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review



**Credentials
Reform:
Technology and
the Changing
Needs of the
Workforce**

Jamie Merisotis

**Appreciating a
Multigenerational
Higher Education
IT Workforce**

Eden Dahlstrom

**Thinking
about the
Future of
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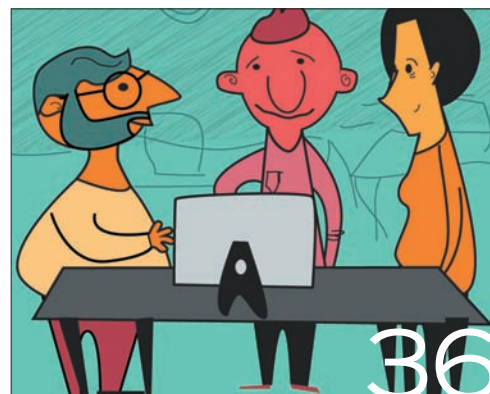
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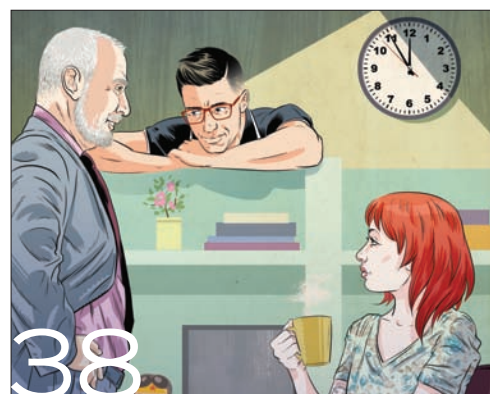
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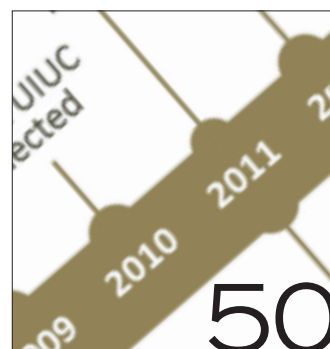
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Brave New Work World

I have experienced a few dramatic moments, epiphanies even, when it became clear that the world I thought I was inhabiting was changing in remarkable ways. As a faculty member, I once cancelled class because I was giving a paper at a national conference. I assumed I would be a hero. In my experience at that time, students loved nothing more than a day to skip class and catch up on all the work I was assigning. Instead, one of my working adult students called me up to read me the riot act. The conversation started with “I paid good money for this class” and went downhill from there. In this single moment, I realized the academy was heading into some decidedly uncharted waters.

When it comes to the brave new work world, I’ll borrow the epiphany of Carolyn O’Hara, managing editor of *The Week*.¹ She explains that she was working with a friend’s personal assistant, Amy, and exchanged several e-mails to handle the logistics for a meeting. O’Hara was impressed with Amy: “She was efficient and gracious, considerate of my schedule constraints, and so polite in her responses that, with the meeting arranged, I began typing up a brief thank-you.” It was then that O’Hara noticed Amy’s e-mail signature and realized that she had been working with a digital assistant *powered by artificial intelligence*. As O’Hara wrote: “Amy wasn’t actually human. She was an algorithm. I’d been corresponding with a machine all along and hadn’t even realized it.” O’Hara predicts that if this hasn’t happened to you by now, it’s going to soon.

This issue is a collection of epiphanies, insights, predictions, and educated prognostications about the future of work.

This issue of *EDUCAUSE Review* is, in many ways, a collection of epiphanies, insights, predictions, and educated prognostications not only about the future of work but also about the interconnected relationship between the academy and careers. Whether you consider that relationship to be symbiotic, reciprocal, mutualistic, or something less interdependent, the articles that follow offer important commentary on a topic that is in the news and on our minds regularly.

In “Thinking about the Future of Work to Make Better Decisions about Learning Today,” the futurist and social scientist Marina Gorbis explores, with the benefit of decades of previous forecasting work, what she calls “deeper transformations.” Focusing on four clusters of technology—smart machines, coordination economies, immersive collaboration, and the maker mindset—she takes the provocative position that Marshall McLuhan got it right: “We shape our tools and afterwards our tools shape us.” Gorbis offers concrete examples of change fully under way, whether Japanese robots building other robots or Internet-connected dinosaur toys designed

to grow with the children for whom they are purchased (adaptive playing?). Jobs are being redefined, transformed, and sometimes “eaten” by new technologies or moved to the cloud. For example, when it comes to coordination economies like Uber, Gorbis points out that employees are changing along with the jobs, moving from “stable 9-to-5 jobs” to “a stitching together of various tasks performed in flexible niches of time.” Jobs are becoming less about large tasks and more about micro-tasks or micro-contributions. Gorbis hints at the future promise of bitcoin to track knowledge acquisition and points to several ways that new technologies offer alternatives to traditional degrees, from badging to GitHub to emerging startups such as Degreed, whose mission is to “jailbreak the degree.”

Jamie Merisotis, president and CEO of the Lumina Foundation, continues this conversation in “Credentials Reform: How Technology and the Changing Needs of the Workforce Will Create the Higher Education System of the Future.” Merisotis takes a deep dive into what he calls “the powerful shift” that has taken place in the last few decades in the field of postsecondary credentialing. Whereas too often we see product development/hype in the driver’s seat, Merisotis refreshingly suggests that the needs of students and employees are “unleashing the power of technology.” His exploration of transformation examines the growth in credentials serving as alternatives to degrees, specifically suggesting that campus IT leaders have

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“a unique opportunity to influence this transformation.” Acknowledging that the transformation of the credentialing ecosystem will take years to accomplish, he observes that key changes are already evident. The system he envisions is most clearly expressed in the Connecting Credentials platform. Co-sponsored by the Lumina Foundation and over 90 others, including EDUCAUSE, this effort aspires to develop a universal taxonomy that will connect all kinds of credentials. These better-connected credentials, along with common definitions and a shared language for understanding, extend Merisotis’s vision and suggest “a digital passport to showcase learning and accomplishments throughout a lifetime.”

Who is earning the nontraditional credentials discussed by Merisotis, and who is working in the nontraditional jobs outlined by Gorbis? Very likely, they span the generations, just as they do in the higher education IT workforce. Eden Dahlstrom, chief research officer for the Data, Research, and Analytics (DRA) unit at EDUCAUSE, uses information from the latest EDUCAUSE Center for Analysis and Research (ECAR) workforce study as a lens for viewing the changes ahead. In “Appreciating a Multigenerational Higher Education IT workforce,” Dahlstrom explores the generational differences as the youngest professionals begin to enter higher education IT professions in force. She acknowledges that the “oversimplified generalization of traits” has limits, but she says such generalizations also offer insights that allow us to “categorize an otherwise complex world.” As Dahlstrom explains, an understanding by Gen Xers and Boomers of the next generation—and vice versa—“will help colleges and universities maintain business continuity during the generational transition.” (Indeed, to ensure that EDUCAUSE members will benefit from the unique perspective of emerging leaders, we recently created our own Young Professionals Advisory Council: <http://www.educause.edu/educause-young-professionals-advisory-council>.)

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By the time you finish reading Dahlstrom's article, you will no doubt have realized that in this issue of *EDUCAUSE Review*, every single keyword in this conversation means something a little different from what it meant a few years ago. Student demographics, the nature of employment, how we measure learning, the workforce—so much has changed. And more change is coming. One of my favorite futurist insights is the prediction that “the illiterates of the 21st century will not be those who cannot read and write, but those who cannot learn, unlearn, and r elearn.”² Another epiphany! With all the jar ring, tectonic transformations in higher education and the workplace, the crucial competency that students will need in order to succeed in the brave new work world is not new at all: it is the age-old ability to change with change. EDUCAUSE

Notes

1. Carolyn O'Hara, “Editor's Letter,” *The Week* (November 13, 2015), 3.
2. This quote is often incorrectly attributed to Alvin Toffler. In fact, Toffler quoted Professor Herbert Gerjuoy, who stated: “Tomorrow's illiterate will not be the man who can't read; he will be the man who has not learned how to learn.” *Future Shock* (1970)

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Tower Records Was Doomed: The Music Industry Was Not

Technology is a tool, not a strategy. It is clear that most campus CIOs understand this, as demonstrated by their top concern noted in surveys: getting faculty to integrate technology into classrooms. I suspect CIOs' deeper concern is getting faculty to rethink the entirety of teaching to take advantage of some of the incredible things technology can do. Why is that so hard?

Technology is disruptive. So people naturally look for a way to keep doing what they were already doing. For example, in my new car with keyless ignition, I was still taking the key out of my pocket for the first few months. Old habits die hard. I would get in the car and then wonder where to put the key while I was driving so that I wouldn't forget it when I left. Eventually, I started leaving the key in my pocket—but that required realizing that the new technology is no longer a key. It is a personal identity tag that tells the car who I am. Once I changed my assumptions, I could drive the car just by getting in. The real potential of new technology comes only when we totally rethink our systems around it.

Think about how resistant the music industry was to technology. Initially, digital technology was used to make new recordings that could then be sold as analog records (marketed as 4D technology!). It should have been obvious that the real product was sound (not albums) and that digital technology would allow music to be bundled into different units and distributed in new ways. Even when CDs were first introduced (just another hard-copy bundle), people moaned that the cover art was an essential part of the product and that CD cases were too small for cover art. Our clue should have been that we called this the "record" industry rather than the music business.

Of course, the pirates were the first to figure this out. Once you have a digital file of music, you can share it without any hard copy. Call them what you like, but pirates are practical. As Napster was showing how this could be done, the record companies continued to resist. Twenty years ago, the suggestion that the real solution to Napster was simply to offer a better music service was inconceivable. At the time, I pitched the idea that if consumers could rent all the music they wanted for a monthly fee, they would not need to buy *any* hard copies. We had new technology, but we also had a bricks-and-mortar distribution, and the "record" industry wanted to figure out how

to save Tower Records rather than come up with an alternative to the current music-delivery system.

In higher education, for-profit colleges may be playing the role of the Napster pirates. Yes, there were and are many bad players, but some have also tried many of the new and previously unthinkable things that technology has made possible. True to form, the rest of the sector has fought back by trying to regulate away this new competition.

Just as those in the music industry discovered their product was actually music and not all the packaging, we in higher education are about to face the same choice. Are we selling athletics, libraries, dorms, and campus life, or are we selling branded credentials and alumni networks? Perhaps we are selling learning. If that is the case, then the size and shape of the packaging might easily change with new technology. Do we need semesters, grades, credits, classrooms, office hours, and departments?

Can we keep learning constant and the time involved variable? Maybe, like Lasik doctors, we could even price higher education based on learning outcomes (like 20/20 vision per eye) instead of on the time spent sitting in classrooms?

Residential campuses and especially residential liberal arts colleges can and do offer a type of learning that cannot be duplicated online. But as learning online gets better, we will have to get better too, and we will have to be clear about the extra learning that is received for all that extra expense. The Internet and its amazing content are disaggregated

and decontextualized. The successful individuals, businesses, and institutions of the future will be either integrators or specialists. In higher education, we probably need to do both.

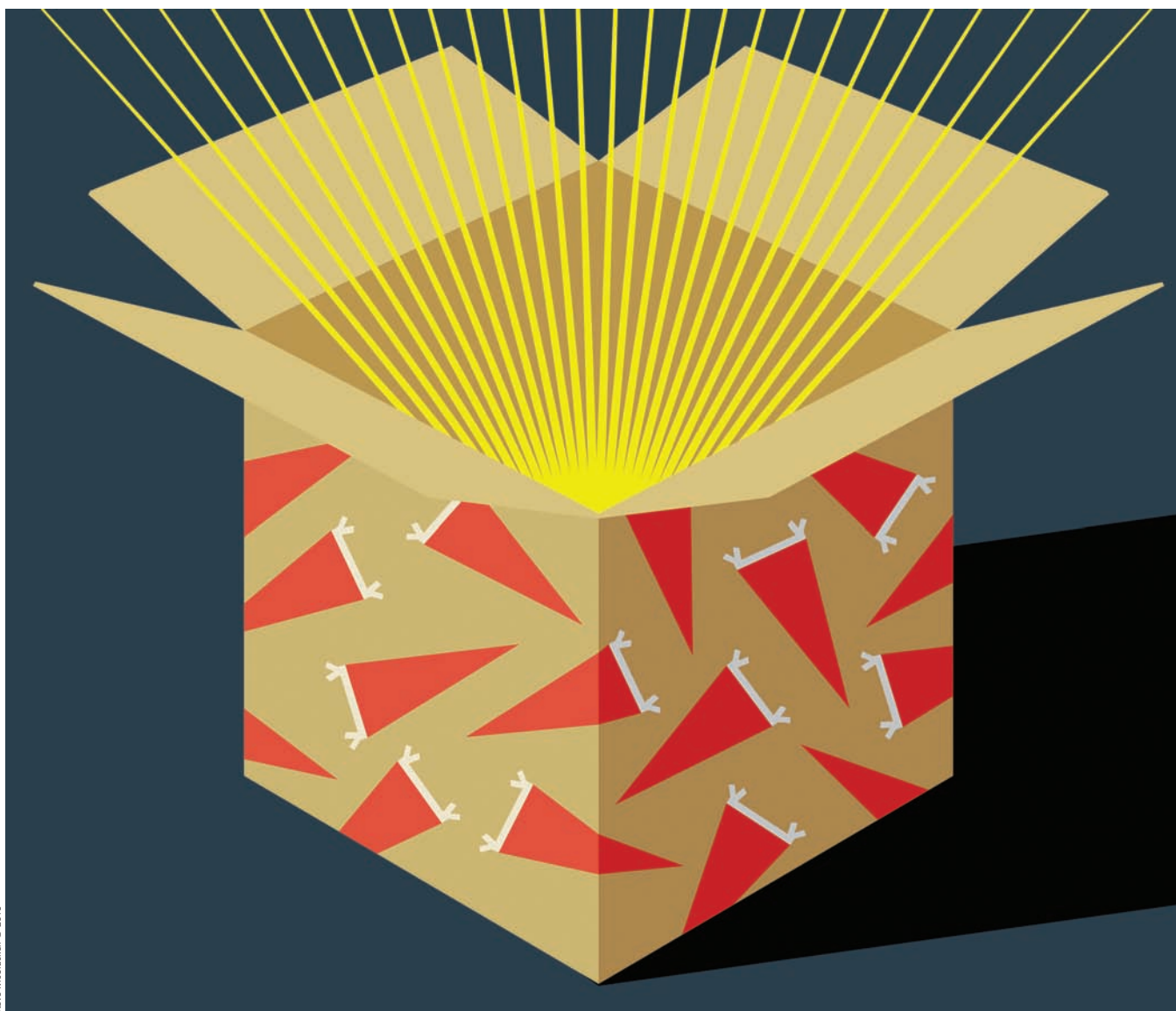
When there was less competition, we could all be the same, just regionally different. Today, however, we don't need more virtually identical curricular and learning environments. A diversity of approaches to learning will create more chances for success and survival. It will also increase the chances of finding a college or university that will work for each individual student.

