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Room to Grow:

Identifying New Frontiers for Apprenticeships

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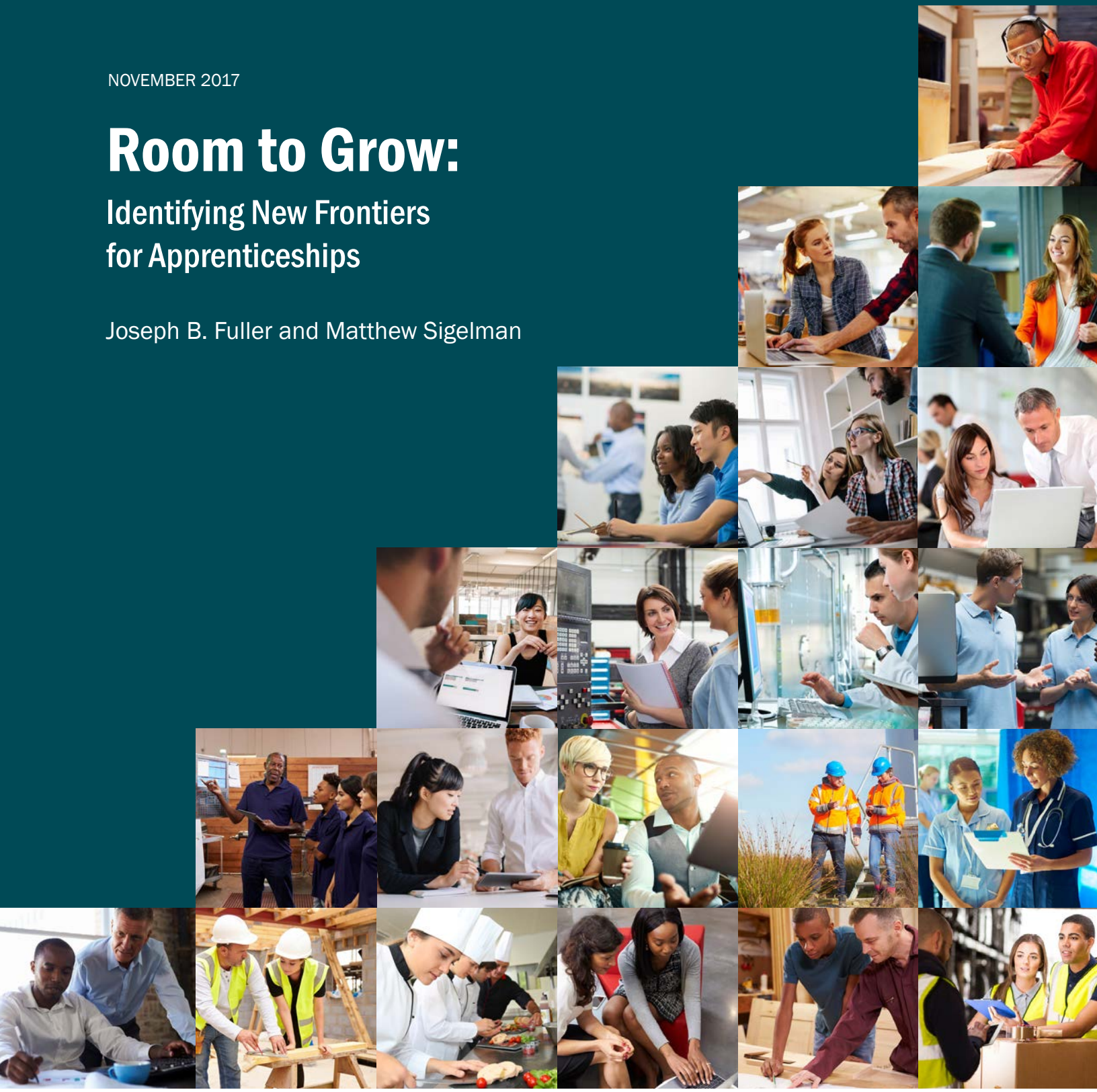

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EXECUTIVE SUMMARY

Apprenticeships are one of the few bipartisan ideas in the realm of workforce development, promising an alternative way of training skilled workers without requiring higher education. Instead of accumulating debt, students get to "earn while they learn." President Obama offered tens of millions of dollars in grants to expand innovative apprenticeship programs,[1] and President Trump recently issued an executive order making it easier for businesses to apply for apprenticeship approvals.[2]

Yet, while apprenticeships are a common part of the employment landscape in Europe, they represent a relatively small number of jobs in the United States. There were only 410,000 active civilian apprentices in 2016, a small fraction of the 23.4 million job postings that year.[3] And that is after decades of widespread agreement across the political spectrum about the effectiveness of apprenticeships and the desirability of expanding them.[4]

This analysis, conducted by Burning Glass Technologies and the Managing the Future of Work Project at Harvard Business School, is designed to answer a basic question about apprenticeships: *What is the true scope or potential for apprenticeships in the U.S. economy?* Armed with this analysis, employers can then pursue a targeted strategy for expanding apprenticeships into more occupations, especially those areas where they see a shortage of middle skills talent. We hope this research inspires more questions: If business leaders and policymakers are committed to making apprenticeships more available, how many positions could be created? What are the characteristics of the occupations that lend themselves easily to apprenticeships? How might apprenticeships help close the skills gap for employers and open up opportunities for average Americans in jobs that provide rising living standards?

