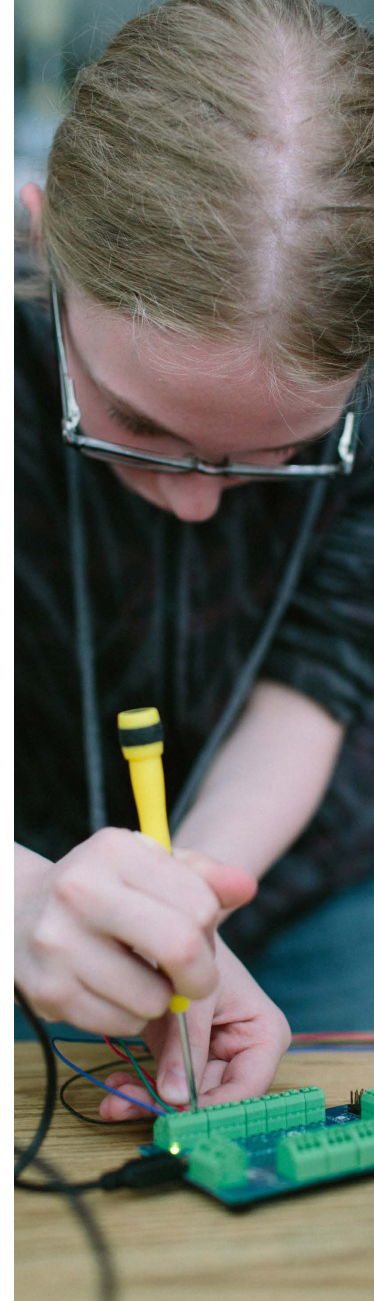




# Still Hiring Humans

THE FUTURE OF WORK IN PITTSBURGH AND BEYOND







**The factory of the future will have only two employees, a man and a dog. The man will be there to feed the dog. The dog will be there to keep the man from touching the equipment."**

— Warren Bennis



## A Tale of Two Factories

"The factory of the future will have only two employees, a man and a dog," said Warren Bennis, the late scholar and writer, in 1991. "The man will be there to feed the dog. The dog will be there to keep the man from touching the equipment."

Part joke, part prediction, Bennis' quote probably seemed a bit hyperbolic at the time. Just a few years earlier, General Motors had commissioned its first "lights-out" manufacturing plant — a factory automated to such a degree that few, if any, humans would be needed on site. Lights would be rendered unnecessary, and the plant would operate without the labor costs and strike threats that had slowed production elsewhere. In 1986, the company installed 260 robots in a Michigan factory, and the age of automation began.

Or so GM had hoped.

From the beginning, the robots refused to cooperate. They installed the wrong bumpers on the wrong cars and welded strange parts together. The robots painted some cars, skipped over others, and even painted themselves. They placed windshields in back seats and sliced up brand-new vehicles. The factory's lights kept burning, and the thousands of workers who remained on site spent more time fixing robots than they did building cars. Tens of billions of dollars later, a humiliated GM largely backed away from automation, choosing instead to ship production overseas.<sup>1</sup>

The episode might have been an embarrassing blip along manufacturing's timeline — a story of robots gone awry and the futility of the fully automated factory. But the company that had supplied GM's robots, a secretive Japanese outfit called Fanuc, took the billions it earned from the project and set out to improve its products. Over time, its robots learned to work together, to give and receive better instructions, and even to learn from their mistakes. Just a decade after GM's experiment, Fanuc opened a "factory of the

future" of its own — one that would prove Bennis right.

About 60 miles southwest of Tokyo, a dense forest rises from the foothills of Mount Fuji. Fanuc's founder planted it there to protect the company's secrets — one of many reasons Fanuc has been called "more cult than corporation."<sup>2</sup> Beyond the thicket of trees lies Fanuc's compound, where workers wear yellow uniforms and drive yellow cars from building to yellow building. Though journalists, investors, and even the company's board members are routinely denied access, those who get through the gates report the same peculiar detail: a clock that ticks 10 times faster than normal, reminding workers to keep ahead of the competition.

Inside Fanuc's main facility, robots build other robots 24 hours a day. They operate unsupervised for up to 30 days at a time, stopping only when they run out of storage. The factory's lights are turned off, as are the heating and air conditioning systems. For weeks on end, human workers are all but absent. When people *are* needed, they eat in automated kitchens, where robots cook rice and pack workers' lunchboxes. (The robots "even wear rubber gloves," reports CNN.)<sup>3</sup>

Fanuc's robots are shipped all over the world, where they automate even more factories. This has made Fanuc one of the most powerful companies on the planet — more than half the world's computerized tools now depend on Fanuc's creations. "They're the Microsoft you've never heard of," says one analyst. "If Mount Fuji erupted and took them out, the world would stop running."<sup>4</sup> You likely carry proof of this in your pocket: The company's signature product, the Robodrill, made your iPhone's metal shell. Without Fanuc, the most revolutionary device of the 21st century might never have conquered the planet.