A few big research institutions will be able to claim the best and most specialized physics or philosophy departments, but most of us need to become really good aggregators. Having local versions of the same content that students can get (for free) online does not create value for a college or university. Most of what students will need to learn for the jobs of the future is still

The real potential of new technology comes only when we totally rethink our systems around it.



By JOSÉ ANTONIO BOWEN



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waiting to be discovered, so the mission of higher education institutions should be to create self-regulated learners. We talk a lot about critical thinking, but if it is so important, why don't we put more effort into measuring critical thinking and demonstrating that our method for teaching it really works?

The future of higher education institutions resides in our ability to integrate all of the learning on a campus. If we can connect the learning in the classroom with what happens in athletics, residential life, and student government, if we can meet and support students where they are (socially, emotionally and technologically), if we can monitor students' progress and well-being over their years on campus, and if we can design comfortable environments that encourage risk, then we will be doing something online courses can't do. We will be adding value. Technology has a huge role to play here, but the process will require a complete rethinking of everything we do and how

the pieces fit together. We need new systems and structures, not just new technology.

Meanwhile, the technology will get better, and someone (probably pirates and hackers) will be busy becoming even more disruptive. Like those in the music industry, we have a choice: we can hire more lobbyists, or we can reimagine our real product. ■

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Thinking about the Future of Work to Make Better Decisions about Learning Today

By Marina Gorbis

If you've participated in recent discussions about the future of higher education, inevitably you have heard people argue about the purpose of education. "It should be about preparing students to be good, educated, and engaged citizens," some argue. "We shouldn't bend education to suit today's needs of acquiring specific work skills. These may quickly change, leaving graduates with little to fall back on as demand for their particular skills wanes. Instead, we should equip people with basic critical thinking skills and a desire to learn. A curious mind is a much greater asset than specific content knowledge."

Others respond: “That is all nice and good, but in an era of rising tuitions and high student debt, it is more important than ever for graduates to be able to earn good incomes, not only to repay their debts but also to lead sustainable lives. To ensure this, we need to more tightly connect education and work preparation.”

Such debates are not new; they’ve been around for decades if not longer. What is new are the ways that both the nature of work and the tools and processes for learning are changing. These fundamental transformations are making distinctions between work, learning, and living ever more artificial. The Institute for the Future (ITF), in partnership with ACT Foundation, recently published *Learning Is Earning in the National Learning Economy*—a visual synthesis of future forces that are shaping this transformation. The work shows how the proliferation of online learning resources (free and for pay), the rise of alternative learning and making spaces (from TechShop to General Assembly and makerspaces), and the

A new generation of smart software and machines is emerging to once again redefine our relationship to work.

diffusion of mobile technologies and peer-to-peer communities allow every moment of the day to become a learning moment. At the same time, the way we have come to think about work—that is, 9-to-5 predictable jobs in formal organizations—is less and less a reality for the growing number of working-age adults. So in thinking about the future, we need to understand the forces that are reshaping both work and learning, and we need to make linkages between the two. Instead of debating whether learning is for learning’s sake or as a means for earning a living, we need to think about the forces and signals of transformation and what they mean for higher education today and tomorrow.

So let’s explore these deeper transformations.¹ From our experience of doing forecasting work for nearly fifty years, we at the ITF believe that it is usually not one technology or one trend that drives

transformative shifts. Rather, a cluster of interrelated technologies, often acting in concert with demographic and cultural changes, is responsible for dramatic changes and disruptions. Technologies coevolve with society and cultural norms—or as Marshall McLuhan is often quoted as having said: “We shape our tools and afterwards our tools shape us.” Nowhere does this apply more critically today than in the world of work and labor. Here, I focus on four clusters of technologies that are particularly important in shaping the changes in the world of work and learning: smart machines; coordination economies; immersive collaboration; and the maker mindset.

Smart Machines: A New Era of Human-Machine Symbiosis

We’re on the cusp of a major transformation in our relationship with our tools, analogous to the transformation humanity underwent during the agrarian revolution. As agricultural production became mechanized, farm labor shrank, with many rural families moving into cities and new generations finding employment in factories and construction. Over time, the consolidation of urban labor produced a managerial class, and the latest phases of development have built out this layer of labor in cities around the world.

Now, a new generation of smart software and machines is emerging to once again redefine our relationship to work. Smart machines have the ability to communicate with each other, adapt to and learn from changing conditions in real time, and do all of this autonomously without human supervision. Diffusion of such smart machines may bring any number of dystopian scenarios to mind: robots taking over the world, software “eating” our jobs, and machines running amok and reproducing themselves. But a look at what is under development today—and at the potential of these pow-

erful new smart machines—yields a much more nuanced view.

Over the coming decade, smart machines will indeed begin to enter virtually every domain of our lives in small and big ways, including assisting doctors during surgery, fighting on battlefields, building things in factories, and helping in classrooms. In particular, smart machines are poised to take on tasks that are repetitive, dangerous, data-intensive, or too large or too small for humans to perform effectively. These are, in fact, the types of tasks that humans are *not* particularly good at.

Naturally, the promise of smart machines spurs anxiety over the loss of jobs. However, it is worth noting that no technology has yet resulted in our working any less. Despite generations of new technologies, we are currently working more than ever before. Adult male peasants in the thirteenth century in the United Kingdom worked an average of 1,600 hours a year; manufacturing workers in 1900 in the United Kingdom worked an average of 1,850 hours; and a full-time employee in the United States today works an average of over 2,000 hours.² Machines don’t just replace what we do. They change the nature of what we do: by extending our capabilities, they set new expectations for what’s possible and create new performance standards and new needs. Yes, smart machines will replace some human labor, but they will also augment humans in new ways and change how we get things done.

Replacing Routine, Repetitive Work

We will continue to outsource to machines any task that can be routinized, decoded, and programmed. We have been doing this in manufacturing and are increasingly doing so in services. David Autor, an MIT economist who studies U.S. labor trends, concluded in a 2010 study that there has been a dramatic decline in mid-skill white-collar clerical, administrative, and sales occupations and mid-skill blue-collar production, craft, and operative occupations. The shift is not sudden but, rather, has been occurring over several decades. The result is what Autor calls “polarization” of



LEARNING IS EARNING in the national learning economy

jobs, with job opportunities concentrated in relatively high-skill, high-wage jobs and low-skill, low-wage jobs.³ In other words, tasks that are predictable, routine, and easily codifiable are increasingly being automated. This impacts not only physical work in manufacturing but also routine knowledge and service work.

We see this shift even in today's classrooms. Already, thousands of robots are assisting with repetitive language instruction (correcting pronunciation) in Korean schools,⁴ and new prototypes of automated food preparation are beginning to enter fast food restaurant chains and supermarkets. For example, Momentum Machines created the world's first fully automatic hamburger machine. This hamburger machine can prepare, cook, and serve freshly ground, custom-made burgers—at a rate of 400 per hour—without a single human hand being involved. The makers claim that their invention “does everything employees can do except better” in what they call “the most labour intensive industry in the country.” In addition, the machine can add the requested toppings (e.g., slicing tomatoes directly onto the burger) and pop the burger out to a neatly wrapped sandwich ready for human consumption.⁵



Augmenting Human Abilities

Since time immemorial, our tools have extended our abilities to manipulate our environment and to do things that individuals can't do alone (e.g., lift large stones). A new generation of smart machines will extend our reach even further beyond human abilities, enabling us to go into places that are too dangerous or simply too hard to reach. For example, robots have played a key role in helping to contain the BP oil spill in the Gulf of Mexico. BP used remotely operated vehicles (ROVs) to conduct underwater observations and repair work. ROVs are operated by human controllers who, sitting in a command

center, see what the ROV is seeing (along with data from other sensors) and control the ROV with a joystick.⁶ Similarly, we're now using drones for warfare, a practice that raises questions about the ethics of remote warfare. But as we substitute humans with machines in direct combat, we're also prototyping systems to help care for humans in the battlefield. Trauma Pod, a system developed by a consortium of organizations led by SRI International, makes it possible to retrieve wounded soldiers from the battlefield, diagnose them remotely, and even perform lifesaving procedures en route to a hospital. Inside the prototype theater is a team of robots,

led by a robotic surgeon remotely controlled by a human surgeon.

Similarly, in the recent Ebola outbreak, robotics emerged as a possible solution to caregiving in hospitals and infected areas. Robotic tasks include everything from managing contaminated waste to “zapping” contaminated environments with ultraviolet pulses to providing care for infected and quarantined babies. This deployment of robots builds on the field of telemedicine and telepresence robots, one of the early testing grounds for collaborative robotics. Robotic manufacturing can take place in conditions that are inhospitable to humans. Already, the Japanese robotics company FANUC is operating a factory in which robots are building other robots at a rate of about 50 per 24-hour shift and can run unsupervised for 30 days at a time—with no lights, air conditioning, or heat required.

Humans are also not suited to manipulate things on a very small scale. Here again, machines will be recruited to do things that previously couldn't be done. Today, nanorobots in pill form can diagnose cancer or deliver highly targeted chemotherapy. Machines will enable us to reach hidden places in the body and assemble objects molecule by molecule in new manufacturing facilities.

And thanks to advances in neuroscience and behavioral economics, we've come to realize that humans generally aren't very good at thinking through probabilities and risks and making rational economic choices based on those probabilities. Whereas we likely don't want to use pure rationality when making moral or ethical decisions, more rationality would be helpful in situations such as when making financial decisions. We're already relying on software to help us make many complex decisions—including modeling climate change scenarios, impacts of financial market interventions, and optimal oil-drilling locations—but what happens when every decision, large or small, incorporates decision support from our machine helpers? This is beginning to happen: we routinely check Amazon ratings before buying a product or scan Yelp reviews before deciding where to eat. Imagine a future in which every decision we make incorporates rational analysis of risks and probabilities. We'll outsource some decisions completely to machines, while also assimilating computational rationality into our own decision processes.

Human-Machine Symbiosis

While smart machines will replace human labor in some areas and enable humans to do new things in other areas, the most profound impact of smart machines is the new level of symbiosis or interconnectedness we will establish between ourselves and such machines. What this means is that most of our interactions—whether at work, in learning, or in health—will involve some level of combined machine and human effort. In fact, a recent McKinsey & Company study claims that at fewer than 5 percent of occupations can be entirely automated using current technology. However, about 60 percent of occupations could have 30 percent or more of their constituent activities automated.⁷ In other words, automation is likely to change the vast majority of occupations—at least to some degree—which will necessitate significant job redefinition and transformation of business processes. BMW

is testing “collaborative robots” that can glue together parts held in place by (more precise) human fingers. The da Vinci Surgical System from Intuitive Surgical can perform laparoscopy, prostate, and other surgeries with a level of accuracy that’s difficult for human surgeons to achieve alone. Rethink Robotics has introduced an industrial robot, “Baxter,” designed to safely interact with humans, who can easily program it for simple tasks. Baxter is intended for sale to small businesses and is being promoted as the robotic analog of the personal computer. IBM’s Watson supercomputer is being used to evaluate evidence-based cancer treatment options for physicians, driving the decision-making process down to a matter of seconds.

Lawyers are using text-mining techniques to perform automated analyses of vast amounts of documents. Similarly, Narrative Science makes it possible to

convert data into stories—taking sports scores or financial data and delivering written narratives that are often hard to distinguish from those produced by human journalists. Increasingly, journalists are using such writings as drafts to which they add personalized flourishes and points of view.

The machine-human symbiosis is also transforming the learning process. Just look at the new generation of smart toys from CogniToys: toy dinosaurs with Internet connectivity, backed by IBM’s Watson artificial intelligence platform, and with speech-processing capabilities. Children can ask their Dino myriads of questions and have various language-based interactions with the toy. As a child begins to play, CogniToys Dino will slowly adjust its content and experience based on how the child is using the toy and on the child’s vocabulary levels, interests, etc. The toy will literally “grow” with the child. This lat-

est generation of toys shows all the important features of symbiotic learning: highly personalized learning, constant feedback loops, integration of learning and play, flexibility and adaptation. What will the generation of kids who are growing up with such learning and play companions expect from their work and educational settings? As artificial intelligence and connectivity become embedded in physical objects and spaces around us, we will have to fundamentally rethink the nature and structures of our educational institutions.

Coordination Economies: Socialstructured Value Creation

The automation and the diffusion of smart machines are accompanied by another development—the emergence of coordination platforms such as Uber, Shyp, and Airbnb. A decade ago, workers in the United States and Europe worried about jobs being outsourced overseas.





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Today, companies such as Upwork and LiveOps can assemble and coordinate teams “in the cloud” to provide sales and customer support, help with editorial work, conduct research, design and prototype products, and perform many other tasks and organizational functions. New digital platforms are beginning to act like real-time online staffing agencies: bridging borders, orchestrating complex tasks across teams of micro-workers, and integrating the global workforce at levels and speeds never seen before. As a result, many workers in the United States are feeling the impact of global labor arbitrage more keenly than ever before. It is easy to find the best programmers, best editors, and best designers from anywhere in the world.

These companies are transforming not only what people do to earn their livelihoods but also, at a much deeper level, how we organize to create value. New types of workers are emerging: micro-taskers—people who are signed up on multiple digital coordination platforms such as Uber, Lyft, Gigwalk, and MobileWorks and whose work experience doesn’t involve stable 9-to-5 jobs but, rather, a stitching together of various tasks performed in flexible niches of time.