To determine answers, we examined the skills demanded in job postings for more than 23 million openings in 2016. We identified the underlying skills in apprenticeship roles and looked for similarities in other positions. We found, based on this skills analysis, that there is significant opportunity to expand apprenticeships in the United States:

- The number of occupations commonly filled via apprenticeships could be nearly tripled, from 27 to 74;
- The number of job openings covered by this approach could be multiplied eightfold, to roughly 3.2 million;
- Many of these additional opportunity areas unlock higher-value careers, offering more than a 20% salary premium, compared with traditional apprenticeship occupations; and
- The occupations covered by those expanded opportunities are ones employers find difficult to fill.

The occupations we identified outside the 27 core group of current apprenticeships fall into two groups. We dubbed one group "Expanders" (21 occupations), those that significantly increase the number of sub-B.A. occupations available to apprenticeships. We named the second group "Boosters" (26 occupations), those that extend apprenticeships into high-value, middle-skills jobs facing "degree inflation," the phenomenon of employers raising the credentials required for a middle-skills job to include a four-year college degree.[5] Both groups include jobs that pay a living wage and offer upward mobility. The most significant difference between them is whether a bachelor's degree is currently necessary for finding the right talent to fill a middle-skills position.

This is not to say that significant barriers to expanding apprenticeships do not exist—they do. But this analysis shows that there is significant unrealized potential in the apprenticeship field, across many occupations in the U.S. economy. By using an apprenticeship approach, businesses struggling with skills gaps can take steps to ensure workers are trained to employer specifications—not to mention getting the value of apprentices' work during training. For many middle- and lower-skills workers seeking to move up career ladders, apprenticeships offer a more viable alternative to traditional trade and technical schools. One barrier in the technical school system is that students either miss out on gaining work experience while they attend school, or they work but can only attend school part-time. Apprenticeships offer workers an alternative that requires neither sacrificing income nor risking exhaustion. Another significant barrier to apprenticeships is that technical schools often find it challenging to forge relationships with potential employers. In an apprenticeship model, employers and local educators can work together to define a curriculum as well as on-the-job training that is aligned with employers' needs and helps direct young talent into the workforce.

ANALYZING APPRENTICESHIPS

What distinguishes an occupation that is appropriate for apprenticeships from one that is not?

Out of 810 occupations identified by the U.S. Department of Labor, 27 make up the core of apprenticeships in the United States (see Figure 1 and Figure 2).[6] More than half of them are in the Construction and Extraction career family (for example, Mining), and another nine are in Installation/Maintenance or Production. Those are all occupations with a higher union membership rate than the national average of 10.7% in 2016.[7] Almost all job postings for those roles require a high school diploma (96%), but less than 1% request a bachelor's degree. They are also roles with relatively low rates of worker mobility, with 47% of workers remaining in the same occupation for more than five years.[8]

Most important, each occupation is focused on a relatively narrow cluster of skills: Boilermakers, Carpenters, Glaziers, and so on. In other words, those roles require a "narrow and deep" skill set, an in-depth ability in one or two specific areas rather than a broad array of skills. This sets apprenticeship jobs apart from other fields, such as the rapidly growing field of "hybrid jobs" that mix skills not normally taught together. Graphic Designers are a good example of hybrid jobs; they increasingly require a blend of skills such as programming, marketing, and content development.[9]

Some apprenticeship fields involve licensing, but not all do. (According to Burning Glass research, licensed fields often include post-secondary training and require certifications to demonstrate competency to government agencies or trade associations.[10])

FIGURE 1: CHARACTERISTICS OF CORE APPRENTICESHIPS CURRENTLY PREVALENT IN THE UNITED STATES

	Core 27
Total Number of occupations	27
Median Annual Wage	$44,212
Total Employment (2016)	7,310,460
Average Employment Growth (2012–2016)	11.5%
Average Employment Growth Projections (2016–2026)	12.3%
Total Job Postings (2016)	1,911,335
Total Job Postings Requesting 0–2 Years of Experience (2016)	1,336,542

Source: Occupational Employment Statistics (OES); BLS Employment Projections Program, https://www.bls.gov/emp/; Burning Glass Technologies data.

FIGURE 2: OCCUPATIONS WHERE APPRENTICESHIP IS CURRENTLY PREVALENT IN THE UNITED STATES

	Occupation	Career Family
1	Boilermakers	Construction and Extraction Occupations
2	Brickmasons and Blockmasons	Construction and Extraction Occupations
3	Carpenters	Construction and Extraction Occupations
4	Cement Masons and Concrete Finishers	Construction and Extraction Occupations
5	Construction Laborers	Construction and Extraction Occupations
6	Drywall and Ceiling Tile Installers	Construction and Extraction Occupations
7	Electrical Power-Line Installers and Repairers	Installation, Maintenance, and Repair Occupations
8	Electricians	Construction and Extraction Occupations
9	Elevator Installers and Repairers	Construction and Extraction Occupations
10	Floor Layers, Except Carpet, Wood, and Hard Tiles	Construction and Extraction Occupations
11	Glaziers	Construction and Extraction Occupations
12	Heating, Air Conditioning, and Refrigeration Mechanics and Installers	Installation, Maintenance, and Repair Occupations
13	Heavy and Tractor-Trailer Truck Drivers	Transportation and Material Moving Occupations
14	Industrial Machinery Mechanics	Installation, Maintenance, and Repair Occupations
15	Machinists	Production Occupations
16	Millwrights	Installation, Maintenance, and Repair Occupations
17	Operating Engineers and Other Construction Equipment Operators	Construction and Extraction Occupations
18	Painters, Construction and Maintenance	Construction and Extraction Occupations
19	Plumbers, Pipefitters, and Steamfitters	Construction and Extraction Occupations
20	Reinforcing Iron and Rebar Workers	Construction and Extraction Occupations
21	Roofers	Construction and Extraction Occupations
22	Sheet Metal Workers	Construction and Extraction Occupations
23	Structural Iron and Steel Workers	Construction and Extraction Occupations
24	Structural Metal Fabricators and Fitters	Production Occupations
25	Telecommunications Equipment Installers and Repairers, Except Line Installers	Installation, Maintenance, and Repair Occupations
26	Telecommunications Line Installers and Repairers	Installation, Maintenance, and Repair Occupations
27	Tool and Die Makers	Production Occupations

