



# EXPANDING TECH APPRENTICESHIPS IN NEW YORK CITY

**Expanding Tech Apprenticeships in New York City** is a publication of the Center for an Urban Future. Researched and written by Judith Messina and Eli Dvorkin. Edited by Jonathan Bowles, Eli Dvorkin, and Laird Gallagher. Designed by Rob Chabebe.

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# EXPANDING TECH APPRENTICESHIPS IN NEW YORK CITY

**New York City is home to nearly 100 apprenticeship programs today, but the vast majority of them—93 percent—are in the building trades and manufacturing.<sup>1</sup>**

As the demand for tech talent surges, the city has an enormous opportunity to leverage this powerful training model to expand pathways into technology careers.

Arguably the most powerful tool for connecting people with limited technical skills and formal education to the training needed to succeed on the job, apprenticeship is ideally suited to New York City's growing tech workforce. The sector is growing faster and creating more good jobs than any other part of New York City's economy, adding more than 46,000 well-paying jobs over the past decade.<sup>2</sup> Meanwhile, both tech companies and non-tech employers face large and growing tech talent needs, including a more stable pipeline of entry-level workers for middle-skills jobs.

But even as the demand for tech talent grows, Black and Latinx New Yorkers as well as women remain significantly underrepresented in tech occupations. Tech apprenticeships present an important opportunity to change that, providing a proven model for launching underrepresented talent into successful careers.

Given the promise of tech apprenticeship to help diversify the sector while expanding pathways into well-paying jobs, it is striking that so few have taken root in New York City to date. This report finds fewer than 15 programs citywide that are currently applying this model to tech jobs, collectively reaching just a few dozen people each year. Among the city-based apprenticeship programs registered with New York State, just three are in tech occupations. None is currently enrolling new apprentices as of November 2019.

At the same time, a small but growing number of local and global employers are finding success with tech apprenticeships in New York City—including Barclays, Spotify, IBM, and Foursquare—suggesting that emerging interest from New York City's tech sector can be harnessed with the right support. And established programs in Washington State, Colorado, California, and elsewhere are demonstrating that tech apprenticeship can work at a much larger scale.

There are understandable reasons why relatively few tech apprenticeships have gotten off the ground—from limited awareness of the model among tech employers and skepticism that a cumbersome state registration process can adapt to a fast-changing sector to concerns that the city's large number of smaller start-ups lack the bandwidth to expand from core HR duties into apprenticeship development.

But as we detail in this report, it is eminently possible to overcome these barriers and significantly expand tech apprenticeships in New York. Doing so will require support from city and state economic development officials as well as leadership from the city's tech employers. This report lays out several steps to realize the promise of tech apprenticeships in New York.

**Based on more than 40 interviews with tech** company leaders and HR directors, training providers, city workforce development officials, education experts, and apprentices themselves, this report—the latest in a series of Center for an Urban Future studies focused on the promise of apprenticeship in New York—examines the opportunity to expand the apprenticeship model throughout the tech sector.

Funded by Barclays, a transatlantic consumer and wholesale bank with global reach, the report explores the advantages for workers and employers alike, lays out the current status of tech apprenticeship in NYC, identifies the major challenges to starting and growing apprenticeship programs in tech, and puts forward workable models and approaches from across the country. The report concludes with several achievable recommendations for city and state policymakers, tech employers, and nonprofit workforce organizations, among others, to harness the full potential of the apprenticeship model to expand career opportunities in New York’s tech sector.

### **The Opportunity to Grow Tech Apprenticeship in New York City**

Apprenticeship programs offer a uniquely powerful model for boosting economic mobility. Built to provide workers with a steady paycheck while developing specific job skills and competencies, the model has been proven to boost earnings over the long term—by more than \$300,000 over the course of an apprentice’s career—while making training and education accessible to job seekers from low-income backgrounds.<sup>3</sup>

For apprenticeships in technology careers, the effect can be even more powerful. Participants in tech apprenticeship programs often progress from minimum wage jobs to full-time salaries of \$40,000 or more while in training and \$70,000 to \$80,000 after receiving a job offer. In many cases, apprentices are accessing these opportunities without college degrees or with just a few college credits. In other cases, apprentices have completed a short course at a bootcamp but otherwise have no background in computer science or experience working in tech.

“It’s the way to go, the wave of the future,” says

Helen Kogan, executive director of NPower in New York, a nonprofit workforce training organization that has developed apprenticeship programs in several states to prepare military veterans and young adults from underserved communities for digital careers. “There are things you can’t teach someone in a classroom that you have to be in the workplace to understand. Successful apprentices are on the train to the corporate tech world. They are getting good jobs—going from unemployment to over \$40,000 per year to start. The needle has moved on their lives, their families, and their communities.”

In New York City, with more than 191,000 jobs in the tech sector and 92,000 tech jobs in non-tech companies, leveraging apprenticeship models to help build stronger pathways into these well-paying jobs is a significant but largely untapped opportunity.

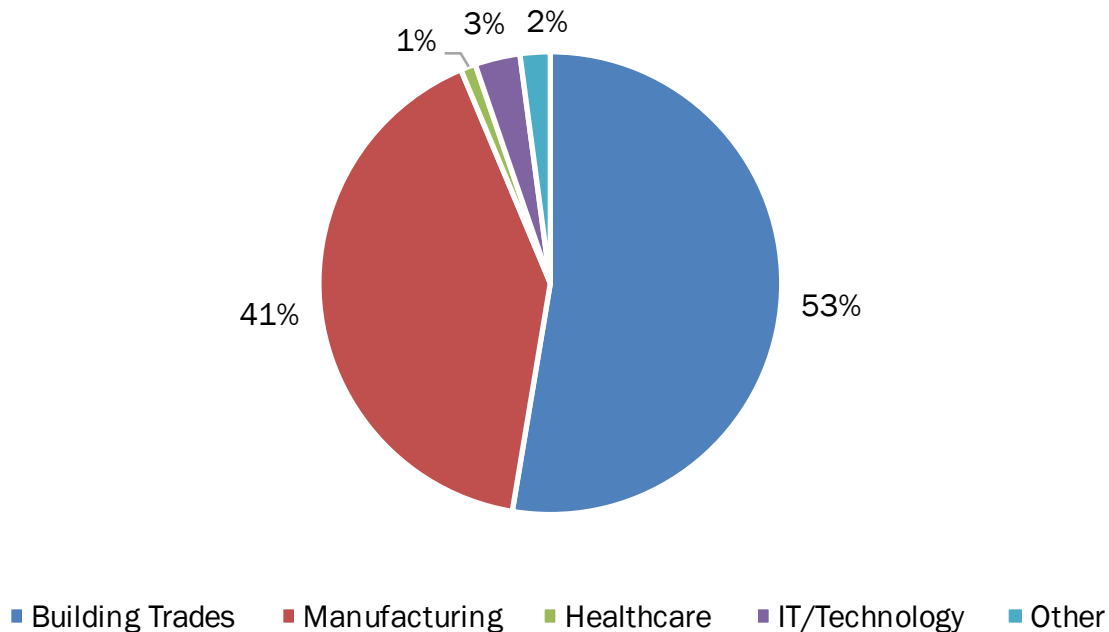
The city is home to more than 9,000 tech start-ups, major offices for nearly every leading global tech company, and thousands of non-tech companies in industries from finance to healthcare that are hiring for a rapidly growing number of tech roles.<sup>4</sup> But despite the significant potential for tech apprenticeships to help strengthen the talent pipeline for New York City’s tech sector while diversifying the tech workforce, our research finds fewer than 15 programs in New York City today that are using apprenticeship to help hire for tech jobs.