The growth of these online task-coordination platforms is reshaping the formal organization of labor built up over the last century, with an accompanying decline in traditional managerial structures as more flexible and adaptive structures take advantage of new technologies to create value outside of formal organizations. I call this type of value production *socialstructuring*. At its core is the ability to divide larger tasks into smaller pieces (micro-tasks), divvy them up among a large network of people according to their availability and expertise, and aggregate the resulting micro-contributions using social tools and technologies.

Wikipedia is probably the best example

of this form of production, but the number of social structures—in fields from health to science to finance—is growing rapidly. We are seeing this in publishing, music, and broadcasting: bloggers, amateur musicians, and YouTube stars can reach audiences larger than those of many established media channels. This new form of economic activity is very different from institutional production because it often happens on an ad hoc basis without clearly assigned roles, hierarchies, or traditional management structures. Algorithms, rather than managers, often distribute tasks and coordinate work. In addition to per-pay contributions to socialstructured work, many contributions are provided at no pay, disrupting traditional notions of monetary incentives and enabling individuals or small groups to use networks of volunteers or micro-taskers and create value comparable to or greater than that produced by paid employees within institutions.

Indeed, the socialstructuring of organizations will fundamentally challenge many long-standing working relationships and structures. As production methods increasingly shift to micro-contributions, algorithmic coordination of tasks, nonmonetary incentives, and reputation metrics, many firms will be forced to reexamine their fundamental operating principles. This adaptation process is likely to include reevaluations of management hierarchies, rewards, physical space use, and even the nature of employment itself. Over time, pressure will increase for organizations to crowdsource, or cloudsource, many functions and to focus their efforts on aggregating these functions to add value. Socialstructured organizations are likely to resemble fluid subcultures more than rigid pyramids. Organizing, coordinating, participating in, and navigating these fluid networks will be vital competencies for making a living in the future.

Socialstructured value creation will

reshape how we think about work and labor and about the skills people will need in order to sustain their livelihoods.

From Jobs to Tasks

At the core of socialstructuring is our ability to break down many large tasks into smaller pieces and assign those smaller tasks to many different people, wherever they might be, quickly and effectively. Such micro-tasks or micro-contributions may take different forms: conducting basic calculations, searching for data, doing some editing or code development, or delivering a packet of medications to a house-bound patient. This new form of coordination not only can help solve the thorniest problems faced by organizations and communities but also can create manageable, accessible jobs for people all around the world. Already, micro-work is beginning to engage the underused talents of people from a variety of geographical areas and from a variety of educational and professional backgrounds.

According to some estimates, almost 54 million Americans—approximately 34 percent of workers—did freelance work in 2015.⁸ This number is expected to grow significantly in the next twenty years as online platforms and tools make it increasingly possible to break jobs up into smaller tasks and to engage many people in competing for those jobs. Upwork is just one online staffing platform that allows businesses to post jobs, search for freelance professionals, and solicit proposals. The platform can evaluate the contractors applying for the job and, once a contractor is selected, serve as a channel for communications and exchanges of work deliverables between contractors and requestors. Payment for jobs, which can be either hourly-rate or project-based, is made by the client through Upwork’s system. Each freelancer can post a profile displaying past jobs and feedback, a portfolio, and specific skill and educational-background information. Another platform is LiveOps, an on-demand contact and call center that enables outsourcing of services for hundreds of companies through its network of over 20,000 independent at-home agents.

LiveOps tracks the performance of each call center representative in minute detail, displaying results on a dashboard and automatically matching callers with those agents who have the highest performance ratings. One more recent innovator in this space is Samasource, a micro-work platform that focuses on providing enterprise services worldwide by tapping poor women and youth in developing regions of the world. It began with a focus on women in refugee camps but has expanded to become a global matchmaker for tasks and people who may not have access to traditional job markets.

Algorithmic Coordination

A key piece of effective social structuring is the use of software to route or manage crowd contributions. In some cases, this is simply a matter of matching a task to the most qualified person available. However, the approach can also be used to tightly coordinate a complex series of tasks so that they come together in an on-demand fashion. This mechanism will be a foundation for coordinating any activity in the coming years and will be a potent force for amplifying and disrupting existing institutions, since the coordination of tasks has been the primary role of management. ReThinkery Labs, a recently announced venture by Devin Fidler, one of my colleagues at the IFTF, makes it possible to automate a variety of organizational processes, including the process of research report writing. In a recent project, its software broke down the research process into discrete tasks, used an algorithm or a set of automated instructions to recruit people on a variety of existing digital work platforms (e.g., Upwork, TaskRabbit, Mechanical Turk), and then managed the work of qualified people on these platforms. The final report involved the work of hundreds of human contributors, aided by machine intelligence and managed by software algorithms—the ultimate example of human-machine symbiosis. This kind of symbiotic relationship is likely to transform most jobs, from entry-level to the most sophisticated ones, including those in research and C-suites.

Rise of Alternative Currencies and Reputation Markers

In his essay “On Money and Magic,” the game researcher Edward Castronova argues that in order to give money or any currency its magical power, a group needs to collectively agree and believe that a particular thing—a piece of paper, an ounce of gold, or the U.S. dollar—has value and that it can be exchanged for goods and services within the group.⁹ It is precisely because we are the ones who imbue money with value, and because the creation and circulation of money requires a social contract (a social agreement of its value), that a group of any size can potentially create a currency. The existence of participatory technologies makes it relatively easy to create social currencies and alternative reputation systems within online groups, whether as in-game currencies (in-gaming communities), reputational badges (alternatives to degrees and grades), or local currencies (valid for local trades). Thus, the proliferation of online participation platforms will inevitably lead to the proliferation of new types of reputation and reward currencies. This trend will impact both the world of work and the world of learning.

In the business and technology circles, substantial resources are being invested in the creation of alternative currencies such as the bitcoin and its underlining blockchain technologies. Although much is still not clear about such technologies, their main impact is the disintermediation of traditional structures of authority and gatekeeping, from central financial regulators to various types of educational certification agencies. The promise of blockchain technologies is to enable true peer-to-peer verifiable transactions, making it easy to track contracts, levels of expertise, and knowledge acquisition.

Even in the absence of such technologies, a growing number of platforms are aiming to replace degrees, resumes, and other traditional markers of experience

and skill with more fine-grained and personalized systems. GitHub, an open-source social programming platform, has enabled many developers to use their creations on the platform in lieu of résumés. Developers’ profiles and contributions are considered their work portfolios. For those wanting to find a job as a programmer, what they’ve created on GitHub is often a more direct pathway to a job than a college degree. Mozilla Open Badges allows users to track skills that they teach and learn informally by issuing verifiable digital badges that are stored and displayed in a “digital backpack.” Degreed, a recently launched start-up, argues that how someone got expertise—whether through informal means or via formal

educational institutions—doesn’t matter. Degreed measures and validates all types of educational inputs, whether they are from formal institutions or from more informal learning platforms such as Khan Academy or Udacity, and then works

with employers to use these scores in hiring and promotion processes.

Technology creates new ways to track and acknowledge learning that happens anywhere—in school, on the job, and in informal settings. Reputation and digital performance trails will increasingly weigh more than college degrees, attendance, or other proxies for assessing knowledge and competency levels. Indeed some employers, including Google, have begun to deemphasize traditionally dominant metrics such as Ivy League diplomas in favor of a more direct analysis of an applicant’s unique personal style and background. Whereas the logistics of this kind of approach would have been prohibitively difficult in the past, the greater visibility of one’s body of work today makes this an ever-easier strategy to use. Clearly, the assessment of skills or suitability for a particular task or job, particularly digital work, will become more varied, complex, and nuanced than ever.



To see how such reputation systems might evolve in the future, the IFTF and ACT Foundation ran a forecasting game centered on the idea of a blockchain-based platform. *The Ledger* tracks everything you've ever learned, every one you've learned from, and every one who has learned from you. *The Ledger* tracks not only what you know but also all the projects, jobs, gigs, and challenges you've used that knowledge to complete.¹⁰

Immersive Collaboration: From Face-to Face to Blended Reality

We are creating a new kind of reality, one in which physical and digital environments, media, and interactions are woven together throughout our daily lives. In this world, the virtual and the physical are seamlessly integrated. Cyberspace is not a destination but is, rather, a layer of experience that is tightly integrated into the world around us. The proliferation of mobile and sensing devices, advances in virtual and augmented reality, and the explosion of various types of lightweight collaboration platforms are making it easier than ever to work, share ideas, and be a part of a global team while still being physically separated. In fact, being a part of a geographically distributed workforce is quickly becoming a de facto standard in today's work environment.

Although the amount of information that can be transmitted via typical online video platforms is currently limited, it is poised to jump dramatically as a new generation of gigabit telecommunications networks is deployed and even rural areas get connected with mesh wireless communication tools. Virtual reality devices, once the purview of science fiction or high-cost research labs, are entering retail markets with the introduction of Oculus Rift, which consumers can purchase for about \$300. These devices are poised to enter not only entertainment spaces but also learning and work environments, enabling people to create shared "realities" independent of geographies.

At the same time, the online social networking industry has seen enormous growth over the last decade. These sites

have so far largely filled a recreational or contact-directory role. At the same time, social network infrastructures are permeating the work domain with team productivity and coordination tools, such as Google Docs and Google Hangouts, Asana, and Slack. Meeting augmentation platforms such as MindMeld promise to deliver critical information flows in the context of online meetings. These systems seek to repurpose the communications tools used by Facebook and others to facilitate a deeper coordination of professional teams. The ability to deftly manage and apply social networking tools—in order to both communicate effectively and facilitate the accomplishment of practical tasks—will be increasingly valued. Many entrepreneurs are also using online platforms to create showrooms and storefronts to sell their products.

This world of immersive virtual collaboration will drive new work patterns, will further support entrepreneurial efforts in countries with high unemployment, and will create new dilemmas that individuals and governments will need to navigate.

24/7 Global Teams

Putting together global teams that can undertake tasks continuously, using time differences as a competitive advantage in the provision of goods and services, has become an efficient and often highly desirable practice in several industries. It is already playing out in the world of finance, where traders operating in global and integrated teams can use minute advantages in timing to create greater profits. Increasingly, this global advantage works for the worlds of programming, selling, and many other areas as well and will drive requirements for a new kind of team literacy in labor markets around the world.

Digital Work Trails

As virtual collaboration across borders becomes ever easier, those workers with the ability to orchestrate, shape, and productively participate in ad hoc value

networks will be greatly prized. Virtual collaboration requires that those involved leave digital trails of their work so that others know where the gaps are, what needs to be done, and where they need to contribute. Google Docs, wikis, and many other collaboration platforms will enable the creation and management of such digital trails. Curating these trails may become micro-tasks for people with local, on-the-ground knowledge as well as those dedicated to and skilled in a new kind of work management. Asana is a web and mobile application designed to enable teamwork without email. Each team gets a workspace that contains projects and tasks. In each task, users can add notes, comments, attachments, and tags. Users can follow projects and tasks, and when the state of a project or task changes, followers receive updates

about the changes. Another example is Trello—a free, online, and mobile collaboration tool that organizes projects into boards. At one glance, Trello users can see what's being worked on, who's working on what, and where something is in a process.



Quantified Work

With so much work being done through digital technologies and with the proliferation of digital trails, it becomes easy to create exceedingly precise individual and team performance and productivity metrics. Having this type of data is essential to creating algorithms for efficiently allocating tasks. Such measurement can be done at an individual level and also aggregated across workers. When this data is collected and used at an individual level, however, it creates concerns about a new kind of Taylorism, potentially increasing individual stress levels and raising concerns about privacy and coercion. We are already beginning to see this issue emerging among package delivery workers, many of whom resent continuous monitoring of their vehicles. Online task platforms such as Upwork can see at what time of day what type of workers are most



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productive anywhere in the world or what type of coding is most efficiently done in a particular country. LiveOps measures time spent by each freelance agent on a task: time spent with a customer can be logged in and correlated with an outcome such as making a sale.

Maker Mindset: Democratizing Production and Creation

The diffusion of mobile technologies and personalized tools for creation—from cheap video cameras to music- and video-editing tools—has gone hand in hand with the rise of digital manufacturing techniques, particularly the maturation of 3D printing technology. This technology, a digitally guided additive approach to manufacturing, enables operators to assemble products layer by layer, allowing variations to be built into individual units. Although remarkable uses of 3D print-



ing have already been developed, from replaceable machine parts to viable human organs, the technology is still in its infancy. It will reach its full potential in the coming decades as it is combined with emerging biotechnology and nanotechnology applications. The rise of more customizable materials will allow manufacturers to more precisely tailor the material properties of a product to its function.

These technologies and tools are contributing to the rise of the global “maker” and “hacker” movements—not just in developed economies like North America and Europe but also in small thriving pockets on every continent. These movements are offering new pathways to education, work, and livelihoods. Bottom-up learning communities connect people who want to learn how to make and build things. Formal and informal community workshops and co-working and co-creating spaces give them a place to use expensive equipment and learn skills from one another. Crowdfunding platforms provide a small-scale funding boost, a source of feedback, and viral marketing. This world of open making is poised to

fundamentally reshape many of our basic assumptions about production itself. The manufacturing industry and, by extension, the nature of many economies will be transformed in the process.

Growth of Maker/DIY Movements

Maker and DIY (do-it-yourself) communities are growing around the world, resulting in what some are calling a *hardware renaissance*. In just the last few years, an entire ecosystem has developed to support entrepreneurial hardware development and hardware start-ups. A support infrastructure of tools, manuals, and instructions for makers is growing. Alchematter is just one example. It is an experimental platform that attempts to

organize manufacturing and making knowledge into tools, materials, people, and processes. Kind of a Wikipedia for making, this platform for modular, sequential procedures hopes to create a universal language for making.

The maker mindset is fostering new cross-border relationships and partnerships among engineers, entrepreneurs, designers, and open source enthusiasts who are connecting through this broad movement. Small entrepreneurs operating out of Tech Shops—membership-based maker spaces—are linking up with small flexible manufacturers in China to produce products at various scales. For example, the creators of OpenROV, a mini underwater robot that is used for exploration on ocean floors, designed the prototype at the TechShop in San Francisco and quickly turned to Chinese suppliers to produce early models.

