "essentially human" in nature.

We are in the early days of integrating industrial and software robots into work—and of un-

derstanding their varying impacts and results. Thus far, the picture is blurry. Recent MIT research, for instance, explores industrial robots' negative impact on employment and wages.[12] For example, a Mercedes-Benz production facility in Germany recently announced plans to reduce the number of robots on its production line and replace them with human labor—with increasing demand for customized auto options, reprogramming and switching out robots was more costly than shifting the line using human workers.[13]

Transforming the workforce: The growth of alternative work arrangements

Technology is transforming more than the way individual jobs are done—it's changing the way companies source labor. Many global companies already actively use crowdsourcing efforts to generate new ideas, solve problems, and design complex systems. Deloitte's Center for Health Solutions and Center for Financial Services, for example, collaborated with insurance company specialists on an online platform provided by Wikistrat, in four days generating 44 use cases regarding the potential for using blockchain technology in insurance.[14] Online platforms are playing a key role in accelerating the growth of this kind of crowdsourcing.

In the next few years, three factors are likely to drive rapid growth of the gig economy—defined as individual self-employed workers bidding for short-term tasks or projects. First, as companies face growing performance pressure, they will have more incentive to convert fixed labor costs, in the form of permanent employees, to variable labor costs incurred when there is a surge in business demand. Second, workers will likely increasingly seek work experiences exposing them to more diverse projects and helping them to develop more rapidly than in a single-employer career. (In a 2013 study, 87 percent of UK students with first- or second-class degrees said freelancing is a "highly attractive and lucrative career option.")[15] And a third factor driving the growth of the gig economy is the desire of workers who are marginalized or underemployed—younger workers in developing economies, older workers in developed economies, and unskilled workers around the world—to find some productive work, even if it may not be full-time employment.

The gig economy has already become a significant component of work in the United States. A recent study by Harvard and Princeton economists showed that 94 percent of net job growth from 2005 to 2015 was in "alternative work,"[16] defined as independent contractors and freelancers. A 2014 study estimated that 53 million people freelance in the United States (34 percent of the national workforce), with 1.4 million freelancers in the United Kingdom.[17]

Over the longer term, the gig economy may evolve into something quite different. Many of the gigs being done today—for example, drivers of cars in mobility fleets and basic data-gathering tasks—are routine tasks that are likely to be

In the new landscape of work, personal success will largely depend on accelerating learning throughout one's lifetime. As a lifelong learning imperative takes hold, we see individuals increasingly focusing on participation in small but diverse workgroups that can amplify learning.

automated over time. Gigs based on human capabilities—emphasizing curiosity, imagination, creativity, social intelligence, and emotional intelligence—will likely grow over time.

As the gig economy shifts to more rapidly evolving creative work, the way that work is done is likely to change, moving from short-term transactions to longer-term relationships that can help to accelerate learning and performance improvement. These more creative gigs—if they still qualify as gigs—will likely be increasingly done by small teams or workgroups that will collaborate on different projects over extended periods of time.[18]

IMPLICATIONS FOR INDIVIDUALS, ORGANIZATIONS, AND PUBLIC POLICY

Implications for individuals

In the new landscape of work, personal success will largely depend on accelerating learning throughout one's lifetime. As a lifelong learning imperative takes hold, we see individuals increasingly focusing on participation in small but diverse workgroups that can amplify learning. Workers will need to take action on their own to enhance their potential for success, but the impact of their efforts will be significantly influenced by the willingness and ability of the other two constituencies—businesses and public institutions—to evolve in ways aligned with the shifting nature of work.

Engage in lifelong learning. As rapid technological and marketplace change shrinks the useful lifespan of any given skill set, workers will need to shift from acquiring specific skills and credentials to pursuing enduring and essential skills for lifelong learning. Individuals will need to find others who can help them get better faster—small workgroups, organizations, and broader and more diverse social networks. We are likely to see much richer and more diverse forms of collaboration emerge over time.

Shape your own career path. Historically, a career was defined as a relatively stable, predictable set of capabilities that aligned with the needs of an organization and an industry. This included a progressive mastery of a set of predetermined skills required to advance in the corporate hierarchy, with accompanying salary boosts. But the half-life of skills and expertise

is becoming shorter and shorter, with new, unexpected skills emerging as valuable. This has two implications. With needs constantly shifting, employers are less and less able to provide employees with well-defined career paths spanning years or decades. And workers, to keep their skills current, must increasingly do whatever is necessary to accelerate their learning, including pursuing a diversity of work experiences or working for multiple "employers" at the same time.

Rather than relying on paternalistic employers to shape their careers' nature and progression, workers will need to take the initiative to shape their own personalized careers. And as work evolves, individuals should cultivate a "surfing" mind-set, always alert to emerging, high-value skills and catching the wave at an early stage to capture the most value from these skills.[19] To avoid getting stretched too thin and stay motivated, they must filter a growing array of skill opportunities through their personal passions.

Pursue your passion. What are the obstacles to success in work as it transforms? The biggest obstacle may be ourselves. Most of us have an understandably negative reaction to the mounting performance pressure that is already beginning to accompany the transition to new forms of work. With any disruptive transition, we tend to experience fear and stress, generating an impulse to hold on to what has driven success in the past. We must resist that temptation and use the shifts in the nature of work and employment as an opportunity to achieve more of our potential.

What can help us do that? Instead of just viewing a job as a means to a paycheck, we need to find a way to pursue work that we are truly passionate about. In our research into diverse work environments where there is sustained extreme performance improvement—everything from extreme sports to online war games—we identified the one common element as participants having a very specific form of passion—something that we call the "passion of the explorer." This form of passion has three components: a long-term commitment to making an increasing impact in a domain, a questing disposition that actively seeks out new challenges, and a connecting disposition that seeks to find others who can help them get to a better answer faster.[20] Tapping into this kind of passion can shift people from the fear of change to excitement about the opportunity to learn something new and to have a greater impact.

Organizations will not only need to redesign work—they will likely need to redesign work environments to support this new kind of work.

Implications for organizations

Employers can help individuals along this journey by shaping work and work environments and encouraging individuals to learn faster and accelerate performance improvement.

Redesign work for technology and learning. To take effective advantage of technology, organizations will likely need to redesign work itself, moving beyond process optimization to find ways to enhance machine-human collaboration, drawing out the best of both and expanding access to distributed talent. Businesses will be well advised to not just focus on automation but to identify the most promising areas in which digital technology can augment workers' performance as they shift into more creative and value-added work. For example, how can the technology be harnessed to "make the invisible visible" by giving workers richer, real-time views of their work? How can companies use robotics to provide workers with access to environments that would be far too dangerous for humans?[21] What are some ways in which AI-based technology can complement human judgment and contextual knowledge to achieve better outcomes than either human or machine alone?[22] This is perhaps the greatest challenge for businesses in the next decade: how to plan for the redesign and reinvention of work to combine the capabilities of machines and people, create meaningful jobs and careers, and help employees with the learning and support to navigate these rapidly evolving circumstances.

Organizations will not only need to redesign work—they will likely need to redesign work environments to support this new kind of work. There's been a lot of effort to reshape environments to make them more enjoyable and flexible to accommodate changing worker preferences and needs, but what if we took the need to accelerate learning and performance improvement as our primary design goal? What would work environments look like then?[23]

Source and integrate talent across networks. As organizations develop a better understanding of the expanding array of talent options available, they will need to design and evolve networks that can access the best talent for specific work. Beyond focusing on acquiring talent to be employed in their own organizations, they will need to develop the capability to access good people wherever they reside. Since this talent will likely evolve rapidly, these networks will have to be flexible and adapt quickly to changing talent markets.

To accelerate learning and performance improvement, organizations will need to decide where they can truly be world-class and where they can access other talent from top global sources. They will need to cultivate a continuum of talent sources—on and off the balance sheet, freelancers, and crowds and competitions—that harness the full potential of the

open talent economy and tap into talent wherever it resides geographically.

Implement new models of organizational structure, leadership, culture, and rewards. Organizational structures are evolving from traditional hierarchies to networks of teams that extend well beyond the boundaries of any individual organization. Hierarchical structures are well suited for routine tasks, but as the emphasis shifts to more creative work done by small, diverse workgroups connecting with each other in unexpected ways, more flexible network structures will become more important. As the continuum of talent resources expands and becomes more diversified, organizations will need to develop richer relationships in larger business ecosystems and find ways to participate more effectively on scalable platforms to access expertise and enhance the ability to work together to accelerate performance improvement.[24]

Organizations will need to cultivate new leadership and management approaches that can help build powerful learning cultures and motivate workers to go beyond their comfort zone. Indeed, leadership styles must shift from more authoritarian—appropriate for stable work environments shaped by routine, well-defined tasks and goals—to collaborative. In the future of work, we expect that the strongest leaders will be those who can frame the most inspiring and high-impact questions and motivate and manage teams.

To foster these new forms of creative work, organizations will need to reassess the rewards they offer to participants. In a world where routine tasks define work, people look to extrinsic rewards such as cash compensation to stay motivated. As the nature of work shifts to more creative work that rapidly evolves, participants are likely to focus more on intrinsic rewards, including the purpose and impact of their work and the opportunity to grow and develop. Organizations may find it increasingly hard to hold on to employees if they focus narrowly on extrinsic rewards.

Implications for public policy

Policy makers have an interest in both hastening the emergence of new forms of work—the better to raise citizens' overall standard of living—and preparing for the stresses of the transition.

Reimagine lifelong education. Policy makers face significant and formidable challenges to rethink education to draw out students' creative capabilities and to establish a framework to help everyone develop their talent more rapidly *throughout* their lives. Our educational institutions were established, decades or even centuries ago, to provide for mass education for stable careers. The short half-life of learned skills and the rapidly evolving technological

work landscape raise the need for new models that support ongoing training and education. How can we create educational models and funding that provide employees with three, four, or more opportunities to reskill and pivot to new fields and new careers?

This emphasis on lifelong education could have an especially strong impact if it were to include a more effective focus on marginalized populations and older generations who do not want to or cannot transition out of the workforce. Payment structures and incentives could

be designed to support this approach to lifelong education: facilitating access to ongoing education and training throughout a working career that might span 50 years and many different types of work.

Transition support for income and health care. What public policies can help in reducing the stresses that workers will likely face when shaping their own careers, learning new skills, and participating in global talent networks? For those caught in challenging and unexpected transitions, how can public policies help to shorten the time spent on the unemployment rolls, support necessary retraining, and ensure the provision of basic necessities such as health insurance? Digital technology infrastructures and more accessibility to data about individuals will make it increasingly feasible to tailor transition programs to people's evolving needs. Governments around the world are considering and revisiting basic income guarantees in various forms, and some recent proposals have surfaced to tax robots as a way to provide funding for transition support programs.[25]

Reassess legal and regulatory policies. What role can all dimensions of public policy play in accelerating broader inclusion in the workforce, talent development, and innovation capability?[26] Governments should consider updating the definitions of employment to account for freelance and gig economy work and the provision and access to government health, pension, and other social benefits through micro-payment programs. Business formation and bankruptcy rules could be updated to make it easier to launch—and exit—a business as an entrepreneur. The future of work will likely involve a higher percentage of start-ups and small businesses. Policymakers will likely find themselves under pressure to update regulations to make starting small ventures easier.

CONCLUSION: A FRAMEWORK FOR THE FUTURE

THE future of work is unfolding rapidly. Today, none of these constituencies—individuals, businesses, public institutions—is prepared for the potentially turbulent and painful transition and possibilities ahead. The goal of this framework is to inform and motivate individuals, various forms of organizations, and public policy makers to *proactively* navigate the future of work and to come together and act now to make the transition as positive, productive, and smooth as possible.

Every constituency needs a plan, today, for how to prepare to address the impact of these forces and their effect on the redesign of work and jobs:

- Individuals need to set their sights on longer careers, with multiple stages, each involving ongoing training and reskilling.

- Businesses must prepare to redesign work and jobs to take advantage of the growing capabilities of machines and the need to retrain and redeploy people to higher-value and more productive and engaging jobs working alongside smart machines and many types of workers—on and off the balance sheet, in crowds, and around the world.
- Public institutions need to proactively prepare for educational challenges, including funding for ongoing education, programs to mitigate the transition costs, and updating regulatory frameworks to support new types of work and workers and a more entrepreneurial economy.

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Here is Your 1956 Leave Card
1 1/4" (3.2cm.)
CALENDAR
Instruction
Figure 11.28
Figure 11.29

Meet the US workforce of the future

Older, more diverse, and more educated

By Patricia Buckley and Daniel Bachman
Illustration by Wayne Brezinka

EXAMINING FUTURE WORKFORCE TRENDS

ARE you a US-based organization searching for tomorrow's workers? Look around your workplace. The oldest Millennials are just 37, and will likely keep working for several decades.[1] The demographic changes that determine many of the key characteristics of the workforce happen slowly. But they happen. Over time, those demographic shifts can compound to make a big difference. It's a difference we can already see.

The main long-term changes in the workforce are, in fact, not new; employers have been adjusting to them for decades. Yet they can have real implications for how organizations approach everything, from workforce planning to diversity initiatives. They are:

1. **The US workforce is aging, and it will continue to age.** That's partly because of low birth rates—but it's also because people more often continue to work even as they get older. If 70 is the new 50, we shouldn't be surprised to find more 70-year-olds working. That's already been happening, and it is expected to happen even more in the future.

2. **The US workforce is becoming more diverse.** Changing immigration patterns and the entrance of more women into the labor force started this process in the 1960s, and it will likely continue. If current trends continue, tomorrow's workforce will be even more diverse than today's—by gender, by ethnicity, by culture, by religion, by sexual preference and identification, and perhaps by other characteristics we don't even know about right now.

3. **Americans continue to become more educated.** Like all demographic processes, the slow rate of the change may make it less than obvious to employers who are coping with fast change in production technologies. But more and more young people are going to college, and many workers are increasingly trying to improve their educational background mid-career.

One could say that tomorrow's workers will be much like today's—but more so. And the challenges and benefits of an aging, diverse, and educated workforce, many of which are already evident, will likely only grow in the future.

CHANGING POPULATION, CHANGING WORKFORCE

WITH Millennials—who represent the largest labor market share of any single generation—holding center stage, and Generation Z (post-Millennials, born after 1995) now entering from the wings, one might think that the US workforce of the future will be increasingly tilted toward younger workers.[2] However, on the whole, pro-

jections suggest that America's future workforce will be *older* than the current workforce, just as it is expected to be increasingly female and more racially and ethnically diverse.

This age shift in the workforce mainly results from increased population and labor force participation among older age cohorts, combined with declining population and labor force participation of the youngest cohort. As shown in table 1, the three oldest cohorts are projected to increase their labor force participation rates through 2024, just as they have over the prior 20-year period. The labor force participation rate of the large middle section of the labor force, 25 to 54, is expected to rebound slightly, after 20 years of decline. The labor force participation of the youngest cohort, 16 to 24, is expected to continue trending down, as more young people stay in school longer, as we discuss later. When the projected labor force participation rates of each cohort are multiplied by the cohort's population size, the overall picture, shown in the last row of table 1, indicates a continued decline in the participation rate.

Changes in population growth across the various cohorts support these labor force participation trends: As older cohorts' populations increase (table 2), so would their presence in the labor force—a 55.4 percent increase in the 65–74-year-old contingent, and an 85.5 percent increase among those 75 and older. An absolute decline in the youngest group's population could translate to a 13.1 percent contraction in that cohort of the labor force. Even with these shifts, the 25–54-year-old group will still make up the majority of the workforce, although the proportion of workers in this

Table 1. Labor force participation (actual and projected), by age group

Cohort	1994	2004	2014	2024
16 to 24	66.4%	61.1%	55.0%	49.7%
25 to 54	83.4%	82.8%	80.9%	81.2%
55 to 64	56.8%	62.3%	64.1%	66.3%
65 to 74	17.2%	21.9%	26.2%	29.9%
75 and older	5.4%	6.1%	8.0%	10.6%
Total	66.6%	66.0%	62.9%	60.9%

Source: Bureau of Labor Statistics.

Table 2. Source of changes to the workforce's age makeup

	Percentage change between 2014 and 2024		
Cohort	**Labor force participation rate**	**Civilian population**	**Total labor force change**
16 to 24	-9.6%	-3.8%	-13.1%
25 to 54	0.4%	3.5%	3.9%
55 to 64	3.4%	3.1%	6.6%
65 to 74	14.1%	36.1%	55.4%
75 and older	32.5%	40.0%	85.5%
Total	-3.2%	8.5%	5.1%

Source: Bureau of Labor Statistics.

category will decline, as will the proportion of 16–24-year-olds (figure 1), under the BLS projections. The only age group projected to gain share between 2014 and 2024 is the 55-and-over age group.

Age will not be the only distinguishing demographic characteristic of the workforce of the future. Women are expected to continue to gain share, rising from 46.8 percent of the workforce in 2014 to 47.2 percent in 2024. Even though the overall labor force participation rate is projected to decline (as shown in table 1), interestingly, the labor force participation rate of women aged 25 to 54 is projected to rise between 2014 and 2024 (from 73.9 percent to 75.2 percent), while the rate for men in the cohort is expected to decline (88.2 percent to 87.3 percent).

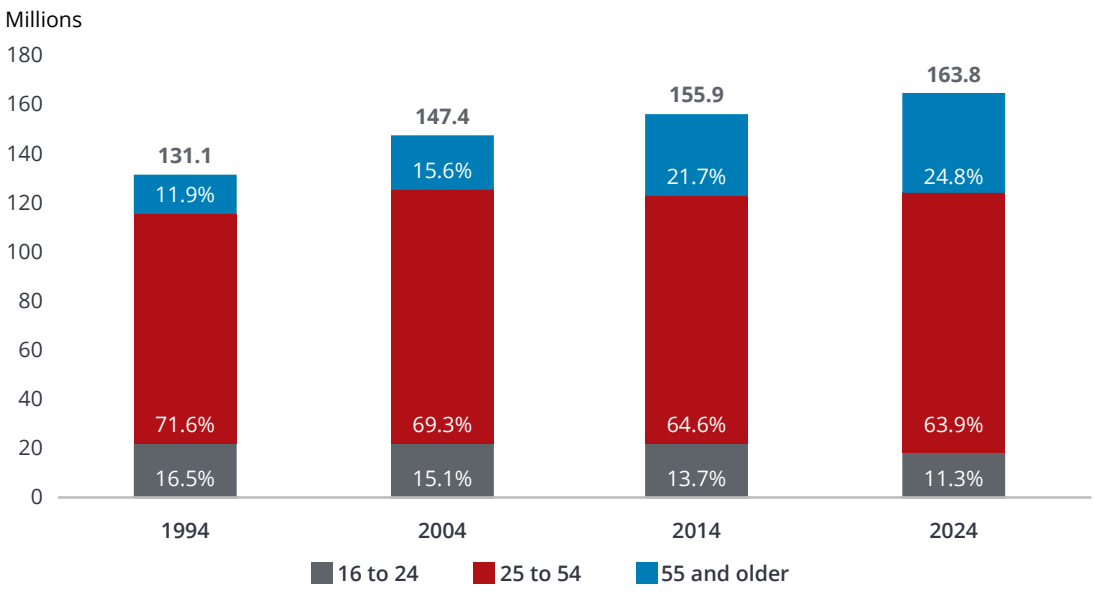
Another trend that is expected to continue through 2024 is the increasing diversity of the workforce. By 2024, less than 60 percent of the labor force is likely to define itself as "white non-Hispanic." As recently as 1994, over three-quarters of the labor force fell into that category. Hispanics could comprise 20 percent of the labor force in 2024.The proportion of African-Americans in the labor force is projected to rise to 12.7 percent in 2024 from 12.1 percent in 2014; the proportion of Asians to 6.6 percent in 2024 from 5.6 percent in 2014.[3]

HIGHER EDUCATION

THE US labor force has become more educated in each progressive generation. That trend does not seem to be slowing. A simple measure of education is the share of the labor force (or population) with at least a bachelor's degree, but this ignores some key details—particularly the important role of community colleges in the US educational system. However, a less detailed picture of education attainment would not change the story, which is fairly straightforward: Young people are increasingly likely to graduate from high school and go to post-high school educational programs, and middle-aged (and even older) people have continued to acquire educational credentials throughout their lives.

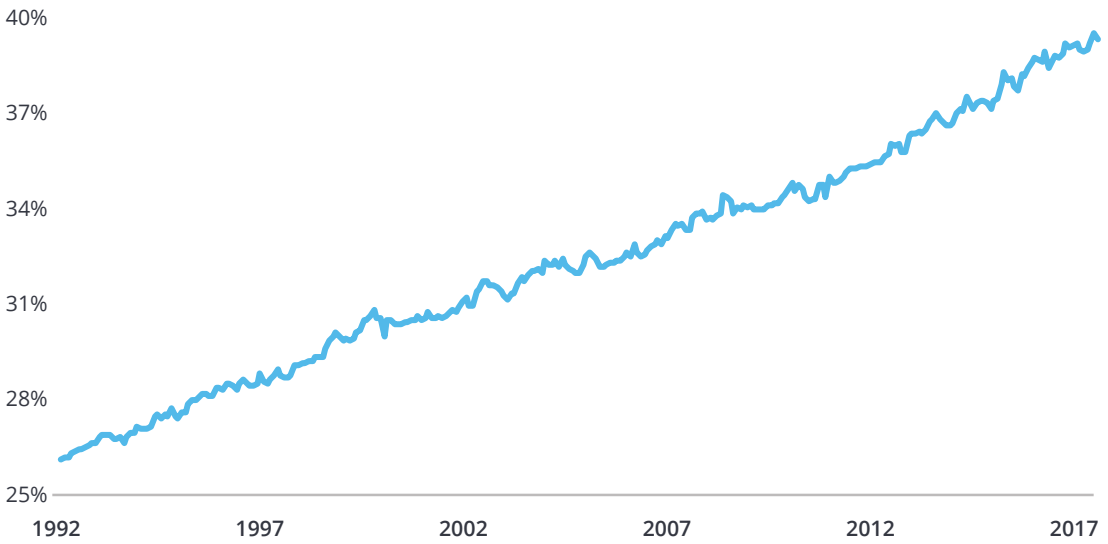
Figure 2 shows that the share of workers with at least a bachelor's degree has continued to grow steadily through business cycles, financial crises, tech and housing booms and busts, and other major economic events. The share of bachelor's and higher degree-holders in the labor force grew from one-quarter to two-fifths of the labor force in less than 25 years. The continued intensification of education reflects an acceleration in the rate in which younger people have been going to college—and an in-

Figure 1. US labor force, by age



Source: Bureau of Labor Statistics.

Figure 2. Share of labor force with at least a bachelor's degree



Source: Bureau of Labor Statistics; Haver Analytics.

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crease in the number of older people who have gone back to school to complete or enhance their education.

Currently, young adults are more educated than older adults. As older, less-educated cohorts leave the labor force, and more-educated cohorts enter, the education level of the entire labor force improves over time. In 1999, 23 percent of the US population had earned a bachelor's degree, and 4 percent had earned a master's. By 2015, these numbers had risen to 27 percent and 7 percent, respectively.[4] The growth isn't fast, but it has been relentless. And, over long periods of time, it can result in a labor force very different from prior decades.

Table 3 shows our forecast of the share of labor with various educational attainments in 2025. The forecast assumes that the educational attainment of the youngest cohort grows at the average rate between 1999 and 2015, and that the educational level of each cohort remains unchanged as it ages.

Our forecast indicates that, by 2025, almost two-thirds of the labor force will likely have some education beyond high school. That contrasts to a little less than half in 2005, just over a decade ago.

This forecast could even be conservative, because it assumes that educational attainment is frozen for each cohort, whereas in fact, people

Table 3. Change in educational attainment by level: History and forecast

	High school or less	Some college/ associate degree	Bachelor's	Advanced
2005	45%	26%	19%	10%
2015	42%	26%	21%	12%
2025	36%	28%	23%	13%

Source: US Census Bureau, *Current population survey: 2015 annual social and economic supplement*; Deloitte calculations.

often continue to go to school later in life. Table 4 shows educational attainment by five-year cohort in 2005, and for the same people (10 years older) in 2015. In every cohort, educational attainment improved—among the same people. Impressively, the number of people aged 40 to 44 years that earned a bachelor's degree by 2015 rose by 1.6 percentage points. Younger

Table 4. Educational attainment growth over time

Age in 2005	Bachelor's degree and above 2005	Bachelor's degree and above 2015	Percentage change from 2005 to 2015
25 to 29	28.8%	36.0%	25.0%
30 to 34	32.0%	36.5%	14.1%
35 to 39	31.1%	34.7%	11.6%
40 to 44	28.9%	31.7%	9.7%
45 to 49	28.5%	30.3%	6.3%
50 to 54	30.6%	31.6%	3.3%
55 to 59	30.1%	31.3%	4.0%
60 to 64	26.5%	26.9%	1.5%
65 to 69	21.1%		
70 to 74	19.9%		

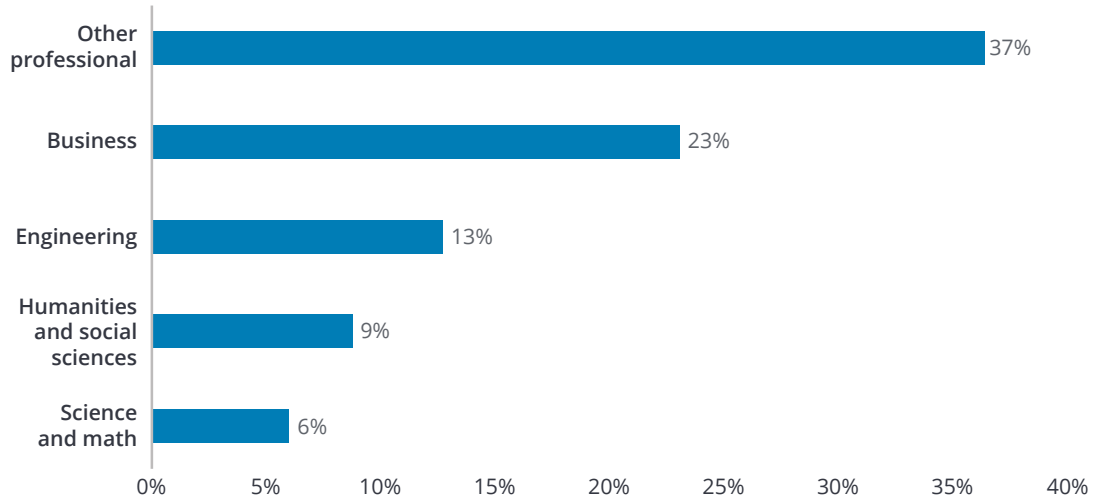
Source: US Census Bureau, *Current population survey: 2015 annual social and economic supplement*.

people saw even larger gains. It is clear that the possibilities of education do not end with the "usual" graduation ages, and that people in young middle age are often willing to continue their education.

What are people studying? This has become a focus of attention in recent years. Some policymakers have expressed concern that US higher education is increasingly turning out graduates trained in less valuable humanities and social science areas, rather than in the (as they claim) more important science, technology, engineering, and mathematics areas.[5] Aside from ignoring the importance of skills in humanities and social sciences for the workplace, the idea that the higher education system is overly skewed toward producing these majors is an oversimplification at best.

Figure 3 shows the share of bachelor's degrees conferred in the 2014–15 academic year by broad category.[6] The chart shows that the vast majority of US students graduated with degrees in professional fields such as education, communications, and law (note that these are bachelor's degrees, not JDs, so these graduates obtained paralegal credentials rather than law degrees). The single largest major was business, accounting for almost one-quarter of all US degrees. Engineering was also a popular subject. Substantially more students obtained bachelor's degrees in engineering subjects than in the humanities and social sciences.

Figure 3. Degrees conferred by major, 2014–2015, share of total



Source: US Department of Education.

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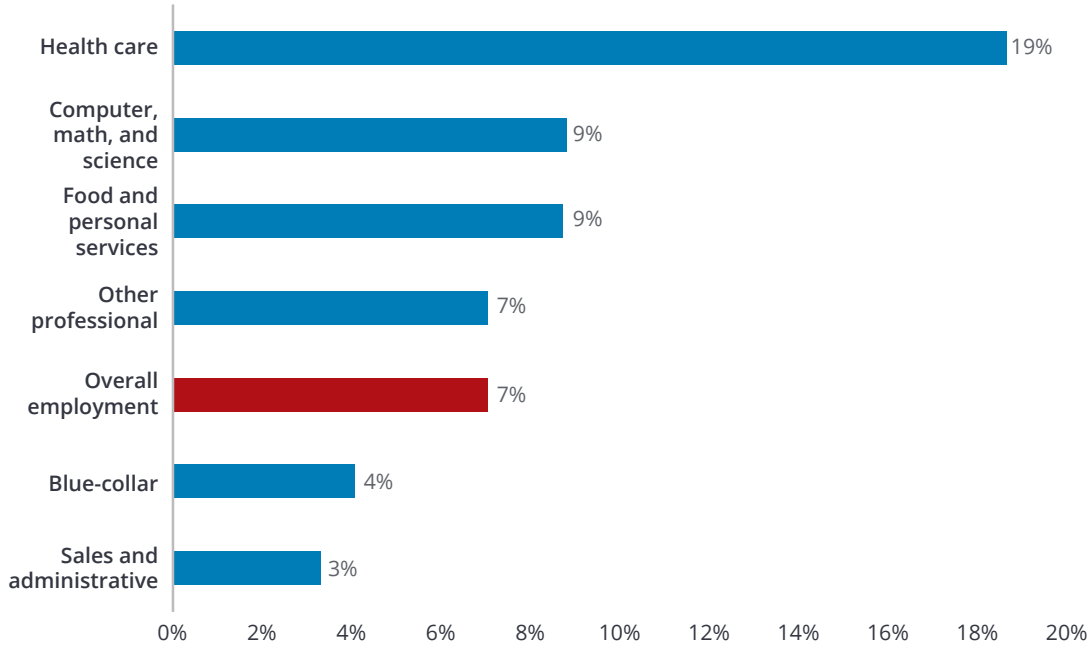
Figure 4. Employment by occupation, projected growth rate, 2014–2024



Source: Bureau of Labor Statistics.

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The types of majors that critics claim are somehow oversubscribed do not, in fact, attract many students. Just over 9,000 students graduated with philosophy majors, for example. History and English graduates were more numerous, although many of them have found employment in the large demand for high school teachers in these subjects. But humanities majors have constituted a small share of total graduates.

Analysts should take care in interpreting the relevance of college majors for the workforce. Only about 27 percent of college graduates work in jobs directly related to their majors.[7] US businesses have traditionally been very flexible about matching credentials to jobs, perhaps viewing a college degree as a more general indication of knowledge and flexibility than an indication of specific knowledge.[8] This suggests that the important question for the future of the workforce may be the rate of growth of college graduates, rather than the specific courses of study they undertake.

OCCUPATIONS OF THE FUTURE

OCCUPATIONS represent the demand, rather than supply, side of the labor force equation. When the labor force becomes more educated, the demand for educated workers is generally also forecast to grow.

While this trend may be well-known, some critical details are often not as well understood.

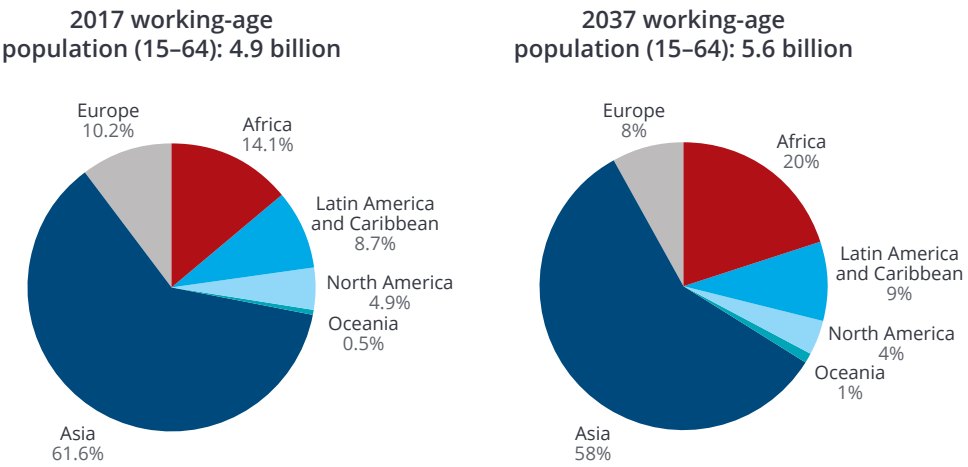
Figure 4 shows the projected 10-year growth of broad occupational categories.[9] The Bureau of Labor Statistics projects total employment to grow 7 percent, but the occupational mix is expected to change. Traditional blue-collar jobs and administrative and sales jobs are projected to grow more slowly than the average. About one-quarter of the net job gain is expected to be in health care occupations, which are projected to grow almost 20 percent over 10 years. Jobs for health care practitioners and technicians could grow more slowly than jobs for health care support occupations although, in absolute terms, the number of new jobs for the former may be greater than new jobs for the latter. That is because there are about twice as many health care practitioners today, so the slower growth rate for practitioners is off a much larger base.

Computer, math, and science occupations are projected to grow relatively quickly (but at half the rate of jobs in health care occupations). However, these occupations are expected to account for just 7 percent of all new jobs, because they make up a relatively small part of total employment (5 percent in 2014). Food service and personal service occupations are projected to also grow relatively quickly. This reflects the increasing bifurcation of the US labor force into highly skilled, well-paid professional jobs and poorly paid, low-skilled jobs, with relatively fewer jobs in middle-skilled, moderate-pay jobs such as traditional blue-collar and administrative occupations.

Occupational definitions and requirements are fluid and change over time. For example, today's accountants need a set of basic computer skills, which would have been completely unnecessary 30 years ago. This means that occupational projections are an incomplete picture of the requirements of the labor force. In particular, some analysts believe blue-collar occupations increasingly require computer and mathematical skills, which was unheard of in the past; occupational projections such as these, which imply a static set of skills for a given occupation, may understate the need for more highly educated workers with quantitative skills in the future labor force where even these "low-skilled" occupations require such skills.[10] Deloitte researchers have explained how demand for general abilities—rather than specific occupational skills—is expected to drive employment in the United Kingdom, and the United States should likely expect to see a very similar trend.[11]

Occupational definitions and requirements are fluid and change over time.

Figure 5. Comparison of future working-age populations, global



Source: US Census Bureau; International Data Base.

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AN INTERNATIONAL PERSPECTIVE

RELATIVE to the rest of the planet, the US labor force, along with its neighbors Canada and Mexico, is projected to continue to shrink. As shown in figure 5, North America, which now accounts for almost 5 percent of the global working-age population, will likely comprise only 4 percent 20 years from now. Asia's share will also likely fall. The future workforce globally could be found more and more in Africa, where the global workforce share is projected to rise almost 6 percentage points.

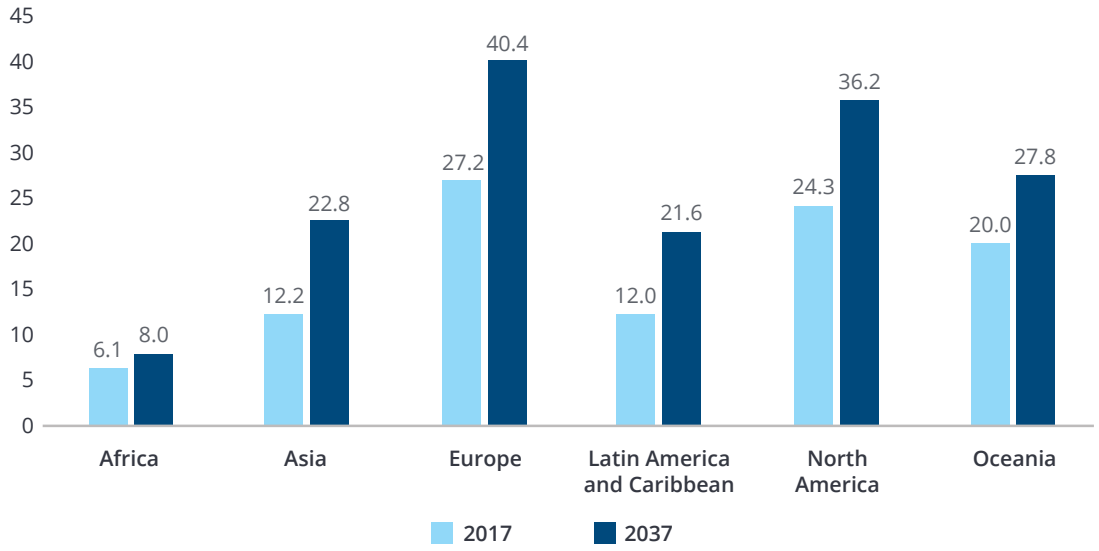
As in the United States, the slow growth of the working-age population combined with longer life expectancies will result in a growing dependency ratio, which is the ratio of retirees to working-age people. In North America, the ratio is projected to rise from 24 retirees per 100 working-age people today to 36 in 2037. Europe could experience an even higher dependency ratio, but the problems associated with a growing population of retirement-aged people will likely be felt around the world (figures 6 and 7).

WHAT DOES ALL THIS MEAN FOR YOU?

THE steady speed of demographic change can provide insights about the future workforce. While tomorrow's workforce won't look completely different from today's, the challenges of the future workforce are still today's challenges. Understanding these demographic changes and directions, along with the changing nature of work and jobs, could be critical for business and government leaders. These demographic trends suggest some

Figure 6. Retiree dependency ratios, global regions

Number of retirees per 100 working-age people



Source: US Census Bureau, International Data Base.

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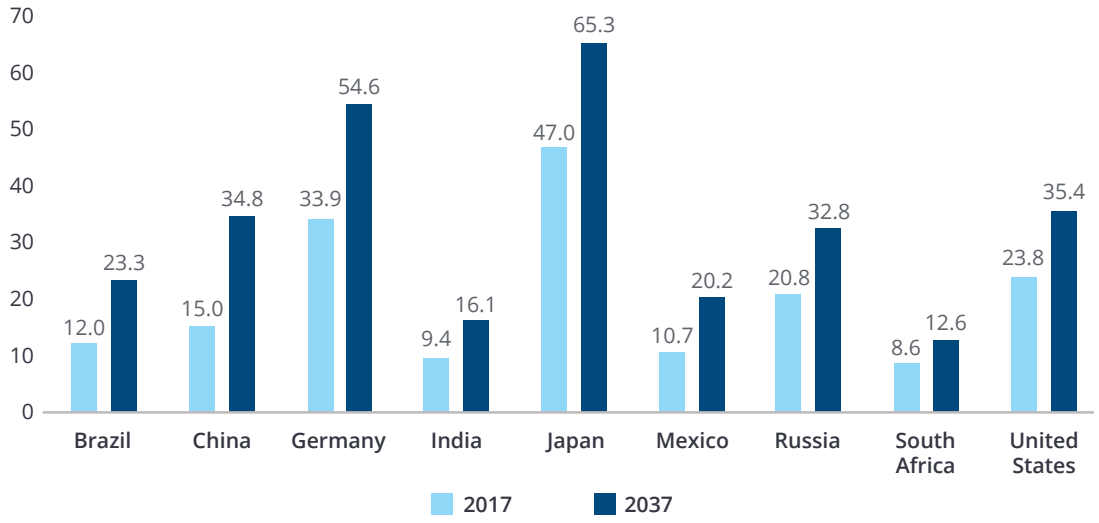
Figure 7. Retiree dependency ratios, selected countries

Number of retirees per 100 working-age people



Source: US Census Bureau; International Data Base.