Source: Burning Glass analysis based on U.S. Department of Labor data.

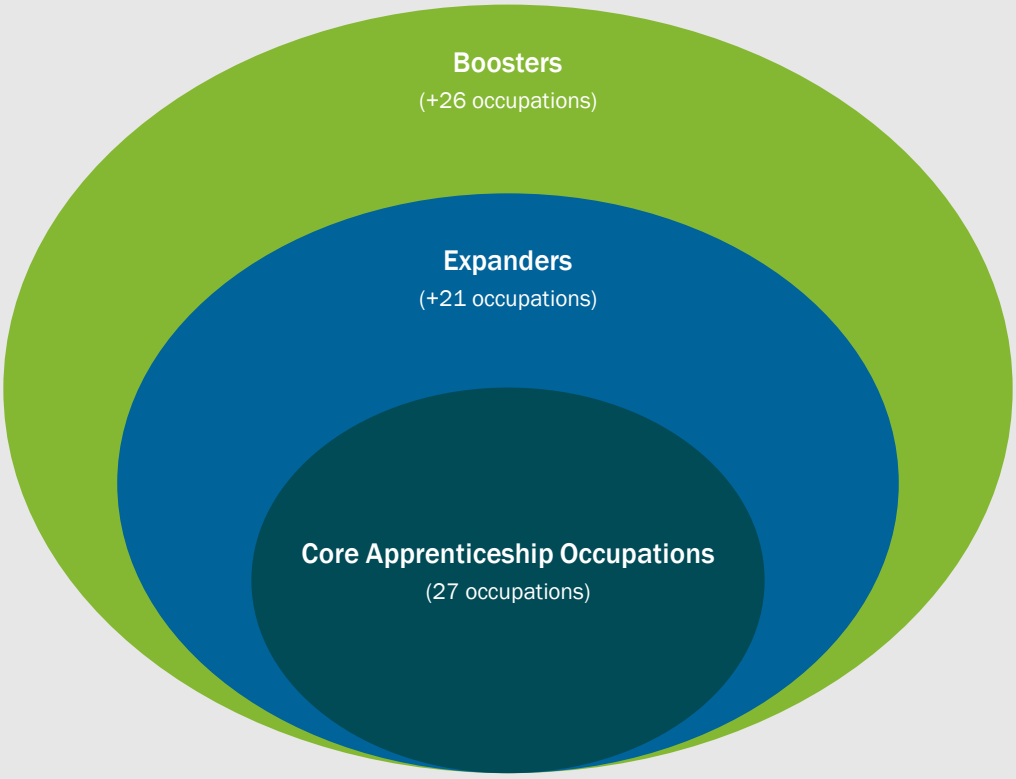
IDENTIFYING POTENTIAL

Based on the criteria established for apprenticeships (see Appendix), we developed a set of criteria by which to identify occupations that have *potential* for apprenticeship expansion:

- **They are not heavily licensed.** While many existing apprenticeships are in licensed fields, licensure represents a separate credential, which may reduce the value of the apprenticeship as proof of a worker's qualifications, while adding an additional layer of government approval onto the process.
- **They require a relatively narrow cluster of skills.** Apprenticeships are best suited to fields that hinge on clearly defined skills obtainable through specialized training.
- **They generally require a high school diploma or an associate's degree, and they do not require a bachelor's degree.** Apprenticeships are often intended as an alternative path to a four-year college degree. Jobs for which most employers require an advanced degree likely involve a range of skills ill-suited to apprenticeship training.
- **They tend to have above-average worker stability.** The positions demonstrate higher-than-average tenure of employment and lower-than-average turnover. For employers and workers alike, that makes the investment in an apprenticeship more attractive, since long-term placement yields a higher return on investment.
- **They pay a living wage ($15 per hour or more).**[11] The investment of time and effort required for an apprenticeship does not make economic sense for either employers or workers when applied to low-paying jobs.

Using those criteria, and comparing them to the skills required for occupations based on job postings, we developed two groups of occupations—Expanders and Boosters—that could prove fertile ground for adopting apprenticeships (see Figure 3). The main difference between those two groups is the level of education employers require of applicants.

FIGURE 3: SCOPE FOR EXPANDING APPRENTICESHIPS TO OTHER OCCUPATIONS



Source: Burning Glass analysis based on U.S. Department of Labor data.

EXPANDERS

The Expanders group encompasses 21 occupations, all of which meet the listed criteria but only include skills that can be gained at a sub-baccalaureate level. Just a small fraction (roughly 7.5%) of employers stipulate a bachelor's degree for those jobs, but even these can be largely attributed to degree inflation, since the skills required in these postings do not necessitate four years in college.