The maker mindset is reshaping how people approach many arenas, from actual design and manufacturing to how we approach social issues, including issues influencing cities and education. Increasingly, people adopting the maker mindset are less likely to accept existing institutions and approaches as immutable. Instead, they are likely to view these institutions and approaches as hackable—

as something that can be taken apart and reconfigured and remixed in new ways.

Community Labs and Maker Spaces

To accommodate the growing DIY movement, the number of community labs (such as BioCurious) and manufacturing clubs (such as TechShop) has grown over the past few years. These spaces, for which members pay a monthly membership fee, serve multiple purposes. They function as research communities, and they provide places for prototyping new ideas, meeting like-minded individuals, taking classes, learning from ad hoc mentors, and even starting companies. Such spaces blur the boundaries between work, learning, and social communities. BioCurious, for example, is a hacker space for people interested in synthetic biology. Participants range from academics doing advanced biology research at universities to teenagers wanting to learn and to engineers and programmers eager to apply their engineering expertise to biological systems. A small membership fee enables participants to take classes, work and learn from others, and collaborate on various projects. A recent much-publicized project coming out of BioCurious aims to create phosphorescent trees that can absorb sunlight during the day and phosphoresce at night, thus saving on electricity.

Crowdfunding Platforms

With the rise of maker spaces and maker mindsets, the domains of consumption and production, which we used to think of as being completely different, are becoming increasingly blurred. Crowdfunding plays a key role, enabling maker spaces to serve as giant experimental labs for creating new kinds of relationships between the people who make things and the people who consume them. Crowdfunding is creating new expectations on the part of the people who back campaigns. They are discovering how much more meaningful it is to buy a product (or service) when their dollars actually matter in bringing it to life and when they get a direct emotional connection with the people who are providing it. In the process, instead of simply buying

and consuming products, people become investors and learn many of the details of how the product is produced, the manufacturing processes behind it, the people involved, and the materials used. The process of production is transformed into a highly social and educational experience.

Betabrand is a fashion company that is structuring its interactions with buyers through a crowdfunding model. Designers and fans submit ideas for products—such as a “hoozer,” which is a suit jacket and a hoodie at the same time—and then people vote on whether or not they’re going to fund the idea for production. So consumption is blending with an investing mentality in a new kind of impact shopping.

Implications

The core set of technologies outlined above will reshape work and the labor force over the next decades, but not necessarily in the same way under all circumstances in all parts of the world. When these technologies combine with external economic, social, and environmental factors, they are likely to produce different outcomes.

For example, these four technology clusters will create unprecedented opportunities for integrating people from developing countries into global production networks and flows of work. While automation will continuously replace many rote and repetitive manufacturing and service jobs, online platforms such as Upwork will enable workers from anywhere in the world to bid on tasks and become members of extended teams. We are already seeing this global labor arbitrage in action as workers from the Philippines, India, and Pakistan are increasingly engaging in editorial, software development, and sales tasks using online work platforms. At the same time, many more people from around the world are able to access capital through various crowdfunding and peer-to-peer mobile online platforms as well as create storefronts, attract customers outside of

any formal channels, and take advantage of distribution and promotion channels online.

There is no doubt that the new generation of technologies will open up opportunities to those who have the basic literacy and media savvy to turn these connections into paid work. In this sense, continued investment in a basic communications infrastructure that ensures access to the widest possible number of people should be a continued priority for governments and development organizations. This should be coupled with an emphasis on developing literacy and media skills. One particularly important avenue for achieving this is creating online content that can be accessed in local languages as well as providing access to a rich ecology of content via global sources such as Coursera and edX.

Even though many of the emerging platforms and tools are likely to engage the more educated and connected people, there is a great opportunity to use the platforms and tools to integrate those who have traditionally been excluded from participation in formal organizational structures: those with disabilities, young people, the elderly. Much of the online work can be done on a task basis, opening up opportunities for those who cannot commit to 9-to-5 or other rigid schedules (e.g., those with caretaking responsibilities). Engagement and allocation of tasks is done on the basis of skill assessment and reputation rather than being based on in-built social hierarchies and biases, opening up opportunities to previously disenfranchised populations.

Finally, a lot of the work can be done in place, thus minimizing the costs associated with commuting to places of work, usually in cities, and again opening up opportunities: for those in rural areas or the elderly. Here again, the focus on digital access and inclusion, coupled with investments in education, can result in substantial advances in integrating previously disadvantaged populations into global

labor flows.

At the IFTF, we firmly believe that the purpose of systematically thinking about the future is not to predict the future but to help people make better decisions today. There is no data about the future. The only data we have is about the past. Historical patterns are important because they give us frameworks for thinking. By looking at historical patterns and identifying signals of change around us today, we can better prepare for the transformations occurring in both work and learning. ■

Notes

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Credentials Reform: How Technology and the Changing Needs of the Workforce Will Create the Higher Education System of the Future

By Jamie Merisotis

While the modern technology revolution has reshaped nearly every sector of society, higher education has managed to retain its fundamental structure from centuries ago. The U.S. postsecondary landscape is still largely dominated by brick-and-mortar colleges and universities where progress is marked by time spent in a classroom and is denoted by highly simplified transcripts controlled by the institutions awarding them.



That's all starting to change. A powerful shift in postsecondary credentialing has taken place over the last few decades, with an explosion in the number of pathways to an education beyond high school. As a result, today's job-seekers can possess not just four-year college degrees but everything from associate's degrees and apprenticeships to occupational licenses and education certificates, all the way to digital badges and employer-based certifications.

The myriad options—and the subsequent push to better connect them—are unleashing the power of technology to fundamentally reshape the higher education landscape. A future system is shaping up in which students are situated at the center and are able to navigate their postsecondary options, from traditional institutions of higher education to a whole host of other learning providers: employers, unions, online programs, and even libraries and museums.

Learning, rather than seat time, will be the core measure of progress in this new system, and students will be able to demonstrate what they've learned through dynamic online platforms. What's more, education beyond high school will be viewed not as a static, one-time experience but as a lifelong journey of building one's knowledge and skills.

The transformation of this ecosystem will take years to complete, but changes are already starting to take shape. As a more diverse credentials landscape has evolved, the push to create a more connected and navigable system has gained steam, opening the way for technological forces to prevail.

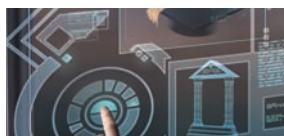
IT professionals understand the power of credentialing in revolutionizing higher education, and they know it has implications for every postsecondary provider, especially four-year colleges and universities, the predominant postsecondary players. They've seen how online systems have made career advancement possible by enabling learners to constantly renew and acquire skills and knowledge.

Higher education leaders have a chance to embrace this change and make their institutions thriving players in the new landscape. And campus IT leaders, as the experts on the issues shaping the higher education technology revolution, have a unique opportunity to influence this transformation.

Creating a Connected System

The growth in different types of credentials—from increasingly popular associate's degrees to modern IT certifications—has been happening progressively over the last several years. What's propelling change today is the effort to connect these credentials into one comprehensive and navigable system.

Even as their ranks have grown, credentials have continued to operate in silos, rather than as part of a connected system. Each type of credential carries a different meaning, and there's no common language to explain what each type means or how one compares to another.



What's more, education beyond high school will be viewed not as a static, one-time experience but as a lifelong journey of building one's knowledge and skills.

That makes it hard for employers and students alike to know what value various credentials carry in the labor market.

Recently, though, leaders in the business, government, philanthropic, and education sectors have begun a robust push to define credentials in commonly understood terms: by the knowledge and skills that each carries. This new effort, which is linking previously disconnected actors, can be best understood via a new Connecting Credentials platform for these actors to learn and share from each other. Rather than a separate set of definitions for each credentialing pathway, there will be a universal taxonomy to connect all credentials. This will transform today's highly fragmented system into one in which all types of postsecondary credentials can be easily understood and compared.

The connecting platform will be

especially transformative for learners and employers using the various credentials. Students today have a hard time navigating the value and meaning of their postsecondary options. Although college degrees are typically viewed as stepping stones to good jobs, it is difficult for students to determine the knowledge and skills they will gain from degrees because time in the classroom is the central measurement of progress and learning outcomes are not fully transparent. Meanwhile, the skills gained through other postsecondary paths, such as employer-based training or certification programs, are often clearer, but those options tend to be viewed as carrying less labor-market value.

Not only is it difficult for learners to know what type of credential to pursue, but it's equally challenging for them to decide how to go about getting that credential. In *Beyond the Skills Gap*, Mary Alice McCarthy, senior policy analyst at New America, cited a hypothetical

example of a Michigan woman seeking to upgrade her skills to enter the medical assisting profession. That woman would be confronted with some 2,000 institutions offering medical assisting certificate programs in the United States—59 in Michigan alone—with a wide variance in cost, credits, program length, and financial support. What's more, even though all of the programs require the same final assessment to move on to a medical assisting career, some of the programs count toward an associate's or bachelor's degree but others do not. That's a lot of variation and, as McCarthy pointed out, "a lot of difficult decisions to make before starting training for a job with an average annual salary in Michigan of \$27,000—or about \$13 an hour."¹

As this example illustrates, additional clarity about what various types of credentials mean would help make the system

more navigable for all learners. A more connected system also makes it much easier for employers, who struggle to understand what credentials signify in terms of the skills and knowledge a prospective hire brings to the job. Although college degrees are indicators of persistence and academic success, they do not tell those who are hiring much about the qualifications that candidates carry. Candidates with other nondegree credentials might have skills better suited for specific positions, but the lack of common definitions makes it difficult for employers to have confidence in those credentials.

These changes will also wield huge benefits for the U.S. economy. America faces a pressing need for talent: workers with the skills and knowledge to fill 21st-century jobs. By the end of this decade, 65 percent of all jobs will require an education beyond high school, yet today only

about 40–45 percent of Americans have at least an associate's degree or high-quality postsecondary certificate.² To alter that paradigm, we must ensure that our postsecondary credentialing system is viable.

The most tangible impact of better connected credentials will be on the system at large. With a nomenclature to ensure that credentials can be related to each other, technology can be unleashed to build out a fully interconnected system. And higher education, as a result, will look dramatically different.

The System of the Future

Although it's hard to envision exactly how the postsecondary landscape will look in five years, two fundamental shifts occurring today provide us with a glimpse.

The first is the effort to give learners tools for seamlessly navigating their options for pursuing postsecondary

credentials. Think, for example, about apps such as Yelp and Travelocity, which have enabled users to quickly mine data about dining and travel accommodations in a one-stop source. Similar innovations could allow users to explore various credentials pathways. Work on such initiatives is underway. George Washington University, for example, is collaborating with Workcred and Southern Illinois University to build a first-of-its-kind online resource enabling users to see and compare the value and meaning of various credentials. The project—supported by Lumina Foundation—uses information from institutions issuing credentials to aggregate data into one source.

Second, as these innovations enable students to better navigate their options, the digital résumé push is empowering students to showcase to employers what they know and can do—while allowing

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employers to better understand what candidates are bringing to the marketplace. Traditional—and in many cases still paper-based—transcripts controlled by higher education institutions have been the primary vehicle for conveying academic accomplishments, but in today's quickly evolving credentials landscape, there's a need for a more dynamic way to showcase prospective hires' qualifications. Several approaches are tackling this need, ranging from online tools that enable degree-holders to securely own and transmit their college transcripts to platforms that empower users to post detailed information about online courses or training programs they've taken to advance their skills and learning.

One of the leading innovations in this movement is digital badges, which denote specific skills and knowledge in order to more clearly convey candidates'

needed—and now possible—is having a digital passport to showcase learning and accomplishments throughout a lifetime.

Opportunities for Higher Education

At first blush, these changes could seem like a jarring threat to traditional higher education institutions, but colleges and universities have a unique opportunity to thrive under the new paradigm of higher education delivery. To seize the opportunity, campus leaders must reorient their approach in light of two new realities.

First, in a system of connected credentials, it will become increasingly evident that degrees bestowed by colleges and universities are one of many pathways to an education beyond high school, an education that today is essential to obtaining a high-quality job. Learners are likely, in time, to become more focused

ties seeking to get ahead of the upcoming creative technology disruption should focus relentlessly on three things: (1) measuring progress based on learning, rather than on time spent in a classroom; (2) producing high-quality learning outcomes; and (3) offering learning opportunities throughout a student's lifetime.

Progress Based on Learning

To thrive in the higher education system of the future, colleges and universities must systematically measure what students have learned and must base students' advancement toward a degree on the acquisition of knowledge and skills. Institutions also must move away from the credit-hour-based model that links progress to time spent in the classroom—increasingly a vestige of an antiquated system that lacks currency in the newly connected credentials world.

Moving to learning-based measurement sounds like a daunting, fundamental overhaul, but it can be achieved in many different ways, ranging from enhancements to the traditional college/university model to more dramatic shifts toward measuring progress based solely on competency. Although the latter approach more closely represents what the future will entail, institutional leaders should keep in mind that any change toward a learning-centered system is a positive step. Three examples illustrate different approaches to learning-based measurement.

McKendree University

Without moving fully away from the credit hour, some colleges and universities across the United States are working to better assess student learning and are adapting their programs and faculty development accordingly. A handful of models—such as the Degree Qualifications Profile (DQP) supported by Lumina Foundation and the Liberal Education and America's Promise (LEAP) initiative from the Association of American Colleges & Universities—map out the key competencies that graduates need for 21st-century jobs. This gives institutions a



Higher education institutions will be less able to rely on brand legacy, campus facilities, and smart marketing campaigns.

qualifications. Learners can earn badges through courses provided by traditional colleges and universities, but other entities—including employers, nonprofits, and government agencies—also can issue badges. In addition to course-based learning, badges can capture tangible measurements such as experience. A veterans group, for example, offers badges for servicemen/women to demonstrate the knowledge and skills they've gained in the armed forces. And importantly, badges can be bundled into robust categories of expertise. Someone with a bachelor's degree in political science might also earn enough badges for a specialization in project management to demonstrate value to a prospective employer.

All of these tools facilitate a new learning paradigm in which students build their reservoir of knowledge and skills through a lifetime of learning experiences. A college transcript doesn't sum up a student's learning; rather, what's

on whether credentials will lead them to a promising career pathway and to be less concerned about who is providing the credential. That will increasingly level the playing field of competition among the various credentials providers: colleges and universities, unions, employers, coding boot camps, cultural institutions, and more.