We identified just a handful of large companies—including Barclays and IBM—and fewer than a dozen mid-sized and smaller companies—including Spotify, Foursquare, 2U, and StackOverflow—offering tech apprenticeships in New York City, collectively working with no more than a few dozen participants annually.

“Each program that exists is expanding the notion of where tech talent comes from,” says Joey Ortiz, executive director of the New York City Employment and Training Coalition. “But it’s a handful of individuals in each organization—a drop in the bucket in terms of the numbers of hires these companies require and the number of New Yorkers that could potentially be served.”

Today, the vast majority of New York City’s apprenticeship programs are in the building

## NYC Registered Apprenticeships by Industry



Source: Center for an Urban Future analysis of data on registered apprenticeship programs in New York City from the New York State Department of Labor, November 2019.

trades and manufacturing, two sectors that have long been champions of the model. Among the 95 current apprenticeship programs registered with the New York State Department of Labor and based in New York City, just three are for IT or tech jobs and none is with a company in the tech sector—all three program sponsors are electrical contractors. Of the 877 active or pending registered apprenticeship programs statewide, just six are in tech occupations and none is sponsored by a tech company.<sup>5</sup>

One notable bright spot is the city's Tech Talent Pipeline, which is partnering with more than a dozen companies—including Spotify, LinkedIn, Stack Overflow, and Foursquare—to develop a fellowship for associate engineers. This apprenticeship-like model is helping to source underrepresented talent for engineering roles and build paid, on-the-job training programs to help entry-level hires succeed. Although these initiatives lack all the features of a multi-year

apprenticeship, this industry-driven approach is the city's first attempt to apply an apprenticeship-like model to tech careers.

In 2017, Mayor de Blasio and the Department of Small Business Services also launched ApprenticeNYC, a \$5 million investment to create 450 apprenticeships in the industrial, health, and tech industries by 2020. This promising initiative is New York City's first government-supported effort to expand the apprenticeship model, and the first cohort of apprentices is already enrolled in an 18-month program to apprentice as CNC machinists in the advanced manufacturing industry. The initiative has also supported other apprenticeship-like models, including the Tech Talent Pipeline's associate engineer program. However, despite the initial goal to expand into the tech sector, the initiative has yet to launch a full-fledged, registration-eligible tech apprenticeship under the ApprenticeNYC banner.

In addition, New York State has launched new efforts to support the expansion of apprenticeship programs into tech occupations. The Empire State

Apprenticeship Tax Credit, which went into effect in January 2018, provides employers with a tax credit starting at \$2,000 per apprentice for registered apprenticeships focused on in-demand occupations outside of the building trades. In September 2019, Governor Andrew Cuomo announced a \$3 million investment in apprenticeship program development at the State University of New York targeted to emerging fields like artificial intelligence, cybersecurity, and cloud infrastructure.

In the years ahead, New York City is projected to create thousands of jobs in specific tech occupations that have proven adaptable to the apprenticeship model. Occupations including software developers, network security administrators, computer systems administrators, IT business analysts, and data center technicians have all been developed into apprenticeship programs in other states and could be launched in New York City.

A major expansion of apprenticeship programs in the city's tech sector could have a profound effect on the goal of expanding economic opportunity. For many New Yorkers from low-income backgrounds, getting on the path to one of these careers can be a major springboard to the middle class. Growing the number of apprenticeships in the tech sector—from dozens today to hundreds or thousands in the next five years—could help to change that dynamic, creating an important new on-ramp to well-paying jobs for New Yorkers without the credentials that typically grant access to these opportunities. At the same time, a major commitment from New York City and State to expand tech apprenticeship can help more New Yorkers become financially self-sufficient and create a ripple of economic activity that will strengthen families, communities, and the city.

“We believe that apprenticeship models represent one of the best tools for expanding economic mobility,” says Deborah Goldfarb, Global Head of Citizenship at Barclays. “When combined with a demand-led approach that focuses on where employers are hiring, this model can help create access to jobs that might otherwise be out of reach.”

## Closing New York City's Tech Opportunity Gap

Jobs in technology—whether at major tech companies, in other sectors like finance and healthcare, or in the city's booming start-up scene—are among the fastest-growing occupations paying middle-income wages or higher. Yet Black and Latinx New Yorkers, women, and people from lower-income backgrounds remain under-represented in tech jobs citywide.

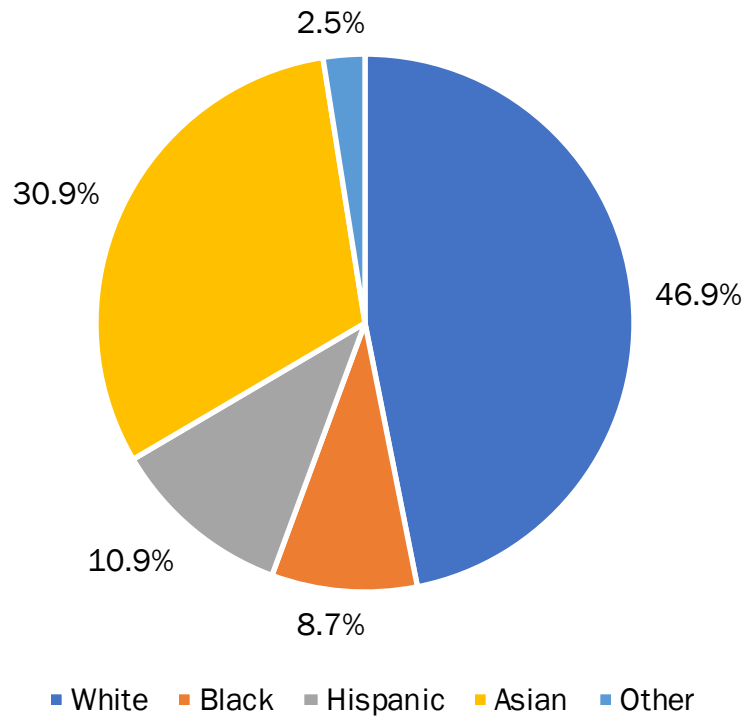
According to our analysis of the 17 major high-tech occupations in New York City's economy, Black and Latinx workers account for 19.6 percent of New York City's tech workforce (8.7 percent Black and 10.9 percent Latinx). Women make up just 24.2 percent.<sup>6</sup>

While these shares are higher than other major tech hubs nationwide, there is still much more progress to be made in a city with an overall workforce that is 18.5 percent Black, 24.4 percent Latinx, and nearly half women.