Occupations in this group include:

- Welders, Cutters, Solderers, and Brazers
- Computer-Controlled Machine Tool Operators, Metal or Plastic
- Tax Preparers
- Solar Photovoltaic Installers
- Customer Service Representatives

Expander occupations accounted for nearly 750,000 entry-level job postings in 2016. The number of these jobs has grown very fast, with average employment growth of 15% over the last five years alone. As a group, the Expanders pay less than the core group of apprenticeships, with a median wage of $34,542 (see Figure 4). However, Expanders still offer a living wage and solid prospects for those without a degree. Most are in demand around the country and not limited by geography.

The existing training for these positions varies. Some workers learn on the job. Others, like Medical Transcriptionists, usually take a post-secondary course resulting in a credential. Some of these occupations do have regulatory requirements. For example, Tax Preparers need to register with and be certified by the Internal Revenue Service. While there is nothing to suggest that existing training programs are inadequate, the fundamental attributes of these jobs indicate that apprenticeships could be added to the mix of training options.

FIGURE 4: CHARACTERISTICS OF POTENTIAL EXPANDER APPRENTICESHIPS

	Expanders
Total Number of occupations	21
Median Annual Wage	$34,542
Total Employment (2016)	5,355,010
Average Employment Growth (2012–2016)	14.6%
Average Employment Growth Projections (2016–2026)	12.2%
Total Job Postings (2016)	953,243
Total Job Postings Requesting 0–2 Years of Experience (2016)	748,578

Source: Occupational Employment Statistics (OES); BLS Employment Projections Program, https://www.bls.gov/emp/; Burning Glass Technologies data.

BOOSTERS

Booster occupations have the same characteristics as Expanders, except that employers commonly require a bachelor's degree (in 20% to 80% of postings, depending on the occupation). While a little more than half of Booster job postings (59%) request a bachelor's degree, at least as a "preferred" qualification, these fields still remain open to those with alternative credentials or experience. Even though some of the required skills for these jobs are more typically associated with bachelor's level work, the bundle of skills demanded is quite consistent between those postings that specify a college degree and those that do not. This consistency indicates that such work is readily performed by those without a degree, suggesting that training, such as that acquired through an apprenticeship, could provide an acceptable substitute for a four-year college degree.

Many employers who deal with "mixed populations"—that is, workers with a four-year college degree as well as workers without one performing the same job in the company—report that on many performance metrics both types of workers perform equally, while workers with college degrees have higher salary expectations, exhibit higher turnover, and are more likely to feel unengaged or underutilized in their jobs.[12]

Creating a pipeline of talent by providing practical training to apprentices could thus be an attractive proposition for employers caught in the trap of degree inflation. Instead of restricting their available applicant pool to college graduates—the portion of the population with the lowest unemployment rate and highest wage expectations—employers can widen their access to workers who are just as productive and far less likely to leave for a competitor.[13] Computer User Support Specialists, who staff IT help desks, are a noteworthy example. While 60% of postings for those positions request a bachelor's degree, an analysis of job postings reveals little, if any, real difference in the skill sets required between postings that require a bachelor's degree and those that do not.[14] Yet employers report that they pay a wage premium of 11% to 30% to hire a recent college graduate to do the same job as a non-degree worker with experience.[15]

The 26 Booster occupations include:

- Claims Adjusters, Examiners, and Investigators
- Insurance Underwriters
- Human Resource Specialists
- Graphic Designers
- Database Administrators

Boosters are high-value occupations, accounting for more than 1.1 million entry-level job postings last year. Currently, they take 10.4% longer for employers to fill than Expander occupations. Perhaps most important, with a median advertised wage of nearly $55,000, they offer an annual salary premium of almost $20,000 over Expander jobs (see Figure 5). This makes Booster occupations a compelling avenue for middle-class earnings without a degree. In Europe, apprenticeships in Booster occupations are an accepted means for bringing young entry-level professionals into the workforce (see the sidebar "Apprenticeships for Booster Occupations Are Popular in Europe").

FIGURE 5: CHARACTERISTICS OF POTENTIAL BOOSTER APPRENTICESHIPS

	Boosters
Total Number of occupations	26
Median Annual Wage	$54,375
Total Employment (2016)	6,785,480
Average Employment Growth (2012-2016)	2.5%
Average Employment Growth Projections (2016-2026)	7.5%
Total Job Postings (2016)	2,390,840
Total Job Postings Requesting 0-2 years of Experience (2016)	1,102,644

Source: Occupational Employment Statistics (OES); BLS Employment Projections Program, https://www.bls.gov/emp/; Burning Glass Technologies data.

Apprenticeships for Booster Occupations Are Popular in Europe

Unlike in the United States, in many European countries, vocational training at the secondary-school level is not limited to a small number of trades. In countries including Switzerland, Germany, Austria, and the Netherlands, many or most of the "Booster" professions are also filled by those coming from apprenticeship programs or other significantly work-based, vocational education.

In Switzerland, for example, vocational training was offered in 240 occupations in 2015. The top occupations chosen by upper-secondary students included a mix of young professional occupations such as "commercial employee," which includes 21 areas of specialization such as retail, banking, and public administration, alongside IT technician, cook, and drafter.[16] Swiss students who completed their vocational training and moved on to a professional school chose occupations such as human resources specialist, technical sales specialist, finance and accountancy specialist, social insurance specialist, or general sales representative.[17]

In Germany, the top three occupations for those graduating from vocational apprenticeship programs in 2016 were office management clerk, retail clerk, and salesperson. Other occupations that made it to the top 15 list included: Industrial clerk, clerk in wholesale, clerk in foreign trade, medical assistant, dental assistant, bank clerk, and cook.[18]

Even in the Dutch vocational system, in which students spend more time in school compared with students in Germany and Switzerland graduates in 2016 received in-work training in occupations such as graphic design; transportation and logistics; catering, tourism, and food; economic and administrative professions; and retail, wholesale, and international trade, fashion and textile.