! In Japan, a factory clock ticks 10 times faster than normal, reminding workers to keep ahead of the competition.





# How Will Work Change in the Coming Decades?

In many ways, the stories of GM and Fanuc both illustrate the future of work. On one hand, history is littered with big predictions about machines and their impact — predictions that, like GM's, often fell far short of reality. On the other, technology has undeniably transformed nearly every sector; today's robots can write simple news stories and perform complex surgery. Fanuc's factory is just one of several worldwide requiring minimal human involvement.

Automation, it seems, is both a distant dream and a current reality. There's even a scientific term for this: Amara's Law states that we overestimate technology's effects in the short run, and underestimate them in the long run.

Whether (and how quickly) the robots will come for our jobs remains an open question. Forecasts range from the rosy to the apocalyptic: The World Economic Forum contends that technology will create millions more jobs than it will destroy.<sup>5</sup> Likewise, the McKinsey Global Institute says only 5 percent of today's jobs could be fully automated (though many more could be partially automated).<sup>6</sup> On the other end of the spectrum, a study from the University of Oxford warns that nearly half of all jobs could disappear by 2033.<sup>7</sup> Still others say complex careers, such as nursing and novel writing, will be moot by the middle of the century.

These conflicting, uncertain predictions have created immense anxiety. What will work look like in 10, 20, or 50 years? What will children find when they grow up to enter the workforce? And how will they compete with ever-smarter technology? Comedy website *The Onion* captures this unease in a satirical news article: "If you're available 24 hours a day, seven days a week, and able to repeat an extremely precise sequence of movements up to 150 million times without pause, there is work for you in this economy,"

announces a fictionalized secretary of labor. "[Jobs] are up for grabs to any person with the ability to lift 250-ton payloads, bend steel plates into three-dimensional shapes, or withstand direct and continuous exposure to a variety of Level 4 biohazards."<sup>8</sup>

Nervous laughter aside, nearly everyone agrees that one thing is for sure: Work is going to change, and then change some more. Technology will impact all of us, from the factory floor to the executive suite. And while this has always been true to some degree — in 19th-century England, for example, a group of factory workers called the Luddites destroyed newfangled weaving machines in a bid to preserve their jobs — the difference now is that today's machines are increasingly capable of recognition. They can operate (and even improve) on their own, reshaping the roles humans play to a degree society has never before experienced.

This creates enormous opportunities and enormous challenges. Sectors that barely existed at the turn of the century, such as app creation and information technology (IT) security, are now among the fastest-growing in the United States. Productivity has skyrocketed. Technology has made many careers more interesting and less deadly, and so far, at least, it has created more jobs than it destroyed.<sup>9</sup> Many of those jobs have created enormous wealth, with the potential to create exponentially more — by 2050, the autonomous vehicle industry alone could be worth \$7 trillion.<sup>10</sup>

At the same time, much of that wealth has yet to improve the lives of workers, and in many cases, technology has exacerbated existing inequality. Already, full-time employment is on the decline, with work becoming more task-driven and project-based. As the internet provides access to specialized, inexpensive labor around the world, employers offer fewer living-wage, benefits-providing jobs — a trend that will only

! By 2050, the autonomous vehicle industry could be worth \$7 trillion.

//

**Unprecedented technological change — including automation, artificial intelligence, and algorithmic decision-making — will impact workers around the world, and transform labor markets with a speed we can scarcely imagine now."**

— Darren Walker, president, Ford Foundation

intensify in the coming decades, according to a forecast by the KnowledgeWorks Foundation.<sup>11</sup> Where full-time roles remain, the majority of employers say they struggle to find creative, collaborative, tech-savvy employees; while workers themselves contend with exclusionary barriers to entry, a lack of diversity in the workplace, and job requirements that shift beneath their feet.

The results have upended traditional work models. Gone are the days when someone could master a skill set, land an entry-level job, and follow a clear roadmap to retirement. In 2018, the average American job tenure was just over four years.<sup>12</sup> It's been estimated that today's young people might change jobs as many

as 15 times over the course of their lifetimes — and that many of those jobs will require work that hasn't been invented yet. "In the contemporary world," notes a report by the Brookings Institution, "people can expect to switch jobs, see whole sectors disrupted, and need to develop additional skills as a result of economic shifts. The type of work they do at age 30 likely will be substantially different from what they do at ages 40, 50, or 60."<sup>13</sup>

Tomorrow's workers, in other words, will have to be like the Fanuc factory's clock — racing into the future, staying ten steps ahead of the competition.