Our research finds that tech apprenticeships could help close this gap. By combining on-the-job training and classroom instruction with the opportunity to earn a salary from day one, apprenticeships can create pathways for low-income New Yorkers without the postsecondary degrees, work experience, or industry certifications that are often prerequisites for tech jobs—and open doors for New Yorkers from low-income backgrounds who might otherwise be overlooked for opportunities in tech.

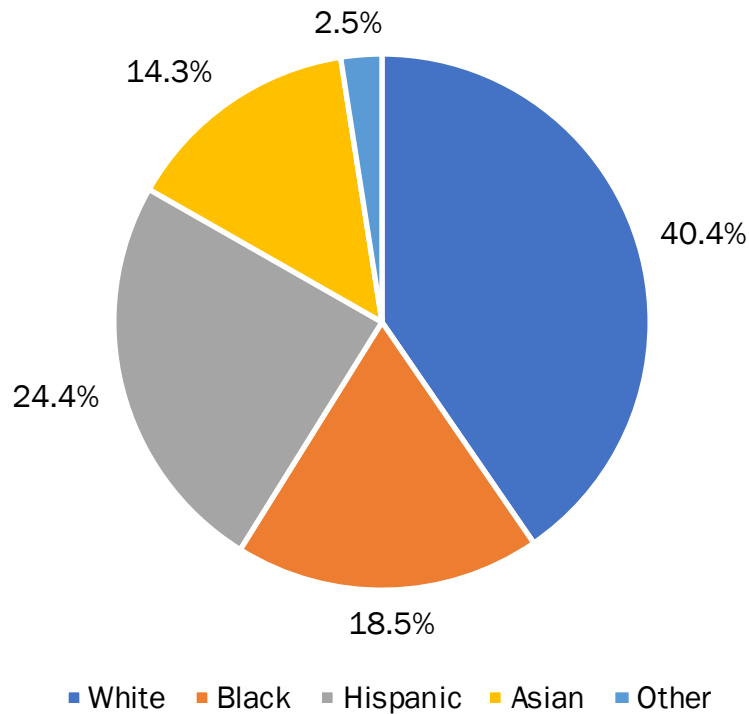
There's little question that a traditional four-year college degree remains the most common credential for people in the city's tech workforce, and expanding access to the tech sector for lower-income New Yorkers should include new efforts to boost college success. But given the costs in terms of both time and money required to earn a four-year degree—and competing demands like family obligations and the need to work full-time to cover living expenses—many New Yorkers could benefit immensely from alternative paths to stable careers. In a city where fewer than 23 percent

## NYC's Tech Workforce by Race/Ethnicity



Source: Center for an Urban Future analysis of data from the U.S. Census Bureau, 2017 American Community Survey, five-year sample.

## NYC's Total Workforce by Race/Ethnicity



Source: Center for an Urban Future analysis of data from the U.S. Census Bureau, 2017 American Community Survey, five-year sample.

of full-time community college students earn a two-year degree within three years, a paid model of work-based training that meets real employer needs could provide a powerful boost to economic mobility for far more New Yorkers.

“We’re taking a new and hard look at apprenticeship programs,” says Kenneth Adams, dean for workforce and economic development at CUNY’s Bronx Community College. “We need to work with employers to design training programs and credentials that demonstrate mastery for entry-level, middle-skill jobs in tech that don’t require a bachelor’s degree. There are tens of thousands of those jobs in New York. We’ve got to give people options.”

Apprenticeship can also serve as a powerful tool for connecting youth to the workplace and bringing hands-on, work-based learning experiences into the city’s high schools. For many high school students, the opportunity to explore how skills and knowledge can lead to rewarding careers has a significant motivating effect—introducing goals that mean far more than just a test score.

“We need to rethink how we train young people,” says Barbara Chang, executive vice president at HERE to HERE, a Bronx-based nonprofit that recently launched CareerWise New York, a major new youth apprenticeship initiative. “Apprenticeships are one of the best ways to get young people trained in the workplace—and tech can lead the way.”

### **The Benefits of Apprenticeship for New York City’s Tech Sector**

Although relatively few companies have launched apprenticeship programs for tech jobs in New York City, the benefits are increasingly clear for those that have.

Across more than 15 interviews with company leaders, engineering managers, and HR directors on the market for tech talent—both within the tech sector and in other industries—three significant benefits emerged that underscore the value of the apprenticeship model: a more diverse workforce, a stronger

pipeline of entry-level talent, and a model for future reskilling needs.

### **A More Diverse Workforce**

Many tech companies in New York City are seeking ways to diversify their tech talent pool. Although the city’s tech sector is more diverse in terms of both ethnicity and gender than other leading tech hubs like San Francisco, Boston, and Seattle, there is still a long way to go until the demographics of tech employment reflect the diversity of the city overall.

Several tech executives and HR leaders we interviewed expressed optimism that robust apprenticeship programs could be an important part of the solution, opening up a talent pipeline that is more diverse in terms of age, ethnicity, gender, educational background, and previous work experience.

“It pays to have a diverse, young talent pool that is eager and has a different perspective than some of the talent that has grown up in the organization,” says Christine Allers, vice president of sales and learning at Broadridge Financial Solutions, a leading provider of communications and data analytics services to financial firms. Five years ago, Broadridge launched an eight-month paid apprenticeship-like program in partnership with NPower, which has been effective for the company and its workers. “It’s proven valuable in boosting creativity and the drive for a young talent pipeline that we’re trying to build,” says Allers.

The latest 14-apprentice cohort at 8th Light, a custom software development firm with offices in New York and four other cities, includes eight people of color and nine women—both significantly higher proportions than the typical talent pool for software engineering roles. Similarly, Pursuit, a Queens-based nonprofit tech training organization that works with companies such as Spotify and Pinterest to train and supply underrepresented talent for apprentice-like opportunities, recruits from across New York City. “Half our cohorts are women and half are Black and/or Hispanic,” says David Yang, co-founder and chief



# “Apprenticeships are one of the best ways to get young people trained in the workplace—and tech can lead the way.”

creative officer of Pursuit. “It is important that people from all backgrounds get access to these jobs.”

A more diverse pipeline would provide multiple benefits, according to industry leaders: research shows that diverse teams perform better, and diverse perspectives in tech are better positioned to meet the challenges and seize the opportunities of an increasingly diverse global market.

“By expanding our approach to talent, we’ve found multiple benefits,” says Hannah Wolf, talent acquisition partner at Spotify, who helps manage the company’s NYC Technology Fellowship Program, an apprenticeship-like model for developing associate engineers. “Creating on-ramps for people who are underrepresented in our workforce today brings more perspectives into the room, people from more walks of life, and allow us to build better products that reflect our users and our platform’s creators.”

## **A Stronger Entry-Level Pipeline Amid Rising Competition**

As New York City’s tech sector grows, competition for talent is growing more ferocious by the day. But some tech executives and HR leaders say that competing for experienced talent comes with high costs and insufficient returns. Smaller start-ups cite problems losing out on experienced talent to larger or better-funded tech companies that can offer higher compensation. Meanwhile, large companies in industries ranging from financial services to IT say that demand for

middle-skill tech roles such as data analysis and cybersecurity is outpacing supply.