The fact that employers currently request a bachelor's degree for many of these occupations reflects both an opportunity and a challenge for the expansion of apprenticeships in the United States. Obtaining a college credential often involves students incurring student debt in order to complete courses of study that do not necessarily prepare them for employment options. A cost-effective alternative that promises to lead to a career opportunity in which a student has an interest and that offers an attractive initial income is likely to draw aspiring workers. It is not only students who have an opportunity to benefit. Burning Glass research indicates that in many middle-skill occupations, employers who demand a bachelor's degree pay a significant premium for candidates with higher educational attainment compared to employers who hire workers without a four-year college degree.[19] Turning to an apprenticeship program should yield savings and, potentially, a more secure talent pipeline in periods of robust economic growth.

Certainly, significant barriers would have to be overcome on both the supply and the demand sides. Apprenticeships do not enjoy the legitimacy in the United States that they do in most OECD (Organization for Economic Cooperation and Development) countries. Parents and young people aspiring to enter the workforce need to overcome the widespread penchant for pursuing a four-year degree, instilled by the constant refrain of "college for all" espoused by political leaders and the media. Employers may be reluctant to take on the initial costs associated with sponsoring apprentices. Many may prefer to continue to outsource skills training to the education sector, despite the evidence that it does not consistently produce graduates ready for the workplace.[20]

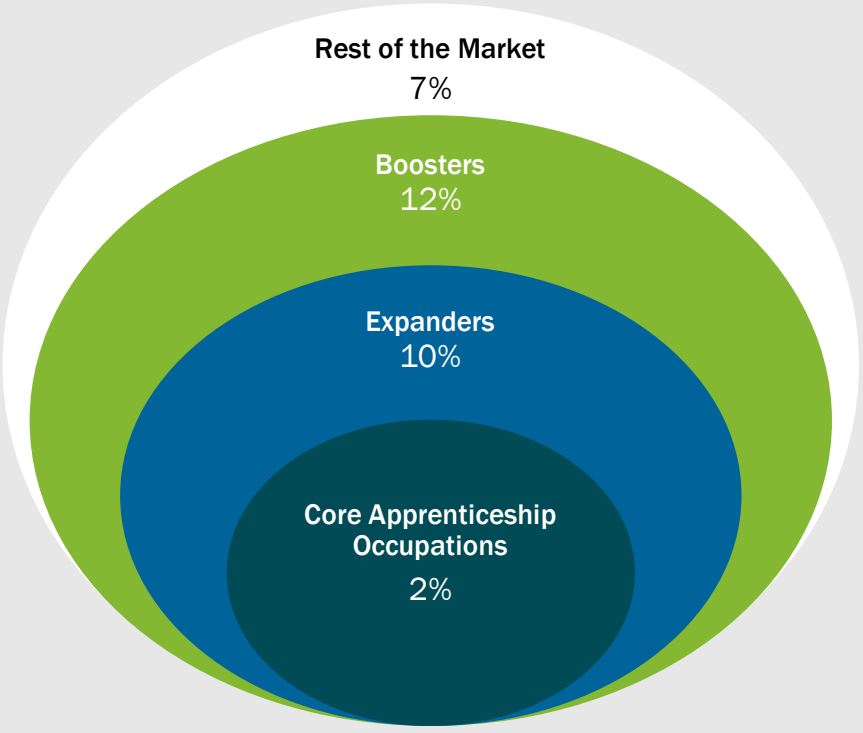
CLIMBING THE LADDER

One criticism of the apprenticeship concept is that most of the occupations in the core group do not have the career ladders for advancement that other fields offer. By contrast, Booster occupations tend to be the entry-level rungs on career ladders that lead to more responsibility and better compensation. Computer User Support Specialist positions, as noted, are the classic first step into an information technology career that can lead into management as well as advanced fields such as programming or cybersecurity. Human Resources positions also often have a well-defined career ladder into advanced and managerial roles.

Based on an analysis of the millions of careers represented in the Burning Glass Technologies resume database, we found that entry-level workers in both Booster and Expander occupations are more likely to advance into higher-paying roles than either the Core Apprenticeship group or those who start in occupations in the rest of the job market (see Figure 6). As a result, Expanders and Boosters are likely to find themselves in occupations with significantly higher salaries than those who start in Core Apprenticeships.

Of course, promotions and role changes are not the only measures of long-term career value. Those in the Core Apprenticeship occupations may well see salary increases over their careers based on seniority and the acquisition of advanced skills.[21] Nevertheless, this analysis suggests that apprenticeships in both Expander and Booster occupations could offer stepping stones to onward career progression in ways that are not typical of currently apprenticed trades.

FIGURE 6: ADVANCEMENT PROSPECTS OF APPRENTICESHIPS BY OCCUPATION TYPE



Source: Burning Glass Technologies analysis based on U.S. Department of Labor data.