Second, with learning at the center of how credentials are defined and evaluated and with technological tools enabling unprecedented transparency about learning outcomes, what will matter above all else in the new system is whether providers can help students gain knowledge, skills, and abilities. Higher education institutions will be less able to rely on brand legacy, campus facilities, and smart marketing campaigns. To compete for students in the next era of postsecondary education, they will need to demonstrate results.

In this new era, colleges and universi-

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roadmap they can use to navigate whether they are preparing students with the right knowledge and skills.

Colleges and universities are using these models to improve their programs and ensure that students emerge better prepared for the future. In Illinois, for example, McKendree University undertook a seven-year initiative to better assess student learning outcomes and link its new assessment system to faculty development. The university adopted seven learning outcomes based on its mission statement and then adapted those learning outcomes based on other models of assessing students' skills and knowledge, such as the DQP and LEAP. As one result of this exercise, McKendree decided to add a capstone experience in all fields of study and is working to create faculty-development experiences tied to the capstone. Though not a fundamental shift, the moves at McKendree represent a step in the right direction toward focusing on learning and improving approaches accordingly.

College for America

Other institutions have made more revolutionary changes to fundamentally alter how they measure students' advancement toward a degree and unmoor themselves from the credit hour. The preeminent example is College for America, the nation's first accredited institution awarding degrees based on competency, rather than time spent in a classroom.

The program is offered through a bricks-and-mortar institution, Southern New Hampshire University (SNHU), but is not anchored by the traditional markings of a university: courses, classrooms, and professors. Instead the program is provided solely online. Students can earn a degree in as little or as much time as it takes them to demonstrate the requisite knowledge and skills to establish mastery of 120 competencies. More than 3,000 students have enrolled in College for America since its inception in January 2013, and more than 300 have received degrees.³

Without being anchored to the credit hour, students can accelerate the pace of their learning and more quickly earn a degree, thereby saving on tuition. Given this, it's telling that College for America's primary enrollees are midcareer working adults, recruited to attend the college—and often paid to do so—by their employers. But this model could, and likely will, be expanded to serve a broader audience. Meanwhile, more than 350 other institutions are similarly pioneering competency-based approaches.

If it seems insurmountable for a traditional college or university to enact this kind of systems-changing approach, consider College for America's organic evolution. SNHU, a traditional campus-based, fully accredited institution serving 4,000 students per year, spawned an online college in the 1990s that now enrolls more than 50,000 students. That online delivery model, in turn, gave rise to College for America—showing that it's possible for institutions to adopt successful nontraditional models over time to better accommodate students' and employers' needs.

Empire State College

Another bold shift in learning measurement has been pioneered by Empire State College, a 35-site network that is part of the State University of New York (SUNY)



System and serves predominantly adult learners. Empire State puts learning at the center of student advancement, but rather than move entirely away from the credit hour, Empire State has embraced a system called prior learning assessment, or PLA, to better capture the real learning students have gained from their experience, including jobs, military service, volunteer engagements, and independent study.

Through PLA, students work with mentors to determine whether their experience-based learning is applicable for translation into college credits, whether

it applies to the degree they're seeking, and how best to demonstrate their learning. Someone with years of work experience in office management, for instance, might be able to demonstrate knowledge in administration, supervision, and technology. Students then go through a formal, thorough process to show how their experience translates into competencies and to appeal for credit hours accordingly.

PLA does not fundamentally disarm the status quo, but it marks an important step toward enabling colleges and universities to divorce themselves from time-in-classroom as the central measurement of advancement. It also represents an important shift toward placing learning at the center of the college experience and awarding students based on what they know and can do. It thereby helps connect degrees—and the institutions bestowing them—to the emerging connected credentials system.

High-Quality Learning Outcomes

In a system where learning is the key metric, the ability of colleges and universities to produce high-quality learning outcomes for students will be measurable like never before. To that end, institutional leaders not only will have to better assess students' learning and enable them to progress accordingly but also must double

Leaders should be thinking critically about how to deliver the structure that provides the best outcomes for students—whether online or campus/experience-based.

down on offering quality programs that produce strong results for students.

Exactly how colleges and universities will do this is less clear-cut—and will vary widely among institutions. There's consternation and ongoing debate about how much of a role online learning will play in the future college/university ecosystem. What seems inevitable is that it will play some role. Rather than getting bogged down in the potential threat from technology to the long-standing lecture model, institutional leaders should be focusing their efforts on thinking critically about

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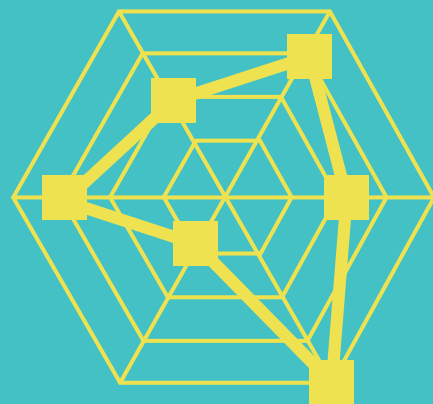
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how to deliver the structure that provides the best outcomes for students—whether online or campus/experience-based.

In many cases, it will be some hybrid of both. For example, campuses can utilize adaptive learning programs that act as virtual teaching assistants, enabling the teacher—whether delivering a classroom lecture or an online course—to convey instruction in ways that better meet students' specific learning needs. These programs work much like standardized tests such as the SAT or GRE, which adapt their questions based on students' performance on the first few questions. Or institutions might use flipped classrooms, where lectures are delivered online and students use in-person classroom time for discussion and dissection of their learning.

Simply put, in a learning-centered, outcomes-based system, higher education institutions will not have time for debates over preserving the old way of doing things. They will need to focus on enhancing quality and leveraging whatever tools necessary to achieve excellent results.

Learning Opportunities throughout a Student's Lifetime

As the move to digital résumés underscores, in the revolutionized higher education system, students will build their knowledge and skills over a lifetime. No longer will an intensive period of learning on campus—or even an advanced degree experience beyond that—be enough to allow for a lifetime of career advancement. The 21st-century workers will need to continually build and grow their reservoir of competencies and will do so through a mix of courses, job experiences, seminars, and more. In the next era of the workforce, employees will need to continually retool and learn new skills and information.

Colleges and universities have ample opportunity to benefit from this paradigm shift. By offering educational opportunities that are relevant to learners across the spectrum of experience, from first-time degree seekers to midcareer workers looking to add a new skill, institutions can be positioned to thrive as

ongoing capability-adding becomes the new normal. This will create an unprecedented level of innovation and creativity at colleges and universities, which will have to compete with a range of other providers to offer courses that are relevant, engaging, and cost-effective and that produce quality outcomes for all learners.

An Imperative to Change

If colleges and universities want to continue to succeed economically, they must adapt and compete. They must make changes that will allow them to be better equipped for thriving in higher education's era of technological revolution. But there's also a major societal benefit to the forthcoming connected credentials system and the related unleashing of



technology to create a learning-centered, student-controlled system: an education beyond high school will be accessible to many more people, not just a select few.

Consider that a growing number of new college students are older, working, and raising children. An increasing number also are first-generation, minority students who traditionally have not been served well by the U.S. higher education system. Today only 23 percent of blacks and 15 percent of Latinos have at least an associate's degree, compared with 40 percent of whites.⁴ The higher education system of the future—with its greater transparency, focus on outcomes, and easier navigability—will help to close these long-standing race- and class-based gaps

in educational equity by better meeting all students' needs so that they can successfully complete their degrees. As a bonus, the forthcoming changes will inevitably make higher education more affordable.

These changes will reap positive rewards for all of us—students, parents, employers, and the economy as a whole. Society benefits from a better-educated populace in both tangible and intangible ways. In fact, the market and nonmarket value of growing the U.S. talent supply has been quantified at around \$7 trillion.

The shift in postsecondary credentialing and the needs of the 21st-century workforce will revolutionize higher education. Colleges and universities have vast potential to be positive agents of this change, and IT leaders can be major influencers in driving the transformation. But higher education leaders must seize the opportunity now—or risk being left behind. ■

Notes

1. Mary Alice McCarthy, *Beyond the Skills Gap: Making Education Work for Students, Employers, and Communities* (Washington, DC: New America, October 2014), 3.
2. Anthony P. Carnevale, Nicole Smith, and Jeff Strohl, *Recovery: Job Growth and Education Requirements through 2020*, executive summary (Washington, DC: Georgetown Public Policy Institute, Center on Education and the Workforce, 2013), 1; *A Stronger Nation through Higher Education* (Indianapolis, IN: Lumina Foundation, 2015), 2, 5.
3. Paul Fain, "Measuring Competency," *Inside Higher Ed*, November 25, 2015; "Interview with Yvonne Simon, Chief Learning Architect for College of America," *Online Education.com*.
4. See Lumina Foundation, *Today's Reality*.

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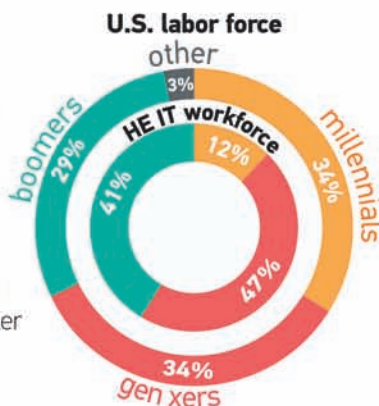
Companies in the top quartile for **gender diversity** are **15%** more likely and those in the top quartile for **ethnic diversity** are **35%** more likely to have financial returns above their respective national industry medians.

WHAT WOULD A DIVERSE WORKFORCE LOOK LIKE IN HIGHER EDUCATION IT ?

The overall composition and individual characteristics of a diverse higher ed (HE) IT workforce would be representative of the diversity found in the overall labor force. While diversity is a complex set of cultural, social, and ancestral variables, this snapshot is limited to age, ethnicity, and gender.

age **Young professionals are underrepresented in the higher ed IT workforce** when compared with the overall U.S. labor force:

The HE IT workforce is older than the U.S. labor force, perhaps as a result of a stronger tradition of employee retention. **HE IT workers remain at their institutions more than two times longer** than the typical U.S. worker stays with a single employer (median of 10 years versus 4.6 years).



The median age of HE IT professionals is 48 years, while the median age for the U.S. workforce is 42 years.

Median age of the HE IT workforce

CIOs	53
Managers	48
Staff	43

WHAT STRATEGIES CAN CREATE A MORE DIVERSE WORKFORCE ?



Inclusion: Actively and intentionally engage in ongoing efforts to diversify the workforce.

Equity: Create opportunities where underrepresented groups can (and want to) participate in the workforce.

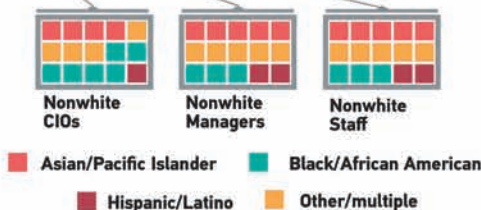
Striving for a representative workforce through diversity, inclusion, and equity

Overall HE IT workforce



- White = 85%
- Nonwhite = 15%

Nonwhite workers are underrepresented in the higher ed IT workforce when compared with the overall U.S. labor force: Nonwhite workers make up 15% of all positions in HE IT and 34% of the U.S. labor force.



ethnicity

But the HE IT workforce is more ethnically diverse now than it was five years ago, especially in CIO positions:



Percentage of nonwhite respondents to the 2015 ECAR workforce survey

gender

Women are underrepresented in the higher ed IT workforce when compared with the overall U.S. labor force:

HE IT workforce



U.S. labor force



The proportion of women CIOs has become larger since 2010, but there is a smaller proportion of women IT managers and staff in higher ed than there was five years ago.



Across the higher ed IT workforce, men outearn women by

\$7,400

(comparing median salaries)

However, for the first time in ECAR workforce research history, **female CIOs and managers outearn their male counterparts** (by \$2,400 and \$3,000, respectively).

For more information and resources about the current state of the IT workforce, visit the IT Workforce in Higher Education, 2016, research hub (<https://library.educause.edu/resources/2016/3/the-it-workforce-in-higher-education-2016>) or the ECAR website (educause.edu/ecar).

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Appreciating a MULTIGENERATIONAL Higher Education IT Workforce

This article is drawn from the recent research by the EDUCAUSE Center for Analysis and Research (ECAR) on the evolving IT workforce needed to support contemporary models of IT service delivery and the emerging world of analytics. The research provides a general picture of the state of the IT workforce, as well as explores the roles, competencies, and career trajectories of incumbent (and aspiring) senior-most leaders in information technology, security and privacy, data, and IT architecture. The research will define professional competencies and lay the foundation for tools that can guide professional development and career planning.

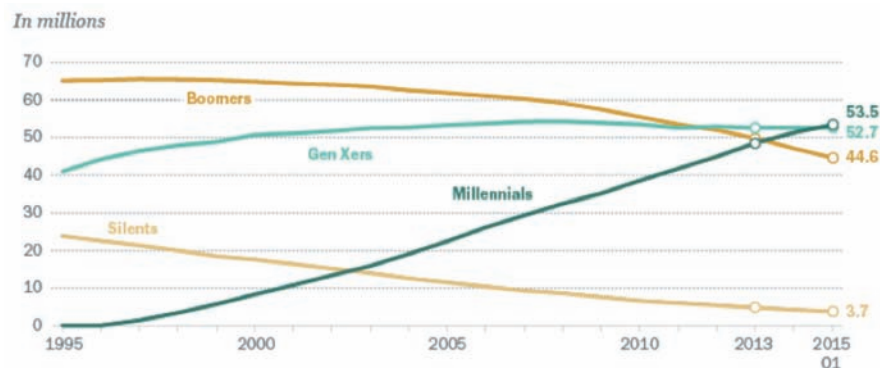
By Eden Dahlstrom

According to a study published last year by the Pew Research Center, the United States recently passed a milestone in the U.S. workforce: there are now more Millennials in the workforce than any other generational group (see figure 1).¹ Millennials were born between 1981 and about 1997, Generation Xers were born between 1965 and 1980, and Baby Boomers were born between 1946 and 1964.² The youngest members of the Millennial Generation are just now entering the workforce, and the oldest members are growing their careers. The youngest Boomers are in their peak productivity and wage-earning years, whereas the oldest members are retiring from the workforce. Gen Xers are situated firmly in the middle.