“It’s a war zone,” says Matt Kamen, senior vice president of engineering at Foursquare, characterizing the market for tech talent in New York City. “For anyone in the industry, it doesn’t matter what type of company they want to work for, they have huge choice in the market. It’s exciting, but it creates intense competitive pressure. Access to talent is the name of the game, and apprenticeship is a way for us to access talent.”

## **A Model for Reskilling**

As automation and advances in artificial intelligence transform day-to-day jobs and tasks across a broad mix of occupations, more companies are recognizing the need to develop systems that can enable their workforces to reskill at scale.

With few proven models for reskilling workers efficiently and effectively as business needs change, a growing number of companies see apprenticeship programs as a promising strategy to future-proof their workforces—creating effective systems for developing talent that can adjust as needs change.

“Apprenticeship-like models show you can build an adaptable workforce,” says IBM’s Thomas Wenzlau. “Every organization will need to develop strategies to upskill their workforces as technology and needs change. Apprenticeship models prove it’s possible.”

# THE LANDSCAPE OF TECH APPRENTICESHIP IN NEW YORK CITY

**Despite significant potential for the apprenticeship** model in New York City's fast-growing tech sector, very few programs exist today. We identified just a handful of large companies and fewer than a dozen mid-sized and smaller companies offering tech apprenticeships in New York City, collectively working with no more than a few dozen participants annually.

New York City's current tech apprenticeship programs follow one of several approaches. A few large companies have developed apprenticeship programs nationally or internationally and are bringing the model to New York, including Barclays and IBM. There are a small number of nonprofit skills-building and tech training organizations—including Per Scholas, Pursuit, and NPower—that are co-creating apprenticeship programs with employer partners to help bridge the gap between an in-depth training program and a successful tech career.

In addition, just under a dozen smaller start-ups and mid-sized tech companies—including Spotify, Stack Overflow, LinkedIn, Betterment, MediaMath, Energy Watch and Foursquare—are working with the city's Tech Talent Pipeline to launch apprenticeship programs for associate engineers. And there are about 17 companies working with CareerWise New York—launched in fall 2019 by the Bronx-based nonprofit HERE to HERE—to offer youth apprenticeship programs, including several focused on tech occupations, to students enrolled in New York City high schools.

There are also three state-registered apprenticeship programs in IT fields—network administrator, software developer, and network engineer—that have been started by local small businesses. (Of those three, two are brand new and still in the approval process.) New York

City's sole registered apprenticeship program for software developers is sponsored by an electrical contractor focused on transit infrastructure and based in Queens.

Tech apprenticeships typically last from three months to a year, with multiple phases. Most programs begin with a ramp-up period, where prospective apprentices gain a burst of technical skills in an educational or training setting before stepping into the workplace.

The most established model in New York City is operated by Barclays. Participants first go through a rigorous 15- to 17-week training program at Per Scholas, a national nonprofit focused on closing the opportunity divide for technology careers, and are then placed on teams at Barclays where they undertake a two-year paid apprenticeship. Since the program started in 2012, Barclays has hired more than 50 Per Scholas students as apprentices and/or full-time employees.

## From the Bronx to Barclays

Back in 2013, Bronx-born Joshua Ortiz was attending Hostos Community College, hoping to major in computer science. But the only tech program Hostos offered at the time was in office technology, which focused on basic computer skills and applications like Excel. He spent a year in the program, thinking he would use those skills to get a job as an administrative assistant, then go back to school at night and start all over again.

When a friend encouraged him to take courses at tech training organization Per Scholas instead, he thought it sounded too good to be true.

“I thought nothing good is free,” says Ortiz. “No thank you.”

Still, he gave it a try—and it has changed his life.

“I thought, ‘What do I have to lose, the course is only 15 weeks,’” says Ortiz, who was drawn to technology as a teenager but had never experienced formal computing education. “After my first two days, I said, ‘I love this.’ I woke up every day and wanted to be there, I wanted to learn, I was so hungry for it.”

His enthusiasm caught the eye of his instructors, and they recommended him for a two-year tech apprenticeship with Barclays where he joined a technical team, was assigned a “tech buddy” as a mentor, and eventually became a senior desktop support engineer. Today he’s moved on from desktop support to being a Citrix virtual desktop engineer, going “from helping one person at a time to helping hundreds of users at a time.” He’s also training new apprentices and continuing to expand his own skills.

“I want to learn as much as I can,” says Ortiz. “Barclays offers free training on all types of technology. I can go anywhere.”

He’s also understandably enthusiastic about the future of tech apprenticeships. He wishes there were more apprenticeship opportunities in tech roles and more training programs to help prepare for them, he says, and that those programs that do exist had the resources to be marketed more broadly.

“I think the success stories need to be broadcast,” he says. “With the right training and support on the job, you’re worth just as much as another person with a computer science bachelor’s degree.”

At Year Up, a national nonprofit that offers two apprenticeship-like programs in tech occupations targeted to underserved young adults, the program includes six months of classroom instruction and six months of on-the-job training with a regular stipend to offset basic costs. At CareerWise New York, the first cohort of high school students is now participating in a three-year-long program, including classroom instruction and paid apprenticeships that will result in both college credits and industry credentials.

In the workplace, apprentices receive support and coaching from a mentor and/or manager. They work in a variety of jobs depending on the company but typically as junior coders, quality assurance technicians, data analysts, cyber security analysts, and computer support technicians. Some take courses or complete a degree while they are on the job. Often, they work toward industry certification as part of the program. Intermediary organizations like NPower often stay involved. In some cases, companies pay tuition for an apprentice to take coursework or finish requirements for a degree. Most programs are unregistered, with the company developing curriculum in conjunction with a bootcamp or workforce development organization.

Caroline Cruz, 29, is one of the apprentices in Pursuit’s program. She spent ten months learning to code at Pursuit and is now an apprentice iOS developer at Pymetrics, a tech-driven talent recruiter. “This has completely changed everything for me,” Cruz says, who was making just \$22,000 when she enrolled at Pursuit and is now earning a salary in the low six figures. Inspired by her career trajectory, she has been teaching her six-year-old daughter and her daughter’s friends simple coding: “They are learning basic programming skills and to think logically.”

# OBSTACLES TO EXPANDING TECH APPRENTICESHIP

**Given the potential of apprenticeship** programs to build a strong pipeline of diverse and underrepresented talent, this model shows significant promise for the tech sector. But our research finds that several significant and understandable challenges are inhibiting the adoption of apprenticeship programs among New York City’s tech employers. To launch and scale up apprenticeships across the city’s tech ecosystem, the following obstacles will have to be addressed.

## **Limited awareness and few working models make for slow uptake and growth**

Across more than a dozen interviews with tech executives and talent team leaders within the city’s tech sector, only a handful were aware that apprenticeship programs could apply to tech jobs. That’s not unusual, says Lauren Andersen, executive director of Tech Talent Pipeline, as most employers associate apprenticeship with the building trades or manufacturing—if they are familiar with the model at all.

“The challenge in tech is that very few companies are aware of the model and its benefits,” says Andersen. “The voices they trust most are from other companies in the industry—and the more companies hear from their peers, the better. But the scale is still so small.”