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important potential implications and actions to consider.

Use data for workforce planning and identifying shifting demographics. Do your company's workforce planning and analyses reflect the changes in your workforce demographics? Data analytical tools can assist in better understanding how your workforce is aging and can provide greater insights on your organization's future workforce. Leaders can proactively prepare talent strategies by utilizing data and workforce planning tools to provide a clearer line of sight into their changing workforce composition.

Develop cross-generational and diverse talent pipelines. Do your development programs reflect the evolving realities of your workforce demographics and, specifically, the needs of different generations and populations in your workforce? It could be beneficial to diversify your leadership pipelines to ensure all populations are well represented in the future. Research for the 2017 Deloitte *Global Human Capital Trends* report showed that, across a sample of 10,400 surveyed executives, many reported weak programs in their pipeline and training for:

- Millennial leaders (45 percent reported weak program capabilities)
- Women leaders (43 percent reported weak program capabilities)
- Diverse leaders (31 percent reported weak program capabilities)

Better addressing the development needs of these often-underserved populations—specifically, by supporting secondary education or additional leadership training—can help strengthen your future workforce pipelines.

> Organizations should consider a focus on training that balances both skills development for current roles while also cultivating the necessary skills for future roles and opportunities.

Develop talent strategies for workforce segments at all ages and at different stages of their career. Generational diversity will likely continue to define the workforce, with older workers representing one of the fastest-growing segments. Providing targeted training solutions that meet their needs and learning styles can be important in ensuring continued productivity throughout a worker's career. Research shows that younger and older adults have somewhat different learning styles.[12] Therefore, organizations should consider putting development programs in place to meet these varying generational needs and

learning styles at each stage in a worker's career.

Offer opportunities for lifelong learning and reskilling. Do your learning and development programs and incentives support, encourage, and reward ongoing learning and reskilling? Do your training policies support the need for constant training in response to the rapid evolution of business and functional knowledge and technologies? Organizations should consider a focus on training that balances both skills development for current roles while also cultivating the necessary skills for future roles and opportunities. To do this, employers are encouraged to facilitate formal degree programs—allowing employees to obtain a second or third degree or certification—to expand their skills, complementing informal programs and resources and gaining access to new career paths.

As the 21st-century labor market becomes older, brings newer skills, and shifts across regions, businesses that expect to be able to manage their future workforce the same way they do today may see less success, while those that start planning for these changes will be at an advantage.

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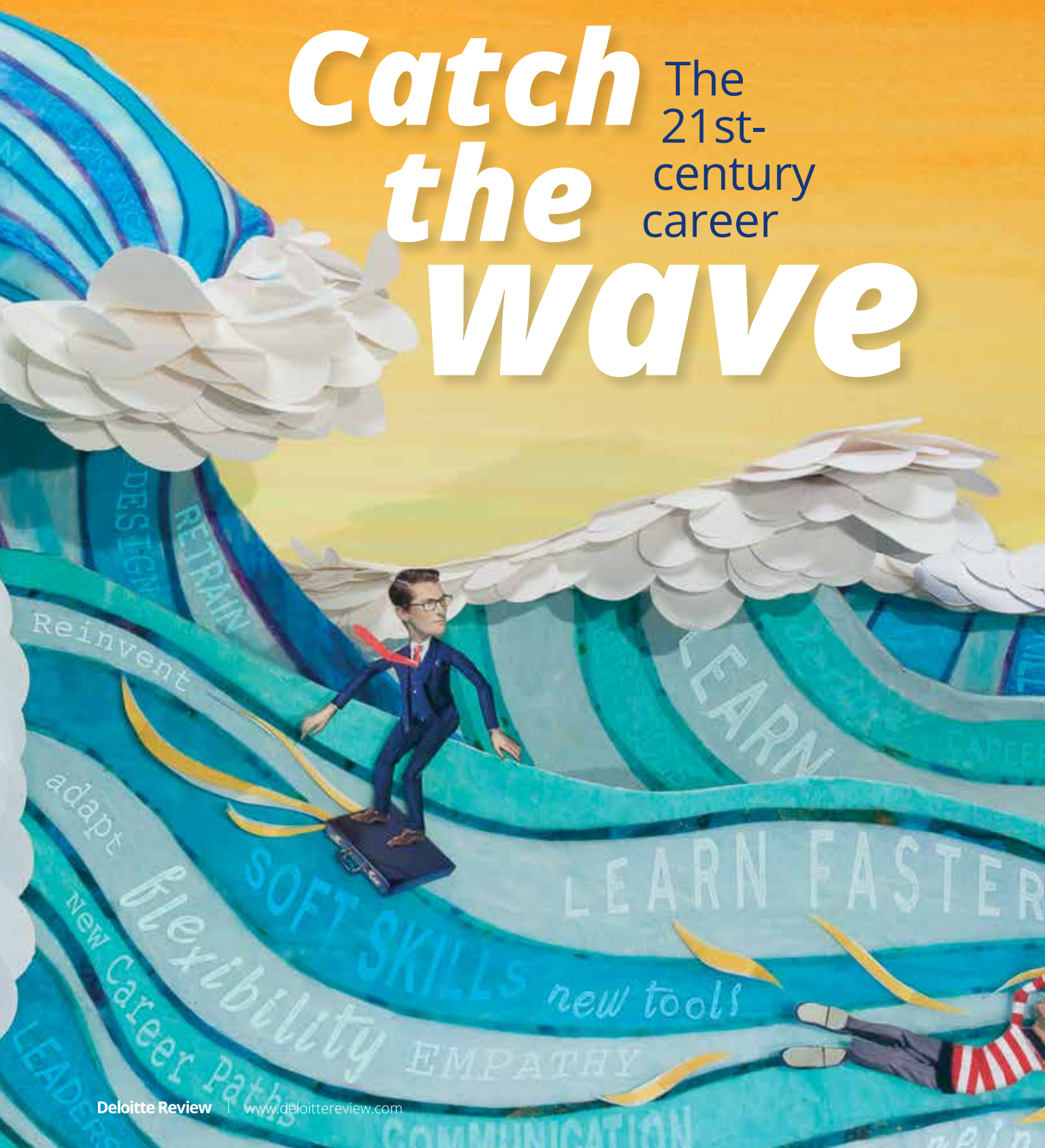
Catch the wave

The 21st-century career



By Josh Bersin
Illustration by Pushart

NEW MODELS FOR A NEW WORLD

OFFERING employees a rewarding career used to be easy: You'd hire a bright young person out of college, plug him into an entry-level role, and then watch him climb the corporate ladder over the years as he progressed toward retirement. The company could plan for this continuous process—hire people based on their degrees, help them develop slowly and steadily, and expect some to become leaders, some to become specialists, and some to plateau.

Today this model is being shattered. As research suggests, and as I've seen in my own career, the days of a steady, stable career are over. Organizations have become flatter[1] and less ladder-like, making upward progression less common (often replaced by team or project leadership). Young, newly hired employees often have skills not found in experienced hires, leaving many older people to work for young leaders. And the rapid pace of technology makes many jobs, crafts, and skills go out of date in only a few years.[2]

The training department used to offer a stable and well-architected career (I spent my entire first year at IBM as a "trainee," with a 10-year career path clearly laid out). Today, many training departments are struggling to keep up, often pointing us to online courses and programs, telling us that it's our job to "reskill ourselves." And while they try to give us what we need to stay ahead, research shows that they are also falling behind: Employees rate their L&D departments a dismal -8 in net promoter score, lower than almost any product in the consumer landscape.[3]

As technology evolves apace and more of us work part-time, these trends are only accelerating. LinkedIn co-founder Reid Hoffman believes that careers are now simply "tours of duty,"[4] prompting companies to design organizations that assume people will only stay a few years. And data bears this out: 58 percent of companies believe their new employees will stick around less than 10 years.[5] (LinkedIn research shows that, on average, new degree-holders have twice as many jobs in their first five post-college years now as they did in the mid-1980s.[6])

But hold on. The world of careers doesn't have to be so difficult and unforgiving. Organizations *can* adapt their career strategies and help people learn faster and continue to stay engaged. It just takes a rethinking of the problem, and a need to be aware of how jobs, careers, and skills are rapidly changing.

The bottom-line question is this: How can organizations build career models that encourage continuous learning, improve individual mobility, and foster a growth mind-set in every employee, year after year? This is the opportunity for today; companies that figure this out will outperform, out-innovate, and out-execute their peers.[7]

The changing nature of careers

Let's examine what a "career" really is. The traditional idea of a career has three components:

- **A career represents our expertise, our profession, and ultimately our identity.** It defines *who we are* and *what we do*. This form of self-identity makes changing careers dauntingly difficult: What if we switch careers and fail? Then who are we?

- **A career is something that builds over time and endures.** It gives us the opportunity to progress, advance, and continuously feel proud. When we are asked to change our career or path, what happens to all we have learned? Do we throw it all away? Or can we carry it forward?

- **A career gives us financial and psychological rewards.** It makes life meaningful, gives us purpose, and pays us enough to live well. What happens if our career suddenly becomes less valuable, even if we still enjoy it? Should we continue to make less money or jump to a new path?

The changing world of work has disrupted all three elements: expertise, duration, and rewards. And as scary as this may be for employees trying to stay ahead, it's equally disruptive for employers who must try to hire and develop the workforce of today, tomorrow, and five years from now.

Expertise has an ever-shorter shelf life

It used to be that only certain types of jobs—think of computer programmers and IT trou-

The changing world of work has disrupted all three elements of a career: expertise, duration, and rewards.

bleshooters—needed constant training and upskilling. Now, all of us are expected to continuously learn new skills, new tools, and new systems. Just as COBOL programmers had to learn C++ and Java, administrative assistants have switched from typewriters and dictation machines to PCs and voice memos, assembly-line workers have had to learn to operate robots, and designers have moved from sketchpads and clay models to touchscreens and 3D printing.

In technical fields, there is constant pressure to master new technologies or risk becoming instantly obsolete. One of our clients anonymously surveyed its IT department about what skills people wanted to learn, and more than 80 percent said they were desperate to learn tools such as AngularJS (a new open-source programming environment for mobile apps), even though the company was not yet using the technology.[8]

Today even experts find themselves disrupted. Few professions today are hotter than that of a software engineer . . . and yet many foresee automation taking over the work of coding in the near future.[9] Artificial intelligence is doing the rote work of lawyers,[10] simplifying the work of doctors,[11] and changing skilled jobs from truck driver to financial analyst. As we describe later, it's important for each one of us to learn new tools, adapt our skills, and become more multidisciplinary in our expertise.

What this means to employers is simple: Your employees are constantly feeling a need to "keep up." Millennials, for example, rate "learning and development opportunities" as the number-one driver of a "good job."[12] Managers should give people time, opportunity, and coaching to progress; if you don't, people often just look elsewhere.

The idea of a single, long-lasting career is becoming a thing of the past

Remember the 30-year "lifelong career" that companies promoted during the last century? Well, today only 19 percent of companies still have traditional functional career models.[13] Why have so many organizations let multi-decade career models fade away?

First, business structures have changed. The iconic industrial companies of the early 1900s (steel, automobile, energy, and manufacturing)

have outsourced to smaller firms many of their business processes and sales channels, as well as various parts of their value chain. The result has been a steady increase in innovation and profitability, but a dramatic decay in the security of a "company man" career.[14]

When I entered the workforce in 1978 as a fresh engineering graduate from Cornell, I remember dozens of big companies looking for young engineers to train for lifetime careers, each offering job rotation, heavy amounts of training, and seemingly lifelong employment. I actually joined one of these companies—IBM—only to find my career options altered entirely when management launched a massive turnaround. (I decided to move to a smaller, faster-growing company.)

Similar stories can be told in automobile, manufacturing, financial services, retail, hospitality, and many other industries. In 1970, the 25 biggest American corporations employed the equivalent of over 10 percent of the private labor force.[15] Today, many of the largest US employers by number are retailers,[16] and the retail industry alone accounts for more than 10 percent of US employment.[17] In the current economic recovery, the fastest-growing segment of work has been health care, including small and large hospitals, eldercare providers, and various types of personal-care work.[18] However excellent these employers might be, their primary workforce is mid-level labor—service and delivery roles that neither pay as well nor offer the long-term "career professional" advancement that large companies once routinely offered.

This has created opportunities for some workers but has left others behind their parents at the same age. One study found that workers who entered the labor force in the 1980s and 1990s were more than twice as likely to stay in low-wage, dead-end jobs over the next decade compared with similar employees who joined the workforce in the late 1960s and early 1970s (at the high point of the corporate economy).[19] Part of the reason: Big corporations have outsourced many specialized (and highly paid tasks), which can make it harder to "move up" in socioeconomic status.

Driven by opportunism (why stay at a company where advancement opportunities are limited?) and necessity (what else can you do when your job is outsourced?), the practice of switching jobs and companies grew more common, until job-hopping became the norm. People my age, for instance, typically worked for four to five companies during their working lifetime. Today, a college graduate may work for as many companies *in their first 10 years* after graduation.[20]

THE LONGEVITY DIVIDEND: PLANNING FOR A LONGER HORIZON

There's a happy reason for some of the anxiety about unsettled career paths: Human beings—in most countries, that is—are living longer than ever.[21] While babies born in 1900 rarely lived past the age of 50, in most countries the life expectancy of babies born today exceeds 70; research suggests that Millennials will reach an average age of 90.[22]

Governments, anticipating a flood of retirement benefit payouts, are responding by looking to push back workers' standard retirement age.[23] And indeed, with unions in decline and much more rapid job mobility, fewer workers—even in labor-intensive roles—are able to retire after 30 years, forcing people to work longer.[24] This means that young people should expect careers spanning half a century or longer; schools and employers should help prepare and guide people through working lives in which they learn, work, learn, work, and cycle through career stages many times.

I recently met with the senior executive team of a revered, century-old manufacturer that enjoys tremendously high employee retention. As we discussed these issues, the executives decided that they were going to redesign their career strategy around employees working longer—actively encouraging and supporting workers' efforts to continuously reinvent themselves.[25]

SURFING FROM WAVE TO WAVE

ONE way to think about careers today is to consider yourself a surfer: We catch a good wave early in our life; as it crests and falls, we need to look for the next wave. Bersin by Deloitte's research and an examination of data from labor market analytics firm Burning Glass Technologies[26] confirm that while many technical skills are in high demand, they decay in value as more people acquire proficiency in those skills. Graphic designers, for example, are far less valuable than when the Internet was invented: Experts can still earn a good living, but organizations need many fewer experts, since in a sense we have all become designers.

In certain emerging fields, of course, expertise is in high demand, driving commensurate rewards. Organizations need technical people proficient in Hadoop and other big data solutions, for example, as well as experts in hot fields such as cybersecurity. And they pay top dollar for skilled people in these areas. But over the coming years, as the supply of expertise in these areas grows, the fields themselves shift in unforeseen ways (Hadoop experts become experts in other technologies, for example). The experts, then, must look to "surf" to the next wave, unless they're content to settle for steadily declining financial returns.

I suggest that each of us should think about our career as a series of waves from post-education

to pre-retirement: We'll catch a wave and ride it until it crests, and then, as it calms on the beach, we paddle out and catch the next one. In each new wave, we gain new skills and new experiences, retraining and educating ourselves along the way.

Soft skills growing in value: From STEM to STEAM

While many companies have outsourced specialized tasks over the years, big companies still need myriad technical and professional talent. Our research with Burning Glass shows that skills in math, statistics, project management, and logical thinking are now prerequisites for most positions (even those in marketing, finance, and HR). The problem, again: Such technical expertise may soon be outsourced, automated, or commoditized by youth, giving way to new technical roles of which no one has yet dreamed. Already, thousands of people are working as "robotic trainers,"[27] analyzing what self-driving cars do and working to make them smarter; it's a good bet they'll be doing something different a decade from now.

Today, anyone who wants a shot at a well-compensated position should consider developing skills in math, statistics, and logical thinking; comfort with data is increasingly essential. It's safe to say that anyone who lacks a basic understanding of science, technology, engineering, and math—the STEM fields—will likely find limited career options. Managers, mentors, and HR teams should realize this shift and make training and remedial education available to everyone in the company.

That said, STEM no longer tells the whole story of skills in the 21st century. Tasks based on math, science, and engineering are vulnerable to automation, so they should be complemented with soft skills and other strengths as well. In the 1800s, machinists and metalworkers were the computer scientists of today; as automated manufacturing grew and more powerful machines were invented, these "metal-bending" careers often turned into careers developing, operating, and fixing machines. If you learned how to be a draftsman in the 1970s, you likely watched your profession taken over by computer-aided-design software in the 1980s and 1990s. And if you're up to date on statistics and math, you may increasingly find yourself stretching to do programming, analysis, and interpretation of data, since software programs do many of the computations.

While the core need for technical skills remains strong, another theme has entered the job market: the need for people with skills in communication, interpretation, design, and synthetic thinking. In a way, we can think of these as the arts, hence the evolution of education from STEM to STEAM.

What does it mean to add *arts* to STEM? It isn't as simple as taking a few courses in art history or reading Chaucer. The jobs of the future,

driven by the increasing use of technology taking over rote tasks, require social skills complementing more technical abilities.

Think about the job of a salesperson, bank teller, nurse or caregiver, or business leader—all in-demand jobs that draw upon empathy, social skills, communication, and synthetic thinking. When an angry bank customer strides up to a teller window, an AI program lacks the tools to sense the best way to assess and defuse the situation, but a well-trained, empathetic teller can—and that's what makes her invaluable to the bank.

Consider figure 1, developed by Harvard researcher David Deming,[28] showing that some of the best jobs in the future—those in green—are those that draw upon *both technical and social skills*. Yes, developers can program com-

WILL YOU STILL HIRE ME TOMORROW?

In early 2016, our colleagues at Deloitte UK looked at Oxford University's noted study predicting which jobs would disappear over the next 20 years. They mapped these jobs against the O*NET job skills required in both the "disappearing jobs" and the "growing jobs," identifying a set of 40+ "essentially human skills" that are becoming ever more important in the workforce.[29] The findings clearly point in this direction:

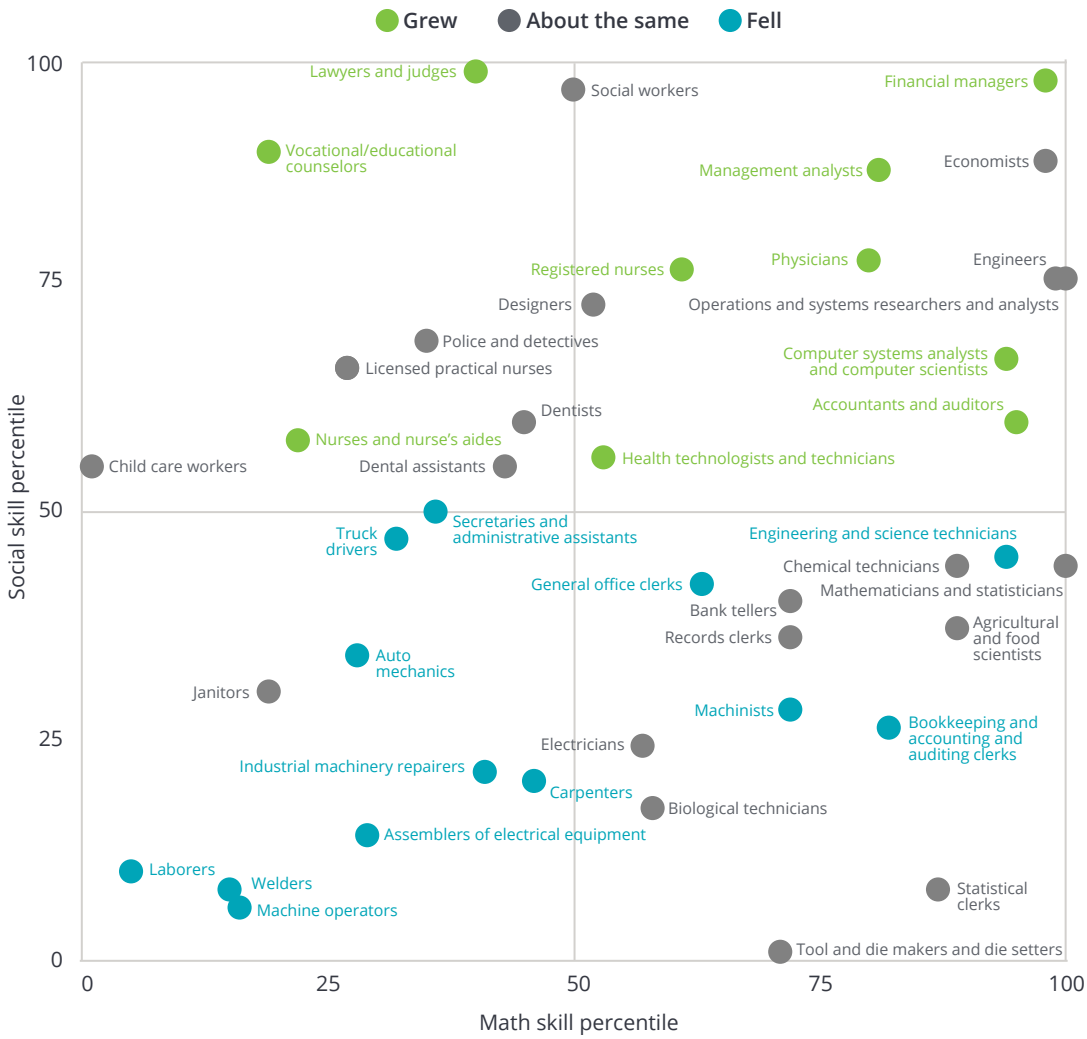
Brains over brawn: In absolute terms, knowledge of specialist STEM subjects is 40 percent more important than the physical abilities of strength, endurance, flexibility, or the ability to manipulate objects.

Social and cognitive skills: A 10 percent increase in cognitive abilities contributes to a 12 percent increase in median hourly earnings.

STEM and STEAM continue to grow: By 2039, math and science knowledge is expected to increase in importance by 8 percent, leading to approximately 4.5 million new STEM-enabled jobs to be created globally, including engineers, scientists, IT and digital professionals, economists, statisticians, and teachers.

This study, one of the largest of its kind, maps skills into various categories across all the "new jobs" and "retiring jobs" to identify what we call the "essential skills" for the future. As this research suggests, skills in communication, critical thinking, visual identity, and reasoning will likely become even more important in the future. For job seekers or career surfers, it is a reminder that our relationship, communication, and thinking skills are critical.

Figure 1. Which jobs require social skills?
Change in share of jobs, 1980–2012



Source: David Deming, Harvard University.

puters to take on rote and information-based tasks, but machines are not yet much good at listening, empathizing, communicating, and convincing.

THE EMERGENCE OF HYBRID JOBS

THE research I've done (including talking with academics, economists, and hiring managers) indicates that wage increases are primarily going to two types of jobs. First, as one might expect, are the hot "technical roles" where skills are (currently) scarce. Second, however, are what we might call "hybrid jobs"—jobs that create whole new job categories by mashing up disciplines.[30] These "renaissance jobs" are those that combine technical expertise (in one or more domains) with expertise in design, project management, or client and customer interaction. They might be titled "experience architect" or "IoT engineer" or "user experience designer" or "security consultant," and they typically involve knowledge of a technical domain, problem-solving capability, project management, and often industry expertise.

Even workers in highly technical fields are increasingly expected to bring softer skills to the table. A 2017 study by Burning Glass, Business–Higher Education Forum, and IBM analyzed new jobs being created in data science and digital marketing and found several important things:[31]

- Organizations are driving a huge increase in demand for analytic roles. Jobs called "data scientist" or "analyst" are growing rapidly, with the overall number of data science and analytics jobs expected to reach 2.7 million annual postings globally by 2020. These jobs are growing in all industries and all developed economies, with particularly high growth in the United Kingdom, Canada, and Australia.

- These jobs are not simply degreed positions—they are jobs that combine math, statistics, critical thinking, and industry expertise, not just skills in data management. Data scientists with industry expertise and experience, for example, command almost 50 percent higher pay than those with pure technical skills.

- These new positions are creating what Burning Glass calls a "new genome" for jobs, combining skills from previous roles into a new role. Whether called "data analysts" or "digital marketing managers" or "HR and people analytics leaders," they combine technical skills with domain and systems expertise in the chosen domain.

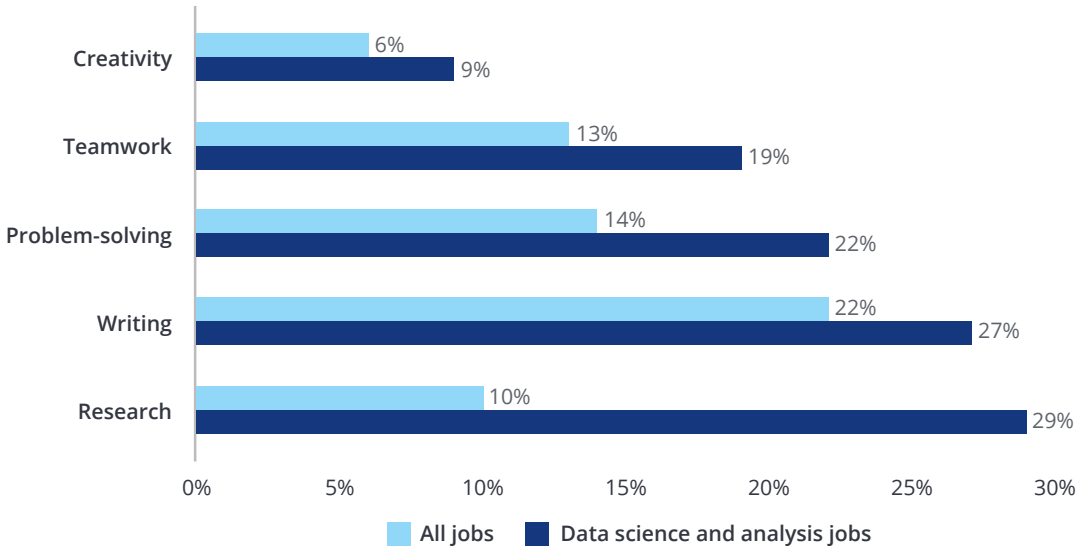
- These roles now require new types of soft skills. Figure 2 shows the types of expertise for which employers are looking in data analysis positions: research skills, writing

skills, and problem-solving skills, along with teamwork and creativity. These are rarely developed through coursework in math or statistics—they're more likely to emerge from a background in English, history, art, or business. Hence the shift from STEM to STEAM.

I remember all too well the early days of the spreadsheet (Multiplan, then Lotus 1-2-3, then Excel) and the fears that these tools would make financial analysts obsolete. Something quite different happened: Yes, analysts had to learn these tools in order to survive, but they then became "super analysts" far more valuable to their employers. This effect, the "machine augmentation of work," can be a positive thing for organizations as well as employees—but only if people take the time to learn how to use the new tools.

Since the Industrial Revolution, workers have had to regularly adjust to working with new machines and systems, but the fast-paced information age makes the hybridization of jobs a never-ending process. Salespeople are now expected to use technological tools such as Salesforce and task management systems; they must understand how to negotiate and forecast, and over time they will likely have to learn how to

Figure 2. Data jobs require more soft skills
Percentage of posts requesting soft skills



Source: Matt Sigelman, "By the numbers: The job market for data science and analytics," Burning Glass Technologies, February 10, 2017.

Figure 3. The evolution of learning and development has been blindingly fast

	1998–2002	2005	2010	2017	2020
	E-learning and blended	Talent management	Continuous learning	Digital learning	Intelligent learning
Formats	Course catalog Online university	Learning path Career track	Video, self-authored Mobile, YouTube	Micro-learning Real-time video Courses everywhere	Intelligent, personalized, machine-driven
Philosophy	Instructional design Kirkpatrick	Blended learning Social learning	70-20-10 taxonomies	Design thinking Learning experience	
Users	Self-study Online learning	Career-focused Lots of topics	Learning on demand Embedded learning	Everyone, all the time, everywhere	
Systems	LMS as e-learning platform	LMS as talent platform	LMS as experience platform	LMS invisible Data-driven, mobile	

Source: Bersin by Deloitte, Deloitte Consulting LLP, High-Impact Learning Organization research, 2017.

take signals from AI-based tools. (Salesforce's new product Einstein is designed to smartly recommend whom to call first.[32]) Managers will likely be increasingly wary of professionals who routinely resist learning new tools until they have no choice.

What is the future role of learning?

If we accept the fact that people need to continuously learn and reskill, how do we make that happen? Do we encourage everyone to go back to school every few years and earn another degree? Not necessarily.

Over the past decade, the training and learning industry has exploded: In 2015 and 2016 alone, investors put more than $1 billion into new US "edtech" companies and ventures.[33] As technologies such as smartphones, embedded video, and YouTube have put high-fidelity learning at people's fingertips, the global marketplace for education, professional skills development, and corporate training has grown to over $400 billion. Individuals can go online to knowledge-sharing sites such as Udemy, courseware sites such as Lynda.com, or technical education sites such as Pluralsight, Skillsoft, and General Assembly and find low-cost courses, lessons, and expert education.

Indeed, many corporate HR teams have found the rapid shift in learning options (figure 3) somewhat disruptive; executives regularly acknowledge to us that their internal learning

and development (L&D) programs lag behind the consumer marketplace. In fact, in our most recent High-Impact Learning Organization survey, employees gave their training departments a low -8 net promoter score, complaining of outdated learning management systems and legacy content.[34]

All of these changes have made L&D a vital part of companies' employment brand and employee experience, and we urge executives to invest in this area. Indeed, innovative companies such as GE, Visa, and IBM are building internal massive open online courses (MOOCs) and entire networks of internally developed content, enabling employees to shop for any training they need, including peer-authored material.[35] Since L&D has become the fastest-growing segment of the HR technology market,[36] we can expect many companies to replace and upgrade their internal learning systems over the next five years.

As a career development tool, the availability of consumer and corporate learning is a godsend: From their desktops, employees can attend MOOCs from firms such as Udacity, Coursera, NovoEd, and edX and take courses from academic and professional experts in a wide range of technical, managerial, and personal-skills topics. Increasingly, too, training firms offer program certificates for those completing courses, indicating new competencies.

SOLUTIONS: THE ROLE OF BUSINESS

As hard as we may try, nothing can reverse the trends toward longer lifetimes, shorter tenure, and the relentless pressure to master new technologies. But organizations can make it easier by adopting an active program to support people's reskilling, re-education, and career development. Our research on this topic shows that it has become a top priority: The 2017 Deloitte *Global Human Capital Trends* report rated L&D the second-biggest issue among business and HR leaders, up from fifth only a year ago, and indicated that 83 percent of companies are re-engineering their career programs.

Many organizations, though, have far to go. Some of the leading practices in this area include:

- Opening up learning and content to employees at all levels at no cost (Bank of America now offers a prepaid "credit card" for employees to skill themselves, for example)[37]

- Investing in a large library of training content for employees to use (IBM and GE license courses and content from dozens of companies and have negotiated pay-per-use contracts)[38]

Forward-thinking companies today offer career-planning tools, actively post jobs internally, and encourage and support internal hires and transfers.

- Creating a culture of learning among management: rewarding managers for developing their people, re-engineering the performance management process to focus on development, giving managers incentives for hiring internal candidates versus external candidates (AT&T has focused its entire corporate culture on the continuous reskilling of its employees)[39]

- Creating career paths and self-assessment tools to help employees find new jobs and new career paths within the company (IBM does this)[40]

- Creating L&D programs to enable employees to develop hybrid skills; design thinking, visualization, project management, problem solving, communication, and other soft skills are vitally needed, and standard programs help create career flexibility and a currency of consistent practices

- Offering micro-learning and macro-learning to let people learn quickly as needed (that is, small nuggets of content in the flow of work as well as courses and traditional training)

- Investing in a chief learning officer with an established corporate budget to watch over and shepherd learning solutions in all the various business units and functional areas

- Investing in onboarding programs and transition-management programs that help people move into new roles (Royal Bank of Canada has developed a new-hire program for branch bankers that lasts an entire year, designed for both new employees and transfers)[41]

- Working closely with business leaders on job design and organizational design as technologies automate work, to help realign people, retrain people, and move people into more "essentially human" roles as technology is adopted

Smoothing the waves

Surfing can be scary even on the sunniest of days; when people's livelihoods are at stake, career surfing feels treacherous, especially as waves cast workers off their surfboards again and again. How can we help people navigate and thrive in this new world of careers, while keeping our organizations intact?

The answer is clear: We as organizational leaders should redesign our companies so they offer diverse and continuous opportunities to develop. We should change our reward systems to encourage people to change roles, build technical expertise, and move horizontally for breadth and experience. Does your company reward people for technical expertise and breadth of experience? Or do you promote only people who move up the corporate pyramid?

We should also put resources into coaching, career planning, and career assessment. The old adage that "you manage your own career here" often means people managing themselves right out of the company. Forward-thinking companies today offer career-planning tools, actively post jobs internally, and encourage and support internal hires and transfers.

One of our clients, a large Asian energy company, characterized its job model as so rigidly structured that many people cannot get promoted until someone in the leadership dies or quits. Executives told me, laughing, that the best way for employees to get a better job was to "quit and reapply for a different job."[42] But this is no joke: I find this story true in many large organizations today.

In short, we have to blow up the traditional career model and work to make it easier for people to take the skills they have and use them in new roles within the organization.

No one would suggest that dealing with the career dynamics of the future will be easy, for either employees or employers. It's important to actively redesign our learning organizations, rethink our job models, create more hybrid roles, and throw away our traditional ideas of the up-or-out approach to success.

For companies that handle this well, the payoff can be huge: Our research has found that organizations that define themselves as great places to learn achieve 23 percent greater financial returns, out-innovate their peers, and endure business cycles far better than their contemporaries.[43] With the next big wave just appearing on the horizon, we all need to learn more about surfing.

***Josh Bersin**, a principal with Deloitte Consulting LLP, is the founder of Bersin by Deloitte, providing eminence, analysis, and research strategy for Deloitte Human Capital Trends and Bersin by Deloitte.*

*The author would like to thank **Burning Glass Technologies** for contributing to this article.*

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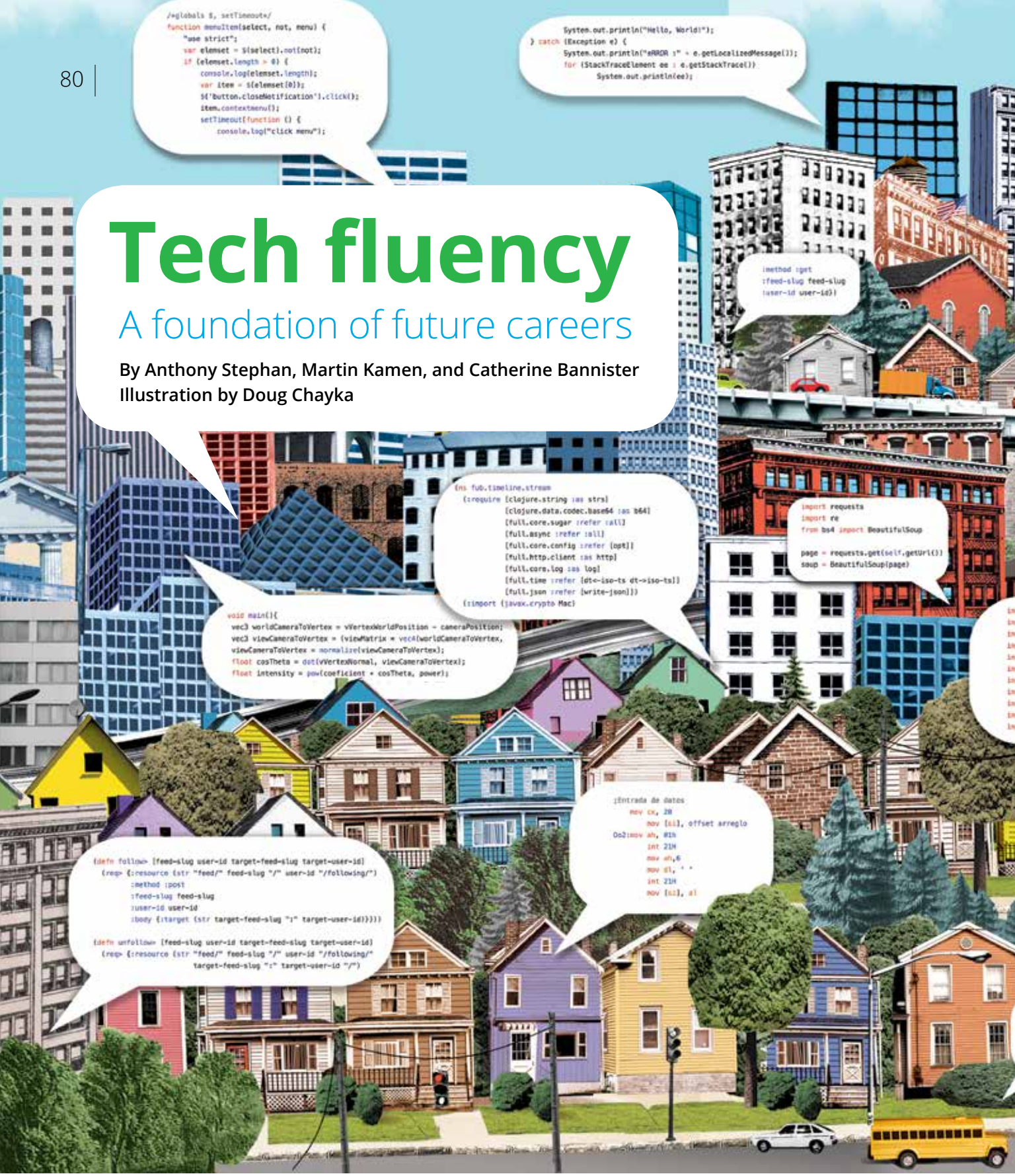
Tech fluency

A foundation of future careers

By Anthony Stephan, Martin Kamen, and Catherine Bannister
Illustration by Doug Chayka

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(update-in [:to] add-to-sig
(defn deserialize-activity [activ
(-> activity
:Entrada de datos
mov cx, 20
mov [si], offset arreglo
Do2:mov ah, 01h
int 21H
mov ah,6
mov dl, ' '
stack segment para stack 'stack'
db 256 dup(0FFH)
stack ends
;
data segment para public 'data'
arreglo DB 20 dup(?)
data ends
;
chomp(my $ input = <STDIN>);
my $ hoge = 1;
for my $ num (1 .. $ input) {
$ hoge *= $ num;
code ends
end main
:headers (-> headers
(assoc-auth-headers feed-slug user-id)
(cond-> body (assoc "Content-Type"
:params (assoc (or params {}) "api_key" @api-key)
:body (when body (write-json body :json-key-fn name))))

THE LANGUAGE OF TECHNOLOGY

In the 21st century, it's often said, *every* company is a technology company. Across industry sectors, powerful technological forces—including mobile, cloud, analytics, and social collaboration—now drive business strategy, fuel new opportunities, and upend long-established markets.