POTENTIAL IMPACT

Apprenticeships are only one of many routes to a job, even for those occupations where they are firmly established. There were 410,000 active apprentices across all occupations in 2016. Even in the 27 occupations that constitute the Core Apprenticeships, the system is far from universal. If apprenticeships became the standard training approach in these 27 occupations, that would increase the total number of apprenticeships in 2016 by at least 900,000 to a total of more than 1.3 million. Extending apprenticeships into the Expander occupations would add nearly 749,000 openings and extending to the Booster occupations another 1.1 million openings (see Figure 7).

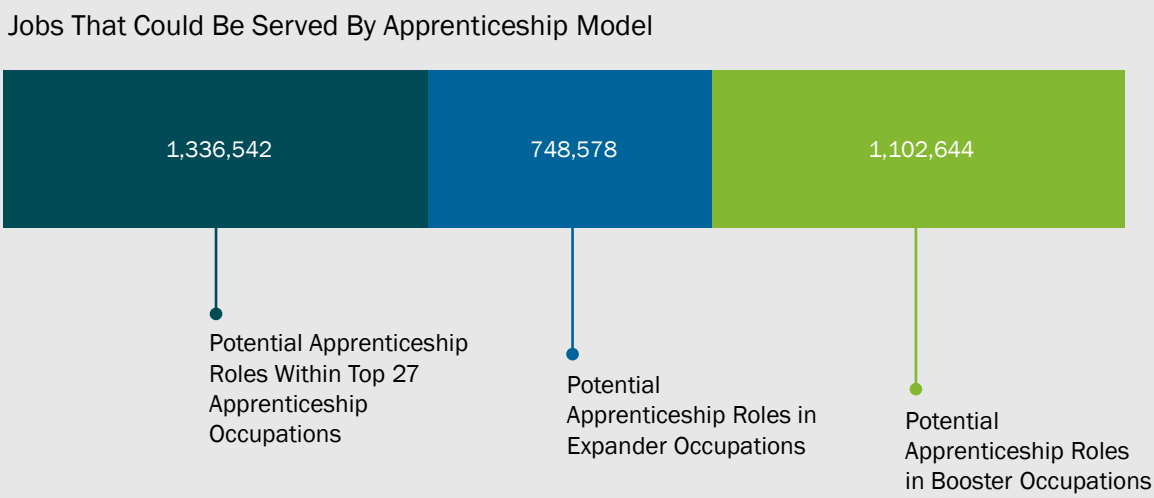
As we discussed earlier, the goal of this report is not to propose some new approach to apprenticeships in the United States, but rather to define the size of the untapped opportunity by identifying those occupations that appear well-suited to this approach to skills development. Important questions remain as to how apprenticeships compare with other training options in specific occupations. For example:

What are employers buying when they ask for a bachelor's degree? The technical skills in these jobs can be acquired via multiple routes, including apprenticeships. But often degree inflation is driven by employers' tendency to use the bachelor's degree as a proxy for specific "soft" skills, such as communications and teamwork.[22] How can apprenticeships be designed to fulfill those requirements?

Do apprenticeships offer upward mobility? Many of the jobs we have identified are the first rung on the career ladder in their fields. IT help-desk positions, for example, are entry-level jobs that can lead to careers in cybersecurity, programming, or network administration. But those careers do require further training and credentials in a field defined by certifications. How can apprenticeships fit into such a system? How do we prevent apprenticeships from leading only to jobs that offer no prospect of advancement and personal growth, a criticism leveled at many of Europe's well-established systems?

What is the return on investment for both students and employers, compared with other training options? Apprenticeships are cheaper than four-year college degrees for students—in fact, since apprentices are paid while being trained, they provide a kick-start on the road to independence. For many employers the perception is that apprenticeships require a significant investment and that they have to contrast the benefit of having job-ready workers with the economics of relying on the "free" candidates offered by admittedly inefficient training systems.

FIGURE 7: POTENTIAL FOR APPRENTICESHIPS IN THE UNITED STATES



Reality shows that employers are worrying about the wrong problem. In fact, it is the practice of hiring college graduates for jobs that could be done by non-degree workers that brings tremendous costs to employers—and apprenticeship programs offer an effective way to reduce such costs. A 2016–2017 hiring and talent management survey found that asking for a college degree for middle-skills jobs carries the following hidden costs: It makes the position difficult to fill; it leads to wage inflation because employers pay significantly more for college graduates to do the same job as non-degree workers; it leads to higher employee turnover among college graduates; and it leads to lower employee engagement because college graduates are more likely to feel underutilized than non-degree workers.[23]

What role should apprenticeships play in newly emerging jobs? A highly dynamic technology environment has been creating whole new categories of jobs in the U.S. economy. For example, today there are almost 100,000 mobile application developers working in the United States. There were none 10 years ago. Such emerging jobs often prove hard to fill, as companies are eager for workers but lack established talent pipelines. Our methodology could serve to identify those emerging occupations that are ripe for apprentice programs. Employers may be receptive to alternative pathways like apprenticeships. If policymakers in workforce development adopt this methodology in up-and-coming job categories, they could get ahead of employer demand and build the kind of robust partnerships that a sustainable apprenticeship system requires.

This may be the most significant barrier to apprenticeships in the public's mind: a sense that this is a career path only used in the industrial or craft-driven jobs of the past rather than the high-tech and service-sector jobs of the future. Our analysis should dispel that belief. Many of these "future-proof" jobs have a great deal in common with existing jobs filled through apprenticeships—and that means apprenticeships have a clear role to play in the future of work.