As a model of intensive, paid training and a tool for expanding diversity, apprenticeships are not well known or understood in the tech community. Short-term internships for college students are far more common in the industry, and most recruiting efforts focus on either engineering talent with several years of experience, or recent graduates from a small number of highly ranked four-year

colleges. Our research finds that many New York-based tech executives assume apprenticeships are best suited—or only apply—to traditional building trades, such as plumbing and carpentry.

That goes for potential recruits, too. Jisoo Shin, who apprenticed at Stack Overflow and now works there as a software developer, had never considered an apprenticeship in tech before enrolling at the Grace Hopper Program’s Coding Bootcamp, an immersive software engineering course for women with no upfront tuition cost. “Out of 30 employers at Career Day, only one offered an apprenticeship,” says Shin. “Apprenticeships were a foreign concept to me and to a lot of my bootcamp cohort.”

Limited awareness of the model in tech means that significant efforts need to be made to market apprenticeships to employers, build a community of tech sector ambassadors and practitioners, and expand the pool of prospective participants who can succeed in these programs.

## **The long-term investment that apprenticeship requires can be challenging, as many tech companies are seeking talent that can contribute right away.**

In industries with long histories of apprenticeship, like the building trades and manufacturing, it’s not uncommon for apprentices to get hired and stay with their employers for years or even decades. As a result, committing to a multiyear apprenticeship program, from the employer’s perspective, can result in a substantial return on investment over an employee’s career.

But in the fast-paced tech sector, where employees change jobs frequently and companies

are looking for skilled talent that can contribute from day one, the concept of a year-long apprenticeship can feel like a risky investment.

“Given all the challenges tech companies face around finding talent here and now, it’s hard for many to envision making that long-term investment for someone who might not be a fit for the company’s needs,” says Eric Westphal, senior director, global workforce strategy and economic development at Cognizant, a Fortune 500 digital services company that consults with businesses worldwide. “Many tech companies will say they need talent right now.”

David Yang of Pursuit says his efforts to bring on employer partners to their fellowship program typically entail months of long conversations, focused on making the case that the long-term investment is worth the cost. The organization’s efforts have been successful, he says, because he is able to focus on cultivating in-depth employer relationships one by one.

“Most employers have established hiring practices and often a college degree or previous work experience serves as a marker of talent,” says Yang. “Candidates who don’t have that seem like a risk to employers. It’s hard for employers to hire someone who doesn’t have those traditional markers of success.”

### **Apprenticeship registration is a major hurdle for many tech employers**

The complexities of registering an apprenticeship program with the New York State Department of Labor risk turning away companies and managers for whom apprenticeships in themselves are already a new concept.

NPower has partnered with companies outside New York to run state-registered, six-month apprenticeship programs for technology careers, but in New York City it has avoided the model so far. “Apprenticeships? In New York we don’t even go there,” says NPower Executive Director Helen Kogan. “The process at the State Department of Labor is so complicated. It’s just not nimble enough for us to do it.” Instead, after 14 weeks of full-time training, NPower connects participants in New

York with 12-week paid internships. 37 percent of those interns have gone on to be employed by their firms.

In New York City, both intermediaries and tech companies say that there is little appetite to navigate the structural complexities and time-consuming process of getting apprenticeships registered with New York State. Our research suggests that those regulations are, in fact, a particular challenge for tech apprenticeships. Registered apprenticeship programs are prohibited by law from modifying their curricula within two years of launch, which would prevent prospective tech employers from helping programs stay up to date with rapidly changing technology.

“When you can’t change the curriculum to meet their needs, it becomes a problem,” says Nakisha Evans, director of Workforce Partnerships at CUNY’s Continuing Education and Workforce Program.

### **New York’s tech start-ups are mostly small, and lack capacity to take on the demands of an apprenticeship program**

When it comes to growth in tech start-ups, New York City is second only to San Francisco among tech hubs nationwide. But in a city where so many tech jobs are growing at smaller and mid-sized companies, the demands of the apprenticeship model can pose a unique challenge. Leaders of New York City-based tech start-ups say that they worry their companies lack the bandwidth and staff capacity to train and mentor apprentices. Typically funded with venture capital dollars and laser-focused on achieving rapid growth, start-ups in particular worry that apprentices could slow their productivity, even as they appreciate the value of the model for larger and more established companies.

“Most tech companies start out as start-ups,” says Andrew Rasiej, founder and CEO of Civic Hall, a center for tech learning and collaboration based in Manhattan. “They don’t have the time, inclination, or perspective to focus on apprenticeships.”

New York City's robust start-up ecosystem is a major strength of the tech sector overall, but poses specific challenges when it comes to advancing the apprenticeship model. At least two of the companies CUF interviewed for this report, both of which have hosted apprentices for one year, have said they haven't yet decided when they will take on more.

"We will have to evaluate it as part of overall headcount and budget," says one hiring manager. "It's more volatile than in a larger company. It's hard for us to make promises other than that we are committed to doing it again in the near future."

### **Engaging employers takes significant time and resources that few training partners have.**

To ensure that tech apprenticeship programs develop talent that meets real company needs, employers have to be part of the process from planning through to launch and execution. In many cases, this process begins with an apprenticeship intermediary or training provider reaching out to employers to gauge interest, discussing the benefits of the model, and offering support with program development, recruitment, and implementation. It takes time and staff resources to identify the appropriate decision makers within a company and then show them how an apprenticeship program can address talent needs. And it can take a sustained, high-level effort for employers to see that nontraditional candidates are worth the perceived risk.

In Washington State, that effort is led by Jennifer Carlson, executive director of Apprenti. Launched by the Washington Technology Industry Association—a trade group with more than 2,000 employer members including Microsoft and Amazon—Apprenti works with tech companies to identify apprenticeable jobs, source training providers, recruit and vet candidates, develop pre-apprenticeship training, manage the apprenticeship registration process, and support companies and apprentices throughout the entire process.

None of that would be possible without the

resources and bandwidth to cultivate employer partners over the long term.

"It takes many meetings just to get the right people at the table," says Jennifer Carlson. "A company leader may think apprenticeship sounds like a great idea, but when they see the candidates on paper, it's still hard for them to stomach someone coming in without the usual skills—and you're paying them. You're building your talent, you're not buying talent. That's the biggest challenge that companies face."

Working through that challenge requires nimble partners and intermediaries who can understand employer needs, articulate a clear case for the model, help navigate the process both internally and externally, and help mitigate the perceived risk—a set of responsibilities that requires hands-on leadership and significant resources on the part of those intermediaries.

"It takes a lot of relationship and trust building to bring these programs to life," says Sarah Conte Wessel, senior director of employer partnerships and career services at Per Scholas in New York. "You have to be on the same page about what you are trying to achieve. I want to ensure that Per Scholas provides a solution to the problems that employers are facing but also that graduates have a great experience entering the work environment. It's a two-way street. It takes a lot of time to develop trust and a relationship."

# NEW YORK CITY'S TECH APPRENTICESHIP OFFERINGS

**Barclays** has partnered with **Per Scholas** to develop curriculum and train students, including many veterans, in cybersecurity. The program lasts two years. Students spend 15 to 17 weeks in the classroom with Per Scholas and then move into apprentice roles at Barclays.