Why do generational cohorts matter?³ After all, they are stereotypical characteristics attributed to a group of people who happen to be born within about twenty years of one another. Like most other stereotypes, these cohorts tend to be based on a sliver of truth, and from a practical perspective, the oversimplified generalization of traits allows us to create mental shortcuts and categorize an otherwise complex world. To use my own example, I am a Gen Xer, and I have eight direct reports: two are firmly defined as Millennials, two are on the Millennial-Gen X cusp, and the remaining four are entrenched Gen Xers. I report to a Boomer. I interact with all three generations on a daily basis, as do most of you reading this article. Understanding a little bit about the core work-related values of a multigenerational workforce can help optimize the work environment, leverage natural generational attributes, and maximize productivity. In addition, we can't stop the hands of time: all of us will move on in our career paths and will eventually retire to enjoy our golden years. One day a Millennial will have my job, and presuming stability of the position, a Post-Millennial will have the job after that.

As more and more Millennials are integrated into higher education work teams, an understanding by Gen Xers and Boomers of the next generation of IT workers and leaders—and Millennials' understanding of the current generations—will help colleges and universities maintain business continuity during the generational transition. Millennials bring a fresh perspective to the table. Their youth can infuse energy into teams, and their lack of entrenchment in the ways things have always been done can help others embrace transformative innovation opportunities. In the first quarter

FIGURE 1. U.S. LABOR FORCE BY GENERATION, 1995–2015

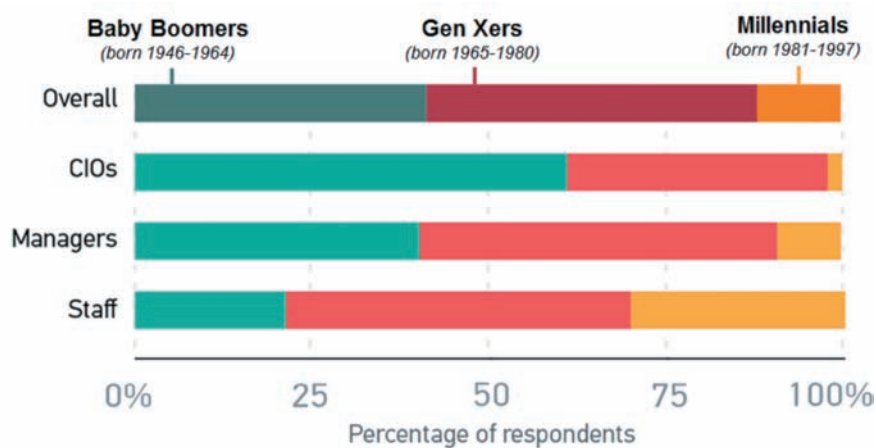


Note: Annual averages plotted 1995–2014. For 2015 the first quarter average of 2015 is shown. Due to data limitations, Silent generation is overestimated from 2008–2015.
Source: Pew Research Center tabulations of monthly 1995–2015 Current Population Surveys, Integrated Public Microdata Series (IPUMS).

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FIGURE 2. ECAR WORKFORCE SURVEY RESPONDENTS BY GENERATION



of 2015, the overall U.S. labor force was composed of 34 percent Millennials, 34 percent Gen Xers, and 29 percent Boomers.⁴ For comparison, the recent survey by the EDUCAUSE Center for Analysis and Research (ECAR) reported 12 percent Millennial respondents, 47 percent Gen X respondents, and 41 percent Boomer respondents (see figure 2).⁵ Either ECAR

surveys don't appeal to Millennials or there is an underrepresentation of Millennials in the higher education IT workforce. A recent Computing Technology Industry Association (CompTIA) study, *Managing the Multigenerational Workforce*, points to the latter. Only 19 percent of 18- to 24-year-olds in that study say they are interested in an IT career.⁶ This isn't very promising for members of the higher education IT community, who will need to backfill positions vacated by retiring Boomers and career-building Gen Xers.

For the Millennials who are part of the higher education IT workforce, a smaller percentage (44%) report that working in higher education (as opposed

The oversimplified generalization of traits allows us to create mental shortcuts and categorize an otherwise complex world.



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to another industry, business, or sector) is very important, compared with their Gen X (51%) and Boomer (55%) counterparts. It is possible that this is a function of Millennials' age (e.g., still exploring career opportunities) or their lack of

years in the workplace (e.g., not yet vested in the stability value-proposition that typically comes with higher education careers). Or it could be an indicator that the things Millennials value aren't well represented in higher education IT workforce jobs. Millennials are ambitious

and entrepreneurial—Mark Zuckerberg is their peer, after all. Millennials want work/life/community balance: they work to live, they want their work to be meaningful, and they want to be acknowledged for their successes.⁷ How well do we foster these ambitions among members of our workforce, and how much flexibility do we have at our institutions to better do so? Whereas some managers and some institutions are better than others at creating a work environment that appeals to Millennials, higher education could undoubtedly do more to attract and retain a Millennial workforce. External factors also pose challenges to attracting young talent to the higher education workforce. Economic circumstances may have tarnished the nobility of higher education for young professionals. Careers in higher education might be particularly unattractive to a generation burdened

with student loan debt and joblessness (or underemployment).

The recent ECAR survey took a closer look at the higher education IT workforce by generation. More than one in four (26%) of the Millennials who participated in the ECAR workforce survey said that they “probably will or definitely will” seek employment outside of their institution in 2016. This was higher than Gen X IT staff (22%) and much higher than Boomer IT staff (17%). Regardless of whether or not Millennial IT staff are planning to stay or go in the next year, the following five aspects are most important for *keeping them at their current institution*:

1. Quality of life
2. Work environment
3. Occupational stability
4. Benefits
5. Boss/leadership

Quality of life was the top issue for all IT staff, regardless of their generational category: more than nine in ten respondents said this was very or extremely important. Work environment, occupational stability, and boss/leadership were also on the “top 5 list” for all generations.⁸ Benefits were not on the top 5 list for Gen Xers or Boomers; this item was beat out by “my colleagues” for those two groups. ECAR didn't provide operational definitions for these items, so *quality of life*, *work environment*, and *benefits* for one person might mean something different for the next. More important than trying to unpack what these things mean for Millennials is seeing the relative comparison of these items to factors that institutional leaders tend to think matter to employees, such as monetary compensation (ranked 9th by Millennials), geographic location (ranked 15th), and reputation of the institution for aca-

demic excellence (ranked 18th).⁹

ECAR found some generational differences when IT staff were asked to rate their agreement with statements about what is most important for *keeping them in their current IT position*.¹⁰ The following is the top 5 list for Millennial IT staff:

1. I have had opportunities to learn and grow in the past year.
2. Someone at work cares about me as a person.
3. At work, my opinions count.
4. I have the materials and equipment I need to do my work well.
5. My personal career goals are attainable.

The first three items also appear on the Gen X and Boomer IT staff top 5 lists, though in a different order. Staff in both the Millennial and the Gen X generations value having “attainable” personal career goals, and Millennials uniquely value having the materials and equipment to do their jobs well. Boomer and Gen X staff place “I have coworkers who are committed to doing quality work” and “I am highly motivated to perform my duties” on their top 5 lists.

What about skills? Millennials say the following are important for success in their current IT position:

1. Ability to communicate effectively
2. Ability to manage complex projects
3. Strategic thinking and planning
4. Ability to manage process
5. Ability to use data to make decisions, plan, manage, etc.¹¹

“Ability to communicate effectively” and “Strategic thinking and planning” made the top 5 lists for each generational cohort. Millennials' top 5 list uniquely



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includes project and process management, whereas Boomers and Gen Xers list "Managing relationships" and "Ability to influence others." Millennials' interest in process is probably more a function of their current situational roles and responsibilities in the workforce (managing projects vs. managing

thing to learn from me, their Gen X manager, about building social capital (i.e., managing relationships and influencing others).

Millennials are more critical of themselves than other generations: they describe themselves as self-absorbed, wasteful, greedy, and cynical at higher



people) than a fundamental difference in core values. As young professionals gain more "people management" and leadership responsibilities, the relative position of relationship management and influence will likely match that of their more experienced counterparts.

Regardless of the reason for generational differences (whether due to situational circumstances or core values), it is important to recognize that diversity of perspectives and experiences can enhance the work environment. Generational differences don't need to be in competition. Rather, they should complement one another. Circling back to my personal experience, the last top 5 list shows me that I have something to learn from my Millennial staff who value working smarter and not harder (i.e., managing process and using data to make decisions) and they have some-

rates than Boomers or Gen Xers. Perhaps they are just more self-aware of and honest about their shortcomings than other generations. Millennials rate themselves highly when it comes to being idealistic, entrepreneurial, environmentally conscious, and tolerant. Add being self-aware and honest to that list, and we have a solid base of characteristics for future IT managers and CIOs in the higher education IT workforce.¹²

For a generation that is often criticized for being overscheduled, sheltered by their parents, and not allowed to fail, Millennials reveal workplace values that are similar to those of their Boomer and Gen X colleagues. As for the differences between the generations? They provide opportunities for us all to learn and grow. By welcoming various generations into our IT organizations, we can both mentor and learn from one another. ■

Notes

1. Richard Fry, "Millennials Surpass Gen Xers as the Largest Generation in U.S. Labor Force," *Fact Tank*, Pew Research Center, May 11, 2015.
2. Members of the post-Millennial generation are not yet in the workforce, and the Silent (born between 1928 and 1945) and the Greatest (born before 1928) generations are typically retired from the workforce. Pew notes that the youngest Millennials have not yet been defined by a definitive chronological endpoint.
3. The Pew Research Center generation categories are used throughout this article as a convenient way to speak about the multigenerational workforce. ECAR acknowledges, however, that young professionals are particularly sensitive to their generational label, as indicated in Pew Research Center, "Most Millennials Resist the 'Millennial' Label," September 3, 2015.
4. Fry, "Millennials Surpass Gen Xers."
5. D. Christopher Brooks, Eden Dahlstrom, and Jeffrey Pomerantz, "The IT Workforce in Higher Education, 2016," EDUCAUSE Center for Analysis and Research, March 28, 2016.
6. CompTIA, *Managing the Multigenerational Workforce* (October 2015).
7. Gabrielle Jackson, "Forget the Career Ladder, Millennials Are Taking the Elevator," *HuffPost Business*, May 12, 2015.
8. These lists are based on the sum of "Very important" and "Extremely important" survey response options. There were no differences in list items or order when ECAR calculated mean values of the 5-point Likert scale of these items by generation.
9. The value proposition of working in higher education, including benefits such as paid time off and occupational stability, attracted many Boomers and Gen Xers to the industry but has eroded steadily in the 21st century.
10. All of these items were negatively correlated with survey respondents seeking a new job. That is, respondents who agreed with these statements are *not* seeking new jobs in 2016. This ordered list is based on the sum of "Agree" and "Strongly agree" survey response options.
11. This ordered list is based on the sum of "Very important" and "Extremely important" survey response options. There were few differences in list items or order when ECAR calculated mean values of the 5-point Likert scale of these items by generation.
12. Pew Research Center, "Most Millennials Resist the 'Millennial' Label," September 3, 2015.

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Growing an IR and IT Garden

As I write this column, spring is almost here. A few buds are fighting the winter cold to start the blooming process, while others are waiting a little bit longer to sprout. The environment can affect the development of the fledgling seedlings, fostering growth or hampering development. Similarly, within every college/university campus, different interactions in the environmental landscape can define the connections between the Institutional Research (IR) and the Information Technology (IT) offices. These relationships may have been forged through the specialized language commonplace in each area, based on practical applications and/or technical expertise. Or they may have resulted from shared reporting structures that can frame the lens shaping the interactions between the areas. Just as sunlight and water are key complements to the growth of plantings, the IR and IT offices need to collaborate, since each has a complementary role that is critical to the other.

Past Does Not Define Future

Every relationship has a history, just as all gardeners have to start with their first planting. Some pathways are positive journeys that flourish from the beginning, whereas others have lengthy stories full of rocky tumbles. Past relationships do not need to dictate all future interactions. This can apply to both positive and challenging relationships. If there is a constructive existing relationship, effort and energy need to be expended to continue the relationship, and these interactions can be positive models for other areas on campus. If there is a strong relationship between the IR and IT offices, how was this partnership created and how has it been sustained? What else is needed to continue to grow this relationship?

Despite all of the leaps forward in agriculture, no miracle elixir or seed will grow in any/all circumstances. Likewise, campus offices are built with people, who are fallible. As a result, miscommunication, frustration, and egos can get in the way of a constructive professional working relationship. Higher education is not a utopia in which everyone always agrees. Competing resources and limited time to accomplish projects can result in less-than-ideal interactions. When a disconnect between the IR and IT areas emerges, it can be challenging (but not impossible) to overcome. Acknowledging past frustrations can be the first step in mending or rebuilding relationships. If there is an ineffective relationship, what tools or tips can be utilized to rebuild the connections and collaboration?

Another danger is falling into the trap of feeling that a project was a failure if it did not work out according to plan. But

an unsuccessful project does not have to lead to a complete failure if learning has resulted from it (and if the unsuccessful parts are not repeated). What methods have been successful in reframing an unsuccessful situation or challenging project into a more favorable outcome? How is this different for individual versus group projects?

Regularly Watering the Plants

Although watering on a regular schedule is an essential part of the gardening process, other aspects of watering can impact how much water the plants actually receive. Watering with a fire hose or watering at high noon in the middle of summer both may be ineffective at supporting budding plants. Similarly, verbal and nonverbal communications are important parts of the campus collaboration process and can be shaped by how and when the communication is delivered. In her article "Effective Communication: Not As Easy As It Seems," Kathy Lang notes five questions for guiding communication.¹ Thinking through communicating messages and considering others' perspectives before sending messages can aid individuals in delivering them effectively, rather than with a fire hose. What are some other successful tips for building effective communication within and between areas?

Regularly celebrating successes and giving credit where credit is due can be integral parts of building relationships and communicating effectively. Projects are not done in a vacuum. Acknowledging the assistance of others can result in great strides being made in building (or repairing) relationships and trust. How have others navigated acknowledgments that may not have been as well received as they were intended? How/why did this happen? What are some other, well-received ways of celebrating success?