Think about how technology-enabled possibilities that emerged over the past decade have transformed the way we work now, whether in a securities trading office in Manhattan, on a factory floor in Ohio, or in an automobile in Los Angeles that is part of a ridesharing network. In each, technology is both ubiquitous and foundational, enabling the communications, transactions, and operations that drive revenue and strategy.

Indeed, technology is integral to almost everyone's daily work, and businesses increasingly rely on innovative applications to engage customers and partners, engineer new products and services, and identify business insights buried within mountains of data. And technology's disruption of business models, markets, and career paths doesn't end there: Cognitive computing, machine intelligence, and advanced robotics are poised to replace some traditional human employees and augment the skills and productivity of others.[1]

Analysts have written plenty about this phenomenon's impact on enterprise technologists

THE SPECTRUM OF TECH FLUENCY

Tech fluency is a concept that, like being fluent in a foreign language, encompasses a spectrum of proficiency. With a basic Spanish vocabulary, for example, a tourist may be able to successfully navigate the streets of Madrid. At the other end of the fluency spectrum, a dedicated student of the Spanish language can thrive in a less polyglot region of Spain, and perhaps even work as a translator. Similarly, the spectrum of tech fluency begins with a basic understanding of enterprise technology principles and systems. This understanding makes it possible for workers to contextualize deeper technology concepts; it enables employees to follow technology trends, differentiate between tech "myth" and fact, and understand how the tools they use each day contribute, directly or indirectly, to business success.

Further along the spectrum, tech fluency becomes more role- and business-function-specific, consisting of a detailed working knowledge of how technology capabilities and their adjacencies can drive new revenue and open fresh opportunities in the near term. At this intermediate level of fluency, employees may be able to understand the possibilities of technology more broadly and harness system capabilities to create efficiencies, drive strategy, and pursue new revenue. And at the advanced end of the tech fluency spectrum, individuals can sense future disruptive opportunities that emerging innovation may make possible three or even five years down the line—and use that foresight to help their companies create sustainable competitive advantage.

and their work within IT organizations. But what does it mean for non-IT workers? If every company is now a tech company, will business leaders, marketers, and HR professionals need to learn to write code in order to get ahead?

We wouldn't go that far—though some have suggested that computer programming could be the next big blue-collar job opportunity.[2] It does mean, however, that to engage in and contribute to a tech-driven business environment, to be able to quickly learn the next big emerging technology's functions, and to grow professionally, all workers—from executives to interns—will need to learn much more about critical systems: their capabilities and adjacencies, their strategic and operational value, and the particular possibilities they enable.[3] In other words, individuals will need to become *tech fluent*.

As established companies across industry sectors reshape and reorganize themselves to capitalize on emerging technologies, some are recognizing that helping workers become more tech fluent can be key to achieving that competitive advantage. Consider, for example, global communications giant AT&T's ongoing effort to retrain its employees. This multifaceted learning program, dubbed Workforce 2020, is driven by strategic necessity: Over the past decade, the storied company that traces its origins to Alexander Graham Bell's 1876 invention of the telephone has been transitioning from cables and switches to IP networks and the cloud and, in the process, is recreating itself as a digital-first purveyor of wireless communication and data services.[4]

For longtime AT&T employees whose expertise lies in business models, systems, and processes that are becoming obsolete, this means developing new skills and, critically, thinking beyond the status quo. For prospective hires, this likely means that the multinational corporation with which they are interviewing next week is now looking for the kind of flexible, digital-first skill sets (and mind-sets) traditionally found in start-ups.

To date, AT&T has reportedly spent upward of $250 million on educational and professional-development programs to support roughly 140,000 employees who are actively engaged in acquiring technology and other skills for newly created roles. In a 2016 interview, Chairman and CEO Randall Stephenson offered a bit of wisdom to his own employees that all workers should take to heart as they navigate the future of work. "There is a need to retool yourself, and you should not expect to stop," he said, adding that people who do not spend 5 to 10 hours a week in online learning "will obsolete themselves with the technology."[5]

NOT YOUR OLD-SCHOOL ENTERPRISE IT

THE emergence of tech fluency as a driver of career success among non-IT workers is a relatively new phenomenon. Until recently, enterprise workers typically

viewed technology as someone else's responsibility: Executives chose it; IT implemented and maintained it. Help was just a support ticket away. Talent at all levels learned to use specific software capabilities that helped them complete assigned tasks—and proudly listed those mastered capabilities on résumés and in job applications.

In thinking about enterprise technology in purely utilitarian terms—much the same way they would think about a kitchen appliance—few workers likely considered its broader potential as a driver of strategy or a new, exciting means for engaging customers, nor did their employers ask them to. Perhaps fewer still recognized the real face of technology disruption: a powerful force that was redefining their careers and futures.

This failure to recognize technology's potential no doubt still permeates many organizations, from bottom to top. For example, there may be C-suite executives who welcome new ideas and business opportunities but have a time-stamped view of what technology can achieve. Likewise, within IT organizations, there may be tech talent with proven domain expertise but little experience working within an agile development environment or with potentially disruptive, leading-edge innovations. Still other employees might understand how to use domain-specific tools to accomplish work-related tasks but have no insight into how and why these tools operate within the larger IT ecosystem.

The days when enterprise technology can be viewed as someone else's concern are coming rapidly to an end. IT workers have long been encouraged to "speak the language of business," but increasingly it is becoming just as important for the business to speak the language of IT, says Jikin Shah, senior vice president and head of OMNI Sales and Services Tech at Atlanta-based financial services company SunTrust Banks Inc.

Shah is currently leading a broad technology transformation effort at the bank that includes, among other components, an initiative to help employees learn about and fully utilize new systems. "Within all companies, technology has moved from being a function to an enabler of strategy," he says. "Yes, everyone must still be a 'student of the business'—that is ultimately how they deliver total value. However, business teams—executives and strategists in particular—must now also understand top-level technology trends, and the particular possibilities these trends offer the business."[6]

Technology's rapid advance will likely only accelerate. Driven by growth in software and IT services revenue, worldwide IT spending is forecast to reach $3.5 trillion in 2017, up 2.9 percent from estimated 2016 spending, according to Gartner, Inc.[7] Meanwhile, CIOs are working to erase traditional boundaries between IT and business by embedding software developers in business teams to work hand in hand with strategists, sales executives, and marketers to design, build, and deploy mission-critical

software tools quickly and efficiently.[8] Expect many CIOs to move aggressively on similar efforts going forward. Deloitte's 2016 Global CIO Survey of 1,200 IT executives found that 78 percent of respondents identified strategic alignment with the business as the organizational capability most critical to IT's success.[9]

BUILDING A CULTURE OF CONTINUOUS LEARNING

To create the agility and flexibility necessary to build competitive advantage, companies will need workers who understand enterprise technology along with the specific applications and systems that enable their own roles—and are aware of potentially disruptive innovations and trends. Developing new and innovative ways of learning and institutionalizing tech fluency learning opportunities can help workers contribute substantively, creatively, and consistently, no matter their roles.

As the 2017 Deloitte *Global Human Capital Trends* report[10] explores, digital organizations are recognizing the need to build continuous learning programs that not only help employees develop technology skills and knowledge quickly but also help them grow and advance within an enterprise model that is ever-evolving.

To meet this need, chief learning officers and other human capital leaders should consider taking one or more of the following approaches:

Make tech fluency learning programs self-directed, digital, and dynamic. Traditional learning management systems are being replaced by new technologies for curation, delivery, and mobile use that put learners in the driver's seat. Moreover, a wide variety of low-cost learning opportunities are emerging in various online and video channels.

Tie learning to professional growth. Offer a curriculum focused on the baseline learning requirements of given roles. This allows users to explore adjacencies and prepare for other jobs within the organization.

Make continuous learning opportunities part of the corporate brand. The employment brand needs to be visible and attractive and learning needs to be part of that brand. Here's why: Glassdoor data shows that among Millennials, the "ability to learn and progress" is now the principal driver of a company's employment brand.[11]

Recruit candidates who have open minds and an endless capacity to learn. Beyond making continuous learning an attractive part of the corporate brand, human-capital strategists and recruiters should consider focusing less on attracting candidates with specific backgrounds in technology and more on recruiting those who are curious, creative, and emotionally intelligent. Candidates with these qualities may be more open to nontraditional learning approaches and to working collaboratively within diverse teams and across enterprise functions.

The challenge is that achieving tech fluency, at whatever level, isn't a once-and-done matter of mastering a particular set of knowledge.

TUNING INTO THE POSSIBLE

GIVEN the sheer number and variety of technologies available for enterprise use, becoming tech fluent may seem daunting, if not impossible, to non-IT workers. The challenge is that achieving tech fluency, at whatever level, isn't a once-and-done matter of mastering a particular set of knowledge. Rather, the process of developing tech fluency is, as AT&T's Stephenson suggests, not a finite journey between two fixed points but, rather, an open-ended adventure of continuous learning. Indeed, given today's rapid-fire pace of innovation, even CIOs, software engineers, and others with advanced technological expertise must continually refresh their knowledge and work to stay on top of the latest trends.

Yawning gaps in employee digital knowledge are not only common—they are likely undermining technology transformation efforts. In a 2016 global survey of managers and executives conducted by *MIT Sloan Management Review* and Deloitte, only 11 percent of respondents said their company's current talent base can compete effectively in the digital economy.[12]

Interestingly, those same respondents cited "lack of agility, complacency, and inflexible culture" as significant internal barriers to digital success.[13] And of course, workers stuck in the past comprise functional departments that have trouble looking forward. Therein lies what may be the strongest argument for all workers aiming to become more tech fluent—and for their employers to create learning environments to help them on this journey. In the absence of a shared understanding of enterprise technologies and their possibilities, companies cannot nurture the collective imagination necessary to move beyond the way things are done today toward a new strategic and operational future. Becoming conversant in technology can help workers of all backgrounds understand not only the realities of today but the possibilities of tomorrow in terms of markets, customers, products, and strategy.

As an example of this concept in action, consider SunTrust, which has been on a technology transformation journey for several years that has involved, among other phases, building a data lake, constructing a private cloud, and transitioning software development teams in its online banking and digital groups from traditional waterfall approaches to an end-to-end, team-based agile approach. Along the way, SunTrust also acquired an online consumer lending business that introduced an entire agile ecosystem into the organization.

According to Scott Case, chief technology officer for the bank's consumer segment, SunTrust's embrace of agile led to a broader adoption of team-based approaches within a framework called the Business Accelerator program.[14] "By early 2016, we realized we needed to reorganize our entire transformation effort," he says. "Our Business Accelerator approach brings together various capabilities—business, IT, design—from across SunTrust who work together in 'accelerator studios' to deliver solutions for our clients and teammates." Case, the program's executive sponsor, says these diverse teams are currently working on public cloud strategies, continuous integration and development capabilities, the implementation of an API strategy, and other initiatives that are powering SunTrust's transformation forward.

In any given enterprise, the need for tech fluency varies by role, and what each individual learns will be shaped by her unique background and experiences.

In rolling out the Business Accelerator program, SunTrust is focusing heavily on training teams and individuals as they prepare to "onboard" into this new delivery approach. For example, team members from business backgrounds need to understand what it means to be part of a scrum team. Likewise, developers need to understand why adopting new processes and tools is such a critical part of the bank's strategy for bringing new solutions to the marketplace and increasing market share. "The more we align delivery teams consisting of both business and technology talent, the more everyone on these teams needs to understand the capabilities required to deliver on an accelerated path," Case says. "It will no longer be OK for a business teammate to stay on one side of the fence, flip some requirements over to a technologist who then goes away and builds something in a vacuum, and comes back in six months for user acceptance testing. What we build or buy in terms of architecture matters to the team, and the entire team needs to buy into the solution.

"As we shift to a team-based delivery culture, everyone needs to be fluent in the what, the why, and the how," Case continues. "I believe each member of a delivery team is responsible for understanding what good looks like for platform decisions, the data required for our teammates and clients, and a basic understanding of what it means to leverage an API framework. Becoming fluent in how the technology and operations ecosystem hangs together inside and outside SunTrust will allow the teams to make better long-term decisions that directly relate to our shareholders, clients, and our purpose."

Nurturing tech fluency among SunTrust teammates has become an integral part of maturing the Business Accelerator framework. Jikin Shah, who leads the program, is partnering with Case, the bank's HR organization, and others to develop change management, training, team alignment, and skill set learning opportunities to ensure that teams are engaged in building tech fluency and are coached appropriately along the way. "We have formed 'tiger teams' to support individuals assigned to projects by giving them special, hands-on training and coaching," Shah says. "We are also looking to industrialize tech fluency training as we mature our delivery models."

WHERE TO BEGIN

WHAT, specifically, are we suggesting when we say that non-IT employees will need to be tech fluent in order to navigate the future of work? In any given enterprise, the need for tech fluency varies by role, and what each individual learns will be shaped by her unique background and experiences. However, the following can serve as a general guideline.

The initial goal of individual fluency journeys—and of tech education programs that companies offer to support continuous learning—should be to develop a depth of understanding of the major systems and concepts that form the technological endoskeleton of enterprise IT. For example, which systems support customer engagement and which support internal functions such as accounting? Which of the major technology forces—cloud, mobile, social media, analytics, cognitive computing—does one's employer leverage, and why? With a baseline understanding of enterprise systems, an employee can nurture a depth of expertise (think of it as putting down roots) into technology and business adjacencies. Though approaches to learning often differ, the following incremental steps may help workers develop the level of tech fluency needed for their specific role:

Step one: Workers should study not only the core systems supporting their company's IT environment but the specific solutions (internal and external) that enable major functions such as finance, customer service, data management, cybersecurity, and sales. Likewise, they should read up on the technology forces that are changing the world in which we live and work.

> When it comes to tech fluency, executives need to be more knowledgeable than their counterparts at competitor organizations in the same market if they expect to sustain a marketplace advantage.

Step two: Workers should explore the market in which their company competes. How does technology support market participation and enable competitive advantage?

Step three: Employees should study their company's business model. Where are the levers of profitability? What technologies support business strategy and drive revenue? How has technology disrupted this business model over the course of the last decade?

When all of an organization's people share this informational baseline, their ideas become shared currency. Thus, the heavy work of imagining a company's digital future potentially be-

comes a lighter lift, as well as more efficient, effective, and impactful.

Building tech fluency for specific roles

From this shared baseline, workers can begin developing deeper tech knowledge in their specific domains while at the same time exploring adjacencies and the way they fit into the bigger picture of core systems, markets, and business strategies. For example:

Executives: When it comes to tech fluency, executives need to be more knowledgeable than their counterparts at competitor organizations in the same market if they expect to sustain a marketplace advantage. For some, this may mean focusing less on numbers and spreadsheets, and more on technology-driven disruption—from within and without the organization. Tech fluency for executives means enhancing the baseline understanding of core systems with in-depth knowledge not only of enterprise adjacencies, but of innovation, R&D, and emerging opportunities on five- or even ten-year time horizons. Executives should be able to monitor and "sense" technology trends continuously. Likewise, they should expect the strategists and technologists in their employ to match, if not surpass, their sensing efforts. A CFO, for example, will likely have the final say on whether a new technology-driven initiative gets funded. And while this CFO will consider the proposal as set forth by project boosters, to make an informed, objective decision, she should have been following the development and applications of technologies involved over the last several years, and should be fluent in that technology's capabilities and risks before the project proposal is even written.

Business strategists: For those ultimately charged with plotting a course toward future success, developing tech fluency not only in their own areas of expertise and responsibility but also in adjacent areas—along with the technologies being deployed in other sectors—will become critical to business and professional success. The ability to sense a potential opportunity in the way a competitor—or, for that matter, a noncompetitor—is leveraging a new platform or tool is grounded in an understanding of technology that is both broad and deep. For example, an HR strategist working to develop new recruitment tactics identifies

When communicating with clients and business partners, faking expertise won't cut it. To tell a technology story, one must understand the technology.

a start-up currently developing a platform that leverages crowdsourcing, social media, and advanced analytics capabilities to identify hard-to-find workers with unique skill sets. To recognize the potential value such a solution could deliver, the strategist must be sufficiently knowledgeable in current digital recruiting solutions and their capabilities to understand how the emerging technology platform could potentially satisfy an unmet need and add value.

Accountants and auditors: The emergence of big data and real-time reporting has profoundly changed the way back-office employees and executives approach their jobs. Bookkeeping and financial reporting processes that were traditionally backward-facing are now—thanks to technology—more future-facing and focused on how today's numbers can be used to project tomorrow's performance. Tech fluency for those working in this domain encompasses not only data management and advanced analytics tools that support forecasting and automated fraud detection—it means a baseline understanding of the various systems that drive revenue. For example, as companies embrace a cloud-based, everything-as-a-service model, finance workers will need to understand how transitioning from internally to externally sourced capabilities could affect IT budgets. They will also need to understand how IT will deploy and utilize cloud services in order to negotiate contract terms with cloud-service providers and accommodate the tax consequences of any new arrangement.

Marketers, writers, and other communications workers: A critical, if often overlooked, aspect of transformation in the digital age is telling the story of that transformation with the end in mind. For those charged with telling this story—and explaining its relevance to customers, investors, and business partners—tech fluency means developing a broad, baseline understanding of a company's IT environment and then being sufficiently curious and flexible to pivot in order to master particular adjacencies, opportunities, and business drivers. Wherever enterprise technology goes, marketing and communications professionals must quickly follow with accurate, clear communications that raise market awareness of new offerings. When communicating with clients and business partners, faking expertise won't cut it. To tell a technology story, one must understand the technology. Meanwhile, there's another technology story developing that communications workers at all levels would be wise to monitor: Software can now generate basic "just the facts" articles without human input.

A NEW LANDSCAPE

GOING forward, individuals in these roles and others—as well as prospective hires wanting to join them—face a career landscape that is radically different from the one workers surveyed only a decade

ago. Many once-solid career paths have been disrupted while others have, and will continue to, emerge. To thrive in a business environment in which the only constant is change, workers at all levels should learn all they can about one of the strongest forces driving that change: technology.

For Jikin Shah, tech fluency is about more than understanding the justification for moving from physical to virtual servers. "At SunTrust, the ultimate goal of our tech fluency efforts is to change our organizational mind-set. Becoming a technology company is not just a way to make more money—in our industry, it is a matter of survival. Over the course of my career, it has become clear to me that when people with diverse backgrounds and from different functions collaborate as a team and speak a common technology language, they begin thinking about projects as if their own money were on the line and the decisions they make are critical to success. This is the kind of engagement that, I find, results in stronger strategies, better use cases, and more valuable outcomes." ●

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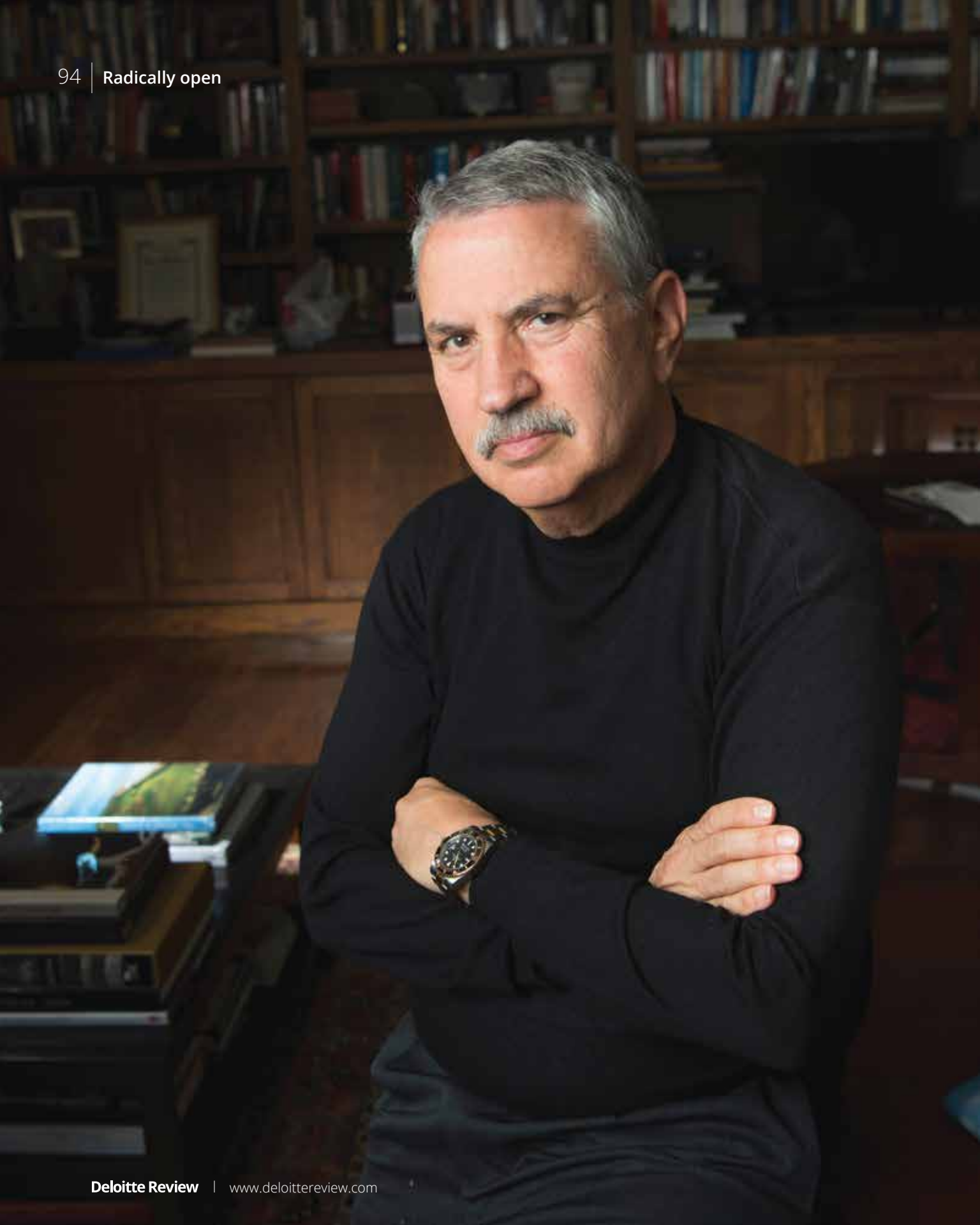


Radically open

Tom Friedman on jobs, learning, and the future of work

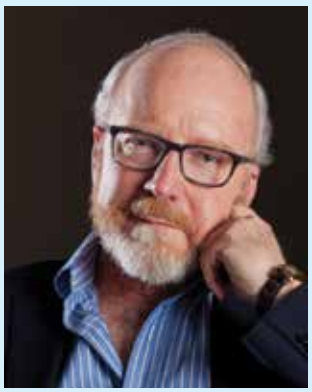
By Cathy Engelbert and John Hagel
Photography by James Kegley

Foreword by John Hagel

Tom Friedman is a well-known Pulitzer Prize-winning weekly columnist for the *New York Times* and the author of seven best-selling books. His insightful work covers a broad range of topics, including globalization, the Middle East, and environmental challenges. I have always been amazed by Tom's ability to see the deeper patterns emerging from beneath the headlines and to anticipate where the world is headed. He resists the temptation to segment and silo; what intrigues him are the connections that drive and shape the evolution of an increasingly complex world.

Cathy Engelbert, CEO, Deloitte US

One of the things that attracted me to Tom many years ago was his desire to explore and understand emerging edges—initially marginal but potentially transformative marketplace phenomena driven by rapid advances in digital technology. We connected over some writing that we had been doing in parallel on the growth of digital technology infrastructures and the increasing importance of richer knowledge flows on a global scale, and we have stayed in touch ever since.



John Hagel, co-chairman, Deloitte Center for the Edge

Our paths recently crossed again with the publication of Tom's newest book, *Thank You for Being Late: An Optimist's Guide to Thriving in the Age of Accelerations*. In this book, he cited some of the research being done at the Deloitte Center for the Edge and discussed a topic that I and others at Deloitte have also been exploring: the future of work. I couldn't resist reaching out to Tom to see if he would speak with Cathy Engelbert, CEO of Deloitte, and me on this particular topic. We ended up covering a very broad terrain with Tom and, in his usual fashion, he brought these diverse trends to life with compelling stories.

John Hagel: Given your broad perspective on global events, I suspect you have a unique perspective on the likely evolution of the future of work on a global basis. At a high level, how would you describe your view of the future of work?

Tom Friedman: My thoughts on the future of work are very influenced by my friend, a business strategist, Heather McGowan. She really describes that what's going on is that work is being disconnected from jobs, and jobs and work are being disconnected from companies, which are increasingly becoming platforms. That's Heather's argument, and that is what I definitely see.

[A good] example is what's happened to the cab business. In Bethesda, we have a [local] cab company that owns cars and has employees who have a job; they drive those cars. They're competing now with Uber, which owns no cars, has no employees, and just provides a platform of work that brings together ride-needers—myself—and ride-providers. And I do think that the Uber platform model, and the way it is turning a job into work and monetizing work, is the future of work.

And that will have a huge impact on the future of learning. Because if work is being extracted from jobs, and if jobs and work are being extracted from companies—and because, as you and I have both written, we're now in a world of flows[1]—then learning has to become lifelong. We have to provide both the learning tools and the learning resources for lifelong learning when your job becomes work and your company becomes a platform.

So I'm not sure what the work of the future is, but I know that the future of companies is to be hiring people and constantly training people to be prepared for a job that has not been invented yet. If you, as a company, are not providing both the resources and the opportunity for lifelong learning, [you're sunk], because you simply cannot be a lifelong employee anymore unless you are a lifelong learner. If you're training people for a job that's already been invented, or if you're going to school in preparation for a job that's already been invented, I would suggest that you're going to have problems somewhere down the road.

Cathy Engelbert: One of the things that I've been thinking about is the idea of "the future of work" versus "the work of the future." I always think "the future of work" sounds ominous, while "the work of the future" sounds more visionary. So what's the one thing you would advise leaders of companies like mine to do to prepare themselves for what I'll call the work of the future?

TF: The first thing that comes to mind is something I'm arguing for America in general right now, which is to do something that would strike many as deeply counterintuitive. That is, when we move into a world of flows, and the flows are the source of strategic advantage where you extract value, and the flows are

getting faster—all the phenomena that John [Hagel] writes about—it seems to me that rule number one is you want to be radically open. And that's a really hard sell right now, because it feels so counterintuitive, and everyone's putting up walls right when you want to be, actually, radically open. Why do you want to be radically open? Because you'll get more flows; you'll get the signals first, and you will attract more flow-minded people, which I would call high-IQ risk-takers. That's from a country point of view, but I have to believe that's also right from a company point of view: that you want to be plugged into as many discussions, as many places, and as many flow generators as possible, because you'll simply get the signals first in order to understand where the work of the future is coming from.

CE: In a recent report from the National Bureau of Economic Research, some leading labor economists did an analysis of net new employment in the United States between 2005 and 2015, and found that about 94 percent of that net new employment was from alternative work arrangements—everything from gig to freelance and off-balance-sheet kinds of work.[2] You've talked already about this notion of, increasingly, work being different from jobs and divorced from companies, which are becoming platforms. So do you believe this is a long-term development in the economy, that the gig economy is here to stay?

TF: Well, it has to be. It goes back to something I argued in *The World is Flat*, which is "Whatever can be done, will be done." The only question is, "Will it be done by you or to you?," but it will be done.

Let's use an example that people wouldn't normally think about, from General Electric. It's called "jump ball." So General Electric woke up one day in 2013 and said, "Geez, whatever can be done, will be done." So I'm GE now, and I'm trying to figure out how to get the most weight out of a fastener that fastens an airplane engine to the wing of an airplane. Now, when you take weight out of anything, especially on an airplane, you save fuel. So over the life of a plane, if you can actually reduce the weight of a fastener by 70 or 80 percent, you've saved enormous money. But GE sort of looked at itself internally and said, "Well, I live in a world now where I could actually take advantage of the brains of anybody to take weight out of this fastener." So they went to the main engineering website, GrabCAD, and they created a contest, which they called a "jump ball." They described the fastener they were currently using, the weight of that fastener under the wing of the plane, and simply threw up a jump ball: "Who in the world can take the most weight out of this fastener?" They offered $20,000 in prize money—$7,000 to the winner, and the rest split up among the other finalists. Well, within six weeks, they got over 600 responses. The 10 finalists were all tested by GE engineers, and they picked the winner. None of the 10 finalists was an American, and none was an aeronautical engineer, and the winner was a 21-year-old

from Indonesia who was not an aeronautical engineer, and he took more than 80 percent of the weight out of this fastener.

Now, what that tells me is, from GE's point of view, if it can be done, it will be done. The notion that, within our stock of engineers, we have all the best talent in the world—what are the odds of that in a flat, fast world? No, let's actually create jump balls and access all the talent wherever it is. Well, that's another version of that 94 percent that you don't think about; when you're not just thinking from the employee side, "I think I'll be an Elancer," but from the company side you're saying, "I live in a world now where I can access talent anywhere. If I don't do it from my point of view, my competitors will, so I better do it before it's done to me." I think that opportunity is going to drive change all across the spectrum. If you have a challenge that's posed to you, why in the world would you limit yourself simply to the talent within your own company? Because the odds of it being the best in this world are really pretty low.

> The day when you could just show up, work hard, and play by the rules, as Bill Clinton said, and still have a high-wage middle-skill job—those days are over.

JH: At least some of the statistics I've seen say that most of the gig economy today is made up of fairly routine tasks, like you mentioned earlier: driving a car, or translation services, or bookkeeping services. Do you see that being sustained? Looking at the trend in terms of technology, certainly in the mobility fleet operator business, a lot of companies are focused on developing autonomous automobile technology, and drivers go away. Do you see that as a significant issue in the gig economy?

TF: Well, my answer to your question is, study Airbnb. You could say that what Airbnb has done has threatened the job of maids, cooks, and hotel managers, because Airbnb has made more lodging available than all the major hotel companies combined. But look what those people are doing now. They're going into the travel business. They're going into the chef business, they're going into the tour guide business, they're going into the "I can provide your security key for 20 Airbnbs, I'll be the intermediary for you" business. So in other words, by creating this platform, Airbnb spun off a whole other set of opportunities for freelance chefs: "I'll come in and cook your meal." Freelance tour guides: "I specialize in art museums," or "I specialize in golf opportunities," or whatever. This is why I go back to my point about radical openness. On my gravestone, they can carve these words: "If horses could have voted, there never would have been cars."

JH: One more follow-up on the gig economy. To the extent that it evolves toward more creative problem-solving tasks, do you see it moving beyond just individuals doing isolated tasks on a contract basis, which is what most people think of when they think of the gig economy? As the focus increases on creativity and lifelong learning, do you see a tendency, perhaps, for these people to come together into more sustained work groups that will work together on these challenging tasks? Or will they just stay isolated individuals?

TF: It makes total sense. Stage 1 is we all go solo, and stage 2 is, some real estate developer comes along and says, "Well, you're all solo, so I might go into the worker space business." Then, somebody's going to come along and say, "Gosh, you all need meals, and you all might need health care advice, and by the way, you might need pension advice." So I think it will all start to adapt around this.

CE: What about the role of companies in terms of fostering lifelong learning? What's your sense of what can companies do to help us make this transition [to workers] who are passionate lifelong learners?

TF: Well, the AT&T model is [one of] the best I've come across. Basically, the CEO shares with the company where the company is going, what world they are living in, and what skills you need to be a lifelong employee at AT&T, then partners with Udacity to create nano-degree courses for each one of those skills. Then the company gives each employee up to $8,000 a year to take those courses, but it says to the employee, "Your responsibility is that you have to take them on your own time." I believe that is the new social contract. "We, the company, with help from government, will create the lifelong learning opportunities, but you, the employee, will have to seize them on your own time." More will be on you.

There are three new social contracts that have to evolve here. Government has to incentivize companies to create these lifelong learning opportunities. Companies have to create the platforms for employees to afford to be able to take these courses. And the employee has to have a new social contract with themselves: "I have to do this on my own time; I have to be more self-motivated." More is on you. That part of the story, I can't change. The day when you could just show up, work hard, and play by the rules, as Bill Clinton said, and still have a high-wage middle-skill job—those days are over.

JH: One of the big themes in your work is this notion of the increasing importance of knowledge flows, and how they help us to learn faster. On the other hand, there's the downside that too much knowledge flow can become overwhelming. So what are the most effective ways you see of participating in knowledge flows so we can learn faster, but at the same time avoid becoming overwhelmed by this avalanche of knowledge?

Give me a young person or employee with a high passion quotient and a high curiosity quotient, high PQ and high CQ, and I'll take them over the person with a high intelligence quotient, IQ, seven days a week.

TF: I would put it in terms of filters. For example, I talk the talk of globalization and technology, but I do not walk the walk. If you are tweeting at me or about me, y'all have a good time. I am not there. I do not look at Twitter. It's a fire hose with too many people who are just throwing stuff up there that I'm not interested in. If I have to learn about the coup, the revolution, or the earthquake three minutes later from CNN, I'm okay with that. And so I am trying to find the right balance of flow and friction. I want to let enough in so that I know what's going on so I can write these books, but not so much that I am so overwhelmed that I'm paralyzed.

I think that's why we need to teach filtering, literally, to our students. There should be Filtering 101, Filtering 102, Filtering 103. How do I filter information so I get enough of it to advance, but not so much that I'm overwhelmed? How do I filter news? The Internet, the mother of all flows, is actually an open sewer of untreated, unfiltered information, and if my employees, my students, and my kids don't have filters built into them to be able to get the best out of flows and cushion the worst, then we're going to have a real problem. So filtering, teaching people how to filter—how to go to three different places to verify the information that used to be in the textbook where you knew it was true, because it was edited and went through all the normal processes—we need to do that. I think we need to be teaching digital civics to every child. You should not be able to get out of elementary school without a class in digital civics on how you talk on the Internet, how you relate to someone on the Internet, and how you filter news on the Internet.

CE: This raises the question of, "What is the role of schools in the work of the future?" It seems that our educational system was modeled to train people for one form of work, and it's not quite clear they're focused on the work of the future.

TF: For me, 95 percent is about teachers and parents, and 5 percent is everything else. I am a journalist today because I had a great journalism teacher in 10th grade at St. Louis Park High School in Minnesota. She inspired me—the only journalism course I've ever taken is her class. Not because I'm that good, but

because she was that good. So great teachers, they can show up anywhere: public school, private school, anywhere, and our job is to simply find and nurture more of them.

At the same time, though, I believe that what happens in all those other 20 or 18 hours of the day when you're out of school, and on weekends, matters more than anything. It's parents who do as little as ask their kid, "What did you learn in school today? How did you do in school today? How was your day in school?" Parents who take an interest and passion in their kid's education and learning. Give me that and I'll make every good teacher great, and I'll make every great teacher outstanding. It's so much about parenting and good values that you nurture at home: love of learning, love of reading. I think we want the public schools, or the charter schools, or whatever, to remediate all the problems of parenting, and there's no teacher who's good enough to do that.

JH: Maybe we can go to another challenge you've already highlighted, which is this notion that if you're training for a job that exists today, or a set of skills that exists today, you're likely to be in trouble. It raises the question of, "Well, okay, so how do you anticipate and get ready for what's next in a way that you can be prepared?"

TF: There's only one way, and I've felt this really is a theme in all my books. You have to teach people to love learning. Some of us are lucky; we were born with it. If you're lucky as a parent, and your kids love to learn, you won the lottery. Some of us have to learn it; others have to have it inspired in them by a great parent, or teacher, or spiritual leader, or president. But there is no more important survival skill than learning to love learning. That's why I've always lived by the formula, which I give in *The World is Flat*, that PQ + CQ will always be greater than IQ. You give me a young person or employee with a high passion quotient and a high curiosity quotient, high PQ and high CQ, and I'll take them over the person with a high intelligence quotient, IQ, seven days a week. PQ + CQ are always greater than IQ.

JH: One of the key themes in *Thank You for Being Late* is the implications of digital technology and Moore's law, and you talk about some of the specific technologies, like robotics and artificial intelligence, that are especially

I think the companies that are doing best are creating what I call STEMpathy jobs—jobs that combine science, technology, engineering, and math with human empathy, the ability to connect with another human being.

relevant to the future of work. I'm wondering if you have some examples or views you can share about what companies are doing well and not so well in terms of integrating this technology into the future workforce. My sense at one level is that they're focused largely on automating work as opposed to augmenting work, and I would be interested in your perspective on that.

TF: I like that distinction you make between automation and augmentation. I think the best companies are doing both, automating wherever they can and augmenting wherever they can, because that's where you're going to get the most efficiencies. I think the companies that are doing best are creating what I call STEMpathy jobs—jobs that combine science, technology, engineering, and math with human empathy, the ability to connect with another human being. When you put those two things together in a manager or in an employee, I think you have the sweet spot of where work has to go.

CE: I've often said I've never met a machine with courage or empathy, so I'm fascinated by your concept of STEMpathy. Please explain a little more what you mean by it.

TF: In terms of planning, and values, and how do I think about the future—you can't automate that. If you think of Watson, who's the best doctor in the age of Watson? It's very different. It's the doctor who can ask Watson the best questions. If Watson's read every article ever written on cancer and no doctor can even think about approaching that, then being able to ask Watson the right question about a patient and then translate that in an empathetic way to that patient—and use Watson not as a substitute, but an augmenter for that doctor's own innate skills—it's in that combination that you're going to get absolutely the best jobs. It goes right down to anyone who's had an elderly parent in an Alzheimer unit, as I have, or even a nursing home. Boy, they know the difference between that caregiver who has both some medical knowledge and the kind of empathy that lets them relate to your parent. And how much more would I pay for that person to be looking after my mom as opposed to the person who doesn't have those skills? I'd pay a lot.

CE: What do you think about this kind of disruption around AI? Do you think society and businesses, and we as individuals, are ready for it?

TF: Probably not, but it's both. I'm not ready for a software program where, if I give it a certain set of views, it will write a column, an opinion column, modeling after my tropes. That's kind of scary to me. But at the same time, I'm a golfer, and I'm a busy person, and you know what I discovered? The hourly weather report. I can now look at the hourly weather report and say, "Oh my goodness, the sun's going to be out from 2 to 4 p.m. in Bethesda. I can work all day when it rains, and then I can do my golf between 2 and 4." It's made me so much more efficient and improved the quality of my life. And I think that applies to all of these systems.