**Scholastic** operates a technology associate program, offering around 12 positions each year to graduates from large research and engineering schools in the Northeast with the goal of identifying, training and promoting the next generation of technology leaders in the company. The program is three years long, during which participants receive programmatic attention on performance evaluation, career management, training, and community development.

**Broadridge Financial Solutions** partners with NPower to offer an apprenticeship-like, eight-month internship program for rising college juniors and seniors, often resulting in a permanent job. Over the past five years, Broadridge has hosted 13 interns, including eight in its technology group.

**IBM's** New Collar program provides tech apprenticeships to high school graduates, community college graduates and graduates of coding bootcamps and career education academies around the country. Launched in 2017 with six apprentices, IBM this year will have 700 paid apprentices—including about ten in New York City—in over 20 roles from cyber security and application development to data science and system administration. An apprenticeship can last as long as 24 months and successful apprentices receive certification and “badges” that build a digital resume and provide access to jobs that match their skills at IBM and at other companies. The program has become a model for others, such

as the Consumer Technology Association, which recently launched a program to help develop and support apprenticeship programs for member companies.

**8<sup>th</sup> Light**, a software consultancy, puts all new engineers through a six-month apprenticeship under the assumption that they will be hired at the end of the program. In 2020, the company plans to have three cohorts, each with ten to 15 apprentices spread across its five offices. For the round that started in September 2019, 133 applicants applied for three slots in New York City. Since launching apprenticeships about five years ago, 8<sup>th</sup> Light has hired 200 people through the program.

**2U**, a technology education company, works with Flatiron School, offering 15-week, paid tech apprenticeships to applicants who are at least 21 years old, have a high school degree or the equivalent, and make a total annual income of \$35,000 or less. At the conclusion of the program, apprentices can apply for full-time positions at 2U.

**NPower** provides tech training to veterans and young adults and places them in paid apprenticeship-like internships with employers, including **Citibank**, **Bank of America**, and **KPMG**. Last year, 37 percent of interns received a job offer, a contractor role, or an extension from their employers.

**Year Up** runs a one-year, intensive training program for low-income young adults, 18 to 24, that includes a 26-week apprenticeship in IT Desktop Support and HelpDesk work. Of the 400 students in the program, 200 are in technology tracks.

**Pursuit**, based in Queens, offers ten- and 12-month tech training programs and works with employers to hire its grads. It is also working with the Partnership of New York's Future Fintech Leaders Program providing tech apprentices to employers, including **Pymetrics**, **Blackrock**, **NPM** and AI company **Kasisto**.

### **CareerWise New York**

Developed by HERE to HERE, a Bronx-based nonprofit, in partnership with the Colorado-based organization CareerWise CO, CareerWise New York launched an apprenticeship program this fall, partnering with more than 20 high schools in the Bronx, Brooklyn, and Queens and 17 major New York City employers to provide paid apprenticeships to 85 high school juniors. Apprentices work in business operations, finance, and information technology, including QA testing, IT infrastructure, and coding. During the first two years, students attend school studying core academic subjects, receive specialized skills training and college credit, and work part time from 16 to 24 hours a week. In the third year, they work 32 to 40 hours a week. Upon completing successful apprenticeships, students receive full-time job offers, enter college—or both.

Companies and organizations providing tech apprenticeships through the CareerWiseNY program include **Accenture**, **Amazon**, **Infor**, **JP Morgan Chase**, **MasterCard**, **Mercer**, **Tata Consultancy**, **Pymetrics**, **Brooklyn Navy Yard**, and **Guy Carpenter**.

### **NYC Tech Talent Pipeline**

New York City's **Tech Talent Pipeline** has partnered with companies, including **Stack Overflow**, **LinkedIn**, **Spotify**, **Betterment**, **MediaMath**, **Energy Watch**, and **Foursquare** to provide *associate engineer* positions as an alternative pathway into the city's tech ecosystem. **Stack Overflow** has so far completed two rounds of 11-week apprenticeships, hosting six grads from coding bootcamps. **Foursquare** launched its six-month associate program in 2018 and has so far hosted two associate engineers. It has offered permanent positions to both. **Spotify** is now on its fourth cohort of apprentices for its 18-week fellowship program, and all fellows are still working for the company.



## NYC Tech Apprenticeships in Profile

### Stack Overflow

Stack Overflow launched its apprenticeship program two years ago when it was starting to grow from a small organization into a larger, more sophisticated operation and found it needed to bring in more junior developers. It specifically did not want to do “internships,” another form of earn-and-learn that is typically short-term and usually doesn’t result in jobs offers. Instead, Stack Overflow wanted to make an investment in its future and bring in people with non-traditional backgrounds that mirrored the backgrounds of many of its members.

Apprentice recruits come from bootcamps and tech training schools, such as the Flatiron School, Full Stack Academy and the Grace Hopper Academy. During the 11-week program, apprentices are mentored and assigned tasks, such as reviewing specs, writing code and testing and deploying changes to code. So far, Stack Overflow has brought on six apprentices and has hired four as full-time employees.

### 8<sup>th</sup> Light

At 8<sup>th</sup> Light, a custom software developer that employs 150 people in New York City, Los Angeles, Chicago and London, apprenticeship is the starting point for all junior developers who join the firm, some ten to 15 people a year across all its offices. Apprentices go through a paid, six-month training period, with the assumption that when it concludes, they will have a job with the firm.

8<sup>th</sup> Light started its homegrown program in part so that it could establish a common base of skills within its engineering teams. Recruits come from bootcamps and community organizations, such as Black Girls Code, and join a cohort of a dozen or more apprentices who go through the process together. One goal is to attract recruits who bring different experiences to the job. Many are career-changers and more than half have gone to bootcamps. In its last cohort of 14 apprentices in its four offices, nine were women and eight were people of color.

The company looks for people who are curious and coachable, says chief operating officer Claudia Richman, and while it assumes a base level of technical knowledge, it doesn’t ask for resumes: “We don’t care where you worked before or where you went to school. It doesn’t tell us about how you learn or how you work.”

In addition to investing in apprentices, 8th Light has also invested in a formal mentor training program to standardize the training and improve mentors’ and managers’ teaching skills. One payoff for 8<sup>th</sup> Light has been better than average retention. Another is a skilled and diverse workforce.

“It gives us really great consultants,” said Richman. “If we were hiring people just out of a computer science program, they would only know how to solve problems in one way. Someone with a variety of life and work experiences can take a different view.”

## Foursquare

Another company that has found success with apprenticeships is Foursquare, a born and bred New York tech firm that works with the city's Tech Talent Pipeline.

First and foremost, the company sees the apprenticeship program as a differentiator and a way to access talent in an extremely competitive market.

"Access to talent is the name of the game, and this is way for us to get access to talent," said Matt Kamen, senior vice president of engineering. "It's valuable to us make opportunities available to a people coming from diverse backgrounds who have excellent skills, are eager to learn and want to grow in their careers."

The Foursquare apprenticeship is a six-month program in which participants typically start working as web developers as they learn the company's "stack." During the first week, apprentices actually start writing code. At the same time, they work with mentors who tailor the experience based on the level of the job and expectations of the particular role.