//

**We're not worried about an employment apocalypse. We're worried that people will find jobs, but the wages they will earn, the benefits they get, will not be enough to sustain a family or a middle-class standard of living."**

— Professor Lee Branstetter, director, Carnegie Mellon University's Center for the Future of Work



## Pittsburgh: A Case Study in the Future of Work

To get a glimpse of that future, one might turn to Pittsburgh — a place long defined by the work it does (and, for a few difficult decades, by the work it didn't do). Today, much of that work is technology-driven: Motorists share roads with autonomous cars. Old-school grocers share streets with lunar-lander designers. Google has set up shop in an old Nabisco factory, and Uber tests autonomous trucks where the city's last steel mill stood. A billboard put up by a robotics firm reminds passersby, "We're still hiring humans."

In many ways, Pittsburgh typifies the country's direction. As old industries fade, cities and towns across America are looking to technology, seeking to reinvent themselves by securing the jobs of tomorrow. By doing so, Pittsburgh has become a well-known success story: According to a report by the Brookings Institution, the region has forged "a strong and growing presence in the sectors that will drive job growth in the coming decades," becoming "a powerhouse" in fields like robotics, artificial intelligence, and software development.<sup>14</sup> The region's technology, health care, and advanced manufacturing sectors continue to grow, creating new opportunities for the top-notch talent produced by Carnegie Mellon University, the University of Pittsburgh, and others.

But for all the benefits of this blossoming economy, there are also plenty of drawbacks — challenges the

region still struggles to navigate. An influx of highly paid workers has transformed areas once considered working class, pricing longtime residents out of their neighborhoods and raising concerns about the region's livability. Poverty has increased, even as median incomes rose. And thousands of Pittsburghers have been negatively impacted by the changing nature of work: As Professor Lee Branstetter, director of Carnegie Mellon's Center for the Future of Work, puts it, "We're not worried about an employment apocalypse. We're worried that people will find jobs, but the wages they will earn, the benefits they get, will not be enough to sustain a family or a middle-class standard of living."<sup>15</sup>

Indeed, when *Politico* published a 2018 exposé on employers' growing reliance on poorly paid freelancers and contingent employees, it centered its story on Pittsburgh.<sup>16</sup>

Increasingly, the region's family-sustaining jobs are concentrated in its high-demand sectors: IT, business and finance, engineering and production, health care, and construction.<sup>17</sup> Pittsburgh's central challenge, experts say, is to prepare its workforce accordingly — and equitably. In 2016, the region's nonprofit civic leadership organization, the Allegheny Conference on Community Development, set out to map how this might be done, and to determine the barriers that stand in the way.



What the organization found was alarming. Absent significant change, its report noted, the region can expect a massive worker shortage over the next decade. Between the coming wave of Baby Boomer retirements and the projected growth of high-skilled occupations, Pittsburgh could be short by 80,000 workers or more. Every year, in fact, the region's employers will have to replace nearly 30,000 retirees while filling 5,000 new positions.<sup>18</sup> The region's K-12 pipeline isn't nearly deep enough to meet such demand, and even if it were, the skills graduates learn are often different than the skills employers need.

