FILLING THE NEW MANUFACTURING JOBS: POLICY OPTIONS FOR 2020 AND BEYOND

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INTRODUCTION

During the research and writing of this paper, COVID-19 emerged as a global pandemic with far-reaching and unknown implications. As of April 2020, the completion date of this paper, businesses have been shuttered, highways and downtowns are empty, and most people are sequestered at home. The timeline for a safe reopening of the economy is uncertain, and once it does reopen, no one really knows how Americans will react as they return to their workplaces and communal lives. Without a crystal ball, it is difficult to predict the impact the pandemic will have on the manufacturing skills gap. Nonetheless, all previous signs of a skills gap—manufacturing jobs going unfilled, inadequate skills for the current workplace, and a lag between skills development and job placement—point to a continuance of the problem. One future scenario might be that while some manufacturing businesses are lost during the pandemic, others may become stronger and introduce additional 21st century technologies into their operations—speeding up economic and business cycles—and demanding additional skills from workers. Post–pandemic investments may breathe new life into the sector and encourage manufacturers to dump outdated legacy systems and move straight to The Internet of Things. Presently, all we have is speculation. But there is one thing that can make a difference going forward, and that is government leadership attuned to the needs of both employers and employees.

This paper was written with the intention of stimulating a policies discourse for future workforce development initiatives in American manufacturing. It is necessarily truncated to focus solely on a variety of policy suggestions (and their antecedents) that can ensure a healthy pipeline of American manufacturing talent well into the future. Because this paper focuses on policy solutions, macroeconomic discussions of the responsibilities of private capital versus public capital are not explored. For the purposes of this paper, the author considers employed labor to be a business expenditure (and investment), and public policy a deliberate system of principles that facilitate, regulate or restrict government-derived actions. The paper's underlying premise is to spur the discussion and adoption of workforce development policies that encourage and support private sector investments, and result in an enhanced competitive position for American manufacturing.

With specific regard to the manufacturing workforce skills gap, the paper focuses on legislation and methods for developing the sophisticated skills needed to work in what is colloquially called "advanced manufacturing." The author envisages advanced manufacturing skills as those that provide additional value-add or economic premiums for both the worker and the firm in the current or future economy. The author hopes to lay out the challenges and potential solutions for government policies with regard to the complex world of "workforce development."

Additionally, the term "manufacturing" encompasses all American manufacturing from the 32 North American Industry Classification System (NAICS) codes and all sizes of firms from around the U.S. The author is generalizing when referring to "manufacturing." Most American manufacturing operations are small—98.6 percent of them—and the Small Business Administration states that 75.3 percent of manufacturing firms have fewer than 20 employees. The number of American manufacturers with more than 250 employees is 56,391 (Source: NAICS Association), and the overall number of manufacturing firms is 295,643 (Source: National Association of Manufacturers). The policy recommendations contained herein regard the government's role in building and sustaining a talent pipeline for all American manufacturers, large and small.

AMERICAN MANUFACTURING'S NEED FOR TALENT, STILL

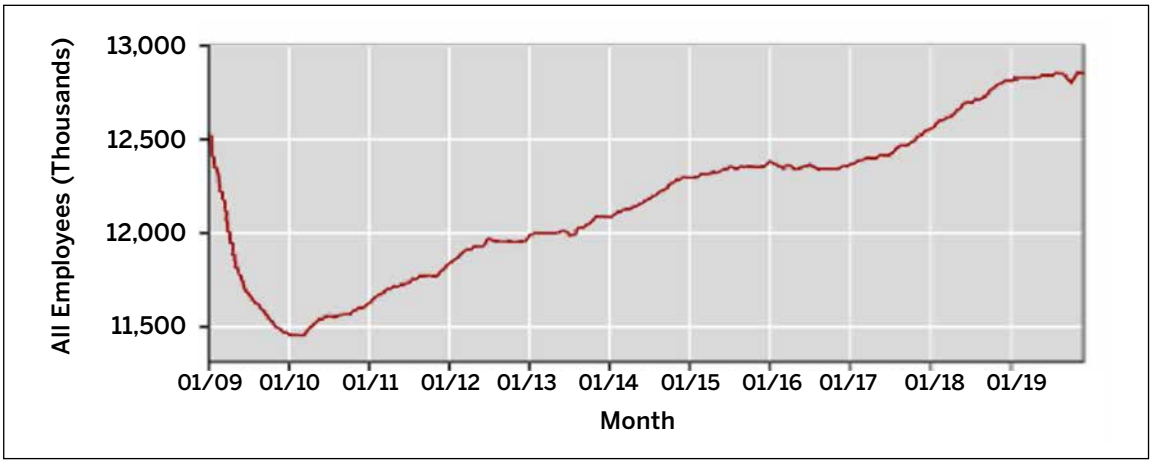
Depending on whom you ask the question "What is manufacturing?", you will likely receive several different answers. Older adults will use terms such as "factories, dirty, and gone," while millennials and Gen Zers will say "lasers, making stuff with printers, and robotics." If you ask about manufacturing firms, the Boomers will say "Ford, GM, and Westinghouse," while the kids will say "Tesla, SpaceX, and Nintendo."

Americans know that a large swathe of manufacturing moved to China in the last two decades. Following the normalization of trade relations with China in 2000, manufacturing employment decreased 17 percent by 2003 (Pierce and Schott 2016). This was partly a policy effect from formally standardizing trade with China, as well as an effect of less labor-intensive production moving abroad (Ibid.). Automation and the 2008 recession compounded those losses (Ahmed et al. 2018). In public discussions, many were quick to say about American manufacturing that it had become a relic of the old economy. But for millions of manufacturers and manufacturing workers, the loss was catastrophic. For them, the loss of manufacturing jobs signaled the beginning of the end of the American way of life. And who is to say it was not? Low-skill workers in manufacturing (and other jobs) suffered a substantial decline in real earnings over the last 40 years (Acemoglu and Autor 2010).