In addition to attracting talent, Foursquare sees the program as way for current staff to develop leadership skills, said Kamen: "It's an opportunity for mid-level or more [advanced] junior engineers to step into a mentoring role and train [apprentices] in valuable skills that will pay off for us. Teaching apprentices challenges you."

Foursquare completed one iteration of the program, in 2018, and ended up hiring the two apprentices who participated.

"It's valuable to us make opportunities available to a people coming from diverse backgrounds who have excellent skills, are eager to learn and want to grow in their careers," said Kamen. "They do valuable work for us. It's not 'creating work.' It's critical."

# MODELS OF TECH APPRENTICESHIP FROM ACROSS THE COUNTRY

**Workforce organizations around the** country have mounted programs to bring tech apprenticeships into the mainstream of education. Two notable programs are Apprenti, which operates in nine regions, and CareerWise in Denver, Colorado. An offshoot, CareerWise New York, launched this fall in with 20 companies offering programs to high school students in the Bronx, Brooklyn, and Queens. In San Francisco, the city's Office of Economic and Workforce Development is launching 300 new tech apprenticeships through its TechSF job training initiative. And in Philadelphia, the Urban Technology Project is using the apprenticeship model to provide technical support in public schools.

## **Apprenti**

Started by the Workforce Institute of the Washington Technology Industry Association (WTIA), Apprenti has developed and licensed a highly workable model for tech apprenticeship that combines a year of paid on-the-job training with three to five months of accelerated classroom education. The program is working with more than 70 companies across the country, including industry leaders like Microsoft and Amazon, and has trained more than 700 apprentices for a variety of tech jobs—from web and software developers to systems administrators and cloud support specialists.

Since launching in the Greater Seattle area in 2016, the program has expanded to Massachusetts, Northern Virginia, Cincinnati, Dallas, Chicago, and the San Francisco Bay Area, among several other markets nationwide.

The impetus for the program was a study that found a shortage of talent for middle-skilled jobs that did not necessarily require a college degree. Partnering with Washington State, WTIA landed a Department of Labor American Apprenticeship Initiative grant to develop their model. Importantly,

WTIA's roughly 1,000 member companies were fully behind the initiative, while Apprenti shouldered most of the required paperwork and navigated state and federal apprenticeship registration requirements.

"Larger companies were willing to sit at the table and say it makes sense, and mid-sized companies were willing to sit at the table because they are competing with big companies for talent," says Carlson. "They agreed that we are all in the same talent shortage, no matter what sector, and needed a system that could scale."

According to WTIA, more than 70 companies of different sizes across the country have signed on with Apprenti and its licensees in 15 markets in 13 states. (The single model, validated and managed by Apprenti as an intermediary, is exportable and reproducible.) Since 2016, over 700 apprentices, 52 percent of them with college degrees, have gone through the program. The rest are graduates of secondary schools, community colleges, online and night and weekend schools. A large majority, 79 percent, have received job offers and overall, 85 percent have stayed tech-employed.

Apprenti has also succeeded in attracting a diverse cohort of participants. In the 15 markets in which it operates, 41 percent of apprentices are people of color, not counting Asians, 55 percent are veterans, and 32 percent are women. Twenty-two percent were unemployed when they started the program and 14 percent have a disability. Coming into the program, apprentices had a median annual wage of \$29,000, says Carlson. For the 85 percent who have stayed tech employed, the median salary is today \$84,000..

In the end, according to Carlson, the essential ingredient for success is a company's determination to make it work: "In the companies we've had the greatest success with, there is a top-down, personal cultural shift by management, [saying] 'We are going to adapt and find talent in different places. We can make this work.'"

## CareerWise Colorado

Inspired by the Swiss apprenticeship system, CareerWise Colorado works with companies to offer apprenticeships for high school students that can expand their career options and, at the same time, meet the talent needs of corporate partners.

Starting in their junior year, high schoolers spend two to four years in the program. In the first two years, apprentices spend two to three days a week in class and 12 to 24 hours on the job. In year three, after graduation, they spend at least 32 per week at a job and earn an average salary of \$30,000. About 20 percent of CareerWise apprentices work in tech jobs, including as junior coders, computer technicians, and software QA testers. They can also take college level courses for credit, all paid for by CareerWise. In the end, they earn a high school diploma, a year of college credit, critical industry credentials, and a job

CareerWise creates the curriculum, matches students with businesses, and trains supervisors and coaches. For that, it charges businesses \$2,000 per apprentice per year. While some say tech apprenticeships are more expensive and difficult to operate, founder and CEO Noel Ginsburg disagrees. The key, he said, is the ability to scale the program. His goal is to reach 10,000 participants.

“In the next seven years, if we get to 10,000 apprenticeships, it will be material enough to shift educational structures in the state, and we will be self-sufficient in terms of the cost it takes to support this model,” said Ginsburg. “We don’t intend to be dependent on philanthropy or the taxpayer. There’s a clear return on investment for businesses.”

## TechSF Apprenticeship Accelerator

Created by San Francisco’s Office of Economic and Workforce Development, TechSF’s Apprenticeship Accelerator is launching a major new apprenticeship program to supplement its existing offerings of no-cost, career-focused tech training. The initiative partners with more than a dozen tech training providers—such as General Assembly and Galvanize—to provide technical skills training followed by bridges into paid on-the-job training with employer partners. Graduates of TechSF’s training programs have gone

on to work at companies including Google, Salesforce, LinkedIn, Adobe, Twitter, and Facebook.

A newly created apprenticeship program—developed in partnership with Twilio, the San Francisco-based cloud communications company—is poised to become the largest city-run tech apprenticeship program to date. Launched in late 2019, the program plans to train and hire 300 new apprentices in software engineering by 2021.

“We found a segment of job seekers are not getting job offers at the end of training because it’s so competitive out here,” says Orrian Lewis, senior workforce development specialist at TechSF. “We saw an opportunity to use the apprenticeship model as a perfect on-ramp for job seekers to gain employment at big companies who otherwise wouldn’t be considered. Every company at some point in its growth cycle will have a strong use case for apprenticeships—and it’s now gaining momentum.”

## Urban Technology Project

Philadelphia has a unique model, the Urban Technology Project, which provides computer support apprentices to local public schools. Started in 2003, the project registered the apprenticeship program with the state in 2005.

The program starts each year with pre-apprentices supported by the federal AmeriCorps program. Typically 18 to 24 years old, pre-apprentices are graduates of Philadelphia public schools, including 15 percent from career and technical education schools. They get IT training from JobWorks, a national workforce development organization, and a \$14,000 annual stipend from AmeriCorps. About half of the pre-apprentices go on to do two-year on-the-job apprenticeships in area public schools, where they receive mentoring from technology teachers, regional technicians, and other specialists. Apprentices start with full benefits and \$23,360 in annual salary plus another \$1,000 for every certification they earn.

Since 2005, the program has trained about 380 pre-apprentices (24 per year) and 150 apprentices. This year, five apprentices completed the program and were offered full-time jobs. The Project also works with a local tech recruiter and has placed apprentices in other public agencies.