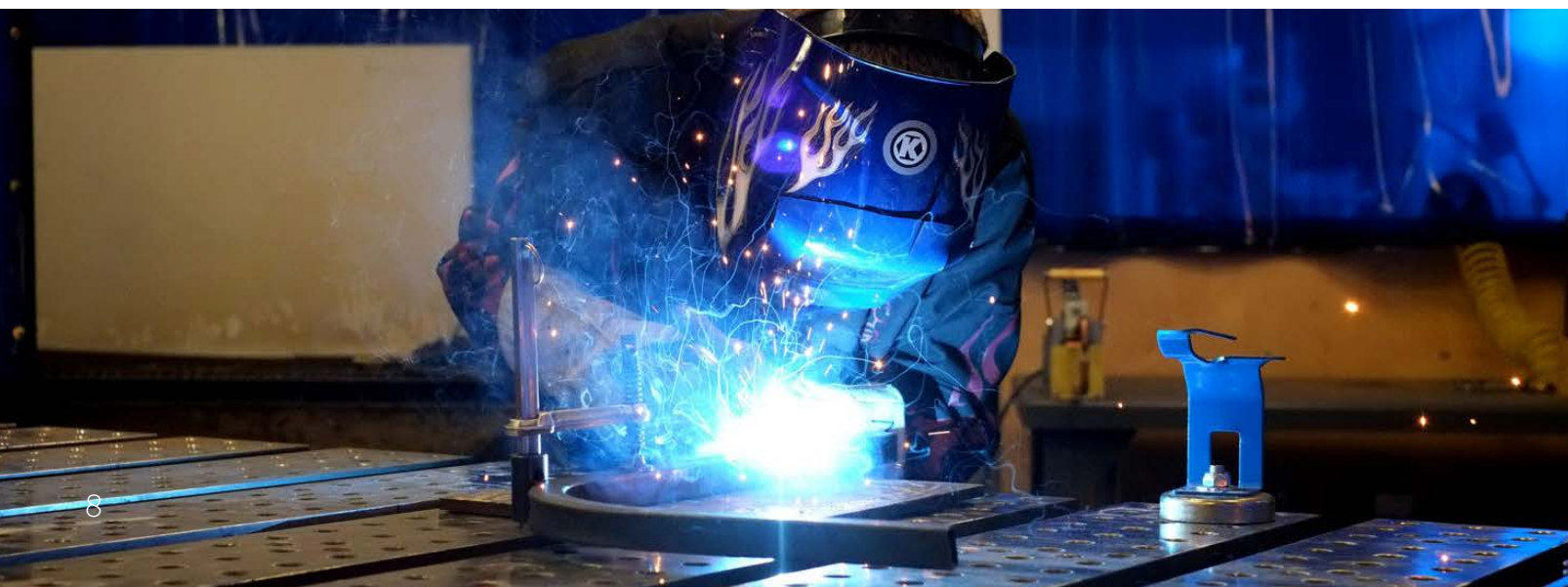
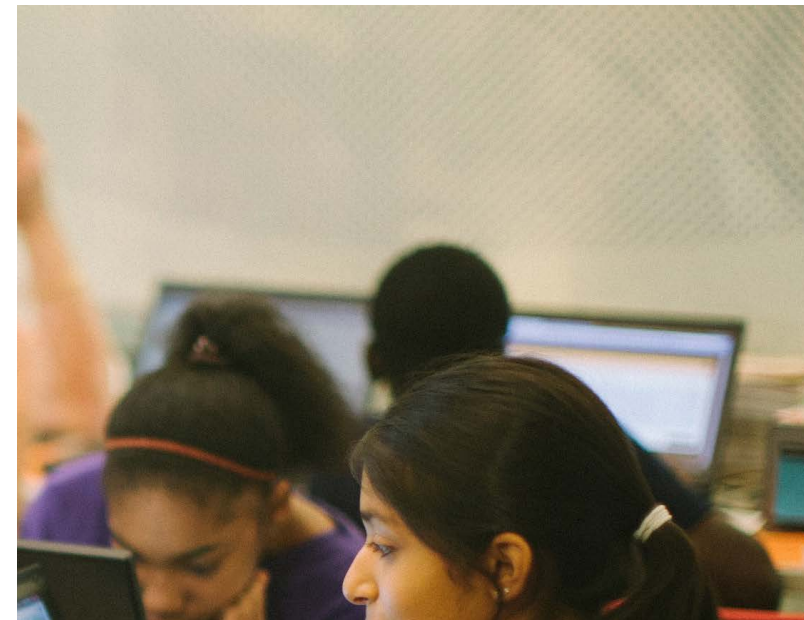
Demographic changes further compound these challenges. Pittsburgh's minority workers are least

likely to work in its highest-paying jobs, and African Americans with bachelor's degrees are leaving faster than they're moving in. Those who leave cite lingering segregation, the lack of a Black middle class, and limited employment and advancement opportunities — none of which bode well for a region already starved for diversity. And despite employers' efforts to recruit and retain minority workers, deep inequities at the K-12 level have kept the bench shamefully shallow: In 2017, more than 3,000 students across Pennsylvania took the AP Computer Science exam. Of those, just 146 were Hispanic or Latino, and 84 were Black. Only two were Native American.<sup>19</sup>

These problems, of course, aren't unique to Pittsburgh. More than half of America's employers say they can't find enough workers with technology skills.<sup>20</sup> Communities around the country are bracing for Baby Boomer retirements — Pittsburgh's demographics just happen to put it first in line. And when it comes to the jobs of the future, young people from low-income families and young people of color face the biggest opportunity gaps nationwide. This is more than a moral failing; it's an economic one, too — one that "imposes the equivalent of a permanent recession on the American economy," according to the nonprofit XQ Institute.<sup>21</sup>

Like the country as a whole, how well Pittsburgh fares will depend on its ability to build an inclusive workforce primed for the challenges of the coming decades. Building such a workforce requires us to rethink the purpose of learning, from early childhood through postsecondary programs and beyond. In the era of increasingly intelligent machines, the ability to memorize information and ace a standardized test will gradually lose its relevance. And while it certainly won't hurt to be, say, a childhood coding prodigy, knowledge and tech savvy alone won't guarantee a thing.

Instead, to thrive in the age of automation, today's young people will need to excel at something else entirely: being human.





