



# Training the Next Revolution in American Manufacturing

By Charles Carson & Jonathan Robison with William Reinsch, Jack Caporal, & Andrew Chatzky JULY 2019

## THE ISSUE

*Much like other aspects of daily life and the economy, technology is changing the way U.S. based companies manufacture goods for the global market. As technology permeates and alters the manufacturing industry, it requires a workforce better equipped with the skills to handle the new demands such advanced technology and techniques imposes. There are currently hundreds of thousands of unfilled manufacturing jobs due to a skills deficit across the U.S. workforce. This report researches different workforce development programs for advanced manufacturing across the nation, and what can be done better to educate the worker of tomorrow.*

## INTRODUCTION

Manufacturing remains a critical sector of the U.S. economy. Manufacturing employment peaked in mid-1979 at 19.5 million jobs. From that peak through 2010, however, the manufacturing sector shed over 8 million jobs. But 2010 was the inflection point, and since then manufacturing jobs have made a slow but steady recovery, now employing nearly 13 million Americans according to the latest figures from the U.S. Bureau of Labor Statistics.<sup>1</sup> Despite this growth, the percentage of U.S. workers working in the manufacturing sector has decreased significantly, with just over 8 percent of the U.S. labor force employed in manufacturing at the end of 2018, compared to 26.4 percent in 1970.<sup>2</sup> Despite employing far fewer people, the U.S. manufacturing industry's productivity continues to grow. According to Harvard economist Greg Mankiw, U.S. manufacturers are producing 47 percent more in 2016 than they were two decades earlier, which is largely attributed to technological progress leading to advancements in manufacturing and output.<sup>3</sup>

While the overall makeup of the workforce has shifted away from manufacturing and toward services jobs, the makeup

of jobs within the manufacturing sector has changed as well. In fact, these changes mirror one another: from lower-skilled, lower-paying jobs to higher-skilled and higher-paying ones. As advanced manufacturing methods and systems have emerged, the demand for workers utilizing those skills has also grown.

However, worker training for these newer occupations has lagged, resulting in a mismatch between the manufacturing skills needed previously and the skills needed now in the twenty-first-century economy. Manufacturing jobs are on the rise, but manufacturing jobs require more complex and different skills than before. Employers are having trouble finding the right workers. Currently, 390,000 manufacturing jobs remain unfilled, with most left empty because they require workers trained in high-skilled manufacturing methods. As Justin Guinn, a Content Analyst at Software Advice, explains, "The prevalence of computer-controlled machinery...now demands manufacturing workers that possess a combination of math skills, intuition, stamina, and often a college degree."<sup>4</sup>

The purpose of this study is to gain a better understanding of the ongoing efforts on advanced manufacturing training below the federal—or even state-wide—level. The Organization for Economic Cooperation and Development (OECD) defines advanced manufacturing technology as “computer-controlled or micro-electronics-based equipment used in the design, manufacture, or handling of a product.” This includes a wide range of processes and devices usually characterized by the use of complex technology and innovative methods to produce new, cutting-edge goods. 3-D printing, automation and robotics, and nanotechnologies can all fit under the umbrella of advanced manufacturing. This study specifically focused on initiatives in the private sector and at academic institutions, with the goal of surveying what nongovernment efforts are underway to educate the workforce on advanced manufacturing techniques. We approached this task with several initial questions:

- What are these programs doing?
- How effective are they?
- What lessons and best practices can be applied more widely to encourage success?

To do this, we studied a number of players in this space, from community colleges and four-year institutions to national certification organizations. We also sought a sample size across a wide geographic range of the United States, particularly in the Midwest and the Southeast. We conducted site visits, in-person interviews, and phone interviews of these organizations to gain a better understanding of current activities and efforts in the field. Additionally, we sent out a survey to relevant groups to expand our sample size and geographic scope. A summary table of the organizations we interviewed can be found on page 3.

## TYPES OF TRAINING PROGRAMS

In general, we identified several types of instruction and programs offered by educational institutions.

### 1. **Short, intensive introductory boot camp programs:**

These have a history of being an entry to the skills needed in shops on the manufacturing floor. Most programs we interviewed still offer these programs, either for potential job applicants looking to get a foot in the door or for employers who need a quick onboarding process for new hires. Many of these programs are being restructured as “pre-apprenticeship” programs, with an emphasis on career-track positions.