They're just dumb systems, in a sense, even AI, and it's all about the human values that we bring to it.

JH: I recently gave a talk at South by Southwest about robots actually restoring our humanity. In the world of scalable efficiency that we've been operating in, we've defined work as tightly specified, highly standardized tasks. If that's what work is, my proposition is actually that robots are much better at that than human beings are. They don't get distracted, they don't get sick, they don't make mistakes. And if the robots start taking over those tasks at a much more rapid rate, it's going to be a catalyst, I believe, to force us to rethink what work could be for human beings. What are those unique human capabilities that we could tap into?

TF: Dov Seidman and I did a column together that said what you just said in a slightly different way. Dov made the point that we used to work with our hands for many centuries; then we worked with our heads, and now we're going to have to work with our hearts, because there's one thing machines can not, do not, and never will have, and that's a heart. I think we're going from hands to heads to hearts, which is just another way of saying what you just said: "What are the most human capabilities we can tap into?"

JH: You've talked about the notion of companies evolving into platforms. Can you talk a little bit more about what role you see platforms

playing in terms of the future of work and what kind of impact they'll have?

TF: When I look at the companies that are really doing well and that aren't just platforms, they're blending the platform potential of their business—the GE jump ball—with creating a really strong in-house learning innovation environment. That's why I love going to these old companies that are still around—AT&T, GE, Intel, Qualcomm. They all have that in common: that they've found a real way to balance what is new, and the new potential of it, with the strength of still having a company, a brand, and a value set around a certain team of people. Again, I'm so Aristotelian in my thinking. Life is always about the midpoint and moderation. It's never about extremes; it's about finding the balance.

JH: You talk about and actually cited some of our work around the mounting performance pressure that comes with all this acceleration of the forces of change.[3] What do you see as some of the negative consequences or potential negative consequences of that kind of pressure, and how do we reduce the risk of those negative consequences?

TF: Well, I'll take an example from my own business. We have newspapers now that have put up scoreboards in the middle of their newsroom. So people can go, "Let's see, Tom Friedman wrote about Deloitte today. Oh my gosh, look at that; it's going up on Google and trending on Facebook, and trending on Twitter. What was that story you wrote about Deloitte? Oh, it was trashing their CEO, really dishing on her." And the person sitting at the next desk is saying, "Wow, Tom, you made it to the top of the scoreboard trashing the CEO of Deloitte. Wait, it turns out Deloitte's called up and they're complaining about the story. It's not true. Yeah, we'll run a correction tomorrow at the bottom of page 822 underneath the ads." But meanwhile, I'm at the top of the scoreboard. Really bad trend. Now, I'd like to think I've been around long enough so I don't fall prey to that. I hope I don't. I try to write about what's important, not just what will go viral. But if you're a starving journalist or if you just don't care about that, and you just care about "Look how many hits I got," it's a really bad trend. It's going to make us really stupid. Because I'll only be writing about what will scale, and I'll only write about Deloitte's failures, not successes.

CE: Tom, let me be a little personal here. I understand you have two Millennial daughters. I also have a son and daughter who are digital natives. My son, about a month ago, came to me and said, "Mom, I'm afraid I'm not going to get a job someday." I said, "Why?," and he said, "Because a robot's going to do my job." So I did the whole "augmenting humans, not replacing humans" thing, and I said I've never met a machine with empathy, and he said, "All right, I'll just have to learn to be a cobot." I said, "What's a cobot?," and he said, "To coexist with

the robot." So what counsel do you give your daughters that you can share from your perspective with all the research and writing that you've done?

TF: Well, I have five pieces of advice for my daughters. The first is to always think like an immigrant. How does the new immigrant think? New immigrants think, "I just showed up here in Bethesda, and there is no legacy spot waiting for me at the University of Maryland. I better figure out what's going on here, what the opportunities are, and pursue them with more energy, vigor, and more PQ and CQ than anybody else." So my first rule is always think like an immigrant, because we're all new immigrants to the age of accelerations.

Second, always think like an artisan. This was an idea I got from Larry Katz at Harvard. Larry points out that, before mass manufacturing, before factories, work was artisanal. Work was built around artisans, and the artisan made every chair, every table, every lamp, every fork, knife, spoon, plate, glass, pitcher, shoe, dress, suit, underwear, stirrup, saddle—all that was made by an artisan. And what did the best artisans do? They brought so much personal value-add, so much unique extra, to what they did that they carved their initials into their work at the end of the day. So always do your job [in a way that] you bring so much empathy to it, so much unique, personal value-add, that it cannot be automated, digitized, or outsourced, and that you want to carve your initials into it at the end of the day.

Third, always be in beta. I got this idea from Reid Hoffman, co-founder of LinkedIn. Reid likes to say that in Silicon Valley, there's only one four-letter word. It actually does start with an F, but it isn't four letters, and that word is "finished." If you ever think of yourself as a finished product, you're probably finished. Reid's motto is, "Always be in beta." Always be in the state of mind of a piece of software that's about 85 percent done. You throw it over the wall, the community tests it, finds the holes, finds the glitches, they throw it back, you work on it some more, you throw it over the wall again, they test it, and so on. Always think of yourself as if you need to be reengineered, retooled, relearned, retaught constantly. Never think of yourself as "finished"; otherwise you really will be finished.

Fourthly, always remember that PQ + CQ is greater than IQ. Give me a young person with a high passion quotient and a high curiosity quotient and I will take them over a kid with a high intelligence quotient seven days a week. In the age of Google, no one really cares what you know, because the Google machine knows everything. All they care is what you can do with what you know, and I will trust PQ and CQ over IQ over the long term on that.

And lastly, always think like a waitress at Perkins Pancake House in Minneapolis. Perkins is my favorite restaurant; I grew up outside of Minneapolis, and there's a Perkins on Highway 100, France Avenue. I was eating breakfast there with my best friend, Ken Greer, when I

was working on a book back in 2011. I ordered three buttermilk pancakes with scrambled eggs and Ken ordered three buttermilk pancakes with fruit, and the waitress took our order and came back in 15 minutes. She put our two plates down, and all she said to Ken was, "I gave you extra fruit." That's all she said. I gave her a 50 percent tip. Why? Because that waitress didn't control much, but she controlled the fruit ladle, and what was she doing back there in the kitchen? She was thinking entrepreneurially. She was thinking to herself, "You know? I'm going to give this guy an extra dollop of fruit." See what happens? Turns out, he was sitting with a chump like me, and I saw that, and I said, "That's kind of cool. I'm giving you a 50 percent tip." She was thinking entrepreneurially. So my advice to my girls is, "Whatever you do, whether you're in the public sector or the private sector, whether you're on the front lines or a manager, always think entrepreneurially." Always think, "Where can I fork off and start a new company over here, a new business over there?" Because [huge manufacturing companies are] not coming to your town with a 25,000-person factory. That factory is now 2,500 robots and 500 people. So we need three people starting jobs for six, six people starting jobs for twelve, twelve people starting jobs for twenty. That's how we're going to get all those jobs. We need everyone thinking entrepreneurially. ●

Editor's note: Mr. Friedman's participation in this article is solely for educational purposes based on his knowledge of the subject, and the views he expresses are solely his own.

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***John Hagel**, a managing director with Deloitte Consulting LLP, is co-chairman for Deloitte LLP's Center for the Edge.*

Endnotes

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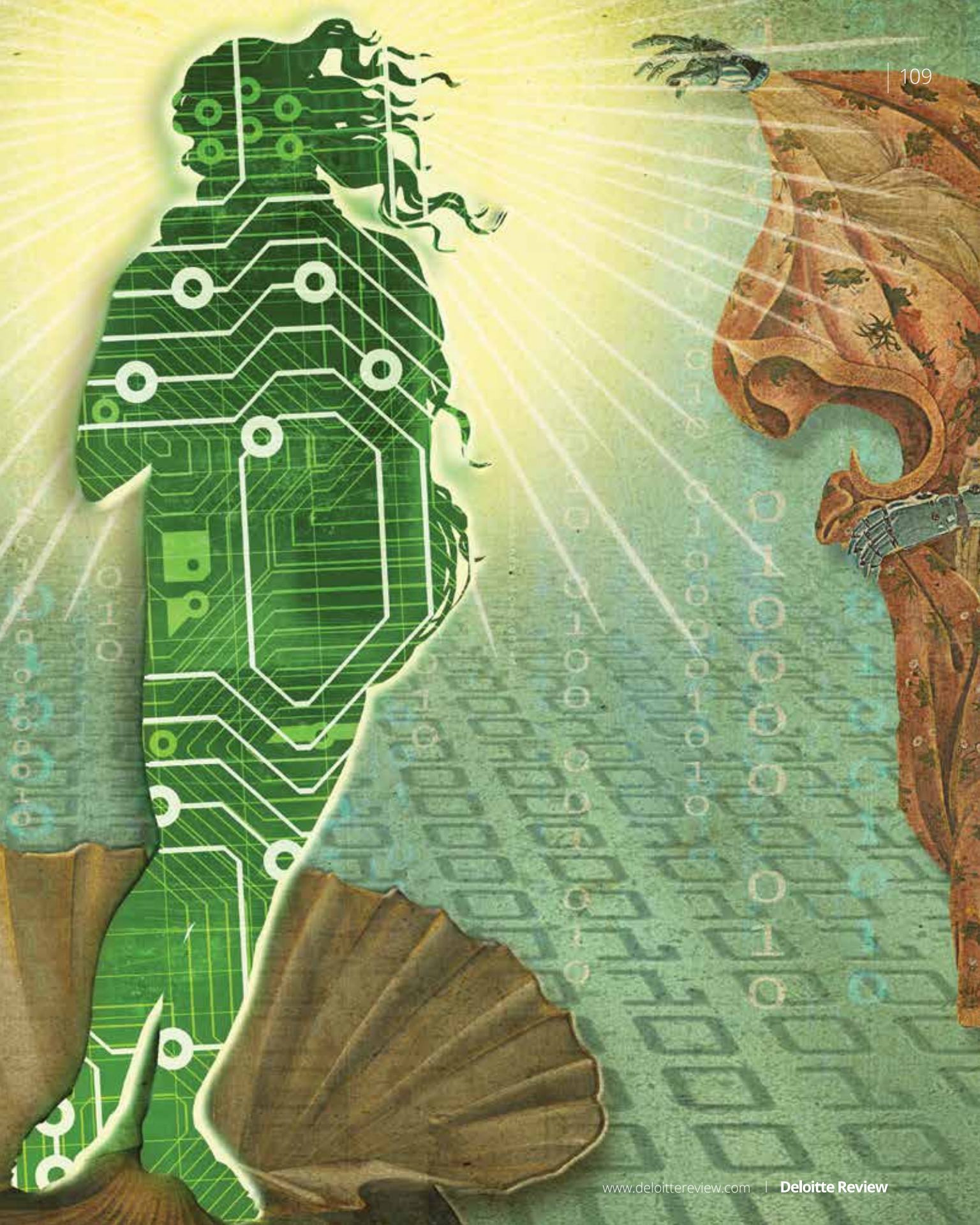
The rise of cognitive work (re)design

Applying cognitive tools to knowledge-based work

By Thomas H. Davenport
Illustration by Anthony Freda



BUSINESS PROCESS CHANGE FOR THE COGNITIVE ERA

NEW automation and cognitive technologies present a unique opportunity to redesign knowledge-based work, but they likely won't do so without a concerted effort to redesign work processes around their capabilities. In order to achieve the productivity and effectiveness benefits that these technologies offer, companies may need to adopt, or readopt, techniques from a variety of systematic approaches to process improvement and change. This time, however, they may want to take a synthetic approach to process change that is consistent with the unique capabilities of cognitive technology.

THE REBIRTH OF REENGINEERING?

IN the early 1990s, one of the most important management trends was "business process reengineering" (BPR).[1] This set of ideas, which encouraged order-of-magnitude improvement in broad business processes, was widely advanced in best-selling books, and led to considerable activity among consulting firms. The primary drivers of the BPR movement were need to substantially improve productivity (in part because of a perceived threat from Japanese competitors) and a powerful new set of information technologies, such as enterprise resource planning (ERP) systems, direct connections between customers and suppliers, and the then-nascent Internet. BPR may have been the only process change approach that specifically addressed information technology as an enabler of innovation and improvement.

Some of the same opportunities and threats appear to be present today. Productivity growth in the United States has slowed for several years,[2] and some prominent economists have proclaimed that information technologies have never fueled the productivity improvements of which they might be capable.[3] As for threats, established firms' primary perceived risks no longer come from large Japanese competitors, but from nimble start-ups in regions like Silicon Valley.

On the technology front, perhaps the most disruptive collection of tools is found in cognitive technologies, the contemporary term for artificial intelligence. This group of technologies, which includes deep and machine learning, natural language processing (NLP) and generation, robotic process automation (RPA), and older tools based on rule and recommendation engines, is currently capturing substantial attention as a source of business and workforce disruption. Perhaps, as in the earlier generation of process reengineering, this generation of technologies can become a driver of work transformation. Also, as in the 1990s, the desired transformation won't take place with technology alone.

It may be time, then, for a renaissance of BPR—this time with a specific focus on cognitive technologies as an enabler of process change, and with a more synthetic approach to process

In addition to focusing on broad, cross-functional processes and radical improvements to them, BPR also differs from other process-focused improvement approaches in that it has a strong focus on information technology.

change methods. The marriage seems a good match. Cognitive technologies need a set of management structures and best implementation practices to yield the benefits of which they are capable. BPR could use some updating to accommodate contemporary technologies, and an injection of new change techniques could make it a more effective methodology.

Most importantly, immediate opportunities for business improvement from cognitive technologies are likely not being realized because complementary process changes aren't being designed and implemented. At one large bank, for example, NLP technology was used to extract payment terms from a large volume of vendor contracts. The terms were then compared to the amounts actually paid by the bank in a large number of invoices (from which the payment amounts had also been extracted with a different set of cognitive tools). The automated analysis identified tens of millions of dollars in contract/invoice mismatches, most of the value of which would accrue to the bank. But the value couldn't be captured until the bank redesigned its processes to review the mismatches and approach vendors to negotiate recovery of inaccurate payments.

Another opportunity for cognitive work redesign may be in the thousands of projects underway today involving RPA.[4] This technology makes it relatively easy to automate structured digital tasks that involve interaction with multiple information systems. But perhaps because of the ease of automating these tasks, very few organizations undertake a systematic effort to redesign the processes and underlying tasks before automating them. While RPA typically leads to substantial gains in efficiency, a process reengineering initiative might reveal substantially greater opportunities for efficiency and effectiveness.

THE POWER OF PROCESS

WHILE other approaches to organizational structure—primarily including business functions such as marketing, finance, and supply chain—may be more familiar, business processes can bring a powerful perspective on monitoring and improving work. Process thinking is at the core of not only business process reengineering, but also Total Quality Management, Six Sigma, and Lean.

Processes are structured sets of activities to accomplish a work-related objective. They can be

broad, cross-functional processes that encompass many activities ("order to cash" or "procure to pay") or small processes that involve only a few activities ("certify vendor"). BPR was intended to create radical improvements in broad processes, the idea being that radical change required taking on many activities at once and that only broad process improvements would be visible and beneficial to customers. Six Sigma and Lean tend to focus on smaller processes with the idea of making many incremental improvements to them.

In addition to focusing on broad, cross-functional processes and radical improvements to them, BPR also differs from other process-focused improvement approaches in that it has a strong focus on information technology. Again, the rationale is that IT has the ability to enable dramatically new ways of working, which is one way to achieve radical improvements in a process. This was the first—and perhaps still the only—business improvement method to couple the power of technology and structured ways of looking at work.

In practice, the technology most likely to support BPR initiatives in the 1990s was ERP systems, which became popular at the same time. The breadth of these systems and their inherent process orientation made them a good fit for reengineering. However, the difficulty and

expense of implementing ERP systems and the challenges of adapting them to fit customized business processes probably contributed to the high failure rate of BPR projects—estimated at between 50 and 70 percent, though never with any rigorous attempts at classification of success and failure.[5]

Cognitive technologies are almost always narrower in their scope of application than ERP. Hence, reengineering methods may need to be modified to some extent to accommodate the fact that cognitive technologies automate or support tasks, not entire processes. Perhaps a synthesis of reengineering methods and Lean or Six Sigma approaches—which can also be relatively narrow in their focus—would be appropriate. Such a blend could couple a broad process innovation vision using cognitive capabilities with a set of shorter-term improvements in specific tasks.

COGNITIVE TECHNOLOGIES AND THEIR IMPACT ON PROCESS TASKS

COGNITIVE technologies have in common the ability to perform tasks with some degree of autonomy that previously only humans could perform. They differ, however, in the types of tasks for which they were intended.[6] Four types of tasks that can be commonly addressed by cognitive technologies include analyzing numbers, analyzing text and images, performing digital tasks, and performing physical tasks.

Analyzing numbers. A key aspect of some cognitive technologies—most forms of statistical machine learning, for example—involves analyzing numbers in structured formats. If any statistical analysis is to be used in a cognitive system, at some point, all forms of data must be converted into structured number formats.

Early numerical analysis was primarily for human decision support, requiring skilled users to direct their use. Now, however, they can run on their own in an automated or semi-automated fashion. Simple machine learning methods can bring different variables into and out of the model to try to create the best fit to the data and the best set of predictions. More complex machine learning models can learn from labeled data and determine strategies in complex business situations, including fraud detection and personalized marketing.

Analyzing words and images. It's always been the province of human beings to read or listen to words and view images, and determine their meaning and significance—a key aspect of human cognition. But now there are a wide variety of tools that are beginning to do just that. Words are increasingly "understood"—counted, classified, interpreted, predicted, and so on—through technologies such as machine learning, natural language processing, neural networks, deep learning, and so forth. Some of the same technologies—deep learning in par-

ticular—are being used to analyze and identify images.

Your smartphone can perform many of these tasks. But the analysis of words and images on a large scale comprises a different category of capability. One such application involves translating large volumes of text across languages. Another is to answer questions as a human would. A third is to make sense of language in a way that can either summarize it or generate new passages. A fourth common application, which is mentioned above, is to use linguistic understanding to extract relevant information from documents such as contracts and invoices. This relatively prosaic task is often quite useful in administrative processes.

When implemented broadly across an organization, the benefits of RPA can add up quickly.

Image identification and classification is the other key activity in this category. "Machine vision" has existed for many years, but today, many companies are interested in more sensitive and accurate vision tasks: recognizing faces, classifying photos on the Internet, or assessing the collision damage to a car. This sort of automated vision requires more sophisticated tools to match particular patterns of pixels to a recognizable image.[7] Our eyes and brains are great at this, but computers are just beginning to get good at it. Machine learning and "deep learning" neural networks seem to be the most promising technology for this application.

"Deep learning" neural network approaches are particularly well-suited to analyzing data in multiple dimensions (x and y location coordinates; color; intensity; and, in videos, time). The "deep" refers not to the profundity of the learning, but rather to a hierarchy of dimensions in the data. It's this technology that is letting engineers identify photos of cats on the Internet. Perhaps in the near future, smart machines could watch video taken by drones and security cameras and determine whether something bad is happening.

The most capable systems in this task category are capable of "learning" in that their decisions get better with more data, and they "remember" previously ingested information. IBM's Watson, for example, can be fed more and more documents as they become available over time; that's what makes it well suited for keeping track of cancer research, for example. Other systems in this category can get better at their cognitive task by having more data for training purposes. As more documents that have been translated from Urdu to Hindi become available to Google Translate, for example, it should get better with its machine translations across those languages.

Performing digital tasks. One of the more pragmatic roles for cognitive technology over the past few years has been to automate administrative tasks and decisions. Companies typically have thousands of such tasks and decisions to perform, and it was realized early on that if they could be expressed in a formal logic, they could be automated.

In order to make this possible, a couple of technical capabilities were necessary. One was the expression of the decision logic itself; this came to be known as "business rules." Rules can bring precision, consistency, speed, and computer-driven efficiency to operations. They can be embedded in any sort of computer program, but they are much easier to manage and modify when they are incorporated into a "rules engine," for which there are a variety of vendors.

In addition to business rules, administrative task automation also needed technologies that could move a case or task through the series of steps required to complete it. In the early days of business rules, that technology was "workflow" (also known as "business process management," "case management," or an "orchestration engine"; the most recent version is "complex event processing," or CEP). Regardless of the name, its role was to move a case or project through a series of information-oriented tasks to completion.

Over the past couple of decades, business rules, workflow, and CEP technologies have been used to support a wide variety of administrative tasks, from insurance policy approvals to IT operations to high-speed trading. While these tools can be somewhat inflexible and don't generally learn over time, they have provided a lot of value to organizations. In insurance, for example, they are widely used for policy underwriting and approvals. Their adaptation to a changing business environment has been aided by the relative ease of modifying rules; in many cases, this can be done by a business user. Some rule-based systems are still being implemented for smaller logic-based decisions that require a definite answer versus a probabilistic one.

More recently, companies have begun to employ RPA for digital tasks.[8] Contrary to its name, this technology does not involve actual robots; it makes use of workflow and business rules technology to perform digital tasks. It can automate highly repetitive and transactional tasks, and is usually easily configured and modified by business users. It typically interfaces with multiple information systems as if it were a human user; this is called "presentation layer" integration. RPA technology doesn't learn or improve its performance without human modification, but some vendors are beginning to claim some learning capabilities.

Examples of service industries and processes in which this technology is popular include banking (for example, for back-office customer service tasks, such as replacing a lost ATM card),

insurance (process claims and payments), information technology (monitoring system error messages and fixing simple problems), and supply chain management (processing invoices and responding to routine requests from customers and suppliers).

There are substantial benefits from this type of automation, even though it is one of the less exotic forms of cognitive technology. The performance gains can approach 30 or 40 percent improvement in the cost and time to perform a process.[9]

When implemented broadly across an organization, the benefits of RPA can add up quickly. A case study of its application at Telefonica Ó2—the second-largest mobile carrier in the United Kingdom—found that, as of April 2015, the company had automated over 160 process areas involving between 400,000 and 500,000 transactions.[10] Each of the process areas employed a software "robot." The overall return on investment of this technology was between 650 and 800 percent. That's a better payoff than most companies achieved from most other approaches to process improvement.

Performing physical tasks. Physical task automation, of course, is the realm of robots. Though humans love to refer to all automation technologies as robots, the classic usage of the term is "a machine resembling a human being and able to replicate certain human movements and functions automatically."[11] In 2015, more than 250,000 robots were installed in industrial processes across a variety of manufacturing industries.[12]

Robots seem to be evolving in several directions. Some robots are designed from the beginning to provide human support. They include robotic surgery, remotely piloted drone aircraft, and "telecommand" mining machinery. Surgical robots, for example, are driven by human surgeons, but provide them with "superpowers" like better vision, straighter cutting and sutures, and reliable execution of repeated motions. Historically, robots that replaced humans required a high level of programming to do repetitive tasks. They had to be segregated from humans because their movements could be dangerous to us. A new type of robots, however—often called "collaborative robots"—can work alongside humans; they move slowly and stop when they touch anything. These opportunities for human-robot collaboration could be designed into the process, perhaps with some iteration over time as organizations become more familiar with collaborative robots.

Some robots are already somewhat autonomous once programmed, but they are quite limited in their flexibility and their ability to respond to unexpected conditions. More intelligent robots would be able to, for example, look around the proximate area if a part isn't found in the expected location. As robots develop more intelligence, better machine vision, and greater ability to make decisions, they could become a combination of other types of

cognitive technologies, but with the added ability to transform the physical environment. IBM Watson software, for example, has been transplanted into several types of robots. FANUC, a Japanese company that is one of the world's largest robot makers, acquired a Japanese deep learning software company, and hopes to make its robots more autonomous using the learning capabilities. As a news article put it,

> Preferred Networks' expertise should allow FANUC's customers to link their robots in new ways. It should also enable the machines to automatically recognize problems and learn to avoid them, or find workarounds in conjunction with other machines.[13]

Similar capabilities are likely to emerge for the "mobile robots" known as autonomous vehicles. Gill Pratt, a Defense Advanced Research Projects Agency (DARPA) program manager who later became head of the Toyota Research Institute, wrote in 2015 that a major change in vehicle intelligence will take place when their intelligence is primarily in the cloud and when vehicles can learn from each other's experiences.[14] These developments suggest that autonomy and awareness are long-term destinations for devices that perform physical tasks, and that the worlds of artificially intelligent software and robots are converging.

Some processes, of course, may involve multiple types of tasks. Tasks may be combined or transformed in applications; some text and images, for example, are converted into numbers for analysis. A customer service application may involve speech recognition, image processing, and machine learning predictions of what is most likely to satisfy the customer. Such combinations are increasingly common with business applications of cognitive technology.

It's important to note that in all of these areas there are still important roles for humans to play. As I've argued (with my co-author Julia Kirby) in a recent book,[15] the most likely future of many processes involves smart humans working alongside smart machines. While there is some possibility of job loss from full automation, most processes can benefit from human oversight, and machines still need some guidance. A redesign effort can determine the tasks within a process for which humans are best suited, and those that can be done primarily by machines.

It's also important to remember that cognitive technologies perform tasks, not jobs or entire processes. It seems that whatever the task, a smart machine can be created to perform it. But a human worker within a business process can typically perform a variety of tasks. Not until we reach the age of "general artificial intelligence" or "the singularity" will this situation change. This suggests that cognitive work redesign efforts within companies should focus on how specific tasks that are supported with cognitive tools fit within broader processes. This is also a better method for thinking about how

humans can be redeployed to activities and tasks within processes that make the best use of their capabilities.

COGNITIVE PROCESSES: REDESIGN NEEDED

In general, cognitive technologies fit best where there is a substantial amount of knowledge needed to make the process effective. Given that cognitive technologies create (from data) and apply knowledge, there are business process contexts for which they are particularly suited. These have historically been processes like product development, health care delivery, and decision making around capital investments, mergers and acquisitions, and strategy. The attributes of likely candidates include the following types of situations:

A knowledge bottleneck—knowledge is unevenly distributed but broadly needed. Knowledge bottlenecks exist where there is substantial knowledge available in one part of a process, but a shortage of it in another. Medical diagnosis and treatment is a classic example. In cancer care, for example, there is substantial knowledge available in academic cancer centers but much less available to the average general medical practitioner—particularly someone in a remote area. A cognitive system can capture the knowledge of the expert (albeit with difficulty, as early results of cognitive cancer treatment systems suggest) and make it available much more broadly. Sofie, the cognitive system for veterinarians from vendor LifeLearn, is a similar solution to a knowledge bottleneck that is particularly severe, given the broad range of animal species for which veterinarians are expected to provide knowledgeable care. Sofie extracts knowledge from the medical literature on animal health and makes it broadly available to veterinarians.[16]

Knowledge is too expensive. In some processes, the requisite knowledge may be available, but is too expensive—perhaps because the knowledge is scarce, or its practitioners are well compensated. The expense could limit the breadth of its application. For example, providers of investment advice have typically charged a fee of 1 percent of invested assets or more. Many less well-off investors don't want to spend that much. And cognitive technologies are now supporting "robo-advisors" that charge less; for a $35,000 portfolio, for example, several robo-advisors charge between 0 and 0.38 percent.[17] College education, widely viewed as too expensive for many students, may also benefit in the future from cognitive technologies such as adaptive learning.

Too much data or knowledge for the human brain to master. There are also processes in which we have little choice about employing cognitive technologies, simply because there is too much data and analysis in the process for the human brain to master.[18] In automated digital advertising (also known as "programmatic buying"), for example, a set of complex calculations (including cost compari-

sons, auction bidding, and personalization to the user) must take place within approximately 200 milliseconds so that an ad can be served on a publisher's website.[19] No human brain could make such calculations in that time frame. The soaring amount of knowledge about cancer treatment has also been cited as a rationale for cognitive diagnosis and treatment approaches to the disease.

Need for high decision quality and consistency. Typical applications of previous generations of cognitive technology (rule-based systems in particular) included automated underwriting systems in insurance and automated consumer credit issuance systems in banking. These are high-volume processes in which an ongoing high level of performance is critical.[20] Rule-based systems are not as capable as more modern cognitive technologies, but there are contemporary technologies that can support these decision-quality and consistency objectives.

> Companies are just beginning to seize on the work redesign idea for cognitive technologies.

Regulatory requirements. Regulators may require a certain approach to decision making or to descriptions of decisions. While regulators do not require companies to use cognitive technologies, these tools may be helpful in achieving regulatory compliance. For example, some firms are creating anti-money laundering "suspicious activity reports" with automated text generation technologies. Having machines do these relatively structured tasks can free human knowledge workers to perform more value-adding roles.

Virtually all business processes require data and information to function, and some data-intensive processes may also be suitable for improvement through data-derived knowledge; that is, analytics. In the traditionally transactional process of order management, for example, customer orders might be treated differently based on their lifetime value predictions. Sales processes could be redesigned around the likelihood of converting a lead to a sale or to assess a customer's propensity to buy. These types of models, as they become more detailed and granular, often require machine learning rather than traditional analytics.

COGNITIVE WORK REDESIGN AT VANGUARD

To see how these concepts can be put into practice, let's look at how the Vanguard Group approached using cognitive technologies in one of its client-facing activities.

In 2015, the Vanguard Group, an investment management company that manages over $4 trillion in assets,[21] announced a new service for semi-automated investment advice called Per-

sonal Advisor Services.[22] The three-year project involved product, technology, and process design, as well as the redesign of the role of investment advisor at the company. This discussion focuses primarily on the work process design and role changes, but it's also important to mention that the advising product that Vanguard chose to offer was relatively straightforward. That made it ideal for a cognitive-based intervention, given the relatively early stage of those technologies. Investment advice is, of course, a knowledge-based offering, so cognitive technologies are appropriate for supporting its delivery.

The Personal Advisor Services product primarily involves basic investment analysis and retirement planning, although it can also address college planning and saving for a home. As with most of Vanguard's business, its analysis largely involves index funds and exchange-traded funds (ETFs) as the investment vehicles it chooses from. These are relatively simple investments, and Vanguard already possessed recommendations for what types of funds were appropriate for different investors' ages and risk preferences.

The goal of the new offering was to have an intelligent system take over many of the tasks of investment advising, including constructing a customized portfolio, rebalancing portfolios over time, tax loss harvesting, and tax-efficient investment selection (figure 1). The system took over some tasks from advisors, including acquiring basic information from customers and presenting financial status information to them. This was sometimes considered tedious for human advisors anyway.

The new process required customers to input more information about themselves, and to

Figure 1. The role of cognitive technologies in delivering Vanguard Personal Advisor Services

Note: The "digital experience" includes, but is not limited to, an intelligent system.
Source: Vanguard Group, 2017.

furnish information about non-Vanguard assets to their advisor or directly to the system. It made somewhat complex information (for example, about Monte Carlo simulations of how long a portfolio would last in retirement) available to customers, and gave them the ability to override actions that the automated system planned.

For advisors, the new work process required them to undertake some new roles. Several of them were actively involved in the product and process design. The primary description of their new role was to be an "investing coach," able to answer investor questions, encourage healthy financial behaviors, and be, in Vanguard's words, "an emotional circuit breaker" to keep investors on plan.[23] Advisors were encouraged to learn about behavioral finance to perform these roles effectively. To keep costs down and preserve face-to-face contact with investors, advisors were encouraged to employ videoconferencing technology for occasional meetings.

The business goals for the new offering were to further lower the cost of advice and to make customized advice available to investors with lower assets. Both goals were met by the new offering. Vanguard lowered its own fees for ongoing asset management advice to 30 basis points, substantially less than the industry average of around 1 percent. Minimum asset requirements for customized portfolios and advice was reduced from $500,000 to $50,000.[24] And Vanguard has accumulated assets under management rapidly in the program—they are now over $65 billion.[25]

HOW WOULD COGNITIVE WORK REDESIGN WORK?

COMPANIES are just beginning to seize on the work redesign idea for cognitive technologies. Thus far, many have "paved the cow path" by automating the basic existing work process, particularly with RPA technology. Simply automating existing workflows can be a fast way to get to implementation and return on investment, but it can miss an opportunity for substantial improvement in the process.

In essence, work redesign is an instance of "design thinking," which has largely been developed since the first generation of reengineering. Design thinking can involve the design of products, strategies, facilities, and work processes. At least one cognitive technology expert—Manoj Saxena, the chairman of Cognitive Scale, and former general manager of IBM Watson—argues that design thinking is a useful method for harnessing cognitive technology.[26] It seems likely that some components of design thinking could be added to a synthetic approach to cognitive process redesign. Some of the principles of design thinking that can be applied in this context include:

Understand customer (end user) needs. In processes, the customer is the person or unit that receives the output of the process. That may (and often should) be an external custom-

er if the process is defined broadly; it may also be an internal customer. In either case, cognitive process designers should interview and spend time with customers to understand their met and unmet needs, the job that the process is performing for them, and how a cognitive technology solution might make it better. The customers may not understand the capabilities of cognitive technology, so process designers may have to translate customer needs into cognitive capabilities.

Work collaboratively, and include people who perform the process. Reengineering had difficulties in part because it didn't involve people who performed the process to be redesigned. There is a "practice" dimension of work processes that involves workarounds, extraordinary steps to meet customer needs, and departures from official procedure.[27] Involving those who do the work not only helps capture the practice dimension, but can also facilitate buy-in once the process has been designed. This can be particularly important for knowledge workers, who may not be interested in being told how to do their jobs.[28] Other participants in the process might include process design experts, cognitive technology experts, and customers or their representatives.

Design iteratively and experimentally. To test a new process design in action, it's important to create prototypes and pilots to assess different aspects of the design. Scale-up can happen later. If possible, consider breaking the design effort into stages in which different aspects can be piloted or experimented with over time. Try to accomplish something visible each week. In short, this is an "agile" approach to cognitive work redesign. Neither business process reengineering nor large cognitive projects have historically been particularly agile, so this is a departure from the norm.

Keep the cognitive enablers in mind. A key principle of design thinking is to connect technology possibilities with customer needs. In order to do that, the team doing the cognitive process design project should have a high level of familiarity with the capabilities of cognitive technology, key cognitive technology families, common use cases, and so forth. Some examples of these capabilities and use cases include image and speech recognition, creating more granular and personalized marketing models, or automating back-office digital tasks. A cognitive expert on the team could educate other team members on this.

Consider multiple alternatives. One danger in a design exercise is often converging too rapidly on a particular design or technology. It is often more valuable to think of a portfolio of technologies and process innovations that can be tested against the needs of the process and its customers. Since cognitive technology includes a variety of technology types, this should be easy to do.

Start with easy and relatively inexpensive problems. Typical design thinking may

not advise starting with simple, inexpensive business problems, but that can be good advice for cognitive work redesign. Cognitive "moonshots" have often proven to be very expensive, at least in the early days of this technology. "Picking low-hanging fruit" appears to be a more successful strategy for cognitive technology for now. For example, in advertising, cognitive technology (machine learning in particular) has been quite successful with digital ads, which are inexpensive. The cost of a bad algorithm is quite low. In television advertising, however, ads can be very expensive—and the industry is probably wise to rely largely on human decision making at this point.

It will probably also be useful to employ at least some of the typical tools used in reengineering and other process-centric methods—such as understanding and measuring the current process and laying out the steps and flows of the "to be" process—in a quick, agile fashion. In addition, it's important to describe the specific "division of labor" between humans and machines at different steps within the process. One call center company, for example, determined that only humans were able to deal with the breadth of call topics from customers calling in for service. So it employs humans for the initial triage of calls, and then connects customers to one of more than a thousand "bots" to handle detailed questions. Another company—a financial asset management and brokerage firm—chose the opposite approach, designing the bot to handle first-line questions and deploying humans to address detailed questions on particular topics. There's no one right answer to this sort of question—only a solution that fits your situation and strategy.

In the future, we expect to see more efforts to use cognitive technologies to redesign key aspects of work. Companies will likely use a blend of participative, iterative methods to incorporate these powerful cognitive tools to capture, apply, and distribute knowledge more effectively within their enterprises. Through these synthetic methods, they can determine the right "division of labor" among smart humans and smart machines. Those who use process-based thinking can be more likely to achieve their business goals, please their customers, and get returns on their investments.

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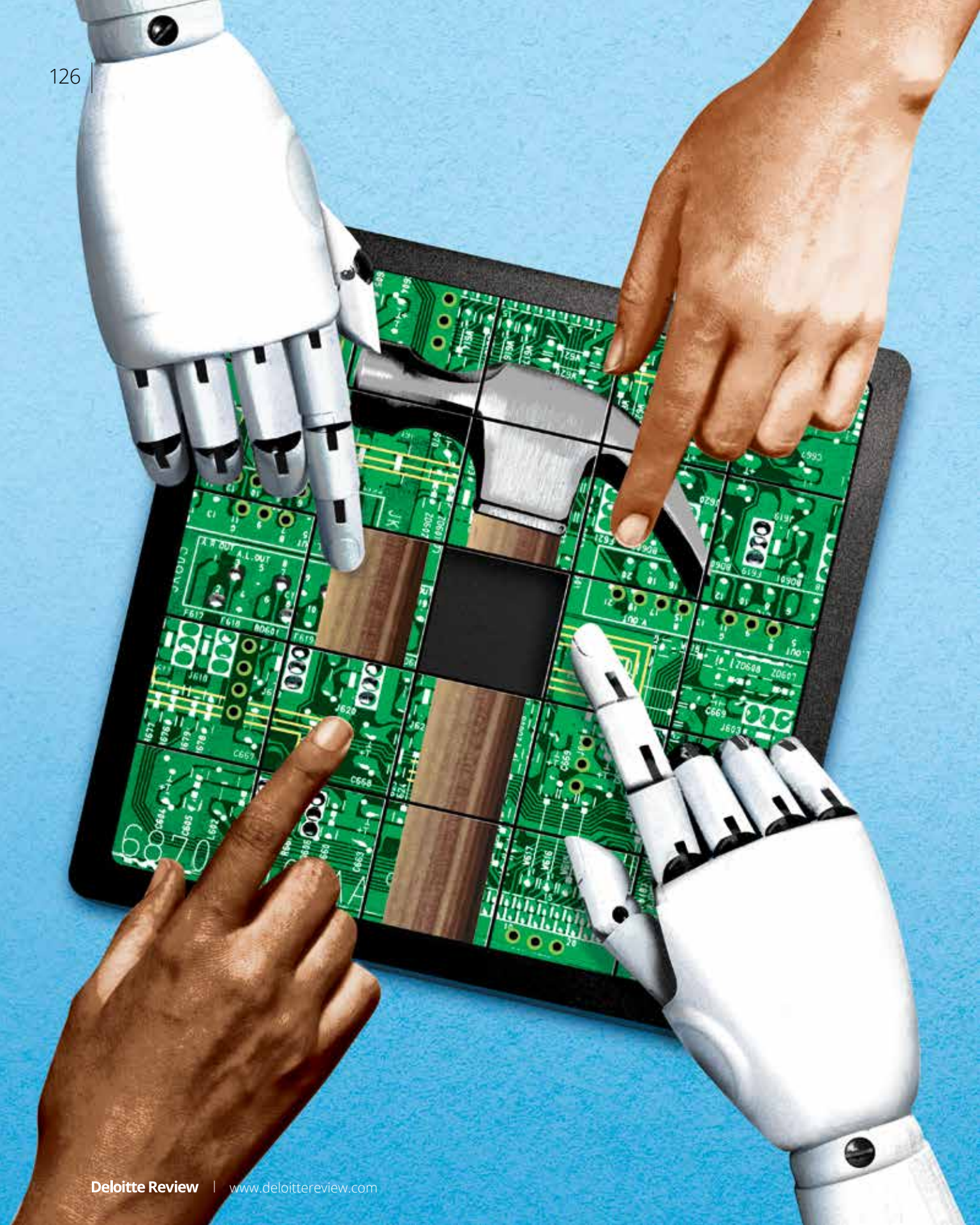

Reconstructing work

Automation, artificial intelligence, and the essential role of humans

By Peter Evans-Greenwood, Harvey Lewis, and James Guszcza
Illustration by Doug Chayka

PESSIMIST OR OPTIMIST?