APPENDIX: METHODOLOGY AND DATA ANALYSIS

In order to identify occupations that represent expansion opportunities for apprenticeships, we first examined the characteristics distinguishing occupations that commonly use apprenticeship programs from those that do not. More specifically, we have used a three-part methodology:

- Identify characteristics that distinguish current occupations in which apprenticeships feature prominently as training programs;
- Based on those characteristics, develop criteria for assessing the universe of occupations in which apprenticeships do not feature prominently; and
- Identify occupations with similar characteristics to those for which apprenticeships are commonly used.

Step 1: Identify characteristics of current occupations for which apprenticeships have gained significant adoption.

Apprenticeships are used primarily in traditional union trade occupations, which the Bureau of Labor Statistics classifies into the Construction and Extraction; Production; and Installation, Maintenance, and Repair occupation groups. All but four of the top 27 apprenticeship occupations are in one of those three categories. However, there are considerably more occupations that lend themselves to well-structured on-the-job training programs beyond union trades and related roles.

The table below compares the Core Apprenticeship occupations and the labor market overall.

	Top 27 Apprenticeship Occupations	All Other Occupations
Averages for Occupation Groups		
Median Annual Wage	$44,212	$52,726
Union Membership within Occupation	19.32%	10.08%
Employment Growth Projections (2016–2026)	12.30%	6.73%
% of Job Postings Requesting High School Degree	95.97%	52.62%
% of Job Postings Requesting Associate's Degree	3.46%	5.69%
% of Job Postings Requesting Bachelor's Degree or More	0.31%	41.27%
% of Job Postings at Entry Level (Less Than 3 Years of Experience)	69.93%	57.28%

Source: Bureau of Labor Statistics; Census Bureau; Burning Glass Technologies data.

Step 2: Develop criteria for expanding the potential universe.

Based on the criteria of which roles are currently apprenticed, the goals of an apprenticeship program, and the dynamics associated with entering into an occupation, we developed the criteria below to suggest additional occupations for which a more robust and well-rounded apprenticeship system could be an appropriate alternative.

Criterion	Measure	Notes/Rationale
Occupation pays a living wage	OES median salary ≥ $15 hour	Workers and employers rarely invest in training for low-paying or low-skilled occupations. Based on calculations derived from the MIT Living Wage calculator, $15 per hour represents a national living wage.
Occupation is an entry-level role	Either 33% or more of postings call for no more than two years of experience, or the occupation ranks in the top 200 occupations that require no more than two years of experience	Apprentices are training for a first step onto the career ladder. We use this criterion to filter for roles that are accessible without several years of relevant prior experience. This criterion excludes managerial positions and other roles into which workers must be promoted.
Occupation has viable on-the-job training entrance requirements	Occupation is not licensed	For a role to be viable as a near-term expansion of apprenticeship programs, those who complete the program must be able to get jobs in their chosen field. For that reason, we exclude jobs with strong occupational licensure requirements for which an apprenticeship would not address the educational requirements commonly required by state licensure boards. This filter excludes most clinical healthcare roles from eligibility.
Occupation emphasizes a particular skill cluster and has a well-defined and consistent skill set	The top one or two skill clusters are requested at least 20% more often than the next proximal skill cluster	A consistent set of skill requirements within the occupation allows apprenticeship developers to build a common curriculum that prepares workers to be successful in the role across the industry.
Occupation is typically available to sub-baccalaureate workers	At least 20% of job postings in the occupation have a requested minimum education level at the high school or associate's level	Given that apprenticeships are typically used by workers who do not have a college degree, we focus this analysis on those roles for which employers customarily accept workers with sub-baccalaureate credentials.

Step 3: Evaluate expansion groups.

We determined two sets of expansion groups. The first group, Expanders, is most proximal to the current set of occupations commonly apprenticed. Expanders are those roles that meet the criteria above and for which the educational requirements are exclusively at the sub-baccalaureate level. The second group, Boosters, are roles for which the educational requirements are relaxed, as well as occupations whose educational requirements are a mix of sub-baccalaureate and baccalaureate credentials.

Group One: Expanders
Cabinetmakers and Bench Carpenters
Coating, Painting, and Spraying Machine Setters, Operators, and Tenders
Computer Numerically Controlled Machine Tool Programmers, Metal and Plastic
Computer-Controlled Machine Tool Operators, Metal and Plastic
Crushing, Grinding, and Polishing Machine Setters, Operators, and Tenders
Customer Service Representatives
Electrical and Electronics Repairers, Commercial and Industrial Equipment
First-Line Supervisors of Personal Service Workers
Gaming Surveillance Officers and Gaming Investigators
Industrial Truck and Tractor Operators
Medical Equipment Preparers
Medical Equipment Repairers
Medical Secretaries
Medical Transcriptionists
Ophthalmic Medical Technicians
Painters, Transportation Equipment
Solar Photovoltaic Installers
Stationary Engineers and Boiler Operators
Tax Preparers
Water and Wastewater Treatment Plant and System Operators
Welders, Cutters, Solderers, and Brazers

Group Two: Boosters
Architectural and Civil Drafters
Billing and Posting Clerks
Camera Operators, Television, Video, and Motion Picture
Chefs and Head Cooks
Chemical Technicians
Claims Adjusters, Examiners, and Investigators
Computer User Support Specialists
Database Administrators
Drafters, All Other
Executive Secretaries and Executive Administrative Assistants
Graphic Designers
Hazardous Materials Removal Workers
Human Resources Specialists
Insurance Sales Agents
Insurance Underwriters
Legal Secretaries
Life, Physical, and Social Science Technicians, All Other
Mechanical Drafters
Medical Records and Health Information Technicians
Nuclear Medicine Technologists
Occupational Health and Safety Specialists
Paralegals and Legal Assistants
Payroll and Timekeeping Clerks
Purchasing Agents, Except Wholesale, Retail, and Farm Products
Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products
Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products

Notes

[1] "Fact Sheet: Investing $90 Million through ApprenticeshipUSA to Expand Proven Pathways into the Middle Class," press release, April 21, 2016, on archived Obama White House website, https://obamawhitehouse.archives.gov/the-press-office/2016/04/21/fact-sheet-investing-90-million-through-apprenticeshipusa-expand-proven, accessed November 2017.