Yet during the 2000s, real manufacturing output rose approximately 7 percent, even though the U.S. manufacturing footprint declined (Charles et al. 2018). Now, in 2020, manufacturing has become more capital and skills intensive (Ibid.), and supports industries such as cybersecurity, advanced machine tooling, high-speed transportation, aeronautics, food production, and robotic medical devices. There are 32 six-digit NAICS codes in manufacturing with ~ 12 million employed in manufacturing firms, about 8.8 percent of the American workforce (Scott 2015). Employment available to less-skilled job seekers (of all kinds) will continue to shrink as it has since the 1970s, but manufacturing jobs will not disappear (see Figure 1), and production jobs are still good jobs.

Manufacturing is not just about making things, it's also a catalyst for the American economy. The leading purchaser of technology is manufacturing. Ninety percent of new patents result from manufacturing innovation. OECD research shows that the U.S. manufacturing private sector accounts for $250B in research and development (R&D) (Source: OECD) and the MAPI Foundation estimates manufacturing's value added multiplier at 3.6. This means that for every $1.00 of value added by domestic manufacturing, the sector generates $3.60 of value-added elsewhere in the U.S. economy (Meckstroth 2016). Economic value is generated through R&D, new product and production design, marketing and sales, customer supports, and innovation. New techniques such as laser welding, 3-D printing, robotics, and computer-based modeling and

FIGURE 1. Employment in U.S. Manufacturing (in Thousands).



simulation are now commonly found in manufacturing operations, changing the old factory floor paradigm and reinforcing the necessity of having educated and skilled workers who can work both sides of production (ideas and making stuff).

THE MANUFACTURING SKILLS GAP

Since the mid-20th century workers with and without post-secondary education could find a good job and good wage in manufacturing (Carnevale et al. 2016). Even now, one doesn't need a four-year degree to be hired, as manufacturing remains the best industry for good jobs without one in 35 states (Carnevale et al. 2019). And no matter one's post–high school education level, manufacturing workers earn more, on average, than workers in skilled services and blue-collar industries (Ibid.). The average wage for workers without a bachelor's degree in high-tech industries is $50,661—58 percent more than the non-high-tech industry average of $32,083 (Foote and Atkinson 2019). Six manufacturing industries employ almost half of all the non-college-educated employees in the high-tech sector overall: household appliances, electrical equipment, commercial and service industry machinery, wired telecommunications carriers, medical equipment, and computers (Foote et al. 2019). Yes, as a share of overall national employment, manufacturing jobs have declined, but 21st century manufacturing jobs are still good jobs with good wages, and it's a critical economic sector for America. Yet manufacturers claim there are not enough job applicants with the "right skills" needed to work in their firms. They say there is a skills gap that hinders their operations from being competitive because they can't find those job seekers.

What's A Skills Gap?

The skills gap is the disconnect between the 21st century skills needed for manufacturing work and the current number of job-seekers in the U.S. who have those skills. To many people, the term "skills gap" connotes different concepts including mismatches, shortages, wage disparities, and baseless hyperbole (Cappelli 2014). Stettner and Yudken (2017) believe the decline of unions has played a role in manufacturing's negative image by lowering wages, making manufacturing work unappealing. Others say that manufacturing, itself, is to blame for its image as jobs offshored and companies downsized (Barr 2018). Osterman and Weaver (2017) catalogue a list of reasons commonly used for explaining the skills gap including structural mismatch, discordant communication, and disaggregation of the manufacturing industry. Skills gap skeptics continue to give rhetorical voice to their argument that "the gap" is not about skills, but about money—the low-wage jobs in manufacturing (Craig 2019). Whatever the reasons are, they are undeniably based in changes in technology, globalization and demographics (Karoly and Panis 2004). Thus,

there is the authentic matter of shifting skill needs, which have made it difficult for manufacturers to find and hire workers (Deloitte and the Manufacturing Institute, 2018; U.S. Chamber of Commerce Foundation, 2020).

Because technology is now ubiquitous, digital connections and networking will change the economic game once again (Atkinson 2019). The digital economy and digital connectivity are synonymous with *The Internet of Things* (IoT), as more technologies become digitally connected and networked, from cars and wristwatches to robots and refrigerators. Connectivity allows machines to do more and software systems to keep the global supply chain streaming. This also means that manufacturers need people with new digital literacy skills—by some accounts 82 percent of future manufacturing jobs will need "medium-to-high digital skill levels" (Atkinson and Ezell 2019, p. 27). These digital skills are both an updated combination of some of the skills of the last 50 years, as well as new skills, including sense-making, adaptive thinking, social intelligence, transdisciplinary facility, new media literacy, computational thinking, cognitive load management, design mindset, cross-cultural competency, and virtual collaboration (Wagner 2013). The World Economic Forum (2018) describes what they believe will be the skills of the future (although they can also be thought of as competencies): creativity, originality and initiative, analytical thinking and innovation, active learning and learning strategies, technology design and programing, complex problem-solving, critical thinking and analysis, leadership and social influence, emotional intelligence, reasoning, problem-solving and ideation, resilience, stress tolerance, and flexibility.

UNESCO[1] describes digital skills along a continuum in which people communicate and share information by virtue of digital networking (https://en.unesco.org/news/digital-skills-critical-jobs-and-social-inclusion). Reading, writing and numeracy, along with functional usage of digital technologies, will become required at the entry-level, while the most sophisticated skills including artificial intelligence, machine learning, and big data analytics will be combined with literacy, numeracy, critical thinking, complex problem-solving, collaboration, and socio-emotional skills. And AI-forward-thinking manufacturers are creating hundreds of new AI specialist jobs in collaborative robotics, machine learning and engineering, and data analytics among them (Atkinson et al. 2019).