WILL pessimistic predictions of the rise of the robots come true? Will humans be made redundant by artificial intelligence (AI) and robots, unable to find work and left to face a future defined by an absence of jobs? Or will the optimists be right? Will historical norms reassert themselves and technology create more jobs than it destroys, resulting in new occupations that require new skills and knowledge and new ways of working?

The debate will undoubtedly continue for some time. But both views have been founded on a traditional conception of work as a collection of specialized tasks and activities performed mostly by humans. As AI becomes more capable and automates an ever-increasing proportion of these tasks, is it now time to consider a third path? Might AI enable *work itself* to be reconstructed?

It is possible that the most effective use of AI is *not* simply as a means to automate more tasks, but as an enabler to achieve higher-level goals, to create more value. The advent of AI makes it possible—indeed, desirable—to reconceptualize work, not as a set of discrete tasks laid end to end in a predefined process, but as a collaborative problem-solving effort where humans define the problems, machines help find the solutions, and humans verify the acceptability of those solutions.

> This impressive history of industrial automation has resulted not only from the march of technology, but from the conception of work as a set of specialized tasks.

CONSTRUCTING WORK

PRE-INDUSTRIAL work was constructed around the product, with skilled artisans taking responsibility for each aspect of its creation. Early factories (commonly called *manufactories* at the time) were essentially collections of artisans, all making the same product to realize sourcing and distribution benefits. In contrast, our current approach to work is based on Adam Smith's division of labor,[1] in the form of the task. Indeed, if we were to pick one idea as the foundation of the Industrial Revolution it would be this division of labor: Make the coil spring rather than the entire watch.

Specialization in a particular task made it worthwhile for workers to develop superior skills and techniques to improve their productivity. It also provided the environment for the task to be mechanized, capturing the worker's physical actions in a machine to improve precision and reduce costs. Mechanization then begat automation when we replaced human

power with water, then steam, and finally electric power, all of which increased capacity. Handlooms were replaced with power looms, and the artisanal occupation shifted from weaving to managing a collection of machines. Human computers responsible for calculating gunnery and astronomical tables were similarly replaced with analog and then digital computers and the teams of engineers required to develop the computer's hardware and software. Word processors shifted responsibility for document production from the typing pool to the author, resulting in the growth of departmental IT. More recently, doctors responsible for interpreting medical images are being replaced by AI and its attendant team of technical specialists.[2]

This impressive history of industrial automation has resulted not only from the march of technology, but from the conception of work as a set of specialized tasks. Without specialization, problems wouldn't have been formalized as processes, processes wouldn't have been broken into well-defined tasks, and tasks wouldn't have been mechanized and then automated. Because of this atomization of work into tasks (conceptually and culturally), jobs have come to be viewed largely as compartmentalized collections of tasks. (Typical corporate job descriptions and skills matrices take the form of lists of tasks.) Job candidates are selected based on their knowledge and skills, their ability to prosecute the tasks in the job description. A contemporary manifestation of this is the rise of task-based crowdsourcing sites—such as TaskRabbit[3] and Kaggle,[4] to name only two—that enable tasks to be commoditized and treated as piecework.

DOES AUTOMATION DESTROY OR CREATE JOBS?

AI demonstrates the potential to replicate even highly complex, specialized tasks that only humans were once thought able to perform (while finding seemingly easy but more general tasks, such as walking or common sense reasoning, incredibly challenging). Unsurprisingly, some pundits worry that the age of automation is approaching its logical conclusion, with virtually all work residing in the ever-expanding domain of machines. These pessimists think that robotic process automation[5] (RPA) and such AI solutions as autonomous vehicles will destroy jobs, relegating people to filling the few gaps left in the economy that AI cannot occupy. There may well be more jobs created in the short term to build, maintain, and enhance the technology, but not everyone will be able to gain the necessary knowledge, skills, and experience.[6] For example, it seems unlikely that the majority of truck, bus, or taxi drivers supplanted by robots will be able to learn the software development skills required to build or maintain the algorithms replacing them.

Further, these pessimists continue, we must consider a near future where many (if not all)

low-level jobs, such as the administrative and process-oriented tasks that graduates typically perform as the first step in their career, are automated. If the lower levels of the career ladder are removed, they will likely struggle to enter professions, leaving a diminishing pool of human workers to compete for a growing number of jobs. Recent advances in AI prompt many to wonder just how long it will be before AI catches up with the majority of us. How far are we from a future where the only humans involved with a firm are its owners?

Of course, there is an alternative view. History teaches that automation, far from destroying jobs, can and usually does create net new jobs, and not just those for building the technology or training others in its use. This is because increased productivity and efficiency, and the consequent lowering of prices, has historically led to greater demand for goods and services. For example, as the 19th century unfolded, new technology (such as power looms) enabled more goods (cloth, for instance) to be produced with less effort;[7] as a consequence, prices dropped considerably, thus increasing demand from consumers. Rising consumer demand not only drove further productivity improvements through progressive technological refinements, but also significantly increased demand for workers with the right skills.[8] The optimistic view holds that AI, like other automation technologies before it, will operate in much the same way. By automating more and more complex tasks, AI could potentially reduce costs, lower prices, and generate more demand—and, in doing so, create more jobs.

THE PRODUCTIVITY PROBLEM AND THE END OF A PARADIGM

OFTEN overlooked in this debate is the assumption made by both camps that automation is about using machines to perform tasks traditionally performed by humans. And indeed, the technologies introduced during the Industrial Revolution progressively (though not entirely) did displace human workers from particular tasks.[9] Measured in productivity terms, by the end of the Industrial Revolution, technology had enabled a weaver to increase by a factor of 50 the amount of cloth produced per day;[10] yet a modern power loom, however more efficient, executes the work in essentially the same way a human weaver does. This is a pattern that continues today: For example, we have continually introduced more sophisticated technology into the finance function (spreadsheets, word processing, and business intelligence tools are some common examples), but even the bots of modern-day robotic process automation complete tasks in the conventional way, filling in forms and sending emails as if a person were at the keyboard, while "exceptions" are still handled by human workers.

We are so used to viewing work as a series of tasks, automation as the progressive mechanization of those tasks, and jobs as collections of tasks requiring corresponding skills, that it is difficult to conceive of them otherwise. But

The lesson here is that human and machine intelligence are different in complementary, rather than conflicting, ways. While they might solve the same problems, they approach these problems from different directions.

there are signs that this conceptualization of work may be nearing the end of its useful life. One such major indication is the documented fact that technology, despite continuing advances, no longer seems to be achieving the productivity gains that characterized the years after the Industrial Revolution. Short-run productivity growth, in fact, has dropped from 2.82 (1920–1970) to 1.62 percent (1970–2014).[11] Many explanations for this have been proposed, including measurement problems, our inability to keep up with the rapid pace of technological change, and the idea that the tasks being automated today are inherently "low productivity."[12] In *The Rise and Fall of American Growth*,[13] Robert Gordon argues that today's low-productivity growth environment is due to a material difference in the technologies invented between 1850 and 1980 and those invented more recently. Gordon notes that prior to the Industrial Revolution mean growth was 1.79 percent (1870–1920),[14] and proposes that what we're seeing today is a reversion to this mean.

None of these explanations is entirely satisfying. Measurement questions have been debated to little avail. And there is little evidence that technology is developing more rapidly today than in the past.[15] Nor is there a clear reason for why, say, a finance professional managing a team of bots should not realize a similar productivity boost as a weaver managing a collection of power looms. Even Robert Gordon's idea of one-time technologies, while attractive, must be taken with a grain of salt: It is always risky to underestimate human ingenuity.

One explanation that hasn't been considered, however, is that the industrial paradigm itself—where jobs are constructed from well-defined tasks—has simply run its course. We forget that jobs are a social construct, and our view of what a job is, is the result of a dialogue between capital and labor early in the Industrial Revolution. But what if we're heading toward a future where work is different, rather than an evolution of what we have today?

SUITABLE FOR NEITHER HUMAN NOR MACHINE

CONSTRUCTING work around a predefined set of tasks suits neither human nor machine. On one hand, we

have workers complaining of monotonous work,[16] unreasonable schedules, and unstable jobs.[17] Cost pressure and a belief that humans are simply one way to prosecute a task leads many firms to slice the salami ever more finely, turning to contingent labor and using smaller (and therefore more flexible) units of time to schedule their staff. The reaction to this has been a growing desire to recut jobs and make them more human, designing new jobs that make the most of our human advantages (and thereby make us humans more productive). On the other hand, we have automation being deployed in a manner similar to human labor, which may also not be optimal.

The conundrum of low productivity growth might well be due to both under-utilized staff and under-utilized technology. Treating humans as task-performers, and a cost to be minimized, might be conventional wisdom, but Zeynep Ton found (and documented in her book *The Good Jobs Strategy*) that a number of firms across a range of industries—including well-known organizations such as Southwest Airlines, Toyota, Zappos, Wegmans, Costco, QuikTrip, and Trader Joe's—were all able to realize above-average service, profit, and growth by crafting jobs that made the most of their employees' inherent nature to be social animals and creative problem-solvers.[18] Similarly, our inability to realize the potential of many AI technologies might not be due to the limitations of the technologies themselves, but, instead, our insistence on treating them as independent mechanized task performers. To be sure, AI can be used to automate tasks. But its full potential may lie in putting it to a more substantial use.

There are historical examples of new technologies being used in a suboptimal fashion for years, sometimes decades, before their more effective use was realized.[19] For example, using electricity in place of steam in the factory initially resulted only in a cleaner and quieter work environment. It drove a productivity increase only 30 years later, when engineers realized that electrical power was easier to distribute (via wires) than mechanical power (via shafts, belts, and pulleys). The single, centralized engine (and mechanical power distribution), which was a legacy of the steam age, was swapped for small engines directly attached to each machine (and electrical power distribution). This enabled the shop floor to be optimized for workflow rather than power distribution, delivering a sudden productivity boost.

A NEW LINE BETWEEN HUMAN AND MACHINE

THE question then arises: If AI's full potential doesn't lie in automating tasks designed for humans, what is its most appropriate use? Here, our best guidance comes from evidence that suggests human and machine intelligence are best viewed as complements rather than substitutes[20]—and that humans and AI, working together, can

achieve better outcomes than either alone.[21] The classic example is freestyle chess. When IBM's Deep Blue defeated chess grandmaster Garry Kasparov in 1997, it was declared to be "the brain's last stand." Eight years later, it became clear that the story is considerably more interesting than "machine vanquishes man." A competition called "freestyle chess" was held, allowing any combination of human and computer chess players to compete. The competition resulted in an upset victory that Kasparov later reflected upon:

> The surprise came at the conclusion of the event. The winner was revealed to be not a grandmaster with a state-of-the-art PC but a pair of amateur American chess players using three computers at the same time. Their skill at manipulating and "coaching" their computers to look very deeply into positions effectively counteracted the superior chess understanding of their grandmaster opponents and the greater computational power of other participants. Weak human + machine + better process was superior to a strong computer alone and, more remarkably, superior to a strong human + machine + inferior process… Human strategic guidance combined with the tactical acuity of a computer was overwhelming.[22]

There are historical examples of new technologies being used in a suboptimal fashion for years, sometimes decades, before their more effective use was realized.

The lesson here is that human and machine intelligence are different in complementary, rather than conflicting, ways. While they might solve the same problems, they approach these problems from different directions. Machines find highly complex tasks easy, but stumble over seemingly simple tasks that any human can do. While the two might use the same knowledge, how they use it is different. To realize the most from pairing human and machine, we need to focus on how the two interact, rather than on their individual capabilities.

TASKS VERSUS KNOWLEDGE

RATHER than focusing on the task, should we conceptualize work to focus on the knowledge, the raw material common to human and machine? To answer this question, we must first recognize that knowledge is predominantly a social construct,[23] one that is treated in different ways by humans and machines.

Consider the group of things labeled "kitten." Both human and robot learn to recognize "kitten" the same way:[24] by considering a labeled set of exemplars (images).[25] However, although kittens are clearly *things in the world*, the concept of "kitten"—the knowledge, the

identification of the category, its boundaries, and label—is the result of a dialogue within a community.[26]

Much of what we consider to be common sense is defined socially. Polite behavior, for example, is simply common convention among one's culture, and different people and cultures can have quite different views on what is correct behavior (and what is inexcusable). How we segment customers; the metric system along with other standards and measures; how we decompose problems into business processes and the tasks they contain, measure business performance, define the rules of the road, and drive cars; regulation and legislation in general; and the cliché of Eskimos having dozens, if not hundreds, of words for snow,[27] all exemplify knowledge that is socially constructed. Even walking—and the act of making a robot walk—is a social construct,[28] as it was the community that identified "walking" as a phenomenon and gave it a name, ultimately motivating engineers to create a walking robot, and it's something we and robots learn by observation and encouragement. There are many possible ways of representing the world and dividing up reality, to understand the nature and relation of things, and to interact with the world around us, and the representation we use is simply the one that we agreed on.[29] Choosing one word or meaning above the others has as much to do with societal convention as ontological necessity.

Socially constructed knowledge can be described as *encultured* knowledge, as it is our culture that determines what is (and what isn't) a kitten, just as it is culture that determines what is and isn't a good job. (We might even say that knowledge is created between people, rather than within them.) Encultured knowledge extends all the way up to formal logic, math, and hard science. Identifying and defining a phenomenon for investigation is thus a social process, something researchers must do before practical work can begin. Similarly, the rules, structures, and norms that are used in math and logic are conventions that have been agreed upon over time.[30] A fish is a fish insofar as we all call it a fish. Our concept of "fish" was developed in dialogue within the community. Consequently, our concept of fish drifts over time: In the past "fish" included squid (and some other, but not all, cephalopods), but not in current usage. The concepts that we use to

Humans experience the world in all its gloriously messy and poorly defined nature, where concepts are ill-defined and evolving and relationships fluid.

think, theorize, decide, and command are defined socially, by our community, by the group, and evolve with the group.

KNOWLEDGE AND UNDERSTANDING

HOW is this discussion of knowledge related to AI? Consider again the challenge of recognizing images containing kittens. Before either human or machine can recognize kittens, we need to agree on what a "kitten" is. Only then can we collect the set of labeled images required for learning.

The distinction between human and machine intelligence, then, is that the human community is constantly constructing new knowledge (labeled exemplars in the case of kittens) and tearing down the old, as part of an ongoing dialogue within the community. When a new phenomenon is identified that breaks the mold, new features and relationships are isolated and discussed, old ones reviewed, concepts shuffled, unlearning happens, and our knowledge evolves. The European discovery of the platypus in 1798 is a case in point.[31] When Captain John Hunter sent a platypus pelt to Great Britain,[32] many scientists' initial hunch was that it was a hoax. One pundit even proposed that it might have been a novelty created by an Asian taxidermist (and invested time in trying to find the stitches).[33] The European community didn't know how to describe or classify the new thing. A discussion ensued, new evidence was sought, and features identified, with the community eventually deciding that the platypus wasn't a fake, and our understanding of animal classification evolved in response.

Humans experience the world in all its gloriously messy and poorly defined nature, where concepts are ill-defined and evolving and relationships fluid. Humans are quite capable of operating in this confusing and noisy world; of reading between the lines; tapping into weak signals; observing the unusual and unnamed; and using their curiosity, understanding, and intuition to balance conflicting priorities and determine what someone actually meant or what is the most important thing to do. Indeed, as Zeynep Ton documented in *The Good Jobs Strategy*,[34] empowering employees to use their judgment, to draw on their own experience and observations, to look outside the box, and to consider the context of the problem they are trying to understand (and solve), as well as the formal metrics, policies, and rules of the firm, enabled them to make wiser decisions and consequentially deliver higher performance. Unfortunately, AI doesn't factor in the unstated implications and repercussions, the context and nuance, of a decision or action in the way humans do.

It is this ability to refer to the context around an idea or problem—to craft more appropriate solutions, or to discover new knowledge to create (and learn)—that is uniquely human. Technology cannot operate in such an environment: It needs its terms specified and objectives clearly articulated, a well-defined and

fully contextualized environment within which it can reliably operate. The problem must be identified and formalized, the inputs and outputs articulated, before technology can be leveraged. Before an AI can recognize kittens, for instance, we must define what a kitten is (by exemplar or via a formal description) and find a way to represent potential kittens that the AI can work with. Similarly, the recent boom in autonomous vehicles is due more to the development of improved sensors and hyper-accurate maps, which provide the AI with the dials and knobs it needs to operate, than the development of vastly superior algorithms.

It is through the social process of knowledge construction that we work together to identify a problem, define its boundaries and dependences, and discover and eliminate the unknowns until we reach the point where a problem has been defined sufficiently for knowledge and skills to be brought to bear.

A BRIDGE BETWEEN HUMAN AND MACHINE

If we're to draw a line between human and machine, then it is the distinction between *creating* and *using* knowledge. On one side is the world of the unknowns (both known and unknown), of fuzzy concepts that cannot be fully articulated, the land of the humans, where we work together to make sense of the world. The other side is where terms and definitions have been established, where the problem is known and all variables are quantified, and automation can be applied. The bridge between the two is the social process of knowledge creation.

Consider the question of what a "happy retirement" is: We all want one, but we typically can't articulate what it is. It's a vague and subjective concept with a circular definition: A happy retirement is one in which *you're* happy. Before we can use an AI-powered robo-advisor to create our investment portfolio, we need to take our concept of a "happy retirement" through grounding the concept ("what will *actually* make me happy, as opposed to what I *think* will make me happy"), establishing reasonable expectations ("what can I expect to fund"), to attitudes and behaviors ("how much can I change my habits, how and where I spend my money, to free up cash to invest"), before we reach the quantifiable data against which a robo-advisor can operate (investment goals, income streams, and appetite for risk). Above quantifiable investment goals and income streams is the social world, where we need to work with other people to discover what our happy retirement might be, to define the problem and create the knowledge. Below is where automation—with its greater precision and capacity for consuming data—can craft our ultimate investment strategy. Ideally there is interaction between the two layers—as with freestyle chess—with automation enabling the humans to play what-if games and explore how the solution space changes depending on how they shape the problem definition.

RECONSTRUCTING WORK

THE foundation of work in the pre-industrial, craft era was the product. In the industrial era it is the task, specialized knowledge, and skills required to execute a step in a production process. Logically, the foundation of post-industrial work will be the problem—the *goal to be achieved*[35]—one step up from the solution provided by a process.

If we're to organize work around problems and successfully integrate humans and AI into the same organization, then it is management of the problem definition—rather than the task as part of a process to deliver a solution—that becomes our main concern.[36] Humans take responsibility for shaping the problem—the data to consider, what *good* looks like, the choices to act—which they do in collaboration with those around them and their skill in doing this will determine how much additional value the solution creates. Automation (including AI) will support the humans by augmenting them with a set of digital *behaviors*[37] (where a *behavior* is the way in which one acts in response to a *particular* situation or stimulus) that replicate *specific* human behaviors, but with the ability to leverage more data and provide more precise answers while not falling prey to the various cognitive biases to which we humans are prone. Finally, humans will evaluate the appropriateness and completeness of the solution provided and will act accordingly.

Indeed, if automation in the industrial era was the replication of *tasks* previously isolated and defined for humans, then in the post-industrial era, automation might be the replication of isolated and well-defined *behaviors* that were previously unique to humans.

INTEGRATING HUMANS AND AI

CONSIDER the challenge of eldercare. A recent initiative in the United Kingdom is attempting to break down the silos in which specialized health care professionals currently work.[38] Each week, the specialists involved with a single patient—health care assistant, physiotherapist, occupational therapist, and so on—gather to discuss the patient.

Each specialist brings his or her own point of view and domain knowledge to the table, but as a group they can build a more comprehensive picture of how best to help the patient by integrating observations from their various specialties as well as discussing more tacit observations that they might have made when interacting with the patient. By moving the focus from the tasks to be performed to the problem to be defined—*how to improve the patient's quality of life*—the first phase of the project saw significant improvements in patient outcomes over the first nine months.

Integrating AI (and other digital) tools into this environment to augment the humans might benefit the patient even more by providing better and more timely decisions and avoiding cognitive biases, resulting in an even higher quality of care. To do this, we could create a common digital workspace where the team can capture its discussions; a whiteboard (or blackboard) provides a suitable metaphor, as it's easy to picture the team standing in front of the board discussing the patient while using the board to capture important points or share images, charts, and other data. A collection of AI (and non-AI) *digital behaviors* would also be integrated directly into this environment. While the human team stands in front of the whiteboard, the digital behaviors stand behind it, listening to the team's discussion and watching as notes and data are captured, and reacting appropriately, or even responding to direct requests.

Data from tests and medical monitors could be fed directly to the board, with predictive behaviors keeping a watchful eye on data streams to determine if something unfortunate is about to happen (similar to how electrical failures can be predicted by looking for characteristic fluctuations in power consumption, or how AI can be used to provide early warning of struggling students by observing patterns in communication, attendance, and assignment submission), flagging possible problems to enable the team to step in before an event and prevent it, rather than after. A speech-to-text behavior creates a transcription of the ensuing discussion so that what was discussed is easily searchable and referenceable. A medical image—an MRI perhaps—is ordered to explore a potential problem further, with the resulting image delivered directly to the board, where it is picked up by a cancer-detection behavior to highlight possible problems for the team's specialist to review. With a diagnosis in hand, the team works with a genetic drug-compatibility[39] behavior to find the best possible response for this patient and a drug-conflict[40] behavior that studies the patient's history, prescriptions, and the suggested interventions to determine how they will fit in the current care regime, and explore the effectiveness of different possible treatment strategies. Once a treatment strategy has been agreed on, a planning behavior[41] converts the strategy into a detailed plan—taking into account the urgency, sequencing, and preferred providers for each intervention—listing

the interventions to take place and when and where each should take place, along with the data to be collected, updating the plan should circumstances change, such as a medical imaging resource becoming available early due to a cancellation.

Ideally, we want to populate this problem-solving environment with a comprehensive collection of behaviors. These behaviors might be predictive, flagging possible events before they happen. They might enable humans to explore the problem space, as the chess computer is used in freestyle chess, or the drug-compatibility and drug-conflict AIs in the example above. They might be analytical, helping us avoid our cognitive biases. They might be used to solve the problem, such as when the AI planning engine takes the requirements from the treatment strategy and the availability constraints from the resources the strategy requires, and creates a detailed plan for execution. Or they might be a combination of all of these. These behaviors could also include non-AI technologies, such as calculators, enterprise applications such as customer relationship management (CRM) (to determine insurance options for the patient), or even physical automations and non-technological solutions such as checklists.[42]

UNIQUELY HUMAN

IT'S important to note that scenarios similar to the eldercare example just mentioned exist across a wide range of both blue- and white-collar jobs. The Toyota Production System is a particularly good blue-collar example, where work on the production line is oriented around the problem of improving the process used to manufacture cars, rather than the tasks required to assemble a car.

One might assume that the creation of knowledge is the responsibility of academy-anointed experts. In practice, as Toyota found, it is the people at the coalface, finding and chipping away at problems, who create the bulk of new knowledge.[43] It is our inquisitive nature that leads us to try and explain the world around us, creating new knowledge and improving the world in the process. Selling investment products, as we've discussed, can be reframed to focus on determining what a happy retirement might look like for this *particular* client, and guiding the client to his or her goal. Electric power distribution might be better thought of as the challenge of improving a household's ability to manage its power consumption. The general shift from buying products to consuming services[44] provides a wealth of similar opportunities to help individuals improve how they consume these services, be they anything from toilet paper subscriptions[45] through cars[46] and eldercare (or other medical and health services) to jet engines,[47] while internally these same firms will have teams focused on improving how these services are created.

Advances (and productivity improvements) are typically made by skilled and curious practitio-

ners solving problems, whether it was weavers in a mill finding and sharing a faster (but more complex) method of joining a broken thread in a power loom or diagnosticians in the clinic noticing that white patches sometimes appear on the skin when melanomas regress spontaneously.[48] The chain of discovery starts at the coalface with our human ability to notice the unusual or problematic—to swim through the stream of the unknowns and of fuzzy concepts that cannot be fully articulated. This is where we collaborate to make sense of the world and create knowledge, whether it be the intimate knowledge of what a happy retirement means for an individual, or grander concepts that help shape the world around us. It is this ability to collectively make sense of the world that makes us uniquely human and separates us from the robots—and it cuts across all levels of society.

If we persist in considering a job to be little more than a collection of related tasks, where value is determined by the knowledge and skill required to prosecute them, then we should expect that automation will eventually consume *all* available work, as we must assume that any well-defined task, no matter how complex, will be eventually automated. This comes at a high cost, as while machines can learn, they don't in themselves, create new knowledge. An AI tool might discover patterns in data, but it is the humans who noticed that the data set was interesting and then inferred meaning into the patterns discovered by the machine. As we relegate more and more tasks to machines, we are also eroding the connection between the problems to be discovered and the humans who can find and define them. Our machines might be able to learn, getting better at doing what they do, but they won't be able to reconceive what *ought* to be done, and think outside their algorithmic box.

> There is a third option, though: one where we move from building jobs around processes and tasks, a solution that is optimal for neither human nor machine, to building jobs around problems.

CONCLUSION

At the beginning of this article, we asked if the pessimists or optimists would be right. Will the future of work be defined by a lack of suitable jobs for much of the population? Or will historical norms reassert themselves, with automation creating more work than it destroys? Both of these options are quite possible since, as we often for-

get, work is a social construct, and it is up to us to decide how it should be constructed.

There is a third option, though: one where we move from building jobs around processes and tasks, a solution that is optimal for neither human nor machine, to building jobs around problems. The difficulty is in defining production as a problem to be solved, rather than a process to be streamlined. To do this, we must first establish the context for the problem (or contexts, should we decompose a large production into a set of smaller interrelated problems). Within each context, we need to identify what is known and what is unknown and needs to be discovered. Only then can we determine for each problem whether human or machine, or human and machine, is best placed to move the problem forward.

Reframing work, changing the foundation of how we organize work from *task to be done* to *problem to be solved* (and the consequent reframing of automation from the replication of *tasks* to the replication of *behaviors*) might provide us with the opportunity to jump from the industrial productivity improvement S-curve[49] to a post-industrial one. What drove us up the industrial S-curve was the incremental development of automation for more and more complex tasks. The path up the post-industrial S-curve might be the incremental development of automation for more and more complex behaviors.

The challenge, though, is to create not just jobs, but *good* jobs that make the most of our human nature as creative problem identifiers. It was not clear what a good job was at the start of the Industrial Revolution. Henry Ford's early plants were experiencing nearly 380 percent turnover and 10 percent daily absenteeism from work,[50] and it took a negotiation between capital and labor to determine what a good job should look like, and then a significant amount of effort to create the infrastructure, policies, and social institutions to support these good jobs. If we're to change the path we're on, if we're to choose the third option and construct work around problems whereby we can make the most of our own human abilities and those of the robots, then we need a conscious decision to engage in a similar dialogue.

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Endnotes

1. The concept of the division of labor—the deconstruction of the problem into a set of sequential tasks, with participants specializing in particular tasks—has a long history, one reaching all the way back to Plato, though it seems to be Adam Smith that most people associate with the idea. It was his 1776 book, *An Inquiry into the Nature and Causes of the Wealth of Nations* (more commonly known as *The Wealth of Nations*), in which Adam Smith posited that enabling workers to concentrate and specialize on their particular tasks leads to greater productivity and skills. It's worth noting that Smith foresaw many of today's problems when he observed that dividing labor too finely can lead to "the almost entire corruption and degeneracy of the great body of the people . . . unless government takes some pains to prevent it." Alexis de Tocqueville made the same point more bluntly when he stated (in his 1841 book, *Democracy in America: Volume I*) that "Nothing tends to materialize man, and to deprive his work of the faintest trace of mind, more than extreme division of labor."

2. For a thoughtful discussion of the application of such AI methods to radiology and the potential impact on practitioners, see Siddhartha Mukherjee, "A.I. versus M.D.," *New Yorker*, April 3, 2017, http://www.newyorker.com/magazine/2017/04/03/ai-versus-md.

3. TaskRabbit (www.taskrabbit.com) provides an online and mobile marketplace for everyday tasks—such as cleaning, handyman work, and moving—that matches consumers with freelance labor.

4. Kaggle (www.kaggle.com) is an online platform for analytics and predictive modelling that enables companies and researchers to post their data and run competitions with freelance data scientists to provide the best data models.

5. Robotic process automation (RPA) is an approach to automating common clerical tasks by creating *software robots* that replicate the actions of human clerical workers interacting with the user interface of a computer system, operating on the user interface in the same way that a human would. Common tasks for these software robots are data entry or transfer, such as an auditor extracting financial transactions from a client's bookkeeping system and entering them into the audit system.

6. The increasing difficulty individuals find in maintaining the knowledge and skills required is often attributed to a combination of a decreasing half-life of knowledge and the red queen effect. The half-life of knowledge is a concept attributed to Fritz Machlup, and was intended to capture the feeling that knowledge ages much more rapidly today than it did in the past (the analogy made between nuclear decay and the erosion of knowledge is awkward at best). More precisely, it is defined as the time that has to elapse before half the knowledge or facts in a particular domain are superseded or shown to be false. In 2008, Roy Tang determined that the half-life of knowledge was 13 years for physics, 9 for math, and 7.1 years for psychology and history. The term is inherently imprecise due the challenges in cleanly defining a domain and identifying (and discriminating between) the knowledge and facts it contains. The red queen effect refers to an evolutionary hypothesis that proposes that organisms must constantly change and adapt, or be overtaken by other organisms that change and adapt faster in a constantly changing environment. The effect is named after the Red Queen in Lewis Carroll's *Through the Looking-Glass*.

7. It's interesting to note that early punch-card looms—where the pattern to be woven was encoded in a series of punch cards—were a precursor of the modern digital computer.

8. Refer to J. Bessen, *Learning by Doing: The Real Connection between Innovation, Wages, and Wealth* (Yale University Press, 2015), for a thorough discussion of the relationship between the initial invention of a new automation technology and the subsequent incremental improvement of the technology by workers identifying better work practices and improvements, and how the productivity improvements reduced cost which, in turn, resulted in higher demand. The first power looms, for example, improved productivity by a factor of 2.5, while the subsequent incremental improvements lifted the factor up to 50 by the end of the Industrial Revolution.

9. It's commonly claimed that the only example of a job that has been entirely eliminated by technology is that of the elevator attendant, though it's interesting to note that this job was also created by technology.

10. Bessen, *Learning by Doing*.

11. Taken from Robert J. Gordon, figure 1–1 ("Annualized growth rate of output per person, output per hour, and hours per person, 1870–2014"), *The Rise and Fall of American Growth: The U.S. Standard of Living Since the Civil War* (Princeton University Press, 2016).

12. This is the "automation paradox": When computers start doing the work of people, the need for people often increases. Rather than replace the human, these solutions still require human oversight. If automation is being used for tasks where human workload or cognitive load is low, then it can complicate situations when human workload is high. A good example is aircraft autopilots, where routine tasks were handed off to automation, leaving the pilot to deal with the tricky scenarios, such as landing or negotiating with air traffic control. The relationship between pilot and plane has changed, and pilots find it unsettling when the automation is not operating flawlessly. Something as simple as a sensor icing up might cause the autopilot to disengage, surprising the crew and nudging them onto a path that leads to a fatal mistake. Joe Pappalardo, contributing editor at *Popular Mechanics* magazine, points out that "catastrophic failures don't happen as often but they are more catastrophic when they do." Pilot error is the notional cause for roughly 50 percent of fatal accidents, but the source of this error might be the interface between human and automation. An entirely manual system was more robust as it lacked this human-computer hand-off. As Pappalardo concludes, "If something went wrong in the 1970s, there was a chance you could land it." See Finlo Rohrer and Tom de Castella, "Mechanical v human: Why do planes crash?," *BBC News Magazine*, March 14, 2014, http://www.bbc.com/news/magazine-26563806.

13. Gordon, *The Rise and Fall of American Growth*.

14. Ibid, figure 1–1 ("Annualized growth rate of output per person, output per hour, and hours per person, 1870–2014").

15. We mistake what is unfamiliar as something that is new in and of itself. Many of the AI technologies considered part of cognitive computing are not new. The statistical approach to machine translation originated in the late 1980s. The groundwork for artificial neural networks was established by Donald Hebb in the '40s, refined in the '90s when key innovations such as back propagation were developed, and became practical mid-2000s when hardware and data sets caught up. Many of the technologies considered part of cognitive computing have similarly long histories. Compare this to the development of motion pictures. As a child, Charlie Chaplin performed in three large music halls an evening. By 1915, 10 years later, he could be seen in thousands of halls across the world. It took radio only 10 years from the launch of the first commercial radio station in 1920, to reach 80 percent of homes. Just 8 percent of urban American households had electricity in 1907. By 1929, 85 percent had electricity. After a long gestation as various inventors attempted to use coal gas to fuel a self-propelled engine, Karl Benz successfully trailed a two-stroke gasoline engine on New Year's Eve of 1879 (just 10 weeks after Edison had perfected the electric light bulb). Just over 20 years later in 1906, Wilhelm Maybach developed a six-cylinder engine that powered a car with equivalent power and function to a modern compact. With that the car took off, taking only another 20 years to rocket from effectively zero percent ownership to 60 percent, after which it took a more leisurely pace as it asymptotes toward today's figure of roughly 80 percent. Today's technology environment, however, is highly entailed—new technologies depend on earlier ones, and as time passes and society accretes new technologies, the technologies themselves become more complex as they depend on a greater number of prior developments and resources. Google Translate appeared in 2006 as this is when Google's engineers had finally obtained a data set that could exercise the statistical algorithms the service was based on, algorithms proposed in the '80s. Autonomous cars quickly flipped from pie in the sky to *you'll be able to buy one real soon* once better sensors were developed and comprehensive electronic road maps were compiled, accurate down to the centimeter. And so on.

16. Anthropology professor David Graeber explored the phenomenon of what he termed *bullshit jobs* in his 2013 essay *On the phenomenon of bullshit jobs*. He noted that many clerical jobs are unfulfilling, with the workers responsible for them feeling that their labor is unproductive and pointless, their work unnecessary. See David Graeber, "On the phenomenon of bullshit jobs," *Strike*, 2013, http://strikemag.org/bullshit-jobs/.

17. Similar to how Ford's early factories were experiencing 380 percent turnover and 10 percent daily absenteeism from work in their first years of operation.

18. Z. Ton, *The Good Jobs Strategy: How the Smartest Companies Invest in Employees to Lower Costs and Boost Profits* (New Harvest, 2014).

19. Bessen provides many fascinating examples that show how the development of *know-how*, the knowledge of how to make best use of technology, provides the majority of the productivity improvement attributed to a new technology, with the invention of the technology itself providing a much more modest productivity boost. Bessen, *Learning by Doing*.

20. This is the theme of the authors' previous work; see Jim Guszcza, Harvey Lewis, and Peter Evans-Greenwood, "Cognitive collaboration: Why humans and computers think better together," *Deloitte Review*

20, January 23, 2017, https://dupress.deloitte.com/dup-us-en/deloitte-review/issue-20/augmented-intelligence-human-computer-collaboration.html.

21. Ibid.

22. Garry Kasparov, "The chess master and the computer," *New York Review of Books* 57, no. 2 (2010): pp. 1–6, www.nybooks.com/articles/2010/02/11/the-chess-master-and-the-computer.

23. While the preponderance of our knowledge might be socially constructed not all knowledge is. We experience our own heartbeat, for example, without intervention, though identifying, delineating, and naming this phenomenon "heartbeat" was the result of social construction. The book *Introduction to New Realism* by Maurizio Ferraris is recommended to the more philosophically minded readers, as a sound definition of the position taken by this report: Maurizio Ferraris, *Introduction to New Realism* (Bloomsbury Academic, 2015).

24. Indeed, it was the development of AI tools that enabled us to do things such as recognizing images of kittens plucked from the Internet, which has caused so many conniptions as prior to that tacit knowledge was considered the exclusive domain of humans.

25. It's interesting to note that children need to see much fewer images of kittens than AI to learn the category. Humans, in general, require less data to learn than machines.

26. Care must be taken not to confuse the *thing* (ontology) with our *knowledge* of the thing (epistemology). The thing—*kitten*, perhaps—is clearly an immalleable object in the world, but our knowledge of the thing is socially constructed. It is the *knowledge* that we work with, that we capture in mechanisms and automate. A machine learning tool doesn't *kitten* (operate on the object directly), it *recognizes* kittens (operates on its knowledge of what a kitten is). Similarly, an autonomous car doesn't interact with stoplights directly, it relies on its knowledge of stoplights and the signals from its various sensors to interpret the environment around it. It is the imperfect nature of this interpretation process that causes autonomous cars to make mistakes (just as humans do). It's for this reason that Nietzsche repeatedly wrote, "There are no facts, only interpretations" in the margins of his notebooks.

27. Franz Boas, in his book *Handbook of American Indian Languages*, discusses how languages don't necessarily draw lines between the lexemes in semantic fields in the same places as other languages. Canadian Inuit separates falling snowflakes (for which the qana- root is used) from snow lying on the ground (for which the api- root is used), just as English separates water running along (as in river) from water standing still (as in lake), and so on. He was stressing that this arbitrariness of lexical denotation boundaries was something the two languages had in common, not that Inuit was quantitatively unusual and made quantitative claims on the number of different words the American Eskimos have for snow. See Franz Boas, *Handbook of American Indian Languages*, 1911, pp. 179–222.

28. We should note that "walking" is also an example of *embodied* knowledge. Embodied knowledge depends on the configuration of one's body (robot or human), and one's ability will depend on the synergies between knowledge and body. Usain Bolt's training partner, Yohan Blake, has a strikingly similar technique and cadence to Bolt, but is a few centimeters shorter and consequently doesn't travel quite as far with each stride. This is also why teaching a robot how to walk is a challenging task. It's not that we don't understand how walking works, it is the difficulty in building a suitable body and dealing with the complex computations required. This is where techniques such as reinforcement learning are powerful, as they enable us to teach the robot by example, rather than having to explicitly define all the processes and calculations required. It is more difficult to transmit embodied knowledge than formal knowledge (math or logic), as the knowledge is only useful to the recipient if they have the same hardware.