[2] "Presidential Executive Order Expanding Apprenticeships in America," press release, June 15, 2017, on White House website, https://www.whitehouse.gov/the-press-office/2017/06/15/presidential-executive-order-expanding-apprenticeships-america, accessed November 2017.

[3] There were 505,371 apprenticeships total in 2016 according to the U.S. Employment and Training Administration, but we have excluded the United States Military Apprenticeship Program from this analysis. U.S. Department of Labor, Employment and Training Administration, "Data and Statistics," https://doleta.gov/OA/data_statistics.cfm, accessed November 2017.

[4] See, for example, Louis Uchitelle, "Business Scene; Apprenticeships: Reluctant Choice," *New York Times*, April 7, 1992, http://www.nytimes.com/1992/04/07/business/business-scene-apprenticeships-reluctant-choice.html, accessed August 2017.

[5] Joseph B. Fuller and Manjari Raman, *Dismissed by Degrees: How Degree Inflation is Undermining U.S. Competitiveness and Hurting America's Middle Class*, Accenture, Grads of Life, and Harvard Business School, October 2017, http://www.hbs.edu/managing-the-future-of-work/Documents/dismissed-by-degrees.pdf.

[6] Active apprentices per occupation (FY 2016) as reported by the U.S. Department of Labor, Employment and Training Administration, "Data and Statistics," https://doleta.gov/OA/data_statistics.cfm, accessed November 2017.

[7] Bureau of Labor Statistics, "Union affiliation of employed wage and salary workers by occupation and industry," January 26, 2017, https://www.bls.gov/news.release/union2.t03.htm, accessed November 2017 and "Union Members Summary," January 26, 2017, https://www.bls.gov/news.release/union2.nr0.htm, accessed November 2017.

[8] Based on Burning Glass Technologies' analysis of its database of 700 million historical job postings and more than 75 million résumés.

[9] See General Assembly and Burning Glass Technologies, "Blurring Lines: How Business and Technology Skills Are Merging to Create High Opportunity Hybrid Jobs," July 2015, http://burning-glass.com/research/hybrid-jobs/, accessed November 2017.

[10] Burning Glass Technologies, *The Narrow Ladder: The Value of Industry Certifications in the Job Market*, 2017, http://burning-glass.com/research/certifications/

[11] Amy K. Glasmeier and the Massachusetts Institute of Technology, "Living Wage Calculator," http://livingwage.mit.edu/, accessed November 2017. For an explanation of the choice of $15, see Appendix.

[12] Fuller and Raman, *Dismissed by Degrees*.

[13] Fuller and Raman, *Dismissed by Degrees*.

[14] Burning Glass Technologies, *Moving the Goalposts: How Demand for a Bachelor's Degree is Reshaping the Workforce*, September 2014, http://burning-glass.com/research/credentials-gap/, accessed November 2017.

[15] Fuller and Raman, *Dismissed by Degrees*.

[16] Nancy Hoffman and Robert Schwartz, *Gold Standard: The Swiss Vocational Education and Training System*, National Center on Education and the Economy, March 2015, http://ncee.org/swiss-vet/, accessed November 2017.

[17] State Secretariat for Education, Research, and Innovation, "Vocational and Professional Education and Training in Switzerland: Facts and Figures 2017," April 2017, https://www.sbfi.admin.ch/sbfi/en/home/news/vocational-and-professional-education-and-training-in-switzerlan.html, accessed November 2017.

[18] German Federal Ministry of Education and Research (BMBF), "Education and Research in Figures 2017," May 2017, https://www.bmbf.de/pub/Education_and_Research_in_Figures_2017.pdf, accessed November 2017

[19] Dienst Uitvoering Onderwijs (Dutch Department of Education), "Per sector, bedrijfstak, type mbo, niveau, provincie deelnemer," https://www.duo.nl/open_onderwijsdata/databestanden/mbo/onderwijsdeelnemers/deelnemers-mbo4.jsp, accessed November 2017.

[20] Burning Glass Technologies, *Moving the Goalposts: How Demand for a Bachelor's Degree is Reshaping the Workforce*, September 2014, http://burning-glass.com/research/credentials-gap/, accessed November 2017.

[21] See, for example, Hart Research Associates, *Falling Short? College Learning and Career Success*, Association of American Colleges and Universities, January 2015, https://www.aacu.org/leap/public-opinion-research/2015-survey-falling-short, accessed November 2017.

[22] It is worth noting that résumé data also have a bias toward those who have progressed to more professional roles, since résumés are often not required in lower-level occupations, although any resulting skew should be expected to affect all of these groups equally.

[23] Fuller and Raman, *Dismissed by Degrees*.

[24] Fuller and Raman, *Dismissed by Degrees*.