Manufacturing productivity continues to improve because of technological innovation, although automation has decreased the overall number of available production jobs; by some accounts three old jobs are lost to every new one utilizing an industrial robot (Carnevale et al. 2019). But propping up uncompetitive jobs with tax breaks and subsidies won't work for long, and only stands in the way of critical new investments (Jacobs 2017). The skills transition is accelerating; new education and training efforts must accelerate as well. The Bureau of Economic Analysis reported that manufacturers contributed $2.355 trillion to the U.S. economy in the second quarter of 2019, and manufacturing accounts for 11.1% of U.S. GDP (Source: U.S. Bureau of Economic Analysis). Improving manufacturing education and training outcomes is as important to America's GDP as trade or taxes.

What is it worth to the next generation to seek out those skills and jobs? Manufacturing establishments will continue to need all kinds of skilled workers so the sector can innovate and proliferate. In fact, the National Association of Manufacturers' *Skills Gap* 2018 report states that 500,000 manufacturing jobs are currently unfilled, and by 2028, 4.6 million manufacturing jobs will need filling (Deloitte and the Manufacturing Institute 2018). So, how will potential manufacturing workers acquire in-demand skills and good jobs? Some employers believe post–secondary diplomas are critical when hiring. But manufacturing jobs have a variety of

educational pathways by which job seekers can learn and demonstrate their competences. These include school-to-work programs, internships, apprenticeships, post–secondary diplomas, industry certificates, and career and technical education coursework (and credentials) in high school and college. That being so, the question becomes: Which manufacturing career pathway(s) will be able to fill the skills gap?

Skills Attainment: Three Pathways

In 2016-2017, 1 million associates degrees and 2 million bachelor's degrees (of many foci) were conferred at American colleges (Source: National Center for Education Statistics). However, in 2016, nearly 3 out of 10 adults thought that a four-year college degree failed to adequately prepare students for a well-paying job in today's economy (CED and Conference Board 2019), and the six-year graduation rate for first-time, full-time undergraduate bachelor's degree students at a four-year degree-granting institutions was 60 percent when students graduated in 2017 (Source: National Center for Education Statistics). Forty percent of entrants did not finish in six years. So, if a million students entered a four-year college in 2011, 400,000 of them did not graduate by 2017. In 2019, the annual current dollar prices for undergraduate tuition, fees, room, and board were estimated to be $17,237 at public institutions, $44,551 at private nonprofits, and $25,431 at for-profit colleges (Source: National Center for Education Statistics[2]).

Sixty percent of Americans will receive post–high school education and training (Carnevale et al. 2010), and that education is offered in many ways, not only at colleges. For example, Career and Technical Education (CTE) is funded by federal and state grants through the Strengthening Career and Technical Education for the 21st Century Act ($1.2B annually). CTE programs prepare individuals for careers without, necessarily, sending them to college for a diploma. CTE state and local programs cover many industries including manufacturing education and training, and the programs operate at the secondary and post-secondary education levels. Students in post–secondary CTE can apply for Pell grants to help fund their education. Ninety-eight percent of public school districts offer CTE and many offer on-the-job work experiences (Source: U.S. Department of Education). The National Association of Colleges and Employers says research shows that these work experiences often lead to employment for the interns.

Apprenticeships provide hands-on experiences in occupations of interest and high demand. The combination of work experiences and academics resonates with employers and job seekers—there were 585,000 apprentices in 2018, a growth rate of 56 percent since 2013—and there are 23,400 registered apprenticeship programs in the United States, according to the U.S. Department of Labor (DoL). Apprenticeships aren't simply in the Trades, as most people think, but in other economic sectors as well. Apprentices earn a wage at the worksite (paid by employers) while they are studying to earn their designations. This makes apprenticeships a good option for both working learners and employers.

New Skills: The Digital Age

The complete adoption of digital technologies and connections will happen (and has already started to happen) in all business sectors, with manufacturing being especially impacted, as the sector is already an investor in automation (Deloitte and The Manufacturing Institute 2018). Investments in new skills for the digital economy need serious attention and support even as people are (rightly) being trained for today's jobs in manufacturing, including current in-demand jobs such as mechatronics, maintenance technicians, and welders. In a perfect world, affordable education, job availability, strong wages, and social good would coalesce into steady employment, upward mobility, and economic growth. In the absence of a perfect world, government policies and legislation can help mitigate some of the worst outcomes of a turbulent world. Government

spending on workforce training falls far short of private sector training expenditures[3] (Carnevale et al. 2015), yet that support can have a powerful effect on economic growth (Hanushek and Woessman 2010).

THE ROLE OF GOVERNMENT IN WORKFORCE DEVELOPMENT

When deliberating policy options to address the skills gap, one must consider the appropriate role of government, as well as legislative timelines. Three justifications are often given for government intervention in labor markets: that education and training constitute a public good that would otherwise be underprovided, that the presence of asymmetric information between employers and potential employees constitutes a market failure that leads to suboptimal outcomes, and that existing governmental programs are inefficient and/or ineffective and therefore in need of modification and/or revision.

A recent report from the President's Council of Economic Advisors (2018) on America's re-skilling challenge reflects these justifications. According to this report, current workforce training is too concentrated in the first 25 years of life; an information gap between employers, workers, and educational institutions makes it difficult to ensure timely skill development; and restrictions on the use of federal funds may no longer be suitable to addressing today's workforce challenges. To put this in more prosaic terms, workers receive less training as they age, creating skills deficits that makes experienced workers obsolete in the workplace. Aademia and business are often concerned with two competing objectives—preparing students for life *or* preparing students to work—and funding for education and training does not take into account that learning, especially lifelong learning, does not always happen in school settings.

Reforms that require congressional action face another hurdle: Congress may take inordinately long to enact new legislation. In other words, change may come too slowly for manufacturing if workforce skills and education policies are not aligned. The Workforce Innovation and Opportunity Act (WIOA) took 16 years from the original legislation, WIA (Workforce Investment Act), to attain reauthorization in 2014. So, too, does America wait on the Higher Education Act (HEA) of 1965 (last reauthorized in 2008). HEA strengthens colleges and universities' educational resources and provides students with financial assistance in post–secondary and higher education. Several new legislative proposals have sprung up as America waits for its reauthorization, such as the Higher Education Affordability Act, the Aim Higher Act, and the Promoting Real Opportunity, Success, and Prosperity through Education Reform (PROSPER) Act, Financial Aid Simplification and Transparency (FAST) Act, Student Protection and Success Act, Empowering Student Through Enhanced Financial Education Counseling Act, the College Transparency Act, and Faster Access to Federal Student Aid Act of 2018. The 2008 reauthorization (Higher Education Opportunity Act, HEOA) provided additional monies for Pell Grants and reduced the interest rates on those loans, and changed loan rules for disabled students.

It is also important to note that workforce education and training mandates are often spread out across different levels of government. For example, federal and state policies often coordinate plans for carrying out federal legislation, although states can build on federal law by enacting their own legislation to support idiosyncratic state issues. In terms of national workforce legislation, WIOA was promulgated from the federal level and is semantically similar when it is disseminated to the states. However, each state has some wriggle room when carrying it out. Governors may have their own workforce initiatives they want to focus on, state budgets vary, skill needs are different, populations are diverse, and rural and urban areas operate in various

iterations. Governors are allowed a 15 percent "set-aside" of federal WIOA funds for their own workforce ideas, and may encourage their state legislatures to set policies that support those ideas.

An example of this legislative synchronicity can be seen in Indiana.

Indiana is capitalizing on WIOA's skill-focused training opportunities, doing more at the local level than what WIOA requires. Indiana's Governor is developing technical skills among its residents by aligning state legislation with state education policies to meet current and future skill demands for high-skill workers. The Governor's Workforce Cabinet (GWC), for example, amended its responsibilities in 2018 to include additional members such as the Indiana economic development corporation, the higher education commission, Ivy Tech (community colleges), the apprenticeship office, the Indiana manufacturers association, and high school career and technical education directors in the Indiana Association of Career and Technical Education Districts, among others. The GWC now provides the governor with a strategic plan for a coordinated statewide talent development system that aligns educational institutions with business workforce requirements. The GWC is expressly committed to establishing strategies and identifying capacity to deliver career navigation and coaching to middle school, high school, postsecondary, and adult students, with priority being given to middle school and high school students.

Recognizing the importance of American manufacturing to the national economy, U.S. government agencies have developed and support programs for workforce education and training. Table 1 shows the breadth of federal leadership in advancing technology and

Table 1: Federal Programs for Workforce Training and Education

Agency	Education and Workforce Development Programs	
DHS	• DHS HS-STEM Summer Internship Program	
DOC	• Manufacturing USA Institutes, Education and Workforce Programs	• MEP Centers, Workforce Development Programs
DoD	• Army Educational Outreach Program • STARBASE • Manufacturing USA institutes, Education and Workforce Programs • Veterans To Energy Careers • Manufacturing Engineering Education Program	• Science, Mathematics, and Research for Transformation Defense Education Program • STEM Outreach Programs • Systems Engineering Capstone • Transition Assistance Program • SkillBridge • National Defense Education Program
DOEd	• Carl D. Perkins Career and Technical Education Act	
DOE	• Manufacturing USA institutes, Education Workforce Programs • Lab-Embedded Entrepreneurship Programs	• Advanced Manufacturing Traineeships • EERE Robotics Internship Program • Industrial Assessment Centers
DOL	• Apprenticeship Programs • Trade Adjustment Assistance	• Workforce Innovation and Opportunity Act
NASA	• Space Technology Research Grants Program • Faculty Fellowship Program	• Established Program to Stimulate Competitive Research Program
NSF	• Advanced Technological Education Program • Broadening Participation in Engineering Program	• Research Experiences for Undergraduates Program • Research Experiences for Teachers Program
USDA	• Academic Scholarships and Aides • 4-H Science Program	• Enhancing Agricultural Opportunities for Military Veterans

manufacturing skills. These programs are disseminated throughout the country and through state, regional and local government partners. In regional pockets all over the U.S., entities are collaborating to increase the number of skilled manufacturing workers. Supporting these programs remains critical to American manufacturing productivity and innovation, although these programs, by themselves, are not enough to keep the U.S. manufacturing skills gap at bay. The lessons and results of these programs should be shared widely among workforce development professionals. At present, not many people know of the existence of these programs (unless they are involved in them).

One of the federal government's enduring accomplishments in manufacturing workforce development is the Manufacturing USA institutes (mentioned in Table 1). Each institute has a dual mission to conduct high impact, pre-competitive research in critical emerging technologies, and to address their education and workforce gaps. The technologies include additive manufacturing (3D printing), digital manufacturing and design, lightweight metals, wide bandgap electronics, composite manufacturing, integrated photonics, flexible hybrid electronics, process intensification, smart manufacturing, fibers and textiles, biopharmaceuticals, biofabrication, manufacturing robotics, and reuse-recovery technologies. Institute partners include small and large manufacturing firms, academia, federal/state/local governments, and other entities.[4]

Although the skills gap continues to burden the manufacturing sector (Deloitte and Manufacturing Institute 2018), it is not because of a lack of effort on the part of manufacturers or American institutions. Many organizations are involved in skill development, job development, curriculum development, social development, partner development, community development, poverty alleviation, entrepreneurship, industrial commons, and creating new sources of ideas and funding. Government, academia, economic development, unions, community-based organizations, non-profits, private training providers, apprenticeship programs, and employers are at the center of the manufacturing skills vortex, figuring out how to design, develop and deploy the necessary hard and soft skills. In spite of this investment, America is still at risk of falling behind its global competition. The capacity to innovate quickly, states the World Economic Forum, will be "the most important capability [in the near future] differentiating the success of countries and companies" (World Economic Forum 2012). America's education and training efforts need greater coordination among the many institutions and organizations providing manufacturing skills and the manufacturing jobs requiring those skills.

Federal policy is the tip of a very large education and training iceberg with much of the execution taking place at the community and regional levels that are, in turn, supported by local and state policies and funding. This does not mean federal policy is inconsequential. On the contrary, the federal level is a strong catalyst for success. But it's also worth looking at the efforts being made throughout the country, at the ground level, that both support and inform policymaking. Knowing what works is the first step. Supporting the expansion of that work is the next. Presently, not enough is known about what works best. While some career pathways programs work just great in a small setting, they may not work well when the number of stakeholders or geography expands. Sometimes there simply isn't enough stakeholder interest or money to create robust programs at a local level. Another issue holding decision-makers back is inadequate information about jobs and salaries, and employers often suffer from a dearth of information about job seekers in their regions with the skills they need. Data collected on workforce development's successes reside in myriad databases, but sometimes may not be recorded at all. Add into that, the American system of government which allows autonomous decisions to be made by states, jurisdictions, districts, cities, towns, and school systems, and the task of

consolidating and analyzing career pathways data seems beyond the possible. This is especially so when considering that state public workforce offices don't have the staff or technology they need to adequately do their jobs helping job seekers and collecting data (https://www.nytimes.com/2020/03/19/business/coronavirus-unemployment-states.html?searchResultPosition=1).

POLICY AND LEGISLATIVE OPTIONS

Legislation is often premised on evaluations of current policies that work (or do not). For example, apprenticeships have shown to be an effective method for helping students understand the work environment by participating in it, and getting a partial wage while doing so. Apprenticeships generate higher gains in earnings and improved productivity than simply classroom learning alone, and are cost effective investments (Hollenbeck and Huang 2017; Lerman 2015; Holzer and Lerman 2014). To date, according to the U.S. Departmetn of Labor, there has been a 56 percent growth in American apprenticeships since 2013 and over 71,000 graduates in 2018. However, career and technical education systems across the workforce, secondary and post–secondary systems remain uncoordinated and siloed (Advance CTE 2018). Without reliable state data across the board, it will be difficult to make decisions going forward about the quality of work-based learning, including apprenticeship, as required for states under the reauthorized Perkins legislation. Some states, such as Georgia, are already on it, collecting work-based learning data through their C-NET system, with the state verifying the data (Advance CTE 2019). But data collection for CTE needs to have standard definitions and should be collected across all the states in similar ways utilizing up-to-date technology to allow policymakers to understand what works and where funding will be best spent. The same is true for all workforce development initiatives.

America needs federal and state policies to continue to improve on the development of 21st century manufacturing skills, including the burgeoning digital technology skills.[5] This support can, and does, take form in different policies in order to meet national workforce goals. Table 2 provides a list of program options that could be expanded to help close the manufacturing skills gap. The table is followed by working examples of each option. Each exists as a separate effort within a school system, across a region, or driven by ideological funding from philanthropy. With the exception of the U.S. Department of Labor's public workforce system, the examples are not

Table 2: Current Policy Options that Address the Manufacturing Skills Gap

Policy Options	*Will Expanding the Policy:* Increase Applicants into Manufacturing?	*Will Expanding the Policy:* Generate Needed Skills Among Applicants?
1. Expand Apprenticeships	✔	✔
2. Expand CTE	✔	✔
3. Raise Awareness of Advanced Manufacturing and Its Jobs	✔	
4. Facilitate Credential Quality/Stacked Credentials		✔
5. Support Community Collaborations	✔	✔
6. Facilitate Sector Partnerships	✔	✔
7. Support Employer-Directed Skill & Competency Development	✔	✔
8. Standardize Data/Retrospective Review		✔
9. Expand Tax Credits and Incentives	✔	

connected to each other or to a nationwide network. All of them could be scaled up if a robust and expansive coordinating infrastructure and funding was legislated to do so.

The program options listed in Table 2 are all—to varying degrees—successful in meeting their missions, albeit in diverse pockets around the country. All of the options have the potential to close the skills gap through a coordinated expansion of efforts and resources that should include better data—and data collection—on where the jobs are and what skills are needed to fill them. Below are examples of public and private (and public-private) initiatives and activities that already support those goals and demonstrate the "on-the-ground" work that is currently taking place around the country, but with little or no coordination or information exchange with other similar programs. Many of these examples fit under more than one program option, however, they are not repeated to simplify the reader's understanding of the activities.

1. Expand Apprenticeships

The Federal Office of Apprenticeship resides at the U.S. Department of Labor, with state and local offices located around the country in six regions overseeing multiple states. Post–secondary institutions and training providers can work in tandem with apprenticeship offices and employers to create manufacturing apprenticeships.

- *Registered and non-registered apprenticeships* are proliferating in manufacturing (as well as other industry sectors). In 2019, DoL released $100 million in grant funding to expand the use of apprenticeships to close the skills gaps in a range of industry sectors, including manufacturing. This effort results from 2017's Executive Order 13801 Expanding Apprenticeship in America. Additional grant funds ($73 million) went to states to support the apprenticeship expansion efforts, while monies were also granted for apprenticeships in non-traditional occupations for women and for sector-based strategies.
- *The Partnership to Advance Youth Apprenticeship* (*PAYA) Network* is a nationwide learning collaborative comprising nine grantees and 40 state- and city-based youth apprenticeship partners. PAYA is a forum for apprenticeship practitioners in which they work collaboratively to remove policy barriers and programmatic problems in youth apprenticeship models using philanthropic support and public institutions.
- *Several states offer tuition assistance for registered apprenticeships* including California, Delaware, Florida, Georgia, Indiana, Iowa, Maine, North Carolina, Tennessee, Texas, Washington state, and Wisconsin.
- *States that provide employers with tax credits for offering apprenticeships* include Alabama, Arkansas, Connecticut, Louisiana, Maryland, Missouri, Montana, Nevada, Rhode Island, South Carolina, Virginia, and West Virginia.

2. Expand Career and Technical Education

The U.S. Department of Education's Office of Career, Technical and Adult Education (OCTAE) administers and coordinates programs related to adult education and literacy, career and technical education, and community colleges. These include, under WIOA and the Carl D. Perkins Career and Technical Education (CTE) Act, federal and state grant programs for adult and career/technical education, and advice for and promotion of the nation's community college system. WIOA legislation requires state workforce boards to partner with Perkins CTE on career pathways. This provides secondary and post-secondary institutions with an opportunity to work together to provide complementary services and increase the numbers of student in technical education.

- Indiana's *Economic Development Corporation* (IEDC) offers business incentives in which a company must create new jobs or provide workplace training in order to be eligible to receive them, and they must be based on new payroll while attracting high-wage jobs and new investment to the state. Concomitantly, the Indiana Skills Enhancement Fund provides training subsidies to companies trying to grow their businesses. The Fund's grants support only training that leads to a recognized credential or degree, or for specialized company training. If the training is offered to incumbent workers, it must be accompanied by a wage increase for those employees receiving training.
- The *American Association of Community Colleges (AACC)* is working with its community college members on a project to increase the number of apprentice programs and services throughout the country. The project, funded by DoL, is being conducted over three years and expects to train 16,000 apprentices. AACC is also working with the National Science Foundation (NSF) on the Advanced Technology Education (ATE) program to improve and expand educational programs for technicians to work in STEM (science, technology, engineering, and mathematics) fields. The ATE program is Congressionally mandated and focuses on both the secondary and undergraduate levels.

3. Raise Awareness of Advanced Manufacturing Jobs and Skills

OCTAE provides grants to states to support career awareness activities. This is done through the online "America's Career Resource Network" (ACRN). The Department of Labor offers career awareness resources through its nationwide Career One-Stop Network (https://www.careeronestop.org/ExploreCareers/explore-careers.aspx). These public websites offer opportunities to explore careers and take self-assessments. They also provide job and wage information. In the private sector, many organizations have taken on career awareness activities.

- *Creators Wanted,* developed by the National Association of Manufacturers, is a national effort to build the manufacturing workforce of tomorrow. The campaign has several goals: to employ 600,000 workers by 2025, to increase by 25 percent the number of students enrolling in technical and vocational schools, to increase by 25 percent the number of students enrolling in apprenticeships and reskilling programs, and to raise to 50 percent—from 27 percent—the number of parents who would encourage their children to pursue a career in modern manufacturing.
- *Manufacturing Day* is another national effort by American manufacturers to change the misperceptions of manufacturing work by opening up their manufacturing operations one day a year and showcasing the maker environment.
- Competitions such as *First Robotics*, and summer camps such as Maker Camp, provide opportunities for youth to develop their interests in making things and engineering. Project Lead the Way provides a curriculum to middle and high schools to teach kids engineering principles, and Scholastic (educational publishing) teamed with the Department of Labor to create student magazines and teacher curricula that describe apprenticeship opportunities and how to get them.

4. Facilitate Credential Quality/Stacked Credentials

For several decades, the U.S. has been wrestling with how best to understand and assign value to credentials, including certificates, degrees, licensure, diplomas, and stackable credentials. The education marketplace, to date, has been opaque to both employers and job seekers in so far as skill development attribution and results. Efforts are now being made to evaluate and standardize the criteria by which credentials are constructed and distributed. Credentials such as certificates

are often the "currency" used by individuals seeking middle-skill jobs—those jobs where one has a high school diploma, but not a four-year college degree (Carnevale et al. 2020).

- *The Lumina Foundation* has launched the Connecting Credentials initiative to help shape the vision and align the work of some 80 co-sponsoring education, labor, and business organizations, and OCTAE will be providing technical assistance to five networks of community and/or technical colleges to embed stackable, industry-recognized credentials within technical associate degree programs.
- *Workcred* researches credentials and educates stakeholders about the need to create, in the U.S., a more integrated and effective system of credential appraisal. Quality credentials have credibility with industry, meet quality standards, and have provided evidence they are effective in the workplace. Workcred works closely with Credential Engine, and its Credential Registry, which is a cloud-based library that collects, maintains, and connects information on all types of credentials, from diplomas to apprenticeships and from licenses to Ph.D.s.

5. Facilitate Sector Partnerships

The U.S. Department of Labor Employment and Training Administration oversees the publicly funded nationwide system of workforce development boards and job centers that serve individuals from youth to adults, and provides businesses with job applicants. Federal WIOA legislation calls for the mandatory use of sector or industry partnerships to match up employers, training, and job seekers.

- *Twenty-one states have sector partnership* policies and 15 states fund them. National workforce collaborations, such as the non-profit National Fund for Workforce Solutions, provide technical support to sector strategies in tandem with education and community-based organizations at the local level.
- *State-funded industry partnerships*, as in Pennsylvania, helped change the state's manufacturing landscape. In 2018, Governor Wolf launched the PAsmart initiative to expand education, training, and workforce development. $40 million in PAsmart grants was announced, $4.6 million of which will be for new industry partnerships. This effort builds on the state's initial industry partnership program which was started approximately 10 years ago.

6. Support Community Collaborations

Some of the most innovative solutions to the skills gap take place at the community level. These collaborations are usually made up of employers, education institutions, workforce boards, community service providers, unions, chambers and industry associations, and philanthropic and government support.

- *SkillSpan* is a nationwide network of non-partisan coalitions working to bring skills and job training opportunities to thousands of people through policy changes in 25 states over the next five years. Its coalitions include policy organizations, workforce advocates, community colleges, community-based organizations, businesses, unions, and others advocating for a shared workforce education agenda.
- *Philanthropic foundations and non-profit organizations* such as the Center for American Progress, Jobs for the Future, Workcred, National Skills Coalition, and the National Fund for Workforce Solutions (to name just a few national-level organizations) are providing technical assistance and how-to information to community collaborations for workforce development efforts across the U.S.

7. Support Employer-Driven Skill and Competency Development

The U.S. Department of Commerce oversees the National Council for the American Worker which convenes to discuss the best methods to link workforce training with economic development. Commerce's Manufacturing USA initiative (www.manufacturing.gov) brings together industry, academia and federal partners within a network of advanced manufacturing institutes to increase U.S. manufacturing competitiveness and promote a robust and sustainable national manufacturing R&D infrastructure.

- The *National Fund for Workforce Solutions* network brings together a wide range of partners to leverage integrated workforce solutions. Through its 30+ sites, it helps employers invest in the American workforce and adopt policies and practices that make jobs better (e.g. job quality, work-based learning, diversity), and helps workers get training. The national office co-invests with local areas in these solutions so communities have the resources they need to do their work, and the Fund acts as a clearinghouse of best practices.
- California's *Employment Training Panel (ETP)* provides funding to employers to assist in upgrading the skills of their workers through training that leads to good paying, long-term jobs. The ETP was created in 1982 by the California State Legislature and is funded by California employers through a special payroll tax. The ETP is a funding agency, not a training agency. Businesses determine their own training needs and how to provide training. ETP staff is available to assist in applying for funds and other aspects of participation.
- *Business Leaders United for Workforce Partnerships (BLU)* comprises over two dozen employers from a range of industries and states concerned about the American skills gap. Individually and as a group, they work with state and local partners to train and hire community residents for skilled jobs, and they regularly visit lawmakers on Capitol Hill to ask for support for policies that invest in the skills of America's workers. Their advocacy work is funded by philanthropic donors such as The Bill & Melinda Gates Foundation, JPMorgan Chase & Co., the Ballmer Group, and others.

8. Data Collection and Review

One aspect of governmental oversight that has always needed improvement is data collection and analysis. In the recent past, state data collection systems have been idiosyncratic, and developed by different technology companies, while collecting data specific to states and programs but unaligned *across* programs, and using various data collection methods and formats. This made analyzing data for government programs difficult as the data were not only apples and oranges, but kumquats as well. Workforce and training data collection is only now coming of age as technology has made data easier to collect and use, and more cost-effective. This is slowing driving better analyses of what's working and what should be changed, as data can be used by multiple stakeholders for review and decision making.

- *The State Workforce and Education Alignment Project (SWEAP)* is demonstrating how state policymakers can use a suite of data tools to develop policies that align workforce and education programs with each other and with employers' skill needs. SWEAP works with select states to develop and use data tools to inform job-driven policies that close the skills gap. SWEAP shares lessons learned so that more states can use data tools to help workers and employers succeed.
- Montana's Governor Bullock convened 42 states to discuss workforce and training policy and what can be done to support America's workforce. His report, *Good Jobs for All Americans*, describes three main areas in which governors can take action: (1) align

skills training with industry needs, (2) use data to accelerate that process, and (3) establish state leadership focused on skills gaps (NGA 2019).

- Congressional Caucuses introduce legislation such as House Manufacturing Caucus' *Championing Apprenticeships for New Careers in Technology Act, Strengthening Investment to Grow Manufacturing in America Act, and Made in America Manufacturing Communities*. While not all proposed legislation gets passed, reviewing and debating the issues helps lawmakers understand the state of advanced manufacturing and the reasons to support it.

9. Tax Credits and Incentives

The Tax Cuts and Jobs Act of 2017 (TCJA) significantly reduces the income tax rate for corporations. While tax credits and incentives can have both good and bad effects, if done properly they can stimulate economic growth and attract investment.

- The Administration's *Pledge to America's Workers* supports and commits manufacturers to providing training opportunities to 1,186,000 manufacturing workers over the next five years.
- *U.S. Governors* convene each year at the National Governors Association to discuss what works in state policy and the critical issues demanding national-state attention. At their February 2017 meeting (and since re-confirmed), the governors adopted policy positions supporting workforce development and post-secondary education, and asked Congress to work with states and the Administration to support the WIOA and the Perkins Act. Their workforce policy preamble describes their intent succinctly stating "federal policy should support state efforts to increase affordability, accountability and innovation and align education, workforce and economic development initiatives."
- In *South Carolina, Alabama, and West Virginia*, eligible businesses can receive a tax credit of $1000.00 for each apprentice they train and hire.
- *Eli Lilly Company* is investing $400 million in a technology center in Indianapolis in part because of state tax reform (H1316). Lilly's investment is expected to create approximately 100 new jobs, such as operators, engineers, chemists, and biologists. HM Manufacturing of Wauconda, Illinois, boosted wages at their operations by 25 percent and invested half a million dollars in capital equipment as a result of tax reform (Source: National Association of Manufacturers).
- *Legislation* such as the Setting Every Community Up for Retirement Enhancement (SECURE) Act allows families to take tax-free 529 plan distributions for student loan repayments, and the Building U.S. Infrastructure by Leveraging Demands for Skills (BUILDS) Act promotes grants for sector partnerships to stimulate economic growth. The Earned Income Tax Credit (EITC) is a tax credit for low-income working families, and the Work Opportunity Tax Credit (WOTC) is a tax credit for employers who hire from disadvantaged populations.

With so many good practices proliferating, it might seem that policymakers can take a breather and move on to things other than training the manufacturing workforce. That would be a mistake. For while many flowers are blooming, a great many do not even bud. It remains incumbent upon policymakers to support education and training for all, not simply because the national economy needs skilled workers, but to give individuals and families a chance to fully participate in the new economy. "Many solutions to the long-term economic challenges confronting America . . . lie in changes to domestic policies on taxes, education, worker training, healthcare, childcare, pensions, family leave, occupational licensing, housing, infrastructure,

transportation, and corporate governance" (Ahmed et al. 2018, p. 10). The Economic Policy Institute's research describes the necessity of *equitable* education opportunities to the nation's economy: "A more educated individual is more likely to participate in the job market, to have a job, to work more hours, and to be paid more, and less likely to be unemployed" (Berger and Fischer 2013, p. 3).

RECOMMENDATIONS TO CONSIDER

The manufacturing skills gap is a multifaceted and complex issue and, as such, does not lend itself to one facile policy solution. The policy options listed below focus on, or are line-of-sight related, to skills gap solutions. Policy makers should give weight to those that address both aspects of the challenge: encouraging individuals to seek careers in manufacturing and too few applicants with the needed skills to fill the "new" manufacturing jobs. Two options—increasing CTE programs and expanding apprenticeships—have enormous potential to help, and both of these options can be tailored to specific contexts, as can the others listed below.

1. Provide better access to, and continued multiple pathways for, manufacturing education and training that carries value in helping people get and keep jobs, such as CTE, apprenticeships, internship, industry credentials, and career pathway certificates.
2. Expand support for students and would-be students in "life issues" such as childcare, transportation, and financial aid through the Work Opportunity Tax Credit (WOTC), Earned Income Tax Credit (EITC), and the Work-based Learning Support Fund.
3. Coordinate and clarify the services of the public workforce system and support partnerships (for career awareness, data collection, social services and OJT) between WIOA providers and other state and local organizations to help people gain access those services.
4. Strengthen and advocate for existing policies that support industry partnerships and the expansion of work-based learning (including apprenticeship and CTE internships).
5. Expand the technological capabilities in the Higher Education Act and the Workforce Investment Opportunity Act to collect and analyze data and coordinate efforts.

AFTERWORD

The United States, and the rest of the world, is now several months into a devastating viral pandemic. Its effects, while not completely unknown, will no doubt bring additional unwelcome surprises throughout 2020. Millions of American workers are now unemployed, businesses have been required to shut down, schools are closed, health care systems are overburdened, financial markets are gyrating, and people of all ages and all walks of life are becoming ill, and sometimes dying.

Yet, at some point, people will return to work and some semblance of a normal life. When employees are called back to the workplace, safe and secure working environments will be needed to restore trust between employers and employees. Undoubtedly, many returning workers will suffer from PTSD of some sort, and productivity will be stifled. To that end, it is critically important that the public and private sectors make accommodations for returning workers with thoughtfully updated human resource policies, practices, and resources. Ignoring employees' vestigial fears will handicap businesses, the economy, and society. Communication and actions will be needed that demonstrate informational transparency and personnel support in America's reanimated workplaces. Re-building the U.S. economy, if done wisely, can potentially offer new opportunities for thinking about the 21st century and American leadership in the global recovery.

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ENDNOTES

[1] United Nations Education, Scientific, and Cultural Organization.

[2] Fifteen million U.S. children live in families with incomes below the federal poverty level (www.nccp.org/topics/childpoverty.html), and 30 percent of American children who live in poverty do not finish high school. Children from lower-income families are more likely than students from wealthier backgrounds to have lower test scores and a higher risk of dropping out of school. Those who complete high school are less likely to attend college than students from higher-income families (https://www.childfund.org/Content/NewsDetail/2147489206/). The Health and Human Services Agency has set the 2019 federal poverty guidelines at $25,750 for a family of four (https://aspe.hhs.gov/poverty-guidelines), which means that a college education is out of reach for millions of Americans.

[3] Employers spend $177B on formal training, annually, while federal job training costs come to $18B.

[4] The federal Office of Science and Technology Policy was created in 1976 to lead coordination of science and technology policy across the agencies, assists with the annual federal review of research and development budgets, and provides scientific and technological analysis and judgment for the Office of the President. Under Section 102 of the America COMPETES Reauthorization Act of 2010 (42 U.S.C. 6622), as amended, the NSTC Committee on Technology plans and coordinates advanced manufacturing research and development programs, and develops and updates the national strategic plan for advanced manufacturing. Its Subcommittee on Advanced Manufacturing (SAM) is the primary forum for information-sharing, coordination, and consensus-building among participating agencies regarding federal policy, programs, and budget guidance for advanced manufacturing. Federal manufacturing assistance programs include the Manufacturing USA Institutes, the NIST Manufacturing Extension Partnership, the Department of Energy's Manufacturing Demonstration Facilities, and their Embedded Entrepreneurship program. Manufacturing R&D has also received assistance through the SBIR/STTR programs in the Department of Defense, Department of Energy, Health and Human Services, National Science Foundation, NASA, and the Department of Commerce.

[5] Outside the U.S., countries are intensifying their efforts to build their manufacturing capacity and creating the sorts of infrastructure (taxes, policies, education and training, digital highways) that will put them in global economic leadership positions. To wit, China's *Made in China 2025* plan wants its domestic companies to control global markets as well as Chinese ones. The plan focuses on 10 key sectors including robotics, artificial intelligence, aeronautics, and new materials, to name a few (http://english.www.gov.cn/policies/latest_releases/2015/05/19/content_281475110703534.htm).

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