29. The cognitive scientist Richard Nisbett's book, *The Geography of Thought*, provides examples of how concepts, categories, and judgments vary across cultures. See Richard Nisbett, *The Geography of Thought: How Asians and Westerners Think Differently . . . and Why* (Free Press, 2003). A brief introduction to these ideas can be seen in Lera Boroditsky, "How the languages we speak shape the ways we think," video, https://www.youtube.com/watch?v=VHulvUwgFWo.

30. This "social accretion over time" is the reason for many of the complexities and quirks of mathematical notation.

31. To pick one example of many novel Australian creatures, such as the kangaroo, emu, or drop bear.

32. Captain John Hunter was the second governor of New South Wales.

33. As the platypus specimens arrived in England via the Indian Ocean, naturalists suspected that Chinese sailors, known for their skill in stitching together hybrid creatures, were playing a joke on them.

34. Ton, *The Good Jobs Strategy*.

35. As opposed to *work to be done*, which represents an inherently task-based view of work.

36. We should note here that shifting our focus from *process* to *problem* enables us to make processes malleable, rather than being static. AI technologies already exist—and are, in fact, quite old—that enable us to assemble a process incrementally, in real time, enabling us to more effectively and efficiently adapt to circumstances as they change. This effectively hands responsibility for defining and creating processes over to the robots: Yet another complex skill is consumed by automation.

37. We note that behaviors are not necessarily implemented with AI technologies. Any digital (or, indeed, non-digital) technology can be used.

38. Matthew Price, The health workers that help patients stay at home, BBC News, February 8, 2017, http://www.bbc.com/news/health-38897257.

39. Personalized genetic medicine promises to avoid dangerous drug reactions by matching the drug to be used to the patient's genetic code. See Dina Maron, "A very personal problem," *Scientific American*, 2016, https://www.scientificamerican.com/article/a-very-personal-problem/.

40. Rule and constraint satisfaction engines are a well-established area of AI, dating back to the 1970s.

41. The first planning engine, STRIPS (Stanford Research Institute Problem Solver), was developed in 1971 by Richard Fikes and Nils Nilsson at SRI International.

42. Checklists have long been used as powerful tools to ensure quality. For more details, see Atul Gawande, *The Checklist Manifesto: How to Get Things Right* (Metropolitan Books, 2009).

43. We assume that knowledge and innovation flow downhill, from basic research or the lone inventor to praxis, though this is not true. While basic research and invention do result in new innovations, it is more common for knowledge to emerge bottom-up, the result of people solving problems and building on what had come before. For a good overview of a complex topic, see Daniel Sarewitz, "Saving science," *New Atlantis*, no. 49 (spring/summer 2016): pp. 4–40, http://www.thenewatlantis.com/publications/saving-science.

44. A trend known as servitization, the conversion of products into value-added services. The classic example is Rolls Royce's TotalCare program, where airlines pay for engine operating hours rather than buy (or lease) the engines themselves. Customers pay a fixed rate for each hour the engine is available for operation, while Rolls Royce monitors the engines remotely and takes responsibility for improving, repairing, or replacing broken engines. TotalCare was first formalized in the 1980s. Since then servitization has moved into the consumer sphere.

45. Who Gives a Crap (https://au.whogivesacrap.org) provides what are effectively toilet paper subscriptions.

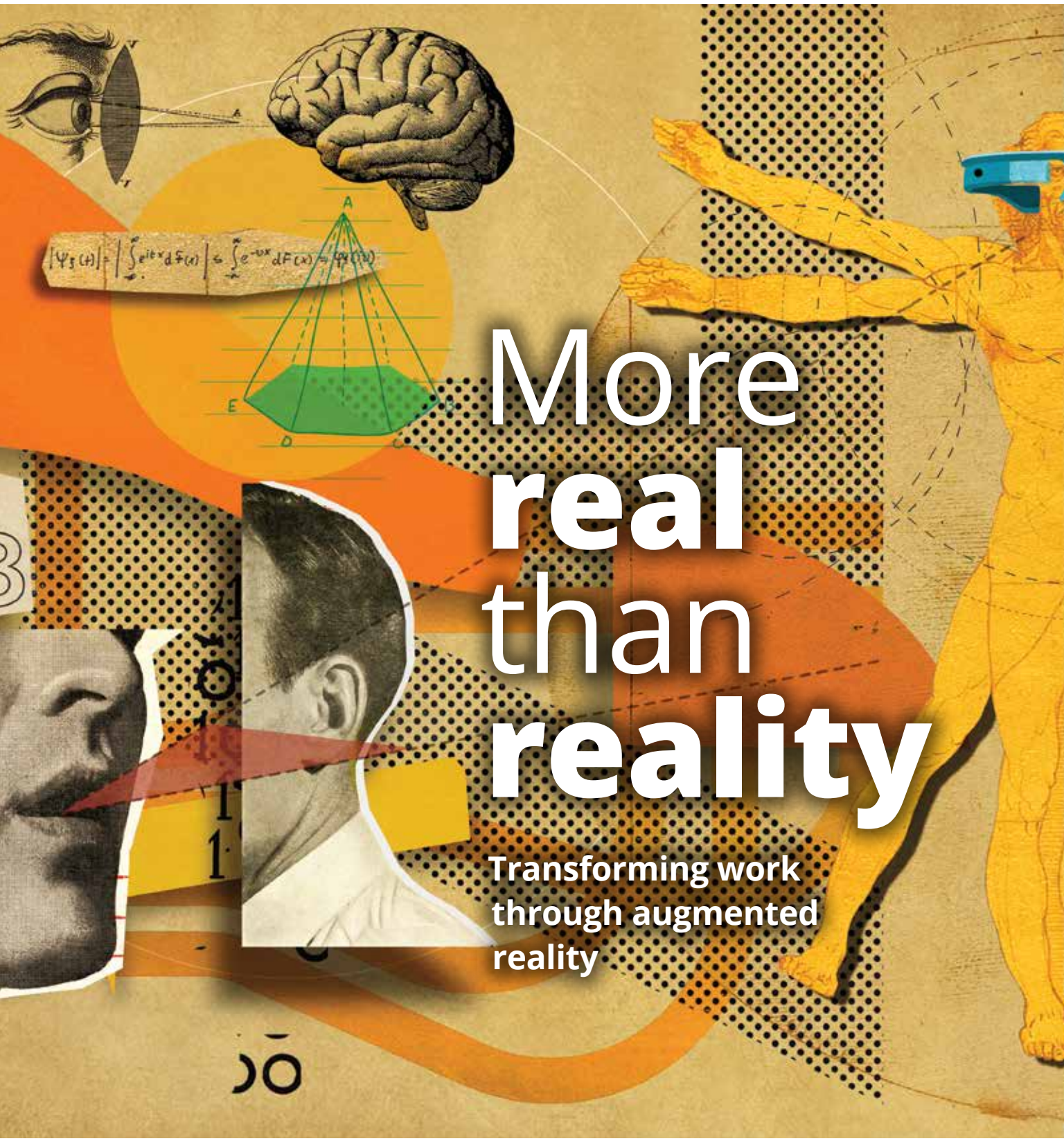
46. A range of services has emerged—such as GoGet (https://www.goget.com.au) and Flexicar (http://flexicar.com.au)—that enables individuals to rent cars by the hour, with the car housed in a parking space nearby.

47. Rolls Royce TotalCare, mentioned in endnote No. 44, enables airlines to buy operating hours ("hot air out the back of the engine") rather than purchase or lease the engines. TotalCare, and similar services, are considered one of the key enablers of the low-cost airline industry.

48. See Mukherjee, "A.I. versus M.D.," for an insightful discussion on the relationship between machine learning and diagnosticians.

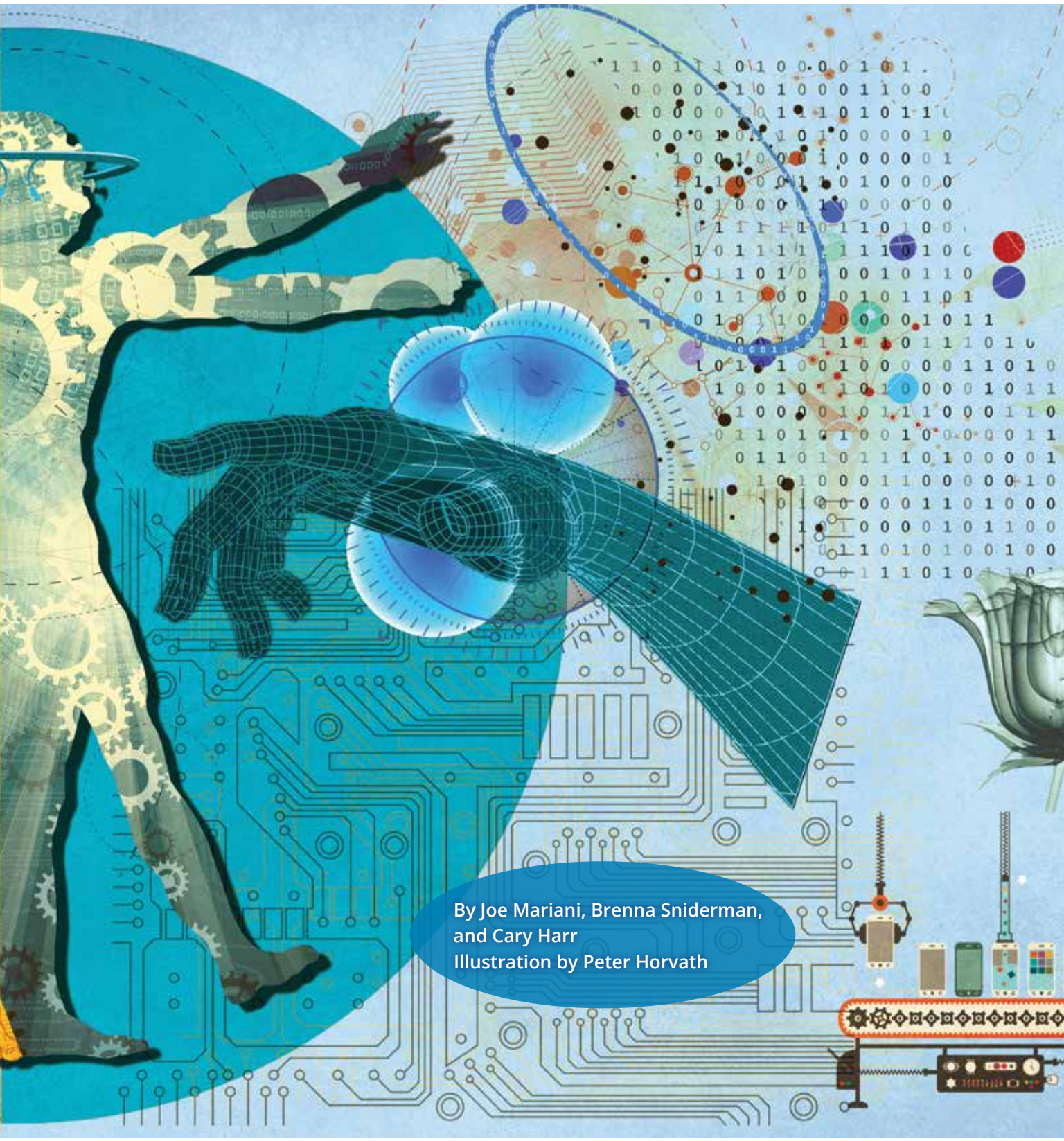
49. An S-curve, also known as a sigmoid, is a line with the rough shape of an "S" leaning to the right. Starting horizontal, the line gradually curves up to a linear middle section, before curving back down to become horizontal again. S-curves are commonly used to represent technology development or adoption, as they mirror the slow-fast-slow nature of these processes.

50. Ford Motor Company, "100 years of the moving assembly line," http://corporate.ford.com/innovation/100-years-moving-assembly-line.html, accessed April 14, 2017; Michael Perelman, *Railroading Economics: The Creation of the Free Market Mythology* (Monthly Review Press, 2006), pp. 135–136.



More real than reality

Transforming work through augmented reality



By Joe Mariani, Brenna Sniderman, and Cary Harr
Illustration by Peter Horvath

SEEING INFORMATION IN A NEW WAY

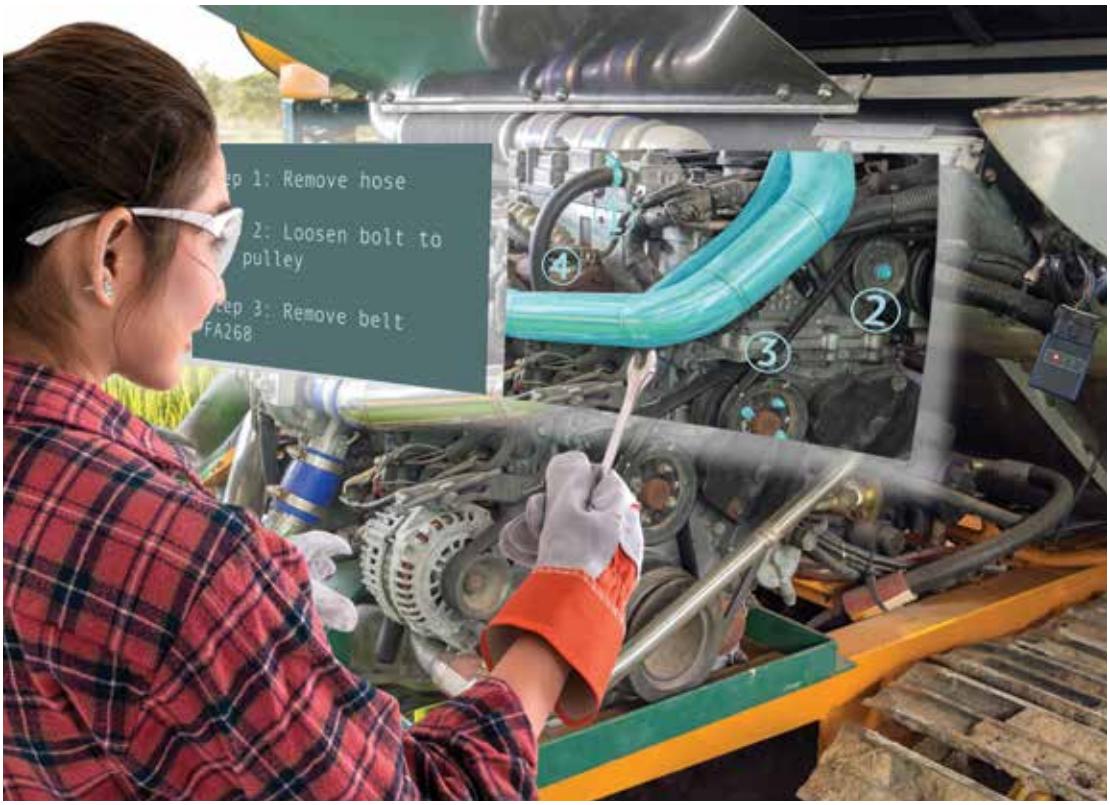
THE first tools used by humans were little more than sticks and small rocks. Later, as tasks became more complicated, tools did as well. More complicated tools, in turn, allowed for new types of work previously undreamt of. Imagine Galileo looking through his newly constructed telescope and seeing clearly for the first time that the uneven spots on the moon were, in fact, shadows from mountains and craters. He had built his telescope to meet the demands of his scientific studies, but in doing so, also created new fields. Little did Galileo know that within three and a half centuries of his sketches, workers from an entirely new career field—astronauts—would be walking in those exact craters.

While simple tasks require only simple tools, today workers are increasingly asked to do much more: to sift through troves of data, and to perform complex, variable, and often unpredictable tasks that require an ability to access and understand that data, often quickly while juggling heavy workloads. Tasks such as diagnosing an almost invisible crack in a jet engine turbine or finding the optimal route for a delivery truck can require workers to access, aggregate, analyze, and act on vast amounts of information—more than any human could possibly memorize—that changes constantly depending on real-world conditions. To avoid overwhelming workers and allow the future of work to actually . . . well, *work*, workers need the ability to sift through it all and determine what is relevant to the task at hand. This means that modern workers will commonly need an entirely new set of tools that affords them a new way to interface with information and tasks.

That new toolset can be found in the promise of augmented reality (AR), enabled by the Internet of Things (IoT). Like the telescope before it, AR can offer an opportunity to see and use information in a new way. AR presents digital information to workers by overlaying it on their view of the real world (figure 1). For example, with AR, technicians who wire control boxes in wind turbines can see exactly where each wire goes in their field of view rather than wasting time flipping pages in a technical manual. In one experiment, eliminating even this seemingly minor inconvenience resulted in a 34 percent faster installation time.[1] By marrying digital and physical information in this way, AR can offer more realistic training, speed up repetitive tasks, and even introduce entirely new forms of work.[2]

By reimagining how humans relate to digital tools, AR can offer fresh insights about how work gets done as well as new opportunities for collaboration and remote work. In this sense, AR can be seen as a tool that can work alongside

Figure 1. What augmented reality looks like



An artist's conception of an AR display, which projects digital information onto an individual's view of the real world. In this case, a farmer views directions for fixing a tractor engine.

people, with humans and digital technologies working together, leveraging their inherent strengths to achieve an outcome greater than either could accomplish alone.

WHAT IS AUGMENTED REALITY, REALLY?

FOR many, the term "augmented reality" may conjure images of slick presentations of data—digital images overlaid on live video or projected on glasses, for example. But that is only one facet of AR; it has the potential to provide far more value to today's workplaces. AR can integrate digital information into the ways in which workers perceive the real world, enabling them to seamlessly use that information to guide their choices and actions in real time, as they accomplish tasks.[3]

Three key elements underpin AR (figure 2):

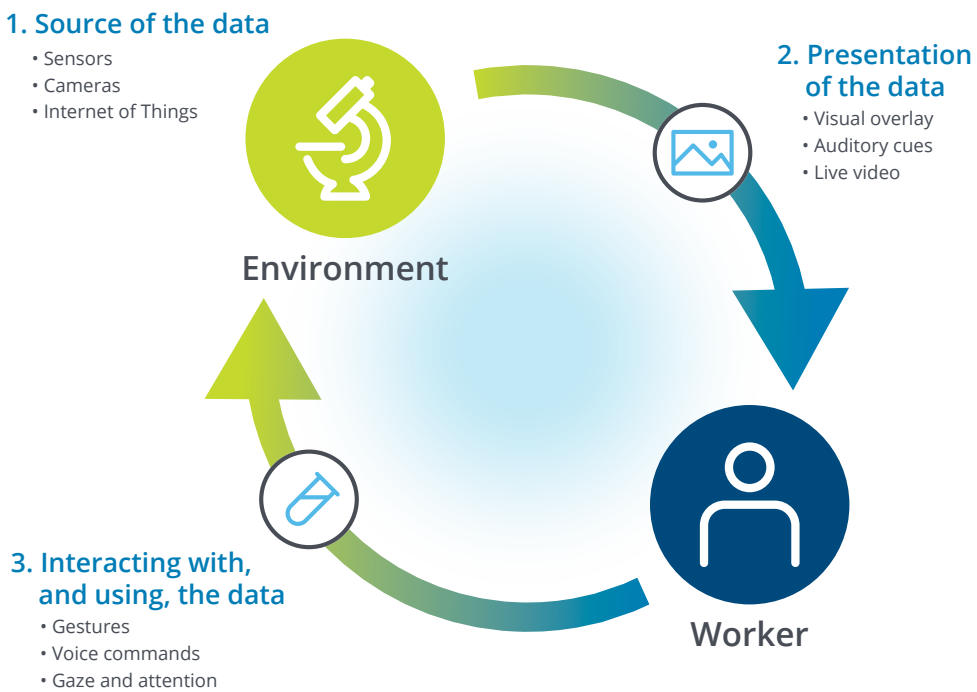
- The source of the data
- The ways in which that data are presented
- The interaction with, and use of, that data as an impetus for action

Together, these three elements combine to make AR a unique tool with powerful potential.

Source of the data

Starting at the beginning, where information is created, takes us outside of the realm of pure AR and into another connected technology: the IoT. Put simply, the IoT creates flows of information from connected tools, systems, and objects—information that, when aggregated, can be used to create a more holistic view of the world and illuminate new insights. Information can drive the workday; workers use informa-

Figure 2. The core elements and technologies of AR



Source: Deloitte analysis.

tion in one form or another, from some source or another, to accomplish their tasks. Much of this information can easily be pulled from databases or reference materials, but in the fast-paced world of the modern workplace, it is not helpful to know the as-designed pressure in a hydraulic pump or what the pressure was last month. Workers need to know what the pressure in that specific pump is today—right now—if they are to accurately use or maintain that pump. Gathering digital information about the world from sensors, and communicating that information so it can be aggregated, analyzed, and acted upon is what the IoT is all about.[4]

Presentation of the data

Simply having the right information isn't always enough. Workers can be quickly overwhelmed when presented with too much information, which can actually lead to poorer performance.[5] Instead, try to present information when it is relevant, and in a manner that workers can easily absorb. Much of the current research into AR focuses on how to present digital information in increasingly natural, contextual ways. For example, while early systems had to rely on specific markers or cues, such as lines or bar codes telling computers where and how to display information, current development focuses on marker-less systems that can more seamlessly weave digital content into a user's field of vision.[6]

Interacting with, and using, the data

Even having the right data, presented in the right way, does not create any new value if it fails to result in action. Value is created only when a worker can use this information to do something new—find the right part faster or get help from an expert. This means that AR sits at the end of a long trajectory of not only displaying digital information, but controlling it in increasingly natural ways.

> AR is fundamentally about allowing humans and machines to team together to achieve results neither could alone.

Early computers displayed data via tape printouts; later versions progressed to screens via command line interfaces. Workers controlled these machines with keyboards or punch cards, but could not easily "edit" or control the data once it had been printed. Later, the graphic user interface and the mouse made consuming and controlling digital information easier. But AR can take this trajectory still further; it not only incorporates the display of information in a way that people naturally perceive the world, but also increasingly allows workers to control that information through movements such as gestures or gazes.[7]

AR is fundamentally about allowing humans and machines to team together to achieve results neither could alone. That teamwork can be the key to success in the complex, data-rich environment of the 21st century.

AR is a prime example of how optimally leveraged new technologies can change the future of work. After all, work is, at its foundation, an interaction between people and tools. New tools introduce new capabilities that can generate measurable improvements in work performance. Freestyle chess exemplifies this. Instead of asking, "Which is better, human or machine?" it takes the question one step further and asks, "What happens if the humans and the machine team up?" In freestyle chess, competitors can use any technical tool or reference aid to help select their moves; this often results in large teams of people and computers working together to try to win a game.

In 2005, playchess.com hosted a freestyle chess tournament. Armed with the best computers, several grandmasters entered the tournament as heavy favorites. But none of the grandmasters took home the prize. Instead, it was awarded to two amateur players who used three home computers.[8] How did they beat the odds? It turned out the most important thing was not technology or the skill of the players, but rather the quality of the interaction between them. As Garry Kasparov later explained, "Weak human + machine + better process was superior to a strong computer alone and, more remarkably, superior to a strong human + machine + inferior process."[9] Similarly, AR is fundamentally about making the human-machine team work as naturally as possible.

WHY AR? WHY NOW?

WHILE AR may seem cutting-edge, it is actually not a new technology. Its roots stretch back to World War II, when British engineers combined RADAR information with a gunsight, enabling fighter pilots to attack targets in the dark.[10] But in the decades that followed, AR failed to catch on in the workplace, likely because it was not required to complete tasks. But as the nature of work in the 21st century is transforming, tasks are changing; in the future, human-machine relationships will likely become increasingly critical to organizational success. To those of us bombarded daily with hundreds of emails, social media posts, and texts, it is perhaps no surprise that the volume of information in the world is increasing every day.[11] In fact, in 2003 alone, the amount of information contained in phone calls alone was more than three times the amount of words ever spoken by humans up to that point.[12] As more companies derive value from this information, the demands of sifting through mountains of information to find the right pieces of data for a complex task will be beyond the capabilities of most people.[13] The result is that AR will likely be increasingly necessary for tasks with high volumes of data or highly variable tasks.

Research from psychology, economics, and industrial design indicate that there are two main factors that determine how we process information to accomplish tasks: the volume/complexity of data and the variability of the task.

Volume and complexity of data. Data is an invaluable asset to decision making and task performance, but it can have diminishing returns: While a little information is good, too much information can actually reduce performance. This is because information overload often distracts workers from key tasks and causes them to miss relevant details. Highway accident statistics illustrate this principle: As car manufacturers continue to make safer vehicles, highway fatalities actually rose in 2015. According to the National Highway Traffic Safety Administration, this was at least partially due to an increase in distracted driving; more drivers are now using phones and other devices when behind the wheel.[14] And while smartphone apps featuring turn-by-turn directions can be useful, they can also cause drivers to miss even more important information, such as the brake lights of a truck ahead.

Variability of task. When each iteration of a task is different, it may also become difficult to sift out the relevant pieces of data.[15] In this case, humans may have the advantage over computers. Computers do a better job handling large volumes of data, but humans are much better at dealing with variation. For example, human language is rich in variation and context. So while a person would quickly detect the sarcasm if a friend said how *"great"* the weather was on a rainy vacation, computers would struggle to detect anything but praise for the precipitation.[16]

Both of these factors can negatively impact job performance, and both are increasingly inherent in the tasks asked of modern workers. In order to accomplish today's tasks, we likely need a new way to interact with digital tools. We cannot rely on ourselves alone because humans cannot process or remember enough information. But neither can we rely solely on automation, because it can only do what it was programmed to do and cannot deal well with variability. And so, it seems clear that increasingly, we will need teaming between human and machine, with each playing to its strengths. In short, for many modern tasks, we would benefit from AR.

WHAT DOES THIS MEAN FOR BUSINESS?

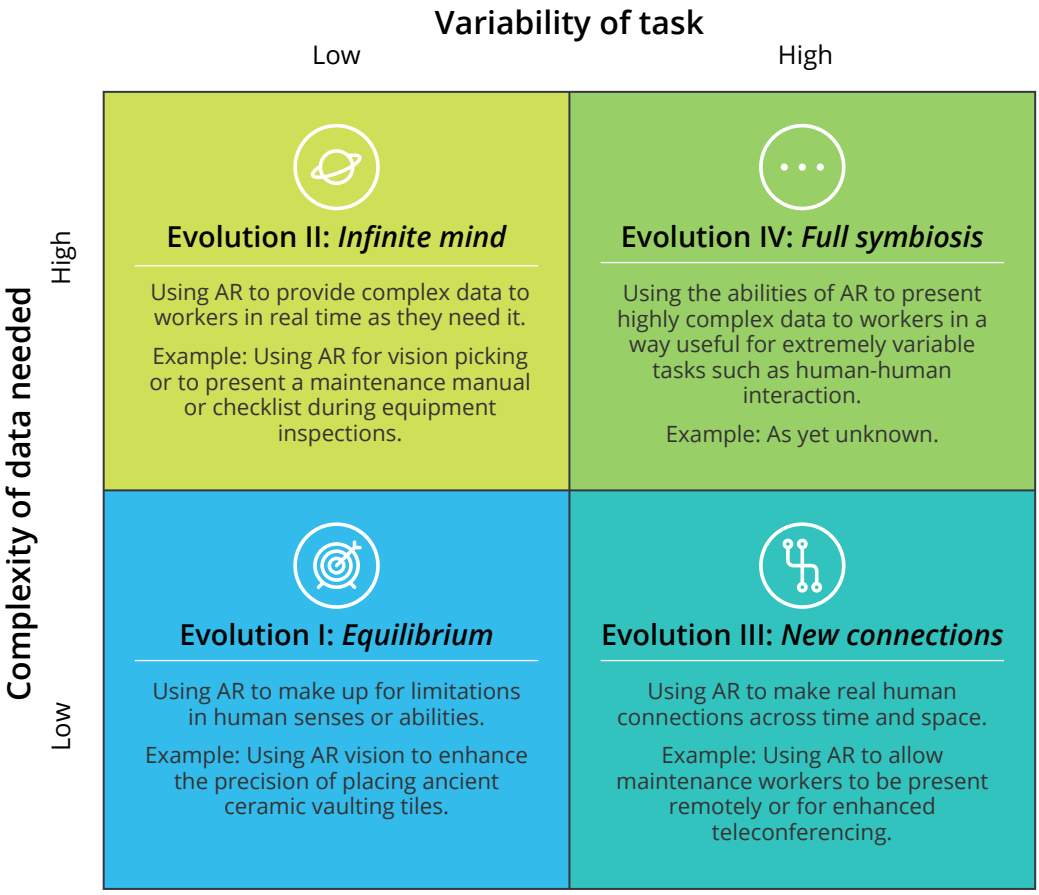
TODAY'S work environment often asks workers to perform tasks that are both increasingly data-intensive and increasingly variable. These two attributes determine the value that AR can bring to an organization. Large organizations will continue to offer a wide variety of jobs, falling across multiple categories, and AR can bring value to each in different ways. So understanding the type of tasks each job requires is the first step to understanding how AR can help. While concepts

such as task variability and volume of data can seem abstract, organizations can work through these two questions to make this process a bit more intuitive:

- What do I need to know to accomplish this job successfully (complexity of information)?
- Where, and how often, do judgment and intuition come into play in this job (variability of task)?

Because these questions can be answered yes or no independently, the result is that AR can bring benefits and improve work along four main categories (figure 3).

Figure 3. The impact of augmented reality across various job types



Source: Deloitte analysis.

In the long run, these uses of AR have the potential to completely reshape how work is done.

Evolution I: Equilibrium

In this scenario, both data complexity and task variability are low. Here, the employee can use AR largely to do what he or she already does today, but perhaps just a little bit better. In this stage, AR can be leveraged to provide insights the typical worker may not easily have at his or her fingertips, which can result in more efficient, more productive, and even more accurate work. This can involve using AR to make up for deficiencies in human senses or abilities, to uncover the temperature of an object via superimposed heat maps, to view three-dimensional visual terrain models, to be guided by other perceptual enhancements, or to provide an overlaid measurement scale that enables greater precision in construction, assembly, or repair.[17] For example, AR has been used to help historical reconstruction efforts painstakingly reassemble Roman vaulting by precisely guiding the placement of each piece of the vault, providing feedback on when a portion had been placed incorrectly.[18]

AR can also be used to help "discover" new information, such as detecting when a machine or device might be emitting excessive heat or radiation, or providing enhanced visibility of terrain in conditions (fog, fire, darkness, etc.) in which humans might not be able to see or navigate on their own.[19]

In other cases, AR can log data and information automatically for the user, transforming how a workforce captures, reports, and shares information. This can, in turn, increase productivity, reduce errors in documentation, and streamline audit or accounting processes. It can also more accurately track physical tasks and labor to help optimize assignments and scheduling based on worker availability and capacity. All of these uses of AR represent a streamlining and potential improvement of current work processes, rather than an evolution of capabilities.

Implications of Evolution I—a new mind-set. While Evolution I does not significantly change the tasks workers are asked to do, it does significantly impact how they are asked to accomplish them. Whether inspecting pipelines for leaks or setting ancient Roman vaults, workers will be asked to do familiar tasks in new ways. The rationale for this shift must be clearly communicated and workers must see some benefit or they may simply revert to older, more familiar techniques.

Evolution II: Infinite mind

Workers are increasingly being asked to handle high volumes of data—in many cases, a greater load than the human mind can possibly handle. For scenarios in which the volume of information is high while tasks are relatively predictable, AR can be used to provide workers with a data overlay in a consumable way that still makes it possible to accomplish tasks. Here, AR can begin to enable workers to accomplish new tasks, or address old tasks in new ways.

Maintenance crew on an aircraft carrier, for example, must maintain and repair a wide variety of extremely complex machinery, from fighter jets to helicopters. This requires highly technical skills, but also the use of bulky manuals; crewmembers often find themselves stopping and starting as they scroll through documentation to find the correct set of instructions to accomplish a task. AR can free the maintenance crew from the need to remember large lists or carry around bulky manuals, by overlaying instructions in the crew member's field of vision in real time, as needed. This makes the work faster and more accurate—and frees both hands to accomplish tasks. In fact, this is already becoming a reality with a beta test from Siemens, which has equipped its Vectron series of train locomotives with AR manuals.[20] These manuals allow workers to pull up CAD drawings or even repair instructions for the exact part they are looking at, offering them immediate and easy access to several thousand pages of information.

Implications of Evolution II—new skills. Evolution II makes huge volumes of data available to workers. This can allow them to perform previously impossible tasks, but it also requires new skills to navigate vast amounts of information. For example, now train drivers would not only need to know how to operate a train, they would also be required to learn how to inspect and use the AR tablet. Care must be taken in the training, and even hiring of these positions, given the new skills required.

Evolution III: New connections

In the third evolution, new connections can be formed using AR, enabling highly variable tasks with simple information requirements. The majority of tasks of this nature involve human interactions, which differ and can be highly unpredictable. Some, however, can require the user access data that a worker might not have at his or her fingertips. So in this stage, having ready and contextual access to that sort of information can enable higher productivity.

At its simplest, this sort of new connection can simply take the form of "see-what-I-see" sharing. For example, continuing with train maintenance, imagine a train that wouldn't start and a worker who, after attempting all of the typical troubleshooting steps, could not identify the malfunction. Since the problem is

unknown, the worker cannot use AR to call up instructions to fix it. So instead, he or she could contact a small cadre of senior maintainers at a central facility. With AR showing those maintainers exactly what the on-site worker sees, they can help to diagnose the issue.

AR can also be used to capture and disseminate specialized knowledge. For example, a surgeon who just developed a novel, potentially life-saving technique can use AR to easily share information and instructions with colleagues, spreading the word more quickly and effectively than a journal article would. By using AR, colleagues would then be able to access this information quickly during surgery, should that specialized knowledge be needed at any given moment. In another scenario, engineers and designers could use AR to make the design process more efficient and less wasteful. Rather than printing or manufacturing physical prototypes to test product ideas, they could use AR to improve designs by planning and testing product assemblies or working with virtual prototypes during the design process.[21]

Implications of Evolution III—untethered work. Evolution III offers the opportunity to break free of the constraints of location. Now maintainers do not need to be in the same location as the machinery; workers can collaborate on designs or share notes across the globe. Much like the tele-work revolution enabled by the Internet, this use of AR will require some care to create cohesive teams that can work together effectively despite the loss of direct contact.

Evolution IV: Full symbiosis

This final evolution represents the culmination of AR's use in the workplace. In assisting workers with highly variable tasks that also require a great deal of information to complete, AR can augment and complement the human strengths of intuition, creativity, and adaptability with those of computing—the ability to handle, access, and analyze high data volumes while connecting with other resources in real time—to enable new capabilities and maximize performance. This can bring the best of both humans and machines together, with machines able to deal with more complex data than any human could, and workers able to adjust to variability faster and more reliably than any computer. In this way, Evolution IV describes the future of human-machine interaction and the future of work.

In these scenarios, AR can link a human worker to, for example, a digital supply network, overlaying data about supplies, expected shipment times, production schedules, external data, and machine functioning over a field of vision, enabling planning processes or re-routing troubled shipments in real time to reach the production site on time.[22] In this way, AR can bring together a full, complex network of constantly changing information and provide it in a contextual, visual manner to enable decision making in the moment.

In these data-rich, fast-paced uses of AR, human-machine interaction goes beyond a simple interface between worker and tool; the human and machine become a true team. Research from NASA offers a glimpse of what these future human-robot partnerships may look like, using AR for space exploration. Through research into joint human-robot teams, NASA is examining ways in which astronauts and scientists can collaborate naturally with robots and computing systems during complex missions via AR. NASA has pointed out that "to reduce human workload, costs, fatigue-driven error, and risk, intelligent robotic systems will need to be a significant part of mission design."[23] The agency points in particular to actions such as "grounding, situational awareness, a common frame of reference, and spatial referencing" as crucial to performing its work effectively, making AR a useful partner to solve these challenges. Using spatial dialog, NASA is looking to AR as a means of facilitating the collaboration between humans and robots as part of a holistic system. Taken back down to earth, similar AR-driven systems can be used to aid humans in highly unpredictable and potentially dangerous situations, such as search and rescue missions.[24]

> The future of work merges humans and machines into one team so that they can seamlessly accomplish multiple types of tasks quickly and intuitively.

In the long run, these uses of AR have the potential to completely reshape how work is done. Imagine it is 2025, and a cybersecurity analyst comes into the office in the morning. Defending a computer network involves sifting through immense volumes of data, but also reacting to the unpredictable variability of human hackers on the other side. After getting his or her morning cup of coffee, the analyst can sit down at the terminal and ask the system, "What is unusual about my network this morning?"[25] If the system detected something unusual, not only could it highlight any unusual parameters, it could also identify who the individual hackers might be and what they may be after.[26] With this information, the analyst can better respond to the variability of the situation and take appropriate action to deny the hacker's goals and protect the system.

Far from being the realm of science fiction, the component parts of such a system already exist. What remains is for leaders to combine them in a way that is suitable for their organizations.

Implications of Evolution IV—Pushing the boundaries. More than any other use of AR, Evolution IV pushes the boundaries of human-machine interfaces to uncover previ-

ously unknown uses of the technology. As with any exploration into uncharted territory, it is likely to uncover new problems that designers or operators of AR may not have anticipated. As a result, companies electing to try to reap the large rewards of such a massive transformation need a workforce that is ready for the inevitable hiccups and motivated by the sheer challenge of exploring new ground.

EVOLVING INTO THE FUTURE

THESE four evolutions of AR are not firm categories that restrict how the technology can be used. On the contrary, they are simply guides to help understand how AR can change the work environment. As a result, the evolutions can—and quite likely will—begin to merge together over time. Take the two areas where AR has already been widely piloted: vision picking and "see-what-I-see" expert support. Vision picking is an Evolution II use of AR; warehouse workers use smart glasses to keep track of a pick list and direct them to the proper shelf to find those items. In "see-what-I-see" support, part of Evolution III, workers are able to call upon experts to help them diagnose issues on the fly.

Flash forward a few years into the future, and we can see how both examples have expanded and pushed the boundaries of AR's potential. The same vision picker now can not only see where the next item to be picked is located, but can also see other workers and their locations, passing items back and forth on lists depending on who is closest (Evolution III). The handful of employees in the warehouse are supplemented by an automated workforce that can take over many of the less difficult and repetitive tasks, such as moving inventory (Evolution IV). In addition, passive capturing of product data can help create records of arriving and departing shipments without the need to stop and answer phones, talk to drivers, or sit at a workstation (Evolution I). The wearable AR device has become a seamlessly integrated tool that allows workers to have maximum flexibility, access to information, and the ability to interface with a wide range of systems, from IoT-enabled machinery to legacy video feeds and communication systems.