2. **Summer camps for middle and high school students:** These programs help to address the negative perceptions of students (and their parents) and expose students to advanced manufacturing techniques. These camps also help students get the skills they need and access additional resources for applying to advanced manufacturing jobs.
3. **Community colleges:** Community colleges are almost always involved in the workforce development programs of those we spoke with. Some community college programs work directly with employers, while others seem to take a more passive approach. Most workforce development organizations and Manufacturing Extension Partnerships (MEPs) have direct relationships with local community colleges and are often co-located on the campus or in the facilities of a community college. These organizations often take on the role of working with employers to design programs, but students ultimately sign up for courses (as well as apply for financial aid) through the community college.
4. **Apprenticeship programs:** Unprompted and often at the start of our conversation, apprenticeship programs and models were brought up with every organization we met with. The apprenticeship model has long been a way to join the skilled trades, but recent focus (and over \$150 million in grant funding) from the U.S. Department of Labor has increased the emphasis on apprenticeship as a model for increasing skills in many industries, including advanced manufacturing.<sup>5</sup> There are a few key elements that make apprenticeships desirable for employers, employees, and educational institutions:
  - a. The ability to work while continuing education. This benefits employees, who do not need to take on debt and can earn a salary while earning a degree. This also benefits employers, who can fill positions immediately and provide training that is focused on their particular equipment or manufacturing techniques.
  - b. Available funding. The U.S. Department of Labor recently announced over \$150 million in grants for apprenticeship programs. In addition, there is often a large pool of state and local government subsidies, as well as private sector grants, to help subsidize employers’ cost of taking on a less-skilled employee and also subsidize educational institutions and employees’ cost of education

## Summaries of Analyzed Programs

<b>Program</b>	<b>Location</b>	<b>Type</b>	<b>Degree or certificate granting program?</b>	<b>Non-educational resource support?</b>	<b>Maker space present?</b>	<b>High school outreach or boot camp programming?</b>
Robert C. Byrd Institute (RCBI)	WV	Community workforce development resource support	No (supports degree-granting institutions)	No	Yes	No (though the institutions it supports do)
Center for Manufacturing Innovation	SC	Manufacturing specific-training facility	Yes (affiliated with Greenville Tech)	No (student services through affiliated school)	Yes	Yes
Siemens Gas Turbine Factory	NC	Private corporation apprentice-ship	Yes (covers tuition at local comm. college)	No	No	Yes (pre-apprenticeship as part of application process)
University of Pittsburgh Manufacturing Assistance Program	PA	Manufacturing specific-training facility, community workforce development resource support, traditional four-year university	Yes	Yes: transportation assistance, drug testing	Yes	No
Cuyahoga Community College	OH	Community college	Yes	No	Yes	No
Ivy Tech Community College	IN	Community college	Yes	No	No	No
Ohio Manufacturing Partnership	OH	Government-funded resource support	No (supports degree-granting institutions)	Yes: transportation assistance	No	Yes
FREEDM Systems Center and PowerAmerica	NC	Traditional four-year university	Yes (credit toward undergraduate degree at affiliate university)	No	No (some equipment for demos)	Yes (for undergraduate students)
Wayne County Schools Career Center	OH	Government-funded resource support	No	Yes: drug testing, drug treatment and counseling	No	Yes (high school career counseling)
Indiana University Manufacturing Policy Initiative	IN	Traditional four-year university, policy analysis and research	Yes	No	No	No
America Makes	Nationwide digital presence, physical locations in TX and OH	Digital resource support	No	No	No	Yes (in Youngstown, OH location)
ToolingU-SME	Nationwide digital presence	Digital resource support	No	No	No	No

and training. Workforce development boards and MEPs are often very knowledgeable about available funding streams and tax benefits and can help employers design programs that tap into these resources in their area.

## KEY CHALLENGES

Overall, we found that the most commonly mentioned challenge for increasing the skilled workforce in advanced manufacturing centered around negative perceptions of manufacturing jobs among the potential workforce. Many people we spoke with noted how this decreased the available pool of quality applicants, and many efforts they worked on were designed to help combat this perception. We found that apprenticeships are increasingly the preferred model for workforce development, and there are many efforts underway with funding available in this area. Existing training programs, especially those with a short “boot camp” training model, are being remodeled as “pre-apprenticeship” programs. There is an extensive network of stakeholders, including employers; employees; public and private educational institutions; federal, state, and local governments; public-private partnerships; and workforce development boards. We saw the greatest successes in areas where these various stakeholders were aligned on common goals and strategy to pool their resources to provide a suite of training programs that meet employers’ needs for a skilled workforce and employees’ desires for credentials and good-paying jobs.

These key challenges are outlined below:

1. **Negative perceptions of manufacturing:** In our interviews, everyone we spoke with mentioned there is a negative perception of manufacturing jobs, but they were clear that perception did not match the reality of modern manufacturing. “This is not your grandfather’s factory” was a refrain heard from several people. In our survey, a majority of respondents agreed that it was challenging finding applicants to advanced manufacturing training programs and that many potential students did not know about options for careers in advanced manufacturing.
2. **Regulatory burden:** For apprenticeships, there is often a heavy paperwork or regulatory burden for programs to apply for certification and funding support. Some programs report the burden to be so high that it discourages applying for financial support and certification.
  - a. Most workforce development boards and MEPs (and other consultants) are willing to
3. **Employee poaching:** For apprenticeships, employers are concerned that other companies will poach their employees after they have invested money and time into workers.
  - a. In our interviews, we found poaching uncommon. Most apprenticeship programs include a requirement for an employee to stay with the employer for a period after the program ends. Even without this requirement, employees appreciate the investment from their employer and feel a loyalty to the company and to the program.
4. **Employer margins:** Many employers note that they sometimes struggle to participate in workforce development programs. Besides the above reasons, there are the simple factors of economics and time; many employers, especially smaller businesses, have very lean operations. If they are already operating at full capacity, it is difficult for them to find time and funds to provide training to their workers.
5. **Finding qualified applicants:** Many companies and training programs struggle with finding qualified applicants for positions or programs for the following reasons:
  - a. The already noted negative connotation drives away qualified and potential applicants.
  - b. Many applicants do not meet the minimum qualifications:
    - i. Vocational skills: The changing nature of advanced manufacturing means applicants need a blend of skills, including traditional manufacturing skills (the ability to operate a hand lathe or mill, for example). With fewer schools offering technical education or even a shop class, many potential students do not have a the basic understanding of how these machines work.
    - ii. Academic background: Applicants do not meet the minimum standards of math and computer proficiency. CNC lathes and 3-D printers need technicians who can competently program or troubleshoot when they break down. Taking

assist employers with paperwork to become a registered apprenticeship and are willing to help an employer design an apprenticeship or upskilling program even if they choose not to become registered.

measurements, using CAD, and translating that into a design requires a mix of skills and a bit of creativity. Often the potential applicants with that mix of skills are more interested in pursuing a 4-year degree.

6. **Poverty and social challenges:** Poverty, transportation, and the opioid epidemic weigh on a potential talent pool. Successful graduates may not have access to reliable public transportation or a private automobile to get them to a potential job site or employer. Some have children but lack access to affordable childcare. The University of Pittsburgh and RCBI in West Virginia both specifically noted the challenges of transportation. RCBI is also situated in a region that has been hard hit by the opioid epidemic, and employers are often reluctant to hire workers with past drug use. RCBI has helped facilitate drug testing for potential applicants, and their pre-apprenticeship programs can help serve as a screening process for future employers.

## RECOMMENDATIONS

### YOUTH ENGAGEMENT

- Students should be engaged at younger ages and familiarized with manufacturing skills and careers as both useful and worthwhile.
- Primary education should improve the teaching of basic STEM skills. High schools should emphasize how STEM skills are used in non-college pathways and build in more vocational training to attract students and encourage them to consider non-college pathways.

### LIFETIME LEARNING

- Mid-career upskilling and training should be improved and expanded.
- Work-study arrangements and apprenticeship models should be expanded for both new and returning student populations, in conjunction with employers.

### LOCAL SUPPORT SERVICES AND ENVIRONMENTAL CONSIDERATIONS

- Providing community resources, like transportation subsidies, drug counseling, or even childcare, is key to creating a healthy, successful, and reliable student population and workforce.

- Local stakeholders should increase access to these services to assist graduates in obtaining employment and escaping the poverty cycle.

### MAKER SPACES

Maker spaces should be expanded because they:

- are an integral, low threshold gateway for those curious to be introduced to advanced manufacturing concepts and techniques.
- serve as an anchor point for the community of entrepreneurs and industries in this area and can foster greater collaboration and innovation.

### FEDERAL AND STATE GOVERNMENTS

- The bureaucratic process for approving and certifying an apprenticeship is overly burdensome and confusing—or widely perceived as so by many apprenticeship programs. It should be streamlined and simplified to allow more programs to start, widen efforts to increase program availability, and enlarge the number of workers with transferable certifications.
- The government should proactively create criteria by which to evaluate programs and conduct evaluations of government-funded programs. This can help reform poorly performing programs and identify best practices.
- The federal government and the U.S. Military, together employing millions of people, should be an example of innovation in upskilling and training the current workforce, showing by example how to integrate best practices for advanced manufacturing techniques. ■

Read the full report at <https://www.csis.org/manufacturingrevolution>.

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*This brief is made possible through the generous support of HP, Inc.*

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## ENDNOTES

1. “All Employees: Manufacturing,” FRED, <https://fred.stlouisfed.org/series/MANEMP>.
2. “Percent of Employment in Manufacturing in the United States (DISCONTINUED),” FRED, <https://fred.stlouisfed.org/series/USAPEFANA>.
3. N. Gregory Mankiw, “The Economy Is Rigged, and Other Presidential Campaign Myths,” *The New York Times*, May 06, 2016, <https://www.nytimes.com/2016/05/08/upshot/the-economy-is-rigged-and-other-presidential-campaign-myths.html>.
4. Justin Guinn, “Manufacturers Are Hiring Again; What Skills Are They Looking For?” Software Advice, September 19, 2017, <https://www.softwareadvice.com/resources/manufacturers-skills-in-demand/>.
5. Glenn Thrush, “Amid Worker Shortage, Trump Signs Job Training Order,” *New York Times*, July 19, 2018, <https://www.nytimes.com/2018/07/19/us/politics/trump-worker-training.html>.