**Tomorrow's most successful workers will be the people you can go to with problems; who can listen, ask questions, and think through complex issues; and who can lead diverse, collaborative teams. They'll be endlessly curious and radically empathetic. And most importantly, they'll be lifelong learners.**



## Preparing Today's Kids for Tomorrow's Jobs

In 2009, Google asked its top statisticians to answer a question. Since its founding, the company's culture had been created and driven by software engineers, who naturally assumed that the best engineers made the best bosses. Google took "a pretty simple approach to management," reported *The New York Times*: "Leave people alone. Let the engineers do their stuff. If they become stuck, they'll ask their bosses, whose deep technical expertise propelled them into management in the first place."<sup>22</sup>

To validate that approach, the company tasked its statisticians with Project Oxygen, a multi-year effort to determine which characteristics defined Google's top managers. The statisticians collected and coded more than 10,000 data points from performance reviews, employee surveys, exit interviews, and more. Their findings shocked the company: Of the eight most important qualities Project Oxygen identified, technical expertise ranked dead last. The other, more important skills included the ability to communicate clearly; to take a collaborative approach to problem-solving; and to think critically. More than anything else, Googlers craved accessible managers who cared about employees' careers, personal lives, and well-being.

To be sure, technical expertise was still essential. But what Project Oxygen suggested — and what employers, educators, and researchers have since confirmed — is that as technology transforms the workplace, the traits that separate humans from machines will become ever more valuable. Tomorrow's most successful workers will be the people you can go to with problems; who can listen, ask questions, and think through complex issues; and who can

lead diverse, collaborative teams. They'll be endlessly curious and radically empathetic. Most importantly, they'll be lifelong learners: According to the Allegheny Conference, employers' "number one demand overall is a *trait* rather than a specific *skill*: the desire and ability to learn a new, high-order skill, such as coding, every single day."

Indeed, the entire concept of "readiness" — for college, career, and life — will have to change. Though long measured by test scores, readiness will be increasingly defined by learners' ability to understand and manage their emotions, establish positive relationships, and make responsible decisions. Education systems will have to pivot from a longstanding focus on content knowledge toward these key social-emotional skills, helping young people develop strong inner selves and the emotional flexibility to weather the rapid changes of the 21st century. Between the impact of automation and the decline of full-time work, it's likely that today's young people will have to reinvent themselves again and again, forging careers that cross multiple sectors and require constant upskilling.

The content kids learn will have to change, too, emphasizing digital skills over memorization and test prep. Nationwide, the share of jobs requiring specialized technology skills has already jumped from 45 percent to 71 percent. In Pittsburgh alone, jobs in IT are expected to grow by 11 percent over the next decade — nearly 3 percent faster than the rest of the economy. Skills such as coding are increasingly required even in sectors beyond technology, such as marketing, advertising, and journalism. In fact, digital skills are quickly becoming a



pre-requisite for *any* role offering middle-class wages. Despite this, computer science remains relatively marginalized at the K-12 level; only 40 percent of American schools offer even a single course.<sup>23</sup>

In Pittsburgh, Remake Learning — a network of more than 500 schools, libraries, museums, and others — has garnered international recognition for its efforts to address these shifts. Working to ignite engaging, relevant, and equitable learning experiences for students of every background, network members equip young people with a mix of high-tech tools and essential skills and mindsets. Remake Learning’s CSforPGH working group, for example, works to expand the region’s access to high-quality computer science education. Meanwhile, the network’s educators help kids collaborate, communicate, and think critically through art, science, activism, and problem-solving — students throughout the region film documentaries about changing neighborhoods, engineer real solutions to community problems, and code software for their peers. And the network’s member districts are changing the way schools prepare young people for the future of work: In 2018, the Montour School District made national news when it announced the country’s first artificial intelligence curriculum for middle schoolers.

Montour’s curriculum is just one pioneering effort to bridge the divide between educators and employers — something experts say is critical in order to prepare today’s learners for tomorrow’s jobs. According to the Allegheny Conference, education systems have lagged behind changes in the workplace in part because they “lack access to real-time jobs and skills data, information about future workforce trends, and the time and ability to infuse classroom curriculum with relevant workforce information.”

Experts have proposed a number of solutions. Apprenticeships, for example, have enjoyed a resurgence as of late. Though long considered a way into the construction trades, their scope has broadened; apprenticeships in cybersecurity, coding, and advanced manufacturing are increasingly common.<sup>24</sup> And because they typically involve paid labor, apprenticeships can be an ideal way to reduce inequities in how young people are prepared for the future of work — learners who might be excluded from unpaid internships, for example, can gain experience without sacrificing a paycheck or incurring burdensome debt. One of Remake Learning’s member organizations, Startable

Pittsburgh, offers a free 8-week apprenticeship that teaches 16- to 18-year-olds entrepreneurship and maker skills by helping them develop, design, build, and market their own creations. In addition to earning a stipend, students in the program meet with mentors in their chosen fields and keep the profits they make from selling their products.<sup>25</sup>

Likewise, career and technical education (CTE) is also getting a fresh look. Only about 67 percent of the country’s high school graduates go directly to college, meaning that millions of young people are left out of fields that typically require a four-year degree.<sup>26</sup> While CTE programs have the potential to help learners develop the social-emotional and digital skills necessary for the jobs of the future, this potential has yet to be realized — at least in Pittsburgh. According to the Allegheny Conference, the region’s CTE programs are under-enrolled and under-funded. Many career centers lag behind traditional schools when it comes to academics, and too many are preparing young people for low-paying occupations. (Cosmetology, for example, attracts 12 percent of CTE students, making it the single most popular career track.) Aligning CTE programs with high-growth, high-paying industries could help more Pittsburghers tap the benefits of future-facing jobs.