# RECOMMENDATIONS: 10 IDEAS FOR EXPANDING TECH APPRENTICESHIP IN NEW YORK CITY

**Create 1,000 new tech apprentice positions in New York City by 2025.** New York City is poised to add thousands of tech jobs over the next six years, including many in occupations that have effective apprenticeship models in other cities across the country. To help expand access to these fast-growing, well-paying jobs while diversifying the tech sector, the city should set an ambitious but achievable goal of creating 1,000 new tech apprentice positions by 2025, becoming the leading hub for tech apprenticeship in the process. These apprenticeships should be created with a broad mix of partners, including in-house programs at tech companies; programs operated by intermediaries and training organizations; programs launched in partnership with CUNY; and programs launched by the city's Department of Small Business Services.

**Launch registration-ready tech apprenticeships as part of ApprenticeNYC.** New York City's first publicly run apprenticeship initiative, ApprenticeNYC started in 2017 with the goal of creating 450 new apprentices in the industrial, health, and tech industries by 2020. But to date, the initiative's only registration-ready program under the ApprenticeNYC banner is for CNC machinists. The city should set a goal to launch ApprenticeNYC's first full-fledged, registration-ready tech apprenticeship by the end of 2020.

**Develop a NYC Tech Apprenticeship Accelerator to speed the design and approval of new programs.** To make apprenticeship

work for the tech sector, the design and implementation of new programs has to operate at the speed of the industry. Cultivating employer partners, designing programs, developing related instruction, and registering programs to enable tax credits can take years—a timeline that's simply too slow for many tech companies to embrace. To speed up the process and help more effective apprenticeship models achieve scale, New York City should launch a Tech Apprenticeship Accelerator. Modeled on a series of initiatives sponsored by the U.S. Department of Labor in 2016, the NYC Tech Apprenticeship Accelerator would facilitate intensive assistance for businesses to jumpstart the development of a customized tech apprenticeship program; bring together interested training partners, educational institutions, and sponsor organizations to connect with employers; and create a platform for ongoing employer engagement and program development.

**Simplify and streamline New York State's apprenticeship registration process.** More than in any other sector, companies in tech say that New York State's lengthy and bureaucratic registration process for new apprenticeship programs—along with rules limiting flexibility in making programmatic changes—present a significant obstacle to greater uptake. New York State benefits from a powerful incentive program, the Empire State Apprenticeship Tax Credit, but very few tech occupations are currently eligible, and no tech companies have sponsored

their own programs so far. To ensure that more tech employers start taking advantage of this important incentive, New York State will have to develop a registration process that is simpler, clearer, and more flexible.

**NYCEDC should convene a Tech Apprenticeship Summit to raise awareness of the opportunity.**

To develop a larger role for tech apprenticeship, more employers seeking to fill tech roles will have to commit to the model. But one major challenge to expanding the model is that relatively few tech employers are aware of the potential in the first place. The New York City Economic Development Corporation (NYCEDC) can play a major role in raising awareness about the value of tech apprenticeship by convening the city’s first Tech Apprenticeship Summit: a day-long event bringing together leading local and global tech employers with the training organizations, intermediaries, and educational institutions leading the charge for tech apprenticeship on a national level.

**Support apprenticeship intermediaries to develop end-to-end services for tech employers.**

For the vast majority of New York City’s tech companies—including small and mid-sized startups, as well as larger companies with immediate hiring needs—moving into tech apprenticeship will require the support of a partner organization that can manage the whole process from end to end; develop and implement training; navigate the landscape of registration and corresponding incentives; and support mentorship and management during on-the-job training. The city’s economic and workforce development agencies should launch new RFPs focused on supporting these New York City-based intermediaries, including cultivating employer relationships through effective business development, designing and launching new programs, and scaling current models with a proven record of success.

**Bring Apprenti to New York City.** Across the landscape of tech apprenticeship programs nationwide, Washington State’s Apprenti program—which has expanded to twelve other

states—stands out as a particularly effective and scalable model with a large number of current employer partners. City leaders should bring Apprenti to New York, where many of Apprenti’s employer partners like Microsoft and Amazon already have a significant presence.

**Issue a tech apprenticeship challenge grant to spur innovation.**

This year, California launched the California Apprenticeship Initiative New and Innovative Grant Program, a \$10 million fund to spark innovative apprenticeship programs in emerging industries, with a strong focus on the tech sector. New York State should go one step further and launch a new \$10 million challenge grant to support the development of apprenticeship programs in high-tech occupations across the state and make a major commitment to become the leading hub of tech apprenticeship in the nation.

**Launch pre-apprenticeship training programs in technology occupations.**

To ensure that a diverse mix of New Yorkers are able to access and succeed in tech apprenticeships, the city should support new pre-apprenticeship training programs in technology occupations. Designed to help level up prospective apprentices who aren’t quite ready to learn on the job, these pre-apprenticeship programs would provide an in-depth technical skills boost, along with soft skills focused on navigating the tech workplace, and would feed into apprenticeship programs with employer partners.

**Scale up Tech Talent Pipeline’s associate engineering program.**

The Tech Talent Pipeline’s associate engineering program is a promising model for connecting underrepresented talent with hands-on training and paid apprentice-like positions at growing tech companies. But expanding this program will take new resources to help support business development and employer cultivation, talent recruitment and vetting, and sustained support for associates and employers throughout the course of a program. The city should increase support for this innovative program and enable it to double over the next three years.

# ENDNOTES

1. Center for an Urban Future analysis of all registered apprenticeship programs based in New York City, as published on the New York State Department of Labor’s Apprenticeship Sponsor List, November 2019.
2. A November 2019 report commissioned by Civic Hall and prepared by HR&A Advisors, “NYC’s Tech Opportunity Gap,” finds that high-tech employment in New York City increased by 46,000 from 2008 to 2018, including high-tech jobs in both tech industries and non-tech industries.
3. Debbie Reed et al., “An Effectiveness Assessment and Cost-Benefit Analysis of Registered Apprenticeship in 10 States,” Mathematica Policy Research, July 25, 2012, <https://www.mathematica-mpr.com/our-publications-and-findings/publications/an-effectiveness-assessment-and-costbenefit-analysis-of-registered-apprenticeship-in-10-states>. Graduates of registered apprenticeship programs earn an estimated \$301,533 more than their peers over their careers, including wages and benefits. For newly created apprentices in tech occupations, that figure is likely to be significantly higher.
4. Center for an Urban Future analysis of data from Crunchbase, a leading global database that tracks tech-enabled start-ups using a mix of public, private, and self-reported sources. Our analysis finds that New York City is home to 9,878 tech start-ups founded since 2008.
5. Center for an Urban Future analysis of all registered apprenticeship programs in New York State, as published on the New York State Department of Labor’s Apprenticeship Sponsor List, November 2019.
6. Center for an Urban Future analysis of the 17 tech-specific occupations tracked in U.S. Census data—such as database administrators, web developers, and computer network architects—using data from the 2017 American Community Survey and employing similar methodology to a [2018 Brookings Institution](#) study and a [2016 U.S. Census Bureau](#) report.



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