A similar story can be told around "see-what-I-see" support. The system continues to offer live video support, but only as a last-ditch effort to solve a problem that has likely been faced before. The field worker is now equipped with a wearable device that has a library of solutions, compiled from a database of previous issues. By simply focusing on a given part within the field, the wearable will be able to identify the specific part and download performance data from sensors on that part. Predictive maintenance algorithms will then be able to show the worker directly when the part will likely fail (Evolution IV).[27] If the part needs to be replaced, an overlay of how-tos will provide the field operator with just-in-time, step-by-step information including sequencing, proper tools, and tips/tricks to move through the pro-

cess (Evolution II). Once completed, the AR device will record the maintenance procedure and the data will be added to better predict future part failures or maintenance needs before they become an issue (Evolution I).

The future of work merges humans and machines into one team so that they can seamlessly accomplish multiple types of tasks quickly and intuitively.

REALIZING THE FUTURE

HOW will this future of work be realized? Certainly the technology must continue to develop. Currently, AR still has some technical limitations, which include the need for tethering (being wired to a PC or laptop for processing power), an inability to recognize 3D objects, and a lack of actual spatial awareness. Much of AR is currently limited to 2D image recognition, meaning that devices can only recognize 3D objects from within a limited angle. And while the current technology can easily create 2D overlays on 3D objects, without the ability to lock these digital items onto the physical environment, it is difficult to accomplish anything meaningful. Hardware, too, must continue to develop; many headsets are clunky and awkward and have a very limited field of view, which make them seem restrictive and can be dangerous in high-risk environments (warehouses, industrial settings, etc.).

While the above may seem like a long list of shortcomings, they are all well-known and improvements are already being developed. So the real challenge to achieving the future of work promised by AR is not technological; it lies in how AR changes work itself. In other words, the impact of AR can stretch far beyond mere technology and touches how we work as individuals and as teams. This is where the true hurdles to AR lie and, as a result, it is where organizations would likely need to take the critical first steps toward achieving an AR-infused workplace.

Organizational leaders should understand that preparing a workforce for the inevitable onslaught of technologies that will support the emergence of an augmented workplace requires a shift in culture toward innovation and collaboration. Leaders also need to provide an incentivized way to integrate technology and just-in-time learning into the DNA of the organization. Here are some practices leaders could adopt to help build a more innovative and collaborative culture:

- **Give credit for explorative and "just-in-time" learning.** Employees could earn credit for activities such as watching TED Talks and listening to educational podcasts, as well as sharing solutions to issues and best practices with colleagues through "lunch and learns." These informal sessions,

in particular, can help develop a culture that values active problem solving.

- **Promote the use of emerging toolsets (such as Skype, FaceTime, and Speech to Text) to increase the adoption of new productivity tools as they become available.** This can be done by making tools readily available and having a rollout plan that includes incentivizing the use of new technologies. For example, encourage staff to use webcasts, screen sharing, and the live chat tool by having more remote meetings or creating work-at-home opportunities.

- **Create a culture of technology integration and play.** Organizations that adopt technical solutions quickly have established a culture of exploration where play is often encouraged. Having activities such as hackathons, where colleagues are provided a "play time" to identify ways in which tools can be used to solve problems, can create a culture where innovation and problem solving are recognized as important aspects of the organization.

- **Cultivate a fast-fail mind-set among your staff.** The fear of failing can choke innovation, stifle problem solving, and slow the adoption of toolsets that can make the workplace more efficient. A culture that encourages a "fail fast" mind-set where experimentation is supported and failures are viewed as learning opportunities—and as such, stepping stones on the path to success—can quickly adapt to innovations as they emerge in the marketplace.

By instilling these features in a workforce, an organization can help ensure that it is positioned to take advantage of the benefits of AR, wherever those lead—even to the moon.

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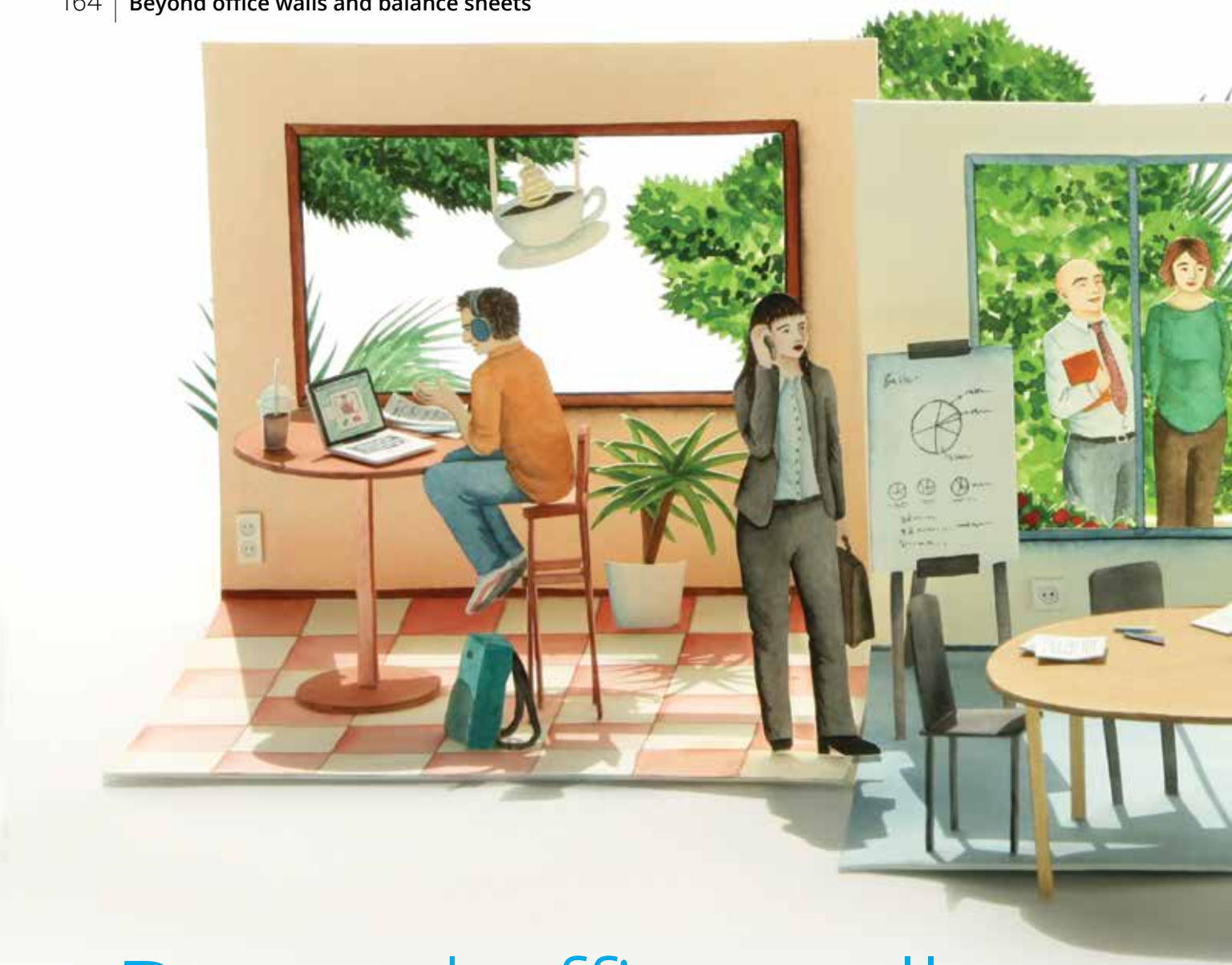
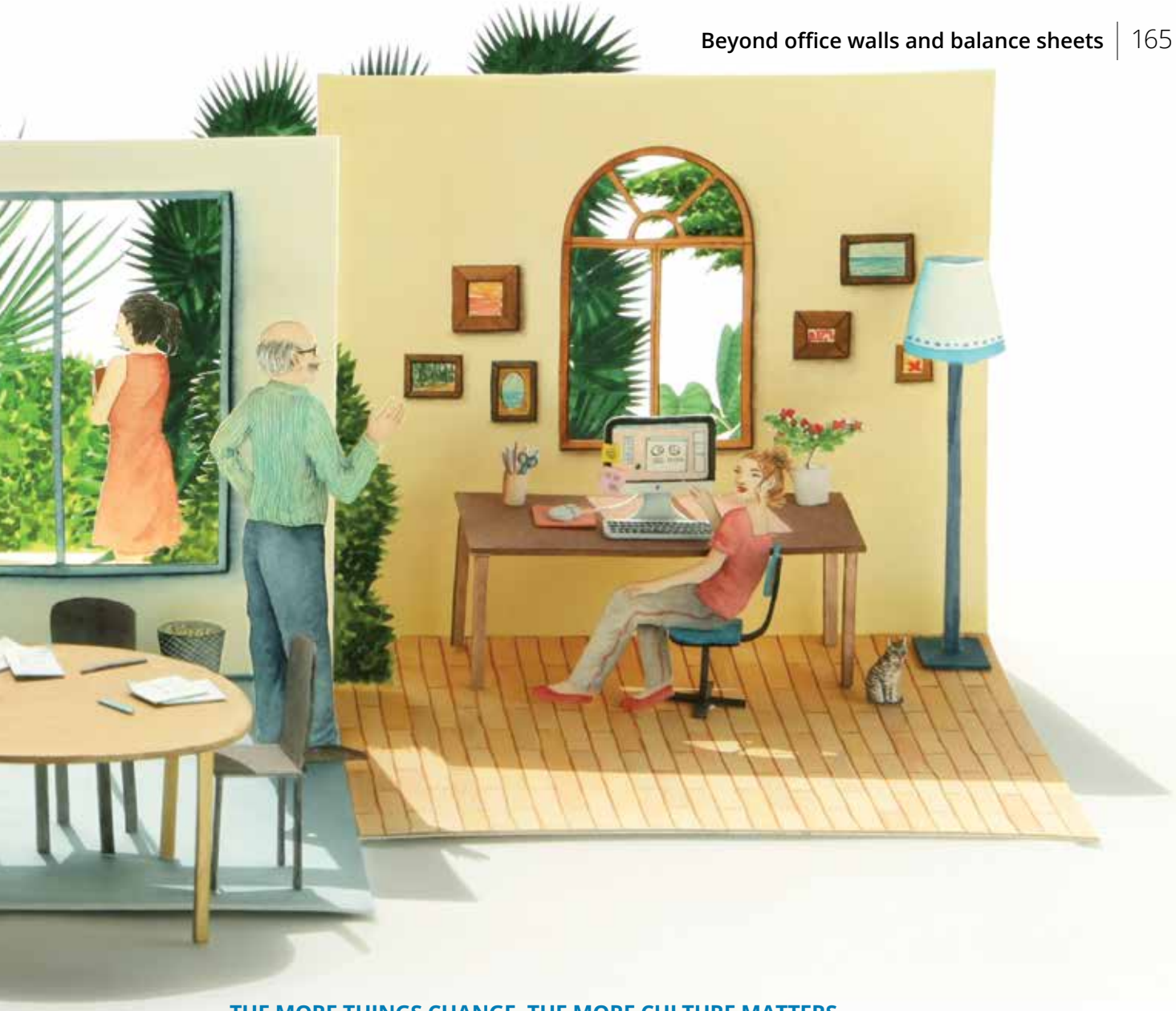


Beyond office walls and balance sheets

Culture and the alternative workforce

By Sonny Chheng, Kelly Monahan, and Karen Reid
Illustration by Mar Cerdà



THE MORE THINGS CHANGE, THE MORE CULTURE MATTERS

WHILE organizational culture may be difficult to define and tricky to manage, it can have a powerful impact on individual and corporate performance. Research shows that organizations that cultivate a positive culture around a set of shared values have an advantage over competitors: Workers who perceive their very human need for meaning and purpose as being met at work exhibit higher levels of performance and put in greater discretionary effort.[1] Beyond simply work output, culture is also a powerful driver of engagement, which has been linked to better financial performance.[2] This is why, at many organizations, leaders strive to deliberately shape a culture that encourages employee effort and collaboration around a shared set of values.

However, how confident can leaders be that their efforts to disseminate organizational culture are reaching *all* of the people they employ? Today, two factors present organizations with new and unique challenges to creating purpose and connection across their entire worker base. First, technology is enabling more and more people to work remotely, physically removing a portion of the workforce from the corporate or local campuses where employees used to congregate. And second, contingent, or "off-balance-sheet," workers are making up a growing proportion of the workforce—and these workers may not necessarily feel the same investment in an employer's mission and goals that a traditional employee might.

Imbuing culture to the remote and contingent workforce may not seem to carry much urgency at companies where such "alternative" work arrangements have historically been few and far between. But when faced with rapid societal and technological change, many of these companies will likely at least begin to experiment with remote and contingent work arrangements, as social mores shift and the technological enablers become less expensive. In fact, 95 percent of net new employment in the United States between 2005 and 2015 consisted of alternative work arrangements, and the number of workers engaged in alternative work arrangements steadily grew from approximately 10 percent in 2005 to nearly 16 percent by 2015.[3] This number is expected to continue to grow: A recent Intuit report predicts that nearly 40 percent of all US workers will be engaged in some sort of alternative work arrangement by 2020.[4] In addition, a 2015 Gallup poll revealed that the number of employees working off-campus has grown nearly fourfold since 1995, with 24 percent of workers noting they mostly telecommute.[5]

Under the new realities of the distributed and contingent workforce, employers face the growing challenge of fostering a shared culture that encompasses all of their workers, on- or off-campus, on or off the balance sheet. In this effort to achieve consistency of culture across all worker types, both location and employment type have distinct implications; therefore, leaders need to develop a nuanced strategy to extend organizational culture to alternative types of workers.

Just as broader organizational strategy must be crafted deliberately, culture must also be intentionally shaped to make workers feel valued and perform well.

THE CASE FOR CREATING A POSITIVE ORGANIZATIONAL CULTURE

People need meaning and purpose in their lives. Caring about *why* we do what we do and *what good* it creates is an essential feature of being human: Research suggests that we all have an innate desire to find meaning, achieve mastery, and be appreciated.[6] These motivations don't check themselves at the door when we walk in to work; in fact, work often amplifies them.[7] As a recent *Harvard Business Review* article noted, "What talented people want has changed. They used to want high salaries to validate their value and stable career paths to allow them to sleep well at night. Now, they want purposeful work."[8]

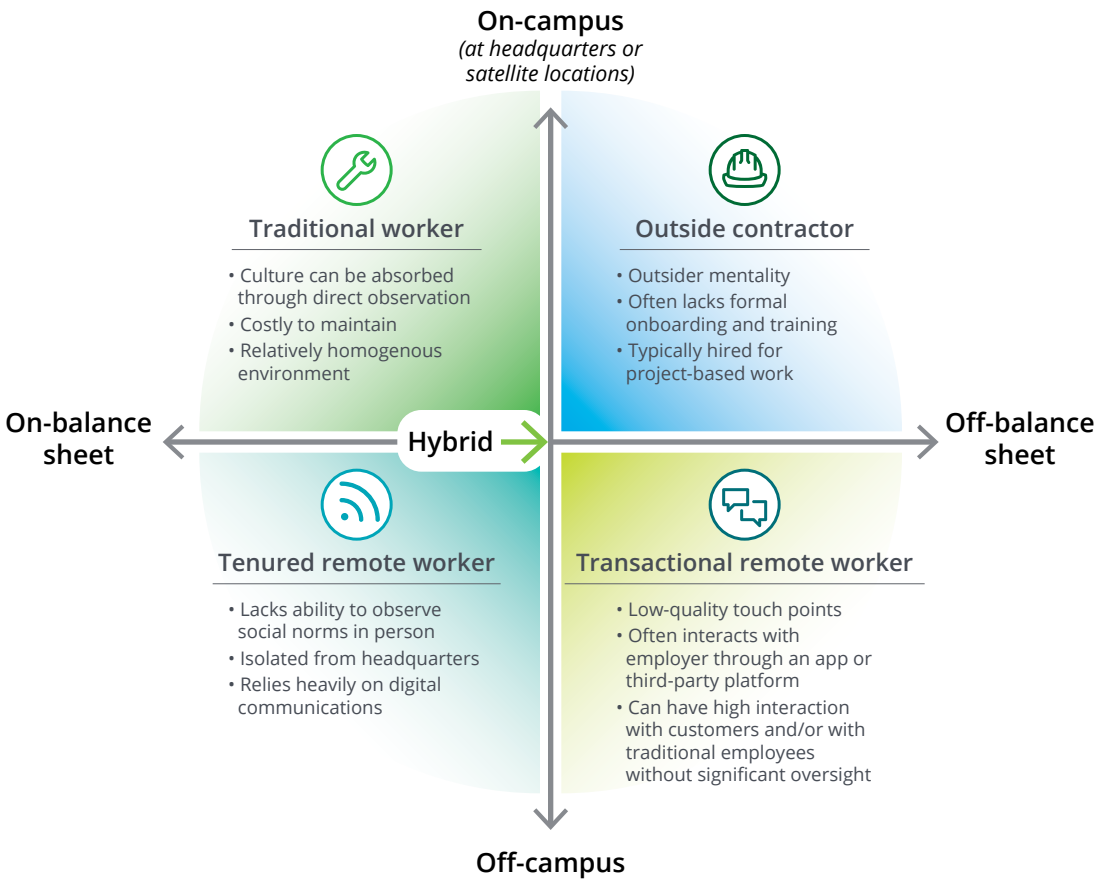
Workers' sense of meaning in their work can be significantly enhanced through a culture that is built upon shared values. In essence, a positive organizational culture is one in which social norms, beliefs, and behaviors all reinforce the value of pursuing a shared goal.[9] A shared culture clearly defines how the organization's and individual's efforts are making a difference. And while individuals may find purpose in their work regardless of their employer's culture, it's reasonable to suppose that being part of a shared culture can play an important role in amplifying that sense of purpose. In fact, studies suggest that workers rate "personal satisfaction from making a difference" as a more important criterion of success than "getting ahead" or even "making a good living."[10]

Organizations that can meet people's needs for meaning and recognition in their work are much more likely to perform at higher levels. Compelling research shows that companies that pursue purpose as well as profits outperform their counterparts by *12 times* over a 10-year period.[11] Deloitte's own research suggests that "mission-driven" organizations have 30 percent higher levels of innovation and 40 percent higher levels of engagement, and they tend to be first or second in their market segment.[12] For example, Unilever launched its Sustainable Living Plan program in 2009, which focused on establishing a sense of purpose among its employees as a key business outcome. Not only did employee engagement scores substantially rise as a result, but earnings per share increased from $1.16 to almost $2.[13]

THE FOUR FACES OF THE ALTERNATIVE WORKFORCE

SOME companies already recognize the challenges of maintaining a consistent culture across locations and extending it to people in alternative workforce arrangements. Consider the challenge that Snap Inc., the parent of Snapchat, acknowledged when it filed its IPO. Snap Inc. broke the Silicon Valley mold by launching its IPO without a designated corporate headquarters. In its IPO filing, the company noted that this strategy was a risk that could potentially be harmful, explaining, "This [diffused] structure may prevent us

Figure 1. The alternative workforce goes to work



Source: Deloitte analysis.

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from fostering positive employee morale and encouraging social interaction among our employees and different business units."[14]

Figure 1 shows how the workforce can be segmented along two axes: location—on- vs. off-campus—and contract type—on- vs. off-balance sheet. Considered in this way, the workforce broadly falls into four segments, each presenting distinct challenges with regard to propagating organizational culture. Note that these axes are fluid in nature; in particular, many workers in certain industries, such as professional services, may split their time between off- and on-campus locations (indicated by the gradient area in figure 1). These workers may be considered "hybrid" workers who experience some of the cultural advantages of on-campus work, while also facing some of the challenges experienced by the remote worker.

The traditional worker. Perhaps the most familiar, the traditional employee works on-campus, in a full-time or fixed part-time arrangement. Given a shared location and regular in-person interactions, social norms and behaviors are generally highly observable among traditional workers, making this setting the most efficient at transmitting culture. But these benefits come at a cost: the overhead involved in maintaining a physical location or multiple locations, as well as the risk of cultural stagnation. Also, if norms are well entrenched, an on-campus setting has the potential to create a static or homogeneous culture that can be difficult to change—an ability that may be crucial as companies increasingly demand nimble and dynamic environments to remain competitive. The risk is that groupthink may arise, leading workers to conform to old ways of acting and thinking rather than challenging the status quo.[15] In addition, traditional workers in satellite locations may feel isolated from headquarters, which can foster resentment or a sense of being "second-class citizens."

The tenured remote worker. Off-campus but on-balance sheet workers are commonly referred to as teleworkers, but they may also include traveling salespeople, remote customer service workers, and those in other jobs that do not require on-campus accommodations. These workers have flexibility of location, but are at a disadvantage when it comes to actually observing social norms as well as experiencing in-person collaboration. Research suggests that remote employees often have less trust in each other's work and capabilities due to a lack of interpersonal communication.[16] In addition, remote workers may feel isolated and separated from the company's headquarters. However, companies still have some traditional levers to pull to engage the tenured remote worker, such as benefits and formal career progression opportunities.

The transactional remote worker. This type of worker is not only off-balance-sheet, but also off-campus. Often, they are paid to deliver very specific services. Many of these individuals operate on flexible schedules and in customer-facing roles.[17] Their relationship with the hiring organization can be marked by low-quality touchpoints and facilitated through technology-based platforms or a third-party agency. The transactional remote worker may also experience a strong sense of instability, which may result in added anxiety.[18]

The outside contractor. On-campus but off-balance-sheet, contract or consulting workers often bring an inherent outsider mentality and an array of previous cultural experiences. They are often brought in to help facilitate a shorter-term or finite project and may be viewed—or may view themselves—as not being subject to the organization's cultural norms and values. These workers usually do not receive the typical onboarding and new hire training opportunities that can help build a sense of culture among on-balance sheet employees. Given that

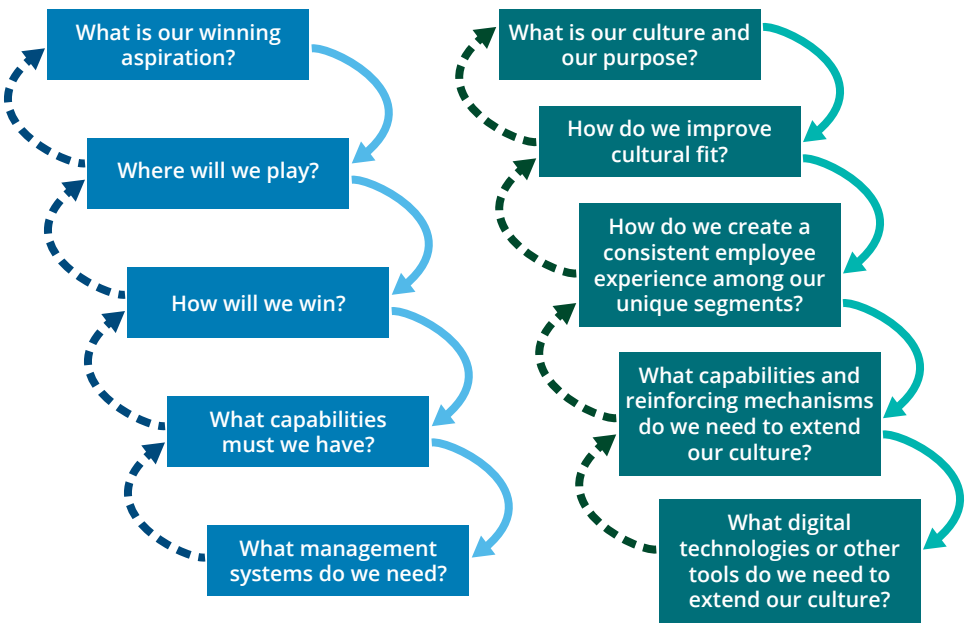
these individuals work on campus and can observe the organization's norms firsthand, however, there may be more opportunities to make them feel like part of the culture.

CREATING A SHARED CULTURAL EXPERIENCE ACROSS A SEGMENTED WORKFORCE

CREATING a consistent culture across these four unique talent segments requires strategic grounding, as a positive organizational culture is not likely to thrive without focus, intention, and action. While culture may often be viewed as an intangible asset, and even as an emotional or personal aspect of business, using a strategic framework can help bring culture to the forefront of leadership decision making.

Just as broader organizational strategy must be crafted deliberately, culture must also be intentionally shaped to make workers feel valued and perform well. Asking a series of questions specifically focused on managing culture can help to guide organizations as they work to sustain and extend their mission amid the growth of alternative work arrangements. Based on the strategic choice cascade—a well-developed framework that is often used to help make intentional decisions about an organization's strategy[19]—this approach applies similar principles in thinking about how to sustain culture across all four workforce personas (figure 2).

Figure 2. The strategic choice cascade for disseminating organizational culture



Source: Deloitte analysis, after A. G. Lafley and Roger Martin, *Playing to Win: How Strategy Really Works* (Harvard Business Review Press, 2013).

What is our culture and purpose?

To leverage culture as an asset to organizational performance, organizations must first *have* a clearly articulated culture—one whose norms and values support the advancement of the organization's purpose and mission. This may seem self-evident, but just 23 percent of the respondents to the 2017 Deloitte *Global Human Capital Trends* survey believe that their employees are fully aligned with their corporate purpose.[20] This is an alarming disconnect, with research suggesting that purpose misalignment is a major underlying cause of the rampant disengagement facing many organizations today.[21]

A strong corporate purpose—however one defines it—can yield dividends, not just for workforce engagement and productivity, but for the brand and company growth as well. Patagonia, the global outdoor clothing manufacturer, cultivates a positive organizational culture by fostering a sense of commitment, shared beliefs, collective focus, and inclusion. For years, the company has been known for its high-end outdoor clothing and bright-colored fleece jackets. Beyond its products, however, the company also emphasizes environmental sustainability. Sometimes known as "the activist company," Patagonia's mission statement reads, "Build the best product, cause no unnecessary harm, use business to inspire and implement solutions to the environmental crisis," and the

company infuses this approach into its work environment.[22]

Patagonia's leadership has implemented and reinforced a culture that motivates employees of all types to play an active role in environment sustainability and live by its mission statement. Employees around the world are given opportunities to participate in programs and initiatives that support the environment; the company donates either 1 percent of total sales or 10 percent of pre-tax profits (whichever is greater) to grassroots environmental groups; and the company takes steps to ensure that the materials and processes used to manufacture their products are environmentally friendly. Through activities like these, Patagonia leaders strive to build an emotional attachment to the company's mission across its employee base.

A positive organizational culture is not likely to thrive without focus, intention, and action.

How do we improve cultural fit?

As organizations continue to leverage alternative workers more and more, it will become increasingly important to obtain consistent, high-quality work products from this talent segment. To reduce onboarding, training time, and costs, companies may opt to create a consistent group of alternative employees who work regularly with the organization. Workers who are naturally a good fit for an organization's culture get along well with the other employees, have a positive experience during their time with the organization, and experience the sense of belonging that can fuel discretionary effort. Therefore, an important step is to screen alternative workers, particularly the transactional remote employees—individuals whose employment relationship was long considered purely transactional—for cultural fit before hiring them. Employers can leverage an array of digital technologies, including video interviews, online value assessments, and even peer-rated feedback, to determine fit throughout the hiring process. Particularly in contexts where teaming and collaboration are important, screening contingent workers for fit during the recruiting process is the first line of defense against diluting an organization's culture.

TaskRabbit, an online marketplace that matches freelance labor with demand for minor home repairs, errand running, moving and packing, and more, understands the value of assessing potential workers—or "taskers," as they call them—for cultural fit. After seeing early missteps by peers in the gig economy who did not accurately screen or ensure quality of work, TaskRabbit started an early process during the recruiting phase to heavily screen

all potential taskers.[23] Now, each tasker goes through a vetting process, which includes writing an essay, submitting a video Q&A, passing a background check, and completing an interview.[24] Additionally, each tasker is reviewed by customers who book his or her services via TaskRabbit's platform. That feedback helps TaskRabbit ensure that its taskers are demonstrating the company's desired culture. "The marketplace is all about transparency and performance. You have people out there providing your product that aren't your employees," says TaskRabbit CEO Stacy Brown-Philpot. "But you still have to put out there what your values are."[25] Organizations can use a screening process like TaskRabbit's, not just for their contingent workers, but for their traditional and full-time remote employees as well.

How do we create a consistent employee experience among our unique segments?

While cultivating a shared organizational culture is important, it is also important not to assume that a one-size-fits-all strategy for shaping the cultural experience across the organization will be effective. This is where the segmentation depicted in figure 1 comes into play. Your organization may depend on a variety of worker arrangements to achieve its business goals; ensuring that your culture is experienced and reinforced consistently across all worker types, albeit through different mechanisms, is key. Indeed, each worker segment is likely to experience the organizational culture from a different perspective. Developing a strong organizational culture can ensure that each segment is valued for their contributions toward a shared goal. Here are some recommendations on how to approach each segment:

- **Traditional workers.** Physical spaces can certainly be the most expensive to maintain, but they can also be the most effective in helping to shape an organization's desired culture. Consider how your organization's space is designed and what that signals to your traditional workers. Leverage the physical space to reinforce a commitment to your purpose. One financial services firm, seeking to create a culture that emphasized a strong commitment to relationships with advisors and employees, sought to redefine the company's culture by starting with some low-hanging fruit.[26] Initial activities included dedicating a wall to employee pictures, renaming conference rooms, and reconfiguring office spaces. Over time, town halls were moved from a formal meeting space to an open floor space where employees could easily mingle with senior leaders afterward. Senior leader parking spaces were removed to signify that all workers' efforts were important to the company's success. Cubicles were reorganized into team pods to encourage cross-functional collaboration. In addition, the company began a quarterly human-centric

award that publicly recognized employees who demonstrated the company's core values. Utilizing the physical space to create intentional employee experiences helped to reshape the company's culture around its purpose.

- **Tenured remote workers.** Make working remotely as simple as possible for this employee segment. Invest in technologies that support digital collaboration and make working and connecting from off-campus easy. As feelings of being excluded from the goings-on can sometimes plague remote workers, take care to include tenured remote workers when scheduling ad hoc meetings where their involvement would be valuable. In addition, consider creating opportunities for these workers to interact in person with other employees—for instance, through annual retreats or local lunches—to encourage trust and team-building. Lastly, this can be an easy group to overlook when it comes to recognition and acknowledgment of milestones. Openly reward and acknowledge tenured remote workers' efforts using venues such as company-wide town halls or newsletters. For example, the financial firm discussed above relied heavily on tenured remote employees to fulfill its customer service requests. In an effort to extend the culture beyond the organization's physical walls, leaders highlighted one remote employee's exceptional customer service through the company-wide newsletter. This relatively small act of recognition went a long way in helping to reduce turnover within this segment of its employee population.

- **Transactional remote workers.** Take the time to understand what these workers are hoping to gain from their temporary assignment, and use this understanding of their needs to build their commitment to your company and its culture. In many cases, transactional remote workers are foregoing traditional worker benefits in exchange for greater freedom and flexibility. Don't micromanage, but rather, acknowledge their ability to be autonomous and make it clear that you support their flexible work arrangements. In addition, because transactional remote workers aren't around all the time, Daniel Pink, author of *Drive*, recommends "spending extra time talking about what the goal is, how it connects to the big picture, and why it matters."[27] Understanding their reasons for accepting the assignment and providing greater context for how their work fits into the larger picture can help leaders better transmit their organization's culture to the transactional remote worker.

- **The outside contractor.** Because this segment of the alternative work population works within your campus, their physical

presence can be leveraged to communicate culture through means such as inviting them to all-company meetings and encouraging their participation in lunches or after-work activities. A recent *Harvard Business Review* article also provides this advice when working with the outsider employee segment: "Try to avoid all the subtle status differentiators that can make contractors feel like second-class citizens—for example, the color of their ID badges or access to the corporate gym—and be exceedingly inclusive instead. Invite them to important meetings, bring them into water-cooler conversations, and add them to the team email list."[28] Stated simply, don't overlook these employees working right in front of you and err on the side of greater inclusion in communications, meetings, and company-wide events.

What capabilities and reinforcing mechanisms do we need to extend our culture?

Leaders should identify both the organizational capabilities and the tools and mechanisms required to help reinforce the desired culture through operations (for example, speed, service, delivery, tools). All aspects of operations should support the desired organizational culture. For instance, if leaders want the culture to encourage continuous learning, they can put in place easily accessible training to upskill employees or reinforce key capabilities or skill sets. Additionally, rewards will come into play as a key reinforcing mechanism; after all, the activities you reward are the ones that employees focus on, so use rewards to reinforce the behaviors that are important to your organization.

Airbnb, a home-sharing platform through which travelers can rent a room or an entire home, reinforces culture through a variety of mechanisms. In addition to up-front screening mechanisms of potential hosts, the Airbnb application includes questions about hospitality standards and asks for a commitment to core values that hosts have to agree to support. Airbnb reinforces these values in several ways. First, it has a Superhost program to reward hosts who exemplify Airbnb's culture. These Superhosts, who now number in the tens of thousands, can earn revenue in the five- to six-figure range; the Superhost designation helps to propel their rentals, creating an incentive that hosts strive to attain. Superhosts also receive a literal badge of honor for their profiles.[29] Airbnb evaluates hosts based on nine criteria, from tactical factors around reliability and cleanliness to the host's experience, communications with guests, and number of five-star reviews. These evaluations also help align hosts with Airbnb's values and purpose.[30] Additionally, Airbnb holds host meetups for knowledge-sharing and community building.[31] For example, in fall 2014, it hosted an Airbnb Open, a conference to "inspire hosts and teach them about making guests feel at home." The

conference ended with a day of community service to reinforce core values.[32] Tactics such as these—from "challenges" like the Superhost program to meetups and events—can be used to reinforce cultural norms and reenergize workers around your purpose.

What digital technologies or other tools do we need to extend our culture?

Digital technologies offer an array of tools that can enable leaders to share up-to-the-minute information, get instant feedback, and analyze data in real time. Leaders can and should leverage these tools not only to drive collaboration and connectivity, but also to understand the employee experience and its evolution. But don't limit yourself to just the digital tools. Third-party co-working spaces—such as WeWork, Regus, Spaces (which Regus operates), RocketSpace, LiquidSpace, and a host of city-specific others—can be used to create communities and meeting places where virtual workers, whether on or off the balance sheet, can connect live. An influx of large companies are renting these co-working spaces for employees to create connection points and appeal to a different type of worker.[33]

As its Menlo Park headquarters grows and its use of other locations and virtual work expands, Facebook is finding ways to effectively use technology to extend its campus culture. The company regularly pulses employees to gather data on their perspectives on culture and engagement. It also has implemented its own product, the collaboration platform Workplace by Facebook, to enable "two-way communication for all of us, CEO to intern, no matter where you are. It connects us, and supports our culture, across the company and around the world," according to Facebook executive Monica Adractas. (For more information, see sidebar, "Sustaining culture: Facebook's approach.")

NEXT STEPS

LEADERS intent on extending their organizational cultures past office walls and balance sheets can consider the following steps:

Identify your alternative workforce populations with data. Take an inventory to understand where, precisely, your employees lay within these four populations, to understand how much you need to prioritize thinking about a shared culture and where to focus. Utilize data analytics to determine the percentage of workers in each segment as well as forecast future alternative workforce opportunities. Then review your strategies for how these populations may evolve in the future to ensure your strategy for maintaining a consistent culture remains relevant.

Utilize the choice cascade to intentionally create a positive culture across workforce segments. Creating consistent

cultural experiences requires an intentional strategy for engaging all worker segments. Just as marketers seek to engage customers under a shared brand experience, albeit through different mechanisms, employers likewise can use the choice cascade to create positive worker experiences under a shared employer brand.

Empower leaders to create a positive organizational culture. Commit to supporting the organization's culture across all levels of leadership. Sustaining a positive culture typically requires great commitment and efforts across all levels. Empower leaders and managers to help workers feel valued and part of a larger effort toward making a difference. This can fuel all employees' sense of meaning and purpose, regardless of employment type.

An organization's culture can help boost its performance—but to deliver its full potential, culture should extend to all types of workers, not just traditional employees. Given the current and anticipated growth in the off-balance-sheet workforce and in the number of individuals working off-campus, leaders should think about how they can include these workers in their efforts to create and sustain a positive organizational culture. Business leaders who are prepared to directly address this imperative will likely have more success in maintaining a culture that enables their strategy.

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SUSTAINING CULTURE: FACEBOOK'S APPROACH

At Facebook, all executives are accountable for strengthening its culture. That includes Monica Adractas, director, Workplace by Facebook. Facebook is using Workplace internally not just to enable collaboration, but to help cultivate the Facebook culture as the company experiences exponential growth. In this interview, Adractas shares her perspectives on Facebook's strategy for maintaining a shared culture in the constantly evolving digital landscape.

Deloitte Review: What role does Facebook's culture play in attracting, motivating, and retaining talent?

Monica Adractas: A recent study found that more than one-third of current students who will soon enter the workforce want to change the world by inventing something. A good idea or invention can change the world—but all good ideas and inventions come from people. Your team is the foundation for everything you do. So a strong, clear mission can fuel a company's work. It also serves as the unifying force that connects everyone's role in the company to a specific purpose. This allows leaders to guide their teams to the work that makes the company better. It also helps to propel employees to think beyond their individual roles and more about how they can contribute to something bigger. So, at Facebook we believe that connecting the world takes every one of us. We can't make the world more open and connected by ourselves. Each one of us is a valued contributor to our mission. And we empower our community by building products that connect people and create positive social impact.

DR: In the future, do you expect Facebook's mission to be more or less important in your efforts to attract, motivate, and retain talent? Why?

MA: We know that building an open and connected world starts with building an open and connected company. Our mission will always fuel our work as a company, and we're only 1 percent done. We look for builders—people who have proven, by rolling up their sleeves and making a direct impact, that they're the best at what they do. Focus on impact is one of our core values, and when we're interviewing people, we seek to understand how they've made an impact in the past and the impact that they want to make in the future.

DR: What tangible practices does Facebook put in place to connect everyone to the organization's culture?

MA: Everybody owns the culture at Facebook. That starts on your first day with our orientation and onboarding, where you learn about our core values: Be bold, move fast, focus on impact, and build social value. Additionally, Design Camp is a two-week-long orientation for all designers entering Facebook. During these weeks, designers can expect to attend prototyping workshops, hear from design leaders, and get to know members of the team.

Another key aspect of Facebook that is central to the success of our values is small teams. Small teams allow us to focus on high-impact projects, moving fast and being bold. Our hackathons are a Facebook tradition and fun event that encourages building and solving complex problems. The only rule of a hackathon is

that you can't work on anything that is part of your regular job. Hackathons are about new ideas. They are about great ideas coming from anywhere in the organization.

DR: What are some examples of employees or leaders putting Facebook's core values into everyday action?

MA: Mark [Zuckerberg] recently laid out his vision for building a global community, which is truly the most powerful example of this. We help people do what they do best. We're a strengths-based company, which means we're focused on designing roles, teams, and an organization that help people do work they're naturally great at and love doing. People perform better if they're doing work that fits their strengths, and we spend time working with people to shape their experience around the interaction between what people love, what they're great at, and what Facebook needs. Another example is possibly one of our boldest moves—the development of Aquila, a solar-powered, unmanned airplane that will bring affordable Internet to people in the hardest-to-reach places. Equally important to what it will achieve, Aquila embodies the notion that to make progress on your mission—in our case, to connect the world—sometimes you need to do something totally new and outside your comfort zone.

DR: What is your strategy for sustaining Facebook's culture as you continue to grow beyond Menlo Park?

MA: Because everybody owns the culture at Facebook, as we grow, every single employee carries our culture with them. All of our locations offer opportunities to work on meaningful projects and create real impact. We have a mission that unites us, to connect the world—but we have a culture that celebrates individuality and being your authentic self. We aim, daily, to personalize the experience of working at Facebook. We do this through gathering data: We can't guess what 17,000 people want, so we constantly ask them and iterate based on their feedback. We created a collaboration platform—Workplace by Facebook, launched in October of last year and now being used worldwide—to fully enable two-way communication for all of us, CEO to intern, no matter where you are. It connects us and supports our culture, across the company and around the world. We work hard to make sure everyone at Facebook has access to as much information as possible about every part of the company so they can make the best decisions and have the greatest impact.

DR: How do employees engage and collaborate onsite and virtually?

MA: For onsite workers, our workspaces are designed to be open and promote close collaboration with people and their teams. You frequently see people up, moving around, and talking to each other as a result of the way our offices were very intentionally designed. For virtual workers, as you would imagine, we use our own product, Workplace by Facebook, in a number of ways to connect and collaborate, whether in the office or on the go. Our teams can share information with the entire company—offices, teams, or projects; onboard new employees; and discover important things we are interested in about the company, such as financial results or product updates to Facebook or Instagram. We also found that using Workplace is a great way to test new ideas, features, and products; it gives us access to a large focus group—our entire global employee base of tens of thousands.

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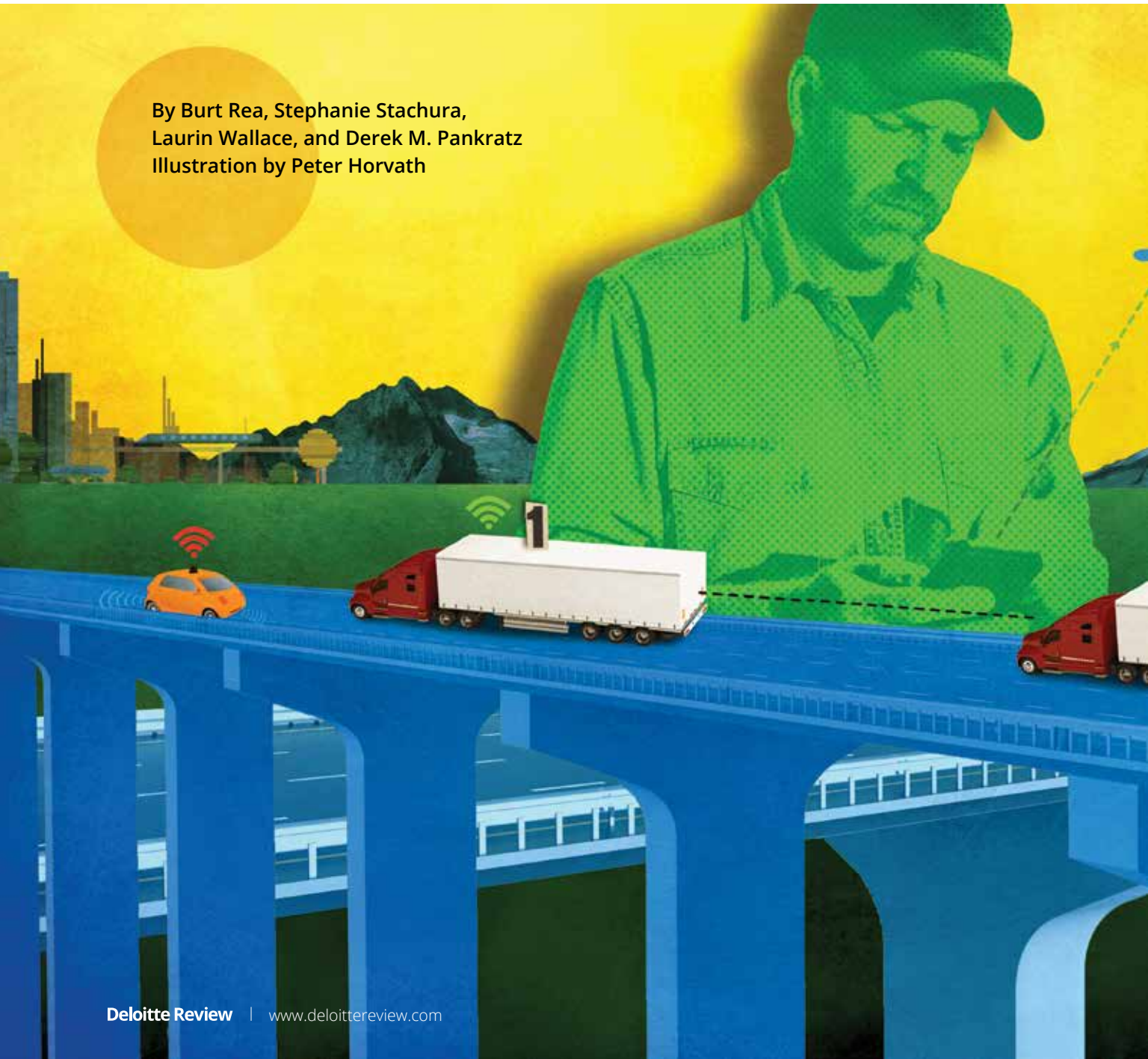
Making the future

How the new transportation ecosystem could

By Burt Rea, Stephanie Stachura,
Laurin Wallace, and Derek M. Pankratz
Illustration by Peter Horvath



# of mobility work

reshape jobs and employment

"The basic fact is technology eliminates jobs, not work."

—Report of the National Commission on Technology, Automation, and Economic Progress, 1966[1]

EMPLOYMENT AND JOBS IN THE FUTURE OF MOBILITY

THE future of mobility promises to transform the way people and goods move about, as shared and autonomous vehicles could offer the opportunity for faster, cleaner, cheaper, and safer transportation. Accompanying those potential changes could be dramatic shifts in the workforce. When transportation modes are profoundly changed, what are the implications for the almost 7 million US auto workers and nearly 4 million professional drivers? How might the future of mobility affect the numerous ancillary jobs that largely hinge on how transportation is provisioned, such as warehouse workers and public works employees? As mobility is expected to increasingly shift from being product-centered to being service-centered, and data could play an ever-greater role, how can companies and governments prepare and adapt their workforces to meet those potentially changing demands?

This article explores how the future of mobility could impact companies' talent needs and the broader workforce. It begins by examining the social and technological shifts that seem to be leading to a new mobility ecosystem. It then identifies the overarching trends that are likely to impact labor across the mobility landscape. Finally, the article looks at a handful of specific sectors—automotive, trucking, and eldercare—to provide a glimpse at how these trends might play out in different contexts. The aim is to examine which jobs are likely to be most affected, what new opportunities could arise and what skills would be needed to realize them, and how organizations can prepare themselves and their people for both the future of mobility and the future of work.

Over the long run and in the aggregate, there is reason for optimism. As MIT economist David Autor notes, while "there is no fundamental economic law that guarantees every adult will be able to earn a living solely on the basis of sound mind and good character," historically the demand for labor has tended to increase as technology advances.[2] The journey is seldom a smooth one, however, with disruption often leading to wage polarization[3] and the potential for significant economic, political, and social turmoil.[4] As stakeholders in the emerging mobility ecosystem ponder how to forge tomorrow's workforce, it's worth remembering that the Luddites were not protesting against technology *per se* but, rather, against its application: "They wanted these machines to be run by workers who had gone through an apprenticeship and got paid decent wages. Those were their only concerns."[5]

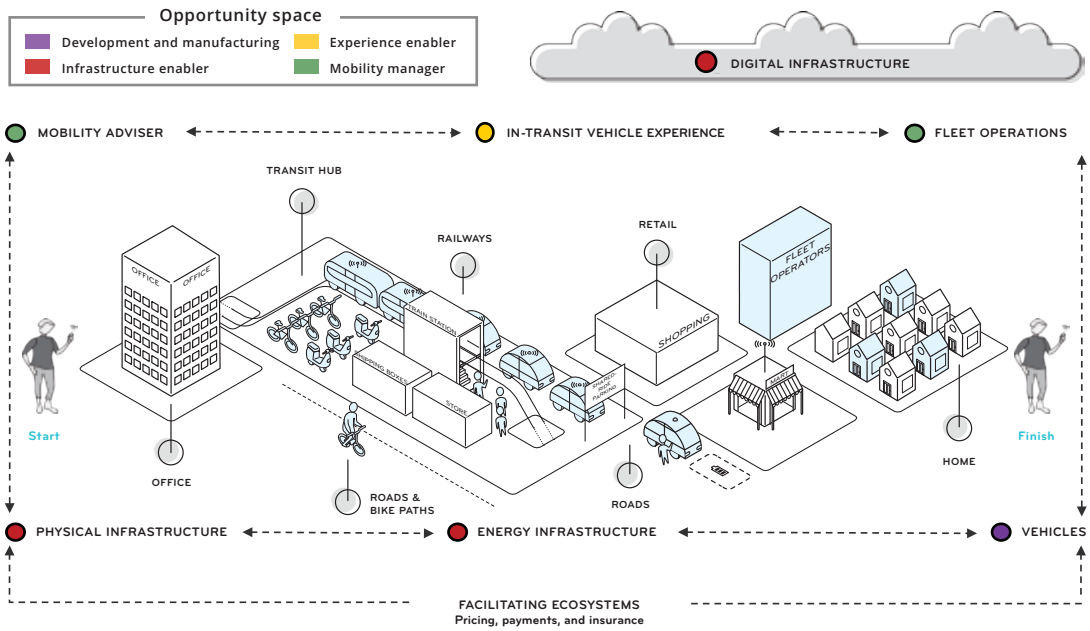
To that end, stakeholders across the mobility ecosystem would do well to "embrace the disruption" of increased automation and innovation for their business models and workforces. Bringing employees along for the journey is essential to capitalizing on these opportunities: To navigate this technological frontier, companies can look to create continuous learning, evolve skill sets, and retune and rethink jobs.

UNDERSTANDING THE FUTURE OF MOBILITY

UNDERSTANDING how changes in transportation could affect workers first requires an understanding of how the mobility ecosystem might evolve. Converging social and technological trends—in particular, shared mobility and the prospect of autonomous vehicles—are reshaping the way people and goods move from point A to point B.[6] In urban areas in particular, shared autonomous vehicles could be integrated with other types of transit, creating a mobility ecosystem that offers seamless, intermodal travel on demand (figure 1).

Making that system work will likely require a diverse set of players. **Vehicle development** is expected to remain critical. The carmaking business will likely give rise to new products,

Figure 1. The future mobility ecosystem



Source: Deloitte analysis.

from small utilitarian autonomous "pods" to highly customized, personally owned self-driving cars, which could be even more amenable to automated production than today's already highly robotized industry. The **in-vehicle transit experience** could become central: In the United States, drivers spend roughly 160 million hours per day behind the wheel, and much of that time would be freed up by shared and autonomous mobility. "Experience enablers"—including content providers, data and analytics firms, advertisers, entertainment equipment providers, and social media companies—would rush to fill this vacuum and make travel relaxing, productive, and entertaining.

Physical infrastructure enablers could look to provide smart tolling and dynamic road usage pricing as well as traffic flow management. Energy providers and retailers could find themselves managing an increasingly complex supply chain, including battery recharging and replacement. A parallel **digital infrastructure** could be every bit as critical, as data become the new oil. To succeed in this area, companies likely need to offer seamless connectivity, network security, and a horizontal operating system shared across the ecosystem that can bridge vehicles as well as mobile devices and Internet of Things architectures.

Mobility management will likely be another vital component in the ecosystem. Mobility advisers could aim to enable a seamless intermodal transportation experience, ensuring easy access, a top-notch in-transit experience, a smooth payment process, and customer satisfaction. They could use customer preferences, traffic data, and more to tailor the most convenient and cost-effective mobility plan for each trip. That means developing mobility data collection, predictive analytics, user control, and relationship management.

Clearly, the effects of these changes are expected to spread far beyond the automotive industry, touching everything from insurance and finance to government, energy, and beyond. And as the new mobility ecosystem transforms the way people and goods move about, so too could it transform the nature of work in many areas. Demand for some jobs might fall, existing job tasks could change, new types of jobs will likely be created, and the skills it takes to succeed may shift.

THREE DRIVERS OF CHANGE IN THE MOBILITY WORKFORCE

We see three overarching trends emerging from the future of mobility that could impact what and how work gets done.

Automation and augmentation

Automation is hardly new in the extended global automotive industry. Arguably, it was founded on automation. The assembly line, which segmented and partially automated routine tasks, enabled manufacturers to bring the automobile to the masses roughly a century ago,[7]

and auto original equipment manufacturers (OEMs) have been at the forefront of deploying many new production processes. But the emergence of increasingly sophisticated cognitive technologies, coupled with the growing ability to cheaply monitor all manner of objects via the Internet of Things,[8] suggests the scope of tasks open to machine control could increase considerably.

For the future of mobility, that trend could manifest most dramatically and obviously in the emergence of autonomous vehicles. Self-driving cars and trucks pose a challenge to the more than 3.8 million professional motor vehicle operators in the United States (a figure that likely undercounts the many thousands of part-time and contract drivers for ride-hailing and other services).[9] The technology is several years away from market readiness, and adoption is likely to be highly uneven and contingent on both regulation and consumer attitudes.[10] Nevertheless, the effects could be profound. Deloitte's projections indicate that by 2040, more than 60 percent of passenger miles traveled could be in fully autonomous vehicles.[11] It's no surprise that some professional drivers are already organizing to blunt the impact.[12]

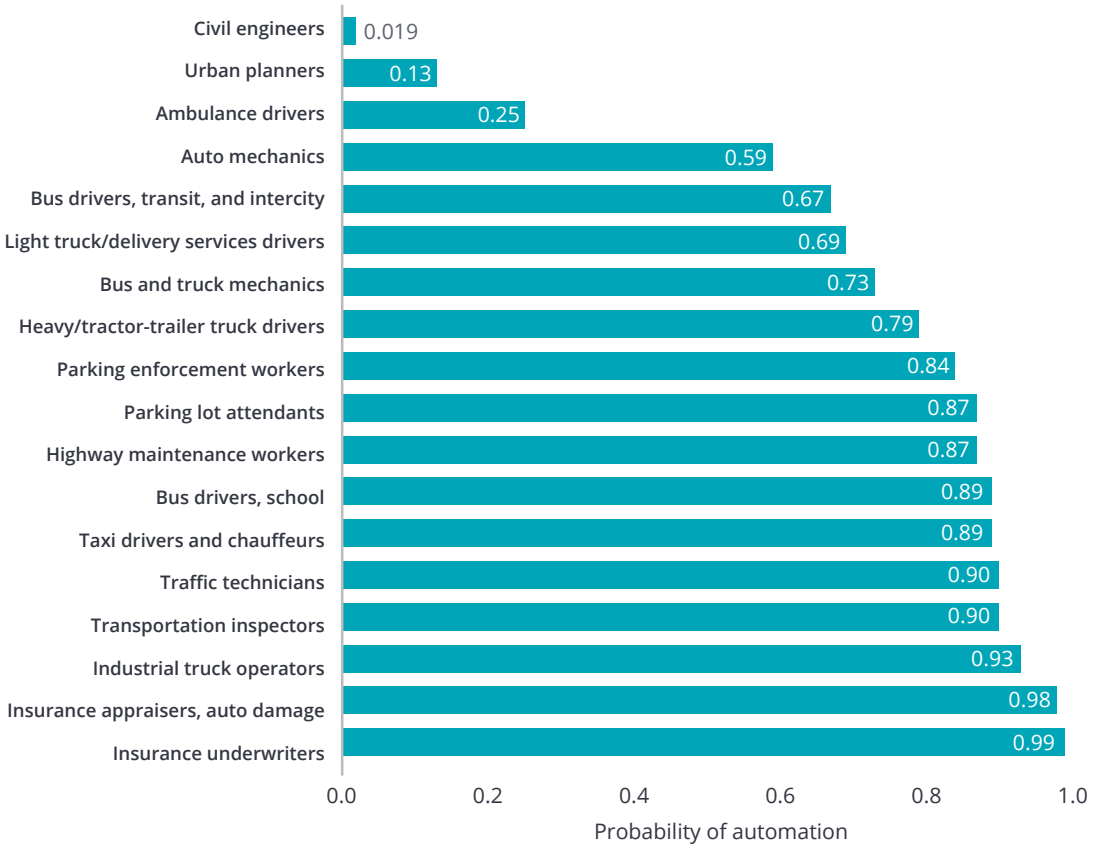
The implications for taxi drivers and truckers may capture headlines, but the effects of artificial intelligence and related technologies on other occupations within the mobility ecosystem would likely be no less profound. For example, vehicle assembly—already highly robotized—is becoming even more automated as industrial robots gain capabilities (such as the ability to "see" using sensors) that enable them to tackle more tasks or take on new forms to assist human workers (such as the "robo-glove" that reduces hand stress from repetitive motions).[13] Everything from insurance underwriting to parking enforcement to auto loan origination could see an array of discrete tasks increasingly being executed by some combination of sensors, data analytics, and cognitive technologies.

The size and scope of the impact would likely vary by industry, but figure 2 suggests that a number of mobility-related occupations could be highly susceptible to automation (or "computerization," in the terminology of the economists who calculated the measure).[14] These estimates are meant to be illustrative, not exhaustive or determinative, but it seems clear that automation will likely affect a number of roles across the mobility ecosystem.

From physical to digital, goods to services

Even as new technologies may automate and augment how work gets done, an equally fundamental shift could take place in *why* work gets done. As personally owned vehicles may be decoupled from the concept of individual mobility, especially in urban areas, so too could value increasingly shift away from physical assets and toward the digital capabilities

Figure 2. Automation potential of select mobility-related occupations



Source: Carl Benedikt Frey and Michael A. Osborne, "The future of employment: How susceptible are jobs to computerisation?," Technological Forecasting and Social Change 114 (2017): pp. 254–80; Bureau of Labor Statistics; Deloitte analysis.

that enable safe, clean, efficient, and customized travel on demand (see figure 3). As a result, data, networks, software, and services are likely to grow increasingly important in all facets of transportation, which could come at the expense of traditional manufacturing.

There have already been some indications of this shift—for instance, the (pre-IPO) value of ride-hailing service provider Uber exceeds that of long-established automakers.[15] Deloitte's analysis has found that the breadth of future mobility use cases requiring connectivity is expected to generate data traffic of roughly 0.6 exabytes[16] every month by 2020—about 9 percent of total US wireless data traffic.[17]

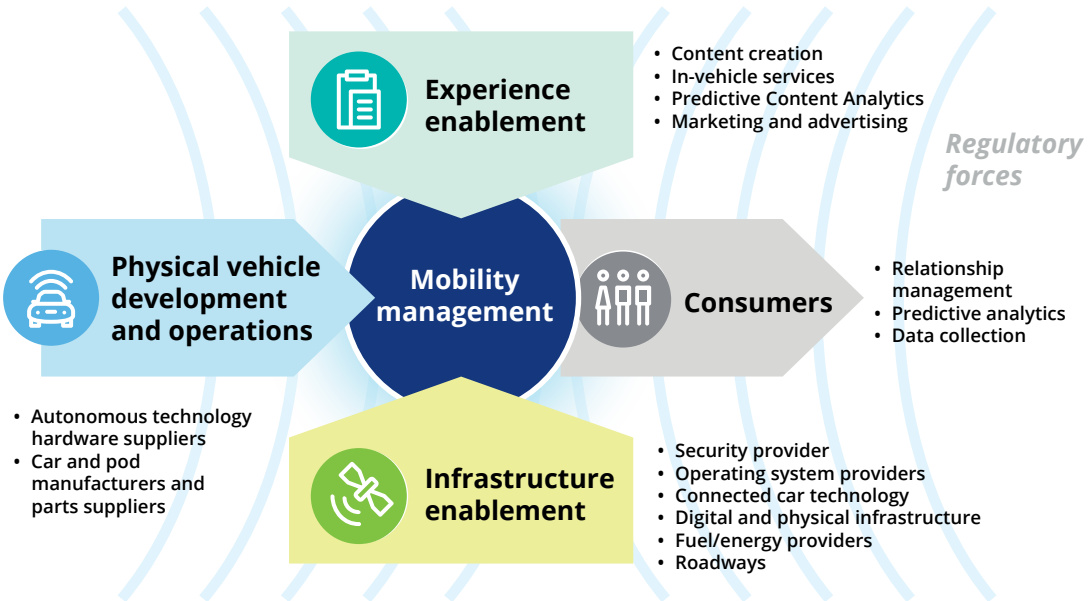
As value likely shifts from the physical to the digital and from goods to mobility services, so too could what skills are in demand and how they are valued. Those with fluency in the technologies and services essential to the future

mobility ecosystem are expected to be sought after and rewarded accordingly—to take just one example, in the auto supply sector, "computer systems software engineer" has been the most-advertised job opening for several years in a row.[18] But there is also a challenge: While the technology-focused jobs that will likely define the future of mobility require higher skills, offer better wages, and promise increased productivity, there may be far fewer of them relative to today's extended transportation industry. That suggests there could be a real need for policy mechanisms to help smooth that transition, including programs such as retraining and income assistance.

Better mobility could drive demand for *more* mobility

To the extent that technology complements—rather than simply replaces—labor, it can often create a powerful engine for increased productivity and overall job growth. Deloitte's analysis suggests there is tremendous potential value to be unlocked from a reimagined mobility ecosystem. The cost per mile of transportation could drop by two-thirds relative to today in a world of shared autonomous vehicles.[19] As mobility potentially becomes cheaper, faster, and more convenient, new population segments (such as the elderly) can gain access, and overall demand could increase. Deloitte estimates that total US miles traveled could

Figure 3. The future mobility value system



Source: Deloitte analysis.

increase by 25 percent by 2040.[20] Trucking volumes have increased steadily since 2000, driven in part by the rise of e-commerce,[21] and show few signs of abating.

All of this could point to significant demand for jobs, with at least the potential to offset or even negate any attrition that automation or shifting sources of value creation might cause. That employment may come from a greater need for existing types of work, but it is just as likely to be generated from entirely new classes of jobs that have yet to emerge. In economic terms, even in cases where households ultimately spend less on a good (in this case, mobility), they can allocate those funds elsewhere (toward, say, in-vehicle content consumption or mobility management services)[22]—and jobs tend to follow spending.

PREPARING A WORKFORCE FOR THE FUTURE OF MOBILITY

HOW these three trends might play out could differ dramatically by sector, and so too could best practices for preparing organizations' workers. Here we explore just a handful of salient examples of how different industries might be impacted, and how companies might best respond.

Auto OEMs and suppliers

Consecutive years of record sales[23] are allowing automotive companies to invest aggressively as they start to define their place within the future of mobility. As they explore new business models, alliances, and technologies, this frenzy of activity may also create change and friction within the workforce. New autoworker roles, with different skills and needs, could emerge alongside new organizational constructs such as crowdsourcing and flexible internal talent markets. Catering to these new roles would invariably affect how companies engage and retain the legacy workforce that has defined the automotive industry for decades. The challenge is likely to create a forward-thinking talent model that meets the evolving need to attract, retain, and develop a new digital workforce, while balancing the resulting cultural and operational shifts with the broader needs of the organization.

While automotive companies pursue autonomous vehicles and new business models centered on ridesharing and mobility services, they should also think through the skills they need to capitalize on these big plays. Many have turned to acquisitions as a quick way to build out their ranks in critical areas, but *retaining* that purchased talent means that automotive companies must cater to a tech-focused talent market that values flexibility, purpose, and experiences.[24] These digitally savvy workers are typically comfortable with independence and transparency.[25] In return, they often expect a "complete end-to-end experience"[26] designed around teams, productivity, and empowerment.[27] This could span everything from the ability to seamlessly shift between assignments

to using digital platforms that create talent experiences focused on meaningful and purpose-driven work. Career development and internal mobility can start to take on heightened importance, requiring their own frameworks to manage thousands of individualized experiences that are moving just as quickly as the technology surrounding them evolves.

Integrating new types of workers, skills, and capabilities into a legacy tried-and-true model is often no small feat. Campaigns such as Michigan's "We run on brainpower" aim to pivot perceptions and convince new generations that a midwestern automotive career can be just as rewarding as one in Silicon Valley.[28] But simply adopting the trappings of tech players—coding workdays, onsite childcare, flexible work settings—is unlikely to be sufficient. Automotive companies will likely need the right infrastructure to support this potentially new type of worker and to create the experiences that enable success. Ultimately, middle managers may have to create a new culture of "always on" learning and development through engaging experiences to transform today's talent model into a flexible and open talent market that can effectively accommodate emerging talent needs.

Even as their talent pool shifts and expands, automakers will likely continue to rely on manufacturing-line veterans and the front offices that have kept the lights on for decades. Even there, however, the numbers and skills of those workers could shift as both the types of vehicles being built (such as relatively simple autonomous "pods") and their volumes could change. These workers, just as critical to automakers' success in the future of mobility, often have a different definition for career development, and auto companies would need to balance these different perspectives as they seek to get the talent equation right. That means both building on the rich history already in place *and* creating a very clear vision for the future—an exciting future that is technology-enabled and customer-focused.

Human resources organizations have a big role to play in driving a new workforce-planning mind-set.

Human resources organizations have a big role to play in driving a new workforce-planning mind-set. The need to forecast skills requirements around analytics, robotics, artificial intelligence, and beyond requires longer-term thinking about how technology could shift the way that work gets done; when new and emerging skills will likely be needed to enable these shifts; and where these skills might sit in the organization. Creating a more flexible model to "right speed" HR to support a changing spec-

trum of needs can be critical for organizations, as the pace of change is only expected to accelerate.

Managers and HR leaders can start by:

- **Unleashing networks of teams.** Consider leveraging start-up thinking and breaking down functional silos by building organizational ecosystems through focused, autonomous, and less hierarchical teams that may more quickly incubate targeted and cross-functional outcomes.[29]

- **Rethinking your hierarchy.** As organizational networks replace traditional hierarchies, consider revisiting the meaning of "career" and what it takes to develop one by exploring multi-role, flexible career paths rooted in ongoing learning. This can be particularly applicable for parts of the organization engaged in exploring innovative mobility opportunities.

- **Developing digital leaders.** Risk-taking seems to have become one of the most important drivers of high-performing leadership cultures, and leaders not learning new digital skills are six times more likely to leave their organization within the next year.[30] That can make it somewhat critical to develop bold leaders who are comfortable with new tools and management approaches across digital mediums and virtual platforms.

- **Pulsing your people.** Consider using internal crowdsourcing and hackathons to collect ideas for how to organize and approach performance management, engagement, and rewards to build a compelling employee experience.

- **Creating a culture of real-time measurement.** Consider investing in applications that provide real-time metrics on engagement, recruiting, and turnover to help your organization make informed and in-the-moment talent decisions.

- **Recognizing learning is everyone's job.** Learning has become an imperative that must be embedded seamlessly in each part of the organization. Through formal and informal knowledge sharing (such as impromptu lunch groups or on-demand, open-source platforms), consider creating a learning culture to foster an environment in which employees want to continue their development journey. This may become an imperative as new vehicles, new assembly techniques, and entirely new business models could play increasingly important roles in the auto industry.

This is a challenging and exciting time for automakers, as the next generation of talent has the opportunity to reshape an industry defined by iconic global brands. It seems to be time for the auto industry to break with the past, apply

grit and dedication, and start a new chapter for the future autoworker.

Trucking

There is perhaps no other industry that the future of mobility could more visibly and dramatically affect than the extended transportation sector. The prospect of an 18-wheeler—80,000 pounds of steel and freight—cruising the highway, guided entirely by sensors and software and with nary a driver in sight, likely excites shipping companies and worries gearjammers.[31]

The transportation sector accounts for a significant portion of the US economy and is expected to represent $1.6 trillion of total GDP by 2045.[32] The trucking industry, which accounts for the largest movement of freight, is expected to increase freight movement tonnage by 43 percent by 2040 (from 13.2 billion to 18.8 billion).[33] Accommodating this growth would place tremendous pressure on every component of the industry, including its already-strained workforce. Since the 1980s, the trucking industry has experienced a high degree of voluntary turnover, much of it attributed to low wages, an aging workforce, and the deleterious health effects associated with long-haul driving. Those challenges are manifesting in the industry's compliance and safety record: Hours of service violations remain one of the top issues plaguing the trucking industry,[34] with crashes involving large trucks ticking up in recent years, though they remain low by historical standards.[35] Absent significant changes to its business model and talent pool, it can be difficult to see how the trucking industry could attract the 890,000 new drivers that the American Trucking Associations estimate will be needed through 2025 to meet rising demand.[36]

The advent of autonomous vehicle (AV) technology could improve or eliminate many of these labor issues. Much of the impact will depend on whether future vehicles are only partially autonomous, employing driver-assist technologies, or truly driverless, with no need or expectation that a human will be in the cabin.

Even relatively modest levels of automation, such as adaptive cruise control for highway conditions, could lead to major reductions in hours of service violations—assuming regulations keep pace and recognize that the toll on a "monitoring" driver is less than that on one actively at the wheel. In the near term, driver shortages and turnover could decrease dramatically if drivers are able to rest more, improving overall health and wellness; younger drivers are attracted to the industry because of the new and sophisticated technologies being used; and wages are increased due to a more sophisticated skill set required to operate and maintain AV technology.

Further in the future and as AV technology could begin to penetrate the trucking industry, fully autonomous systems may allow the

"driver" to be completely absent from the truck, perhaps instead providing remote oversight over several trucks from a central operations center, or in the lead vehicle in a platoon of trucks but focused on planning and logistics while in motion. Duties that require human intervention—such as client relationship management, equipment management, route planning, and cargo management—could gain new importance.

However, new and expanded responsibilities will likely require a shift in skills and potentially the type of jobs needed to manage, operate, and maintain fleets of AVs. For example, "fleet monitors" working at a central hub would need to understand how to use tracking systems, dynamic routing, and AV technologies to ensure that vehicles on the road are operating smoothly. Inspectors and even law enforcement would need to be aware of the new technology and understand the state and federal regulations that govern the new technology. Mechanics, who work for carriers, would need to learn how to perform repairs on increasingly sophisticated autonomous operating systems.

The pace at which the industry adopts AV technologies will likely depend heavily on levels of investment, changes in regulations, and the emergence of supporting infrastructure that would allow the trucking industry to see tangible benefits. Widespread use of even partial autonomy will likely take at least several years, with fully autonomous trucks perhaps a decade away or more.

That said, the industry likely needs to begin preparing its workforce today. To address a world of *partially autonomous vehicles*, trucking companies should consider:

- What are the economics of incorporating autonomous systems into their fleets? Depending on the distance and complexity of a carrier's routes, its predominant type of freight, and the nature of its labor challenges, investing in partially autonomous vehicles may not make sense. We expect the technology's biggest payoffs to come from reduced driver fatigue, fewer accidents, and improved fuel economy (via platooning) during long-haul trips. Those focused on last-mile delivery may see less upside from upgrading legacy systems.

- Will this influence the owner-operator labor model and affect contract terms and conditions, including the heavy debt burden that independent contractors traditionally incur? In the short term, partially autonomous vehicles may allow owner-operators to drive farther and longer.

- For large carriers, what is the most effective way to train a widely dispersed pool of drivers on new technologies? Companies should consider various e-learning options

as a starting point, or look to capitalize on natural workforce turnover to bring aboard those familiar with the latest systems.

- Will this impact the compensation model so that trucking companies can increase what they pay employees? If new licensing or technical competencies are required to operate partially autonomous trucks, labor costs could rise.

Over the longer run, as *fully autonomous systems* may begin to replace drivers altogether, carriers would need to radically reshape their labor forces. Key questions to consider:

- How can employers attract the high-skill, highly educated workforce that would be required to maintain, operate, and oversee a fleet of self-driving trucks?

- What becomes of owner-operators? Without the need for a driver, the viability of the business model for small owner-operators—and the trucking companies that rely on them to haul freight—could be in doubt.

- How will organizational structures adapt? If erstwhile drivers assume dispatch or operations roles, they could affect companies' asset mix and geographic footprint, potentially requiring new operations hubs to house them—or even a shift to a virtual workforce.

Eldercare

The workforce implications of the new mobility ecosystem extend to unexpected corners of the economy. Consider the eldercare sector, where the future of mobility could have a profound impact on the way seniors choose to live. Traditionally, a critical turning point for seniors has been the day they lose their driver's license. This equates to a loss of personal independence that many seniors dread. The resulting dependence on loved ones to shuttle them to social events, shopping excursions, or doctor's appointments has a significant impact on many seniors' sense of self, sense of autonomy, and sense of happiness. This transition to "dependent mobility" often leads seniors and their families to make the move to assisted-care living.[37] Yet the vast majority of seniors say they would prefer to stay in their own homes.[38]

With the advent of convenient and cost-effective ridesharing services, seniors now have the ability to stay in their homes despite the loss of personal driving abilities. With easy-to-use apps, a no-hassle ride experience, and the ability of family members to schedule rides for their loved ones from anywhere, today's ride-hailing providers have improved upon many of the challenges seniors have long faced in utilizing traditional taxis.[39] No more calling a dispatcher, waiting an unknown amount of time for the cab to arrive, or fumbling for cab fare.

With ridesharing models, no longer must many non-driving seniors rely on friends and relatives to take time away from work or school to provide a ride to an essential doctor's appointment or weekly bridge club. Personal freedom and mobility can be restored. Major ride-hailing providers are already exploring this space, partnering with cities, health care providers, and others to offer transportation for seniors.[40]

In parallel, new ways of bringing products to seniors' front doors with speed and convenience often eliminate the need to drive to the store or pharmacy. Mobility solutions that more easily bring goods and services to homebound seniors are likely to increase in demand, and jobs involved in maintaining and operating these types of delivery services could grow.

How might this dynamic impact the workforce? Beyond the potential boon to ridesharing providers and the increase in demand for home delivery services, there are impacts specific to the eldercare sector. The United States has approximately 1.5 million full-time eldercare workers,[41] but caring for an aging Baby Boomer population could demand as many as 5 million workers by 2020, creating the possibility of a severe shortage.[42] But if more flexible mobility options allow more seniors to stay in their homes, this shortage could be lessened. There might also be a corresponding rise in demand for home-based care for seniors who do not need constant attention, yet would benefit from occasional help. These roles exist today but in limited numbers, as fixed, institutional roles dominate: Roughly 85 percent of eldercare workers are based in nursing homes and assisted living facilities, with just 10 percent providing home health services.[43] (These home caregivers could benefit from the same ridesharing services that their clients enjoy to overcome the need to use a personal car to make "house calls.")

As another result of slackening demand for residential senior care, we may see traditional nursing care and integrated care facilities reconfiguring their services to try to attract seniors who may not *need* to move to an assisted-care facility but who could be attracted by a more connected community experience, increased social activities, or other characteristics that these facilities can offer. Residential care facilities may choose to team with mobility services to bring seniors to their facilities on a daily basis. This may open up new or expanded job opportunities as these operators could seek to expand on the "customer experience." These facility operators could add or expand roles in marketing, sales, promotion, community relations, communications, digital outreach, or directing social programs.

Ultimately, like many other sectors, eldercare is poised for disruption as a result of dramatic changes in personal mobility: New jobs could emerge, and many current jobs will likely shift or change their focus or manner of delivery. For eldercare, the opportunities for employ-

ment growth are already there, given current demographics—10,000 Baby Boomers on average retire each day[44]—and the shortage of labor in this space. So the impact is potentially a win-win, resulting in either a better-enabled eldercare workforce with more opportunity to choose a workstyle that fits their preferences, or an increase in job opportunities in the eldercare sector as new business models offer different and expanded types of jobs.

MAKING THE FUTURE OF MOBILITY WORK

HISTORY shows that new technologies often lead to *increases* in workforce participation for impacted sectors. Famously, since the introduction of ATMs in the late 1970s, the number of bank tellers and bank branch employees has actually increased—but the nature of the work and the tasks they perform have changed.[45] The real challenge for workers may lie not in being replaced by a machine but, rather, in how to reskill to work side-by-side with the new tools and capabilities that advanced technologies bring.

The labor implications of the new mobility ecosystem could be profound, and this article only scratches the surface. Deloitte plans to continue exploring the myriad ways that the future of work and the future of mobility might intersect to shape tomorrow's workforce.

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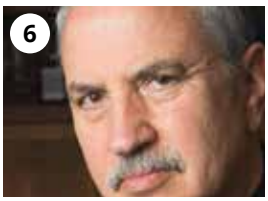
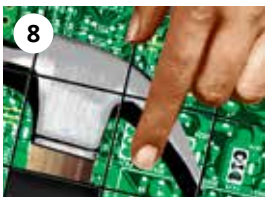
45. James Bessen, "Toil and technology," *Finance & Development* 52(1), March 2015, www.imf.org/external/pubs/ft/fandd/2015/03/bessen.htm.

ARTISTS





1. A long-time contributor to many Deloitte University Press publications, **Jon Krause** is featured again. He is a native of Philadelphia.

2. The textured, colorful digital collage by **Tim Marrs**, is the cover image for this issue's feature subject.

3. Creating textural works with paper, paint, and found and repurposed items, **Wayne Brezinka** hails from Nashville, Tennessee.

4. Blending hand-made art elements, **Pushart** then assembles and photographs them to create their three-dimensional look. They are based in New York.

5. & **8.** A first-time contributor to *Deloitte Review*, **Doug Chayka** uses familiar imagery that comes together in his own eclectic look. He works in his New Jersey studio.

6. Based in the Washington, D.C. area, **James Kegley** photographed Tom Friedman in his D.C. Office. James previously shot General Stanley McChrystal for *Deloitte Review* issue 19.

7. **Anthony Freda** combines a timeless Renaissance motif with a feeling of tomorrow in his illustration. He works in Long Island, New York.

9. & **11.** Illustrating two of this issue's articles, **Peter Horvath** combines photos and artwork alike to convey complex concepts.

10. **Mar Cerdà** creates small worlds with her intricate and detailed three-dimensional artwork. She enjoys living in Barcelona, Spain.

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Wastewater generation:	Reduced by 30,350 gallons
Solid waste production:	Reduced by 1,910 pounds
Greenhouse gases:	Reduced CO_2 by 6,682 pounds

*Source: Environmental Paper Network, papercalculator.org.

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