Experts and policymakers also say more needs to be done to teach students in traditional K-12 environments about the future of work — specifically, about which careers can match their interests while offering stability, security, and a high return on educational investment. In most of America, notes the XQ Institute, high schools still resemble “shopping mall high schools” — “schools that, like their commercial counterparts, seek to satisfy their student consumers with a wide range of course choices and take no position on which choices are most worthwhile.” In a country where student debt now totals \$1.5 trillion<sup>27</sup> — equivalent to the entire GDP of Canada — and high-paying positions *still* go unfilled, it’s clear that improved career guidance would benefit both learners and employers. Experts also say high schools need to educate young people about careers that require two-year degrees or alternative credentials, rather than pushing too many students toward expensive four-year programs.<sup>28</sup>

That’s assuming, of course, that employers are willing to meet learners halfway. As education systems adapt to the future of work, employers, too, must

! Startable Pittsburgh offers a free 8-week apprenticeship.

reconsider how they recruit, interview, and hire new workers. In Pittsburgh, less than 10 percent of employers work with the K-12 system to keep educators abreast of their needs, and fewer than half provide internships for college students. At the same time, many have inflated their degree and experience requirements: Many job listings routinely and unnecessarily require bachelor’s degrees, screening out otherwise-qualified workers and costing employers additional time and money in their effort to fill the roles. Moving forward, employers and educators must work together to develop new ways of measuring and demonstrating competence, such as work portfolios and digital badges.

They must also collaborate to embed relevant people skills into K-12 curricula, both in and out of school. According to the Allegheny Conference, more than two-thirds of employers prefer or require a few years of experience even for entry-level jobs — the main reason being that employers are unable or unwilling to train new hires in basic workplace behaviors like professionalism and teamwork. To that end, classrooms and out-of-school programs have increased their focus on collaborative, project-based learning; while companies such as the Pittsburgh-based SimCoach Games have developed games designed to teach learners requisite workplace skills.<sup>29</sup> When taken to scale, such efforts could eventually help lower or eliminate prohibitive experience requirements.

Finally, parents and families must have access to accurate, up-to-date information about the future of work. Too often, media coverage of automation and related trends suggests a doomsday scenario, envisioning a world in which jobs have vanished and human beings have been rendered irrelevant. Instead, families should have a clear understanding of how jobs — and the skills and mindsets young people need — are likely to change. To that end, Remake Learning launched Remake Learning Days, an annual festival that draws tens of thousands of people to the Pittsburgh region each year. Comprised of hundreds of events that give families a firsthand look at the future of teaching and learning, Remake Learning Days has turned heads everywhere from *Forbes* to the World Economic Forum, and has begun a national expansion designed to reach families across America.

**As education systems adapt to the future of work, employers, too, must reconsider how they recruit, interview, and hire new workers.**







## Conclusion

Pittsburgh is on the cusp of becoming a global innovation hotspot. With its growing tech sector, world-class universities, and long history of resilience and reinvention, the region is well positioned to tackle tomorrow's challenges — yet its success is by no means guaranteed.

In fact, when a research team from the Brookings Institution came to study the region in 2017, they envisioned two scenarios for Pittsburgh's future.

In the first, a small number of future-facing jobs are driven by university research, tech firms, and others, while the rest of the region's economy consists of service-industry work and low-level manufacturing jobs — jobs that, “like in much of the Rust Belt, are increasingly automated or outsourced.” This is the GM scenario: a storyline in which a fortunate few reap technology's benefits, while the rest scramble for an ever-smaller pool of secure, family-sustaining jobs. Existing inequalities widen, and young people without digital and social-emotional skills face immense difficulties as their job prospects — and the region's potential — slip away.

In the second scenario, however, everyone in Pittsburgh has options. The gap between employers and educators has been closed, and efforts at the K-12 level have equipped *every* young person for the future of work. The region's high-growth industries, meanwhile, “collaborate, adopt, and nimbly deploy technology to stay ahead of global competitors . . . creating a reliable tax base and pool of high-wage jobs.” This is the Fanuc scenario — one in which a highly prepared workforce thrives amid rapid, remarkable change. In this scenario, Pittsburghers of every background share in technology's benefits, and young people are “ready” in the new

sense of the word: They're creative, curious problem-solvers; clear communicators; good collaborators; and lifelong learners. Pittsburgh's employers support them throughout their educational journey, helping them learn new skills and reinvent themselves as the region becomes a model of inclusive innovation.