Reporting structures can influence the natural interactions between campus areas. The IR and IT offices may not always report through the same reporting structure. What impact does reporting structure have on building and maintaining a strong IR/IT relationship? How have others been able to create and sustain interoffice relationships and break down silos? How have these practices been integrated into sustainable and regular operations, rather than a one-time project or only with specific individuals?

The Higher Education Landscape

Many different issues affect our understanding of a landscape. In gardening, this can be seeing how weather patterns, soil composition, and insects can affect the growth of the plants. In higher education, this can be recognizing trends that can lay the groundwork for potential future issues, projects, or



By ELIZABETH CLUNE-KNEUER



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collaborations. Understanding the broader aspects of emerging higher education trends, initiatives, or new reporting requirements can help both the IR and the IT offices see the impact from a cross-functional perspective. This creates a better outcome than if either single area approached the project as a silo.

An example that those of us connected with community colleges (irrespective of our primary roles at the institution) need to be concerned with is student retention and completion efforts. One person starts this process by planting the seed of enrollment. Taking this first step to enroll (or re-enroll) in college can be a very scary or overwhelming process for students and/or their families. There are many different discussions, on state and national levels, about reducing the barriers to education to increase retention and completion, and these can have an effect on the technological infrastructure at institutions as well as the reporting from data that is collected. A collaboration between the IR and IT offices can improve institutional efficiencies regarding what information is tracked and where it is stored in database systems. Additionally the IR and IT offices can partner in “translating” the technical (and sometimes very complex) systems, processes, and limitations for the general campus community.

What are other emerging higher education issues that can impact both the IR and IT offices? What are issues that pertain

to specific sectors, such as community colleges?

Outside of the Comfort Zone

Engaging in knowledge and learning communities outside of functional areas can bring additional resources and information. Attending conferences beyond the mainstream vendors or functional-area specialized conferences can highlight notable topics as well as challenges that other areas face. Funding for travel is something many offices may find challenging to obtain. Although some time and effort may be required to apply for grants, they can be an excellent way to stretch competing resources and to obtain additional funding. I was fortunate to have been awarded the Diane Balestri Memorial Scholarship to attend my first EDUCAUSE Annual Conference in the fall of 2016; my interest in a strong collaboration with information technology had been sparked when I had worked closely with the IT office at a previous institution. Additionally, social media can be a great (low- or no-cost) way to supplement resources. LinkedIn and

Twitter are two platforms with strong learning communities, many times with LinkedIn groups and Twitter chats constructed with cross-functional practitioners.

What other conferences or social media resources can assist in continued professional development outside of immediate functional areas? How can groups, both in person and through social media, create positive environments to reach out and welcome others who may not typically attend or engage?

Conclusion

The relationship between the IR office and the IT office has many different aspects that can influence how strong this garden can grow. Spring is time for renewal and growth. Whether the IR and IT offices have strong existing connections, or are just starting an emerging relationship, or are working to rebuild a strained one, planting a seed is always where this starts. ■

Note

1. Kathy J. Lang, “Effective Communication: Not As Easy As It Seems,” *EDUCAUSE Review* 50, no. 5 (September/October 2015).

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The HathiTrust Research Center: Exploring the Full-Text Frontier

Many readers of *EDUCAUSE Review* are familiar with the HathiTrust Digital Library (HTDL), which was featured in an E-Content column by Jeremy York and Brian E.C. Schottlaender a couple years ago.¹ However, readers may not yet be aware of the research counterpart to this mass-scale digital library: the HathiTrust Research Center (HTRC).² In this column, we want to help readers better understand the HTRC mission—a mission that supports new knowledge creation through novel computational uses of the HTDL.

Birth of a Research Center

In the original *Google Books Settlement Agreement* in 2008,³ funds were to be set aside to create a research center that would enable researchers worldwide to accomplish data-mining and analysis on texts in the public domain and under copyright in a manner that was secure and compliant with appropriate U.S. copyright law. This did not happen, because the court rejected the agreement in 2011. However, the HathiTrust Board of Governors believed in this public good and announced a request for proposals to build such a center in 2009.⁴ In 2011, the HTDL announced that Indiana University Bloomington and the University of Illinois at Urbana-Champaign would run the HTRC under an agreement with the HathiTrust Board of Governors and the University of Michigan. The HTRC has been an active production service since 2014, with tools available to analyze a set of out-of-copyright content equaling around 4.4 million volumes.⁵ In 2016, the HTRC plans to enable analysis of the entirety of the 14 million volumes held currently by the HTDL.

Understanding Non-Consumptive Research

To understand the tools and methodologies of the HTRC, one needs to understand the conditions under which scholars are permitted to access and use the collection. Use of the HathiTrust collection is governed in part by agreements among Google and others who digitized the works. Much of the collection is in copyright, so any use of those materials must carefully follow copyright law. Thus the HTRC has focused on *non-consumptive research* using the digital surrogates. The rejected settlement defines this as “research in which computational analysis is performed

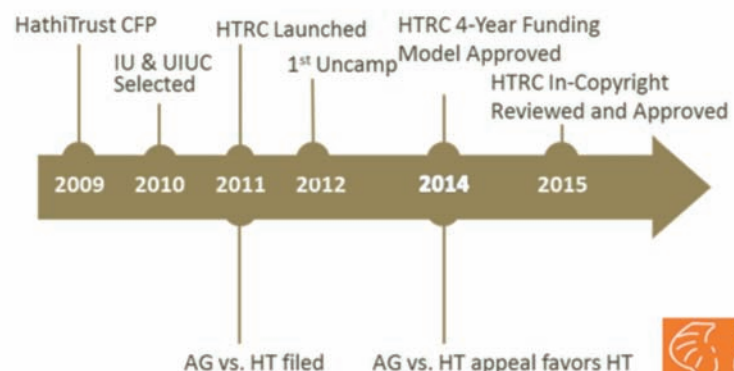
on one or more books, but not research in which a researcher reads or displays.” Operationally, the HTRC defines *non-consumptive research* as that in which no action or set of actions on the part of users, either acting alone or in cooperation with other users over the duration of one or multiple sessions, can result in sufficient information gathered from a collection of copyrighted works to reassemble pages from the collection.

Current Tools and Methods

Currently the tools of the HTRC can be broken into four distinct categories that build off each other in terms of usefulness to the scholar:

1. The *HTRC Workset Builder* (HTRC-WB) enables scholars to utilize a faceted browsing interface to build unique collections from within the HTDL collection. This is part of the overall HTRC Portal.
2. The *HTRC Data Capsule* (HTRC-DC) is the heart of the platform, providing scholars with a unique Virtual Machine (VM) and data enclave that is supported by cyberinfrastructure at Indiana University to run analysis on the content of the individual worksets created by scholars.⁶
3. The *HTRC Solr/Lucene API* allows scholars to work directly with the Solr/Lucene index of the HTDL corpus in novel ways.
4. The *HTRC Extracted Features Dataset* (HTRC-EFD) was

HTRC Startup / HT Corpus Availability Timeline





By **J. STEPHEN DOWNIE, MIKE FURLOUGH, ROBERT H. McDONALD, BETH NAMACHCHIVAYA, BETH A. PLALE, and JOHN UNSWORTH**

published in May 2015 and has since been used to create a further refined extracted features dataset based on volumes published between 1700 and 1922 and including specific information for genre.

Bridging the Scholarship Gap

The work of the HTRC has enabled a contextualized usage of the metadata plus the full text of the entire corpus—an approach described by many in the digital humanities fields as *distant reading*.⁷ This type of distant reading scholarship meshes well with the one-to-many uses of the completely digitized content and metadata of the HTDL. Key concepts for future work around distant reading scholarship need to include options for enhanced metadata improvement and new models for workset creation within the HTRC platform.⁸ This work will be useful when exploring how to enhance discovery within the HathiTrust production platform, perhaps by enhancing metadata with new data on genre, date, or gender of the author.

Advanced Collaborative Support (ACS) Program

A critical aspect of having a multiyear funding model for the HTRC includes the opportunities that have been created through the HTRC Advanced Collaborative Support (ACS) program. This micro-grant program offers scholars in-kind development support supplied by the HTRC staff. The development support is specific to the project that is proposed to the ACS program by the scholar and includes assistance in migrating code to work on the HTRC compute platforms as well as in developing advanced worksets and other types of data enhancements. The first round of ACS awards was announced in January 2015. As was evident at the third annual HTRC UnCamp in 2015, the ACS program has encouraged many strides ahead in use of the HTRC platform in disciplines as diverse as English literature, language topic modeling,⁹ literary theory, and economics.

A Scholars Commons Outreach Approach

The HTRC is working to extend the pedagogy of its tools and services through an innovative partnership between the Scholars' Commons at Indiana University Libraries and the Scholarly Commons at the University Library of the University of Illinois. These two libraries are partnering to develop instruction and models for conducting research consultations to support the integration of text data-mining concepts into scholarly research and the classroom. This partnership, in conjunction with three other libraries, is developing and testing a set of curricular material for use as "train the trainer" library workshops that will focus on teaching key concepts in text data-mining research. This effort, supported by funding from the Institute of Museum and Library Services (IMLS) Laura Bush 21st Century Librarian Program, will enable the delivery of effective text data-mining instruction, based on freely accessible training materials, to graduate students and other groups of scholars. The HTRC aims

to enable more productive research for scholars as well as integrating its tools and services within a variety of disciplines.

Conclusion

Today's digital scholars are embracing new opportunities to explore their disciplines in ways that are enhanced through the types of computational analysis that the HTRC provides. Nonetheless, the heightened level of integration and collaboration required to offer these new scholarly services requires a transformed working relationship between the academy, the digital scholar, and research support units as described in this article. For this reason, the HTRC is pooling resources that operate above any one campus, in order to create a shared service that can be used by all.

Notes

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2. See Beth Plale, Robert McDonald, Yiming Sun, Inna Kouper, Ryan Cobine, J. Stephen Downie, Beth Sandore Namachchivaya, and John Unsworth, "HathiTrust Research Center: Computational Access for Digital Humanities and Beyond," *JCDL '13: Proceedings of the 13th ACM/IEEE-CS Joint Conference on Digital Libraries* (New York: Association for Computing Machinery, 2013).
3. Google Book Search Copyright Settlement (October 2008).
4. "Call for Proposal to Develop a HathiTrust Research Center," December 7, 2009.
5. See the HathiTrust Research Center Documentation.
6. See Jiaan Zeng, Guangchen Ruan, Alexander Crowell, Atul Prakash, and Beth Plale, "Cloud Computing Data Capsules for Non-Consumptive Use of Texts," *ScienceCloud '14: Proceedings of the 5th ACM Workshop on Scientific Cloud Computing* (New York: Association for Computing Machinery, 2014).
7. This concept was coined by scholar Franco Moretti in his book of the same name: *Distant Reading* (New York: Verso, 2013).
8. Terhi Nurmikko-Fuller, Kevin R. Page, Pip Willcox, Jacob Jett, Chris Maden, Timothy Cole, Colleen Fallaw, Megan Senseney, and J. Stephen Downie, "Building Complex Research Collections in Digital Libraries: A Survey of Ontology Implications," *JCDL '15: Proceedings of the 15th ACM/IEEE-CS Joint Conference on Digital Libraries* (New York: Association for Computing Machinery, 2015).
9. Jaimie Murdock, Jiaan Zeng, and Colin Allen, "Towards Cultural-Scale Models of Full Text," HTRC ACS Technical Report (December 2015).

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Diversity, Equity, and Inclusion: A Call to Action

What does a diverse higher education IT workforce look like, and why is it important?

Higher education IT leadership doesn't appear to be particularly diverse. Statistics from the 2015 Center for Higher Education Chief Information Officer Studies (CHECS) survey show that 95 percent of responding CIOs identified themselves as "White." This represents a 4 percent increase from 2014. The CHECS data also covers IT leaders considered to be one level below the CIO. Of those who responded, 95 percent identified as "White." The 2015 percentage of these IT leaders who were women and who identified as aspiring to be a CIO reached a new low of 24 percent, with the highest percentage over the past six years at only 31 percent.¹ Similarly, data from the College and University Professional Association for Human Resources (CUPA-HR) shows that in 2014–2015, only 20 percent of CIOs in higher education were women.²

These statistics for higher education IT leaders, and the events that have unfurled across the United States and within higher education dealing with race,³ should indicate a strong need to take action to diversify the overall higher education IT workforce. However, there's a perhaps even more compelling reason: improving organizational performance.

Incorporating diversity, equity, and inclusion into the workforce isn't just "the right thing to do." These values are imperative for improving decision-making and outcomes. Improved organizational performance has been demonstrated repeatedly in the private sector⁴ and applies to higher education as well.⁵ Additionally, "IT Workforce Hiring and Retention: Ensuring adequate staffing capacity and staff retention as budgets shrink or remain flat and as external competition grows" was listed as #4 on the EDUCAUSE 2016 Top 10 IT Issues list.⁶ Diversity, equity, and inclusion are critical to the recruitment, hiring, retention, and career advancement for IT staff in higher education.

Now is the time for all of us in higher education information technology to examine who we are as an industry and a profession, starting with comprehensive data about our current demographics. A partnership between colleagues from EDUCAUSE and CUPA-HR could be critical to answering some key questions: Are we improving? Are we remaining static? Are we heading in the wrong direction? How can we grow and develop our pipeline? How do we address the lack of representation of marginalized groups as staff move up the leadership ladder?

The future of the profession depends on ensuring that at current and, more important, future leaders know and understand the importance of diversity, equity, and inclusion as well as develop a culture and strategy that continually fosters improvement. This is a matter of extreme importance and should be valued as much as budgets, strategies, governance, and the technologies we deploy and support.

This year colleagues from EDUCAUSE, CUPA-HR, and search firms that focus on higher education are embarking on a year-long discussion of and strategy development on diversity, equity, and inclusion, to include blogs, articles, webinars, and conference sessions. We are issuing a call to action: What does the community need to do—and do now? Some possibilities:

1. Publish diversity demographics for the higher education IT community through a partnership between EDUCAUSE and CUPA-HR
2. Collect data or additional data to continually assess how we are doing
3. Structure programs to help leaders, managers, and supervisors recognize and reduce unconscious biases
4. Develop target development programs for underrepresented talent
5. Champion diversity, equity, and inclusion within our community through increased educational opportunities such as blogs, articles, research, webinars, and conference sessions
6. Collect, store, and share best practices from member institutions that have positively increased diversity within our community
7. Offer programs that provide the EDUCAUSE membership with usable approaches to increase workforce diversity

What can *you*, as a member of the community, do to help?

- Educate yourself on the issues. Contribute to upcoming EDUCAUSE activities around diversity, equity, and inclusion. Act!
- Understand the unconscious biases that are prevalent and play a significant role in every workplace situation.⁷

Finally, what other activities do you want to see? What topics do you want to discuss? What sessions do you want to attend and participate in at the 2016 EDUCAUSE Annual Conference? Please let us know in the Comments section! ■



By MELISSA WOO and KEITH W. McINTOSH



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Notes

1. *CIO Roles and Responsibility*, 2015, CHECS report.
2. According to Jacqueline Bichsel, director of research, CUPA-HR, personal communication based on presentation material, December 21, 2015.
3. See Alia Wong and Adrienne Green, "Campus Politics: A Cheat Sheet," *The Atlantic*, March 4, 2016.
4. "Global Diversity and Inclusion: Fostering Innovation Through a Diverse Workforce," *Forbes Insights*, July 2011; Geoffrey Colvin, "The 50 Best Companies for Asians, Blacks, and Hispanics: Companies That Pursue Diversity Outperform the S&P 500—Coincidence?" *Fortune* 140 (July 19, 1999); Sylvia Ann Hewlett, Melinda Marshall, and Laura Sherbin, "How Diversity Can Drive Innovation," *Harvard Business Review*, December 2013; Sherry Kuczynski, "If Diversity, Then Higher Profits?" *HR Magazine* 44, no 13 (December 1999).
5. Mark D. Winston, "The Importance of Leadership Diversity: The Relationship between

Diversity and Organizational Success in the Academic Environment," *College & Research Libraries* 62, no. 6 (November 2001).

6. See Susan Grajek and the 2015–2016 EDUCAUSE IT Issues Panel, "Top 10 IT Issues, 2016: Divest, Reinvest, and Differentiate," *EDUCAUSE Review* 51, no. 1 (January/February 2016).
7. For an excellent presentation on this topic, view the video "Unconscious Bias @ Work," a presentation by Brian Welle (Google Ventures).

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Why Diverse Teams Matter

Two main cases can be made for diversity and inclusion of women and other underrepresented groups in information technology: the social justice case and the innovation case. The social justice case appeals to us with “it’s the right thing to do,” as a humanitarian call for fairness, equal representation, and opportunity, within both academia and industry. Its antecedents echo from civil rights and feminism, backed by decades of social progress and research. The innovation case is a more recent phenomenon, emerging from best practices and research that points to the competitive advantages of diverse work teams along dimensions of innovation, productivity, efficiency, and problem solving.

In both cases, the context for an all-hands-on-deck call to action is at once overwhelming and compelling. In higher education, in 2011 women earned 57 percent of all undergraduate degrees but only about 18 percent of degrees in computer sciences, which is the lowest for any STEM field. For women who also belong to one or more ethnically underrepresented categories (e.g., black, Hispanic, Native American), the number of computer science graduates dwindled to 4.8 percent in 2012.¹ These numbers are reflected in industry, where women hold only 26 percent of U.S. tech jobs and make up only 19 percent of software developers.² Likewise, when Google bravely released its diversity numbers in the summer of 2014, it revealed some uncomfortable facts: only 17 percent of its IT workforce were women, only 2 percent Hispanic, and only 1 percent black. Other tech giants followed Google’s example and also released their diversity data, showing similar numbers.³ Meanwhile, the size and influence of the tech sector in nearly all spheres of modern life has exploded.

The Best and the Brightest?

It has long been assumed that assembling the best and the brightest in the room will yield the best and the brightest results. Therefore, searches for the best talent have, over time, increasingly narrowed the collective sense of who does tech best (and who does not) and where to recruit them (and where not). But these assumptions are now being called into question.

Scott Page’s landmark 2007 book *The Difference* makes a compelling case for the value of diverse teams. Through case studies and mathematical modeling across a range of organizations (industry, education, communities), he details the relation between diversity of people and strength and functionality of organizations in terms of productivity and problem solving. Throughout, he demonstrates that diversity can trump ability. Other research has demonstrated that the number of women on work teams is a stronger predictor of a group’s collective intelligence than is the total IQ of a group’s individual mem-

bers. Additional studies have shown that gender diversity benefits organizations along dimensions of financial health, productivity, efficiency, employee performance, and innovation.⁴

Even though exactly why and how “people diversity” translates into “functional diversity” to yield the benefits in innovation and productivity is a topic of ongoing investigation, such evidence signals us to rethink competitive strategies for recruiting and building diverse work teams. Primarily, it shifts the focus from acquiring the best *individuals* to assembling and empowering the most effective *teams*. In this sense, the strategy is akin to that in *Moneyball*, the book and film chronicling the paradigm shift in major league baseball: using analytics and data to move away from evaluating and hiring “star players” and toward evaluating and hiring effective teams. In information technology, the emphasis is on building teams for greater functional diversity—that is, diversity of thought. And in this sense, it is worth noting that such a clear plus for the innovation case of diversity and inclusion is fundamentally rooted in its social justice case, since diversity of thought ultimately stems from a diversity of life experience and identity.

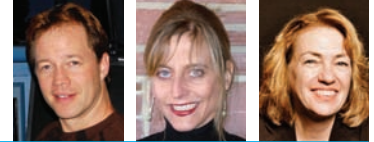
But recruiting for diverse teams won’t do any good if we don’t create environments in which women and minorities are retained and can thrive. Currently, women in the tech industry have a quit rate double that of men. According to a report by the Center for Talent Innovation, 80 percent of U.S. women in SET (science, engineering, and technology) say they “love their work,” yet 56 percent leave their private-sector organizations midcareer. This represents a huge brain drain, not to mention millions of dollars in investment walking out the door, most often to competitors, start-ups, and nonprofits.⁵

Unconscious Bias Goes to Work

What is the “secret sauce” to engaging and retaining more women and minorities in information technology? It starts with the social processes that inhibit diverse participation. By now, most of us are familiar with *unconscious bias*: implicit associations that everyone makes regarding gender, ethnicity, age, sexual orientation, etc. These biases can unfairly disadvantage and disenfranchise people who are members of underrepresented or historically marginalized groups. Unconscious bias is part of our mental makeup and our culture. However, recognizing it and raising it to a *conscious* level allows us to address it, interrupt it, and mitigate its potential negative impacts.

Unconscious bias in the workplace manifests in institutional barriers that may include the following:

- *Recruiting practices*: biased sourcing of candidate pools; job ads that include biased language and messaging; biased



BY BRAD McLAIN, CATHERINE ASHCRAFT, and LUCY SANDERS

résumé-review processes and interview strategies, including all-male interview committees

- **Retention factors:** unequal pay for equal work; environmental elements signaling that women and/or other minorities do not belong, including “geek-culture” décor and “brogrammer” culture; lack of support for competing work and life responsibilities, including flex-time; biased annual performance review protocols and criteria that subtly favor men and reinforce the dominant culture
- **Advancement:** biased and/or hidden advancement processes and criteria that subtly favor majority group members over minorities; lack of effective sponsorship for women and minorities; lack of role models and peer-group members for women and minorities in positions of power (a self-reinforcing cycle)

In addition, unconscious bias can be represented by interpersonal barriers and challenges:

- **Micro-inequities and micro-aggressions:** subtle but cumulative slights and exclusions that occur daily (“Dude, let’s talk about it over a beer”)
- **Stereotype threat:** the fear of reinforcing negative stereotypes associated with an identity category, resulting in behavior that can significantly affect performance, participation, and sense of belonging
- **Tokenism:** the expectation that someone represents and can speak for all others in a specific identity category, often resulting in women and minorities avoiding participation in “women’s groups” or diversity programs
- **Personality penalties:** being labeled as pushy, aggressive, or bossy for the same behaviors for which male or majority group counterparts are praised

Solutions

There is no single recipe for success in attracting and retaining diverse IT teams. Nevertheless, colleges and universities can lead the change, for both the professional sector and higher education. How?

First, educate top leaders and managers about the facts regarding women and other diverse people in information technology, training leaders to recognize and address unconscious bias in both its institutional and its interpersonal forms.

Second, recruit more diverse people. Hiring staff that embody a diverse and inclusive environment sends a strong message. Doing so requires a proactive recruiting strategy that follows from a top-leadership directive to seek out and hire a diverse staff and that does not in any way lower standards to accomplish this goal. A review of job ads for language that may include unconscious bias is also needed, as is sourcing to a wider range of potential candidates in order to change the traditional demographics of IT applicants.

Third, retain and advance diverse employees. As pointed out above, recruiting will do little good if retention is not achieved. And this means changing the culture of an organization—from its policies and procedures down to the ways individual employees interact—in order to remove the barriers that exclude diverse people and the benefits they bring. To enable this scale of change, the National Center for Women & Information Technology (NCWIT) has assembled an industry reform model for organizations to use.⁶ Its purpose is to frame a strategic approach to organizational change that promotes diversity and inclusion and to do so in a way that encourages customization to the specific needs of different groups. This framework emphasizes a holistic effort that bridges strategic and tactical action.

Finally, be accountable for change. Organizations must set targets, measure progress, and conduct and apply research for new ways of addressing these challenges. NCWIT is proud to be undertaking, in collaboration with Internet2, a new research project to gather and analyze gender diversity data from member organizations. This information will form a baseline from which the Internet2 community and individual member organizations can assess where they stand and then measure meaningful progress.

Casting diversity and inclusion as both a social justice case and an innovation case, dispelling the myth of “the best and the brightest,” shifting focus to building and supporting diverse teams in order to reap their demonstrated benefits for *all* people (majority and minority alike), and adopting a strategic change effort that is holistic in design are steps along a path way of progress with clear and elevating goals: diversify; innovate; and celebrate the wealth and potential of our differences. ■

Notes

1. National Girls Collaborative Project: <https://ngeproject.org/statistics>. Women in information technology reached a zenith in the mid-1980s, at nearly 40 percent representation, and again in 2002–2003, but that number has been in steady decline over the past decade. See National Center for Education Statistics: https://nces.ed.gov/programs/digest/d12/tables/dt12_349.asp.
2. U.S. Department of Labor, Bureau of Labor Statistics, 2013 (Occupational Category: 15–0000).
3. Alison Griswold, “Google’s Workforce Is Mostly White and Male,” *Slate*, May 28, 2014; Alison Griswold, “When It Comes to Diversity in Tech, Companies Find Safety in Numbers,” *Slate*, June 27, 2014.
4. For a detailed summary of much of this research, see Lecia Barker, Cynthia Mancha, and Catherine Ashcraft, “What Is the Impact of Gender Diversity on Technology Business Performance?” National Center for Women & Information Technology (NCWIT) Research Summary, May 29, 2014.
5. Sylvia Ann Hewlett and Laura Sherbin, *Athena Factor 2.0: Accelerating Female Talent in Science, Engineering & Technology* (New York: Center for Talent Innovation, 2014).
6. The NCWIT IT Industry Reform Model can be found in “Strategic Planning for Increasing Women’s Participation in the Computing Industry,” National Center for Women & Information Technology (NCWIT) Workbook, April 1, 2010.

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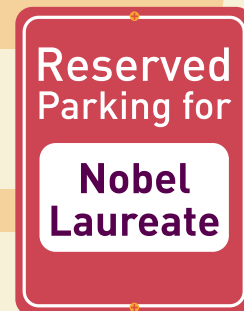
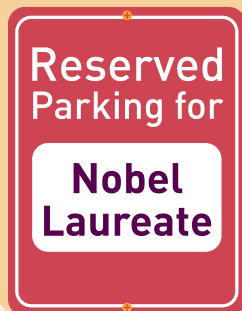
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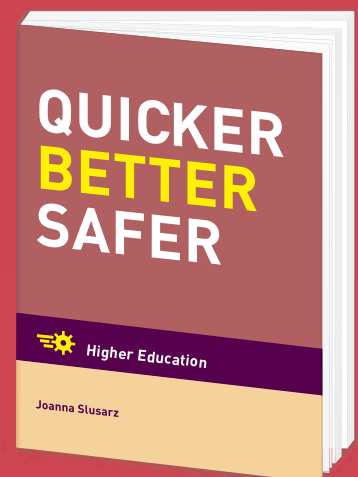


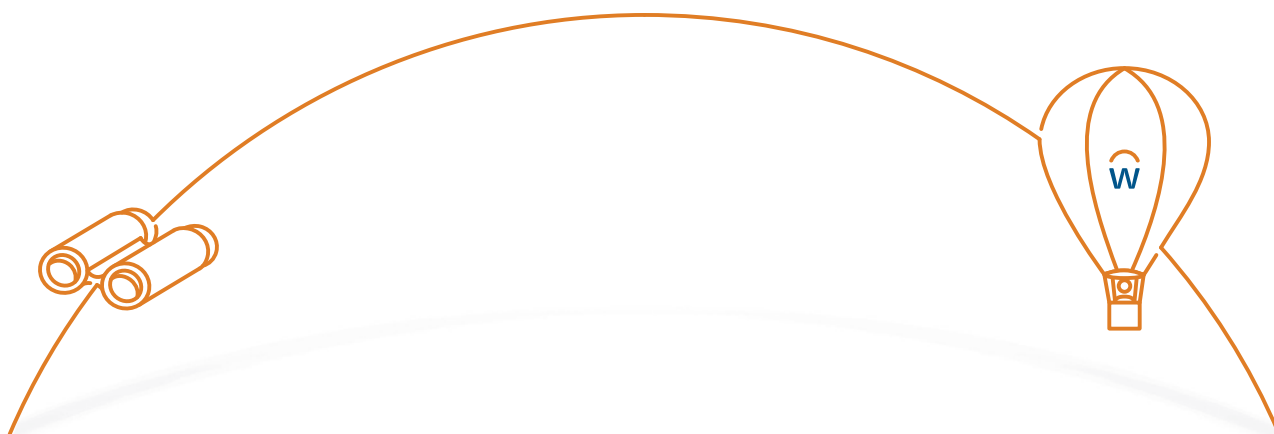
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