These two scenarios also await the country at large. While the march of technology may be inevitable, how young people fare depends entirely on the decisions we make — or don't make — today. “It's not hard to imagine what might happen if we do nothing,” writes Darren Walker, president of the Ford Foundation. “We can't afford decades of dislocation, unemployment, and downward mobility . . . Societies already plagued by inequality can't bear such levels of upheaval and tumult.”<sup>30</sup>

It's this possibility that keeps a growing number of business, education, and philanthropic leaders awake at night. In Pittsburgh, however, there are plenty of reasons to hope: Thanks to the efforts of educators, innovators, Remake Learning, and others, more young people than ever are preparing for the jobs of tomorrow.

But our collective work is far from finished.

“[It's] time to move beyond conversation and to take definitive actions,” writes Bill Demchak, president and CEO of the PNC Financial Services Group and chairman of the Allegheny Conference. “While many promising new initiatives are underway, we need more employers to take a chance on young talent, more partnerships between educators and businesses to align our talent efforts, and an ongoing commitment to a collective effort to elevate, retain, and attract talent to ensure our region's future prosperity.”



**While many promising new initiatives are underway, we need more employers to take a chance on young talent, more partnerships between educators and businesses to align our talent efforts, and an ongoing commitment to a collective effort to elevate, retain, and attract talent to ensure [the Pittsburgh] region's future prosperity.”**

—Bill Demchak, president and CEO of PNC Bank and chairman of the Allegheny Conference



Written by Ryan Rydzewski  
Photo credits: Ben Filio, Joey Kennedy,  
Sandra Hartkopf, Brian Cohen,  
Christopher Sprowls

## CITATIONS

<sup>1</sup> Hunt, Joshua. "This Company's Robots Are Making Everything—and Reshaping the World." Bloomberg News. <https://www.bloomberg.com/news/features/2017-10-18/this-company-s-robots-are-making-everything-and-reshaping-the-world>

<sup>2</sup> Pilling, David. "An Activist Raid Forces New Logic on Fanuc Robot Factory." Financial Times. <https://www.ft.com/content/0179ec68-b5f3-11e4-a577-00144feab7de>

<sup>3</sup> Null, Christopher, and Brian Caulfield. "Fade To Black The 1980s Vision of 'lights-out' Manufacturing, Where Robots Do All the Work, Is a Dream No More." CNNMoney. [https://money.cnn.com/magazines/business2/business2\\_archive/2003/06/01/343371/index.htm](https://money.cnn.com/magazines/business2/business2_archive/2003/06/01/343371/index.htm)

<sup>4</sup> Clenfield, Jason. "Fanuc Cashes in on Global Shift to Automation." Cape Times. <https://www.pressreader.com/south-africa/cape-times/20101125/283695475938725>

<sup>5</sup> Choudhury, Saheli Roy. "A.I. and Robotics Will Create Almost 60 Million More Jobs than They Destroy by 2022, Report Says." CNBC. <https://www.cnbc.com/2018/09/17/wef-machines-are-going-to-perform-more-tasks-than-humans-by-2025.html>

<sup>6</sup> Manyika, James. "Technology, Jobs, and the Future of Work." McKinsey & Company. [https://www.mckinsey.com/featured-insights/employment-and-growth/technology-jobs-and-the-future-of-work#section\\_2](https://www.mckinsey.com/featured-insights/employment-and-growth/technology-jobs-and-the-future-of-work#section_2)

<sup>7</sup> Frey, Carl Benedikt, and Michael A. Osborne. The Future of Employment: How Susceptible Are Jobs to Computerisation? University of Oxford. [https://www.oxfordmartin.ox.ac.uk/downloads/academic/The\\_Future\\_of\\_Employment.pdf](https://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf)

<sup>8</sup> The Onion. "Secretary Of Labor Assures Nation There Still Plenty Of Jobs For Americans Willing To Outwork Robots." The Onion. <https://www.theonion.com/secretary-of-labor-assures-nation-there-still-plenty-of-1819578194>

<sup>9</sup> Allen, Katie. "Technology Has Created More Jobs than It Has Destroyed,

Says 140 Years of Data." The Guardian. <https://www.theguardian.com/business/2015/aug/17/technology-created-more-jobs-than-destroyed-140-years-data-census>

<sup>10</sup> Inflection Point 2017-18: Supply, Demand and the Future of Work in the Pittsburgh Region. Allegheny Conference on Community Development. [https://www.alleghenyconference.org/wp-content/uploads/2017/12/018\\_InflectionPoint.pdf](https://www.alleghenyconference.org/wp-content/uploads/2017/12/018_InflectionPoint.pdf)

<sup>11</sup> Prince, Katherine, and Jason Swanson. The Future of Learning: Redefining Readiness from the Inside Out. KnowledgeWorks. <https://knowledgeworks.org/resources/future-learning-redefining-readiness/>

<sup>12</sup> Bureau of Labor Statistics. Department of Labor. "Employee Tenure in 2018." News release. <https://www.bls.gov/news.release/pdf/tenure.pdf>

<sup>13</sup> West, Darrell M. "The Need for Lifetime Learning during an Era of Economic Disruption." Brookings. <https://www.brookings.edu/blog/brown-center-chalkboard/2018/05/21/the-need-for-lifetime-learning-during-an-era-of-economic-disruption/>

<sup>14</sup> Andes, Scott, Mitch Horowitz, Ryan Helwig, and Bruce Katz. Capturing the next Economy: Pittsburgh's Rise as a Global Innovation City. Brookings Institution. [https://www.brookings.edu/wp-content/uploads/2017/09/pittsburgh\\_full.pdf](https://www.brookings.edu/wp-content/uploads/2017/09/pittsburgh_full.pdf)

<sup>15</sup> Fraser, Jeffery. "Technology Shift." H Magazine: The Magazine of The Heinz Endowments. [http://www.heinz.org/UserFiles/Library/2018\\_Issue\\_1\\_Technology\\_Shift.pdf](http://www.heinz.org/UserFiles/Library/2018_Issue_1_Technology_Shift.pdf)

<sup>16</sup> Vinik, Danny. "The Real Future of Work." POLITICO Magazine. <https://www.politico.com/magazine/story/2018/01/04/future-work-independent-contractors-alternative-work-arrangements-216212>

<sup>17</sup> Inflection Point 2016-17: Supply, Demand and the Future of Work in the Pittsburgh Region. Allegheny Conference on Community Development. <https://www.alleghenyconference.org/wp-content/uploads/2016/08/InflectionPoint.pdf>

<sup>18</sup> Ibid.

<sup>19</sup> Code.org

<sup>20</sup> Snapp, Mary. "The Workplace of Today Is Not What It Was 35 Years Ago. Computational Thinking Is the New Basic Requirement." The 74. <https://www.the74million.org/article/the-workplace-of-today-is-not-what-it-was-35-years-ago-computational-thinking-is-the-new-basic-requirement>

<sup>21</sup> "High School & The Future of Work: A Guide for State Policymakers." XQ Institute. <https://xqsuperschool.org/future-of-work>

<sup>22</sup> Bryant, Adam. "Google's 8-Point Plan to Help Managers Improve." The New York Times. <https://www.nytimes.com/2011/03/13/business/13hire.html>

<sup>23</sup> Iasevoli, Brenda. "How One District Is Preparing Students for an AI-Powered World." Education Week. [http://blogs.edweek.org/edweek/curriculum/2018/08/how\\_one\\_district\\_is\\_preparing\\_students.html](http://blogs.edweek.org/edweek/curriculum/2018/08/how_one_district_is_preparing_students.html)

<sup>24</sup> Prebil, Michael. "Teach Cybersecurity with Apprenticeship Instead." New America. Accessed October 15, 2018. <https://www.newamerica.org/education-policy/edcentral/teach-cyber-apprenticeship-instead/>

<sup>25</sup> Lev, Katy Rank. "The Modern Apprenticeship." Remake Learning Blog. <https://remakelearning.org/blog/2018/03/23/the-modern-apprenticeship/>

<sup>26</sup> "College Enrollment and Work Activity of Recent High School and College Graduates Summary." News Release. Bureau of Labor Statistics. Department of Labor. <https://www.bls.gov/news.release/hsgsec.nr0.htm>

<sup>27</sup> Friedman, Zack. "Student Loan Debt Statistics In 2018: A \$1.5 Trillion Crisis." Forbes. <https://www.forbes.com/sites/zackfriedman/2018/06/13/student-loan-debt-statistics-2018/#5b6b47c97310>

<sup>28</sup> Gonser, Sarah. "Out of Poverty, into the Middle Class." The Hechinger Report. <https://hechingerreport.org/out-of-poverty-into-the-middle-class/>

<sup>29</sup> Lev, Katy Rank. "Engaging Every Student." Remake Learning Blog <https://remakelearning.org/blog/2018/03/30/engaging-every-student/>

<sup>30</sup> Walker, Darren. "On the Future of Work(ers)." Ford Foundation Blog. <https://www.fordfoundation.org/ideas/equals-change-blog/posts/on-the-future-of-work-ers/>



**Questions? Ideas?**  
Contact [ryan@grable.org](mailto:ryan@grable.org).

This publication  
was supported by:

