IMPROVING THE IMAGE OF MANUFACTURING:
Promoting Manufacturing in Career and Technical Education

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Executive Summary

Manufacturing is vital to the United States economy. In fact, if considered as its own economy, the U.S. manufacturing sector would be considered the 10th largest economy in the world. In 2014, manufacturing was the second largest contributor to the U.S. gross domestic product (GDP), falling only behind real estate, and in 2013, manufacturing had a total gross output of $5.9 trillion (35.4 percent of U.S. GDP). Manufacturing is a major contributor to U.S. exports, national defense, research and development, the workforce, and is a large factor in determining our nation’s standard of living.

According to a Manufacturing Institute and Deloitte study on the public’s perception of manufacturing, while our nation believes manufacturing is important and understands its necessity to our nation’s stability, the public is less than enthusiastic about pursuing manufacturing as a satisfying and meaningful career path. In order for manufacturing to remain competitive internationally, manufacturing jobs need to be filled, but there simply are not enough workers who have the necessary skills required or are willing to learn the skills needed to fill these jobs. The public has a tendency to view manufacturing as a dark, dirty, and dangerous career when, in actuality, it is a harmonious orchestration\(^1\) of high-tech innovation, complex design, and ingenuity.

\(^1\) Correspondence with Ritesh Lakhkar, June 10, 2016
In order to address the skills gap found in manufacturing, the public’s perception of manufacturing has got to change. Many institutions have already started to address this problem by creating Career and Technical Education (CTE) and non-CTE programs designed to encourage K-12 students to pursue manufacturing in hopes of changing the manufacturing image and decreasing the skills gap. The federal government, state governments, schools, and industry have all shown success in creating policies, programs, and partnerships working on this issue; however, these programs need more attention and resources to increase participation and change the manufacturing image.

To address these issues, I recommend:

1. The National Academy of Engineering produce a study report reviewing the present scope and impact of K-12 manufacturing-related education efforts and their effects on the manufacturing workforce skills gap.

2. Congress authorize and amend H.R. 5587, the Strengthening Career and Technical Education for the 21st Century Act, to provide the resources for CTE in schools, encourage our school systems and state education agencies to include manufacturing curricula in their frameworks, and incentivize states to continue their school CTE programs in manufacturing.

3. A database be created by the Office of Career, Technical, and Adult Education in the Department of Education compiling all of the exemplary programs that already integrate manufacturing into CTE curricula.

4. Better publicize current efforts in changing the public’s perception of manufacturing.
Preface

About the Author

Emily Sheffield is a rising junior at Harding University studying mechanical engineering and pre-law. She has been actively involved with several student organizations and has held many student leadership positions including Vice Chair of the university’s ASME student chapter. She has also been instrumental in many large-scale charitable events and helped organize a humanitarian trip to Panamá to survey for the installation of solar panels at a school and orphanage. She is also the calculations lead on the humanitarian project, “Shower the People.” Emily plans on going to law school after receiving her Bachelor degree and studying intellectual property law.

About the WISE program

The Washington Internships for Students of Engineering (WISE) program was founded in 1980 through the collaborative efforts of several professional engineering societies to encourage engineering students to contribute to issues at the intersection of science, technology, and public policy. The nine-week program allows students to spend the summer in Washington, D.C. to gain exposure to the legislative and regulatory policy-making processes through meetings with leaders in the Administration, federal agencies, Congress, and advocacy groups. In addition, each student is responsible for independently researching, writing, and presenting a
paper on a topical engineering-related public policy issue that is important to the sponsoring society. For more information about the WISE program, visit www.wise-intern.org.

About ASME

ASME helps the global engineering community develop solutions to real world challenges. Founded in 1880 as the American Society of Mechanical Engineers, ASME is a not-for-profit professional organization that enables collaboration, knowledge sharing and skill development across all engineering disciplines, while promoting the vital role of the engineer in society. ASME codes and standards, publications, conferences, continuing education and professional development programs provide a foundation for advancing technical knowledge and a safer world. https://www.asme.org/about-asme/who-we-are/mission-vision-and-strategic-focus

About the AMNPO and NNMI

The National Institute of Standards and Technology (NIST) hosts the Advanced Manufacturing National Program Office (AMNPO) – the interagency office responsible for overseeing the planning, management, and coordination of the National Network for Manufacturing Innovation program. The interagency office works with representatives from federal agencies with advanced manufacturing-related missions to maximize cooperation and coordinate federal department and agency programs and activities. The National Network for Manufacturing Innovation (NNMI) consists of linked Manufacturing Innovation Institutes with common goals, but unique concentrations. Through NNMI, industry, academia, and government partners are
leverage existing resources, collaborating, and co-investing to nurture manufacturing innovation and accelerate commercialization. Each institute is designed to be a public-private membership organization that provides vision, leadership, and resources to its members. For more information please visit: https://www.manufacturing.gov

Acknowledgements

The author would like to thank ASME and the AMNPO for its support of the WISE program. The Faculty-Member-in-Residence, Michael Marcus, deserves special thanks for coordinating meetings with policy experts and providing feedback on this paper. The author thanks ASME sponsor, Melissa Carl, and AMNPO sponsor, Robert Rudnitsky; this paper would not have been published without their continual work, support, and advice. Additional thanks goes out to the following people for their time and expertise: Shreyes Melkote, Rolf Butters, Frank Pfefferkorn, Lisa Fronzcek, Samantha Fijacko, Amy Firestone, Zara Brunner, Greg Henschel, and Megan Brewster.
Introduction

Manufacturing is of utmost importance to our nation’s well-being; it bolsters the economy, contributes greatly to the workforce, and increases our country’s standard of living. Today’s manufacturing is an orchestration of high-tech innovation, complex design, and ingenuity, but our society still tends to hold on to the antiquated “dark, dirty, and dangerous” perception of manufacturing. This negative perception is causing damage to our manufacturing sector’s effectiveness. We can begin to change the negative image of manufacturing by showing students what manufacturing means today and for 21st century jobs. Many initiatives have been launched to help change this public perception. These initiatives have shown varying levels of success, but more is needed to fully change the way the public views manufacturing.

Manufacturing’s Contribution to the Nation

Manufacturing is a driving force in today’s economy. In 2012 the manufacturing sector generated $2.03 trillion in value added, and if considered as its own economy, the U.S. manufacturing sector would be considered the 10th largest economy in the world2. In 2014, manufacturing was the second largest contributor to the U.S. Gross Domestic Product (GDP), falling only behind real estate, and in 2013, manufacturing had a total gross output of $5.9

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trillion (35.4 percent of U.S. GDP). In addition, manufacturing has the highest multiplier effect of any other sector; for every $1.00 spent in manufacturing, another $1.40 is added to the economy. The manufacturing sector is a large contributor to the United States' exports, national defense, and it also funds the largest percentage of the United States’ private research and development which in turn increases our standard of living.

Manufacturing gross output and GDP as a share of national GDP, 1997–2013

Figure 1: Manufacturing gross output and GDP as share of national GDP


In addition, manufacturing contributes to our economy through the workforce. There are 12.33 million workers in the manufacturing industry accounting for 9 percent of the US workforce. Manufacturing workers earn an annual income of $80,000 on average compared to the $64,000 average annual income of all other industries, and manufacturing workers consistently make higher wages compared to other industries among all education backgrounds. The manufacturing industry also offers great benefits to its workers, i.e., some of the highest percentages of workers are eligible for health care and retirement. In 2015, 92 percent of manufacturing workers were eligible for health insurance benefits.

![Average Hourly Earnings by Industry and Educational Attainment, 2011](image)

*Figure 2: Average Hourly Earnings by Industry and Educational Attainment, 2011*

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6 “The Benefit of Manufacturing Jobs”, U.S Department of Commerce Economics and Statistics Administration-  
[http://www.esa.doc.gov/sites/default/files/1thebenefitsofmanufacturingjobsfinal5912.pdf](http://www.esa.doc.gov/sites/default/files/1thebenefitsofmanufacturingjobsfinal5912.pdf)

7 “Top 20 Facts About Manufacturing”, National Association of Manufacturers  
Despite these appealing statistics, the public still tends to have a negative view of manufacturing. This negative public image is due in part to lack of awareness about the importance of manufacturing and in part due to lack of information about the actual skillsets needed to fill these manufacturing jobs. A stronger effort is needed to promote manufacturing for what it is and remove the stigma against skilled manufacturing workers. By creating a positive image of career-driven paths for K-12 aged students, we can begin to draw future workers into these high-paying manufacturing jobs where their work will help strengthen the nation’s workforce.

The Stigma Toward CTE

In today’s school systems, there seems to be an ever increasing push for students to go to college. College enrollment increased 18 percent in the ten-year time span between 1993 and 2003, and between 2003 and 2013 college enrollment increased 20 percent\(^8\). This growth trend is predicted to remain steady for the next decade. A college education can be a key to higher earning potential over the course of a person’s career, but technical training can also have this

\(^8\) Back to School Statistics, National Center for Education Statistics
http://nces.ed.gov/fastfacts/display.asp?id=372
effect\textsuperscript{9,10}. The percentage of students pursuing careers in the manufacturing industry has been decreasing over the years. In 2005, only one-fifth of high-school students were on an industry-focused education path compared to one-third of students in 1982\textsuperscript{11}.

A large disconnect exists between what employers in today’s economy are needing and what school systems are providing. According to research conducted by Edge and City & Guilds, 72 percent of employers say Career and Technical Education (CTE) training is essential for preparing all students for the working world, including students planning on pursuing a 4-year degree. However, the public seems to see CTE not as supplemental education used for gaining life skills but rather as the education alternative for those less academically gifted. The Edge and City & Guilds study shows that only 27 percent of parents thought CTE was worthwhile, and only 51 percent encouraged their children to pursue CTE qualifications. School systems also seem to be discouraging the CTE track as only 35 percent of students studying CTE feel as if they have their school’s support compared to the 65 percent of students who are pursuing the


\textsuperscript{10}Employment Projections, Bureau of Labor Statistics http://www.bls.gov/emp/ep_chart_001.htm

\textsuperscript{11}“Too narrow, too soon?: America’s misplaced disdain for vocational education”, The Economist http://www.economist.com/node/16380980
straight academic route. In fact, 22 percent of students were discouraged from CTE being told they were ‘too clever’ for that path\textsuperscript{12}.

This disconnect between employers and educators should be of great concern. A large proportion of industry jobs require skilled workers, but the demand for these workers does not meet the supply. Currently, our nation tends to view college only as going to a four-year institution to receive a degree, but our nation needs to redefine what it means to go to college. College should be redefined to mean going on to receive any post-secondary education that will help further one’s career. Once technical schools and receiving industry-credentials are as regarded as “going to college” and esteemed as such, this stigma against manufacturing and CTE will begin to disappear.

The Ability for Career and Technical Education under the ESSA

In December of 2015, the bipartisan Every Student Succeeds Act (ESSA) was signed by President Barack Obama as the national education law set to create high standards and equal opportunity for all students. The ESSA replaces the 2002 No Child Left Behind (NCLB) Act and prioritizes the goal of preparing all students for success in college and careers\textsuperscript{13}.

\textsuperscript{12} “Stigma attached to vocational qualifications is unjust”, The Telegraph http://www.telegraph.co.uk/education/educationopinion/10860678/Stigma-attached-to-vocational-qualifications-is-unjust.html

\textsuperscript{13} Every Student Succeeds Act, Department of Education http://www.ed.gov/essa?src=rn
As the nation’s education act, ESSA is important for decreasing the stigma against CTE. ESSA has been lauded in giving the general control of education frameworking back to the states, and local control allows for states to have greater flexibility in implementation. How states go about defining and creating these rigorous college and career ready frameworks is up to them, provided that they meet the ESSA’s broad objectives\textsuperscript{14}.

This flexibility allows states the possibility to strengthen the role of CTE in their education frameworks if they choose. It opens up a wealth of opportunities for the states, provided local support exists by way of coalitions or state laws. The ESSA requires challenging frameworks for the core academic subjects as well as any other subjects chosen by the states, and it also requires states to show that these standards are aligned with entrance requirements for further education and any ‘relevant’ state CTE standards. States also have to create success assessments. These assessments can be extended to include career readiness indicators such as technical skills assessments, skills certification achievement, and the completion of concurrent enrollment in postsecondary classes\textsuperscript{15}. Thus, states are free to innovate CTE implementation into their frameworks under the national education law. States should not overlook these opportunities.


\textsuperscript{15} “Every Student Succeeds Act, Career Readiness Accountability”, ACTE [https://www.acteonline.org/uploadedFiles/Policy_and_Advocacy/Key_Issues/ESSA_Fact_Sheet_Career%20Readiness%20Accountability.pdf](https://www.acteonline.org/uploadedFiles/Policy_and_Advocacy/Key_Issues/ESSA_Fact_Sheet_Career%20Readiness%20Accountability.pdf)
While government and various industries are starting to recognize the need for skilled technical workers and the importance of training students to become ready for these jobs, there still seems to be a lack of awareness among the public. Various programs, scholarships, industries, and events have been created to help improve the image of manufacturing and create a positive perception of skilled workers in degreed and non-degreed jobs, but these efforts are not having a broad enough impact.

More people need to know about manufacturing in order for negative perceptions to change. A plan needs to be formulated to increase the awareness of the severity of these issues and promote the efforts being undertaken to improve the current state of the public’s image of manufacturing.
Background

Manufacturing’s Skills Gap

Currently, the manufacturing industry has a need for 3.5 million jobs, but in ten years 2 million of those jobs will likely still be unfilled. As workers in the baby boomer generation start to retire, many manufacturing jobs become vacant, and manufacturers are struggling to fill those vacancies. The manufacturing industry is already offering better pay, benefits, and job security but still seems to have a problem attracting potential workers.16

Figure 3: Manufacturing skills gap and workforce shortage

According to a survey conducted by the Manufacturing Institute and Deloitte, the public views the manufacturing industry as essential to our nation’s economy, standard of living, and

16 The Skills Gap in Manufacturing Infographic, Deloitte
defense. The survey shows that 90 percent of respondents ranked manufacturing as “very important” or “important” to maintaining the nation’s economic prowess. These respondents also ranked manufacturing first when asked which industry they would select if given an opportunity to create 1,000 new jobs in their community in any industry. Americans see manufacturing as necessary and crucial; however, they do not view manufacturing as an appealing career opportunity.

Manufacturing jobs include engineers, computer programmers, management, and highly-skilled, technically-trained workers; however, the public tends to only think of what they perceive to be “low-end” assembly line workers when considering careers in manufacturing. When asked to rank career choices, respondents ranked manufacturing fifth out of the seven listed options. Millennials ranked manufacturing last. Only 37 percent of parents who responded to the survey said that they would recommend pursuing manufacturing as a career to their children. Further, most of the parents who would recommend their child pursue a career in manufacturing believe that the school districts are not doing enough to prepare students for a manufacturing career. Only 40 percent of respondents thought that students were qualified enough to work in the manufacturing sector. Over half believe that their schools are providing exposure to manufacturing skills, but only 30 percent believe that their school systems are encouraging their students to pursue jobs in the manufacturing industry.\(^{17}\)

\(^{17}\)“Overwhelming Support: U.S. public opinions on the manufacturing industry” Deloitte and Manufacturing Institute
http://www.themanufacturinginstitute.org/~media/DD8C9A2E99B34E89B2438453755E60E8.ashx
Manufacturing needs technically skilled workers in order to keep up with the demand of the growing U.S. economy, but without a drastic change in the public’s perception, many jobs may go unfilled.

Figure 5: Deloitte study, Percentages of Respondents who strongly agree or agree with each statement

<table>
<thead>
<tr>
<th>Overall Respondents</th>
<th>Millennials (ages 19-33) Respondents</th>
<th>High Familiarity Respondents</th>
</tr>
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<tbody>
<tr>
<td>Industry</td>
<td>Rank</td>
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<tr>
<td>Technology</td>
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<td>Healthcare</td>
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<td>Healthcare</td>
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<td>Financial Services</td>
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<td>Financial Services</td>
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<td>Energy</td>
<td>4</td>
<td>Retail</td>
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<tr>
<td>Manufacturing</td>
<td>5</td>
<td>Communications</td>
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<td>Communications</td>
<td>6</td>
<td>Energy</td>
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<tr>
<td>Retail</td>
<td>7</td>
<td>Manufacturing</td>
</tr>
</tbody>
</table>

Figure 6: Deloitte study, Ranking by respondents of industry preference if they were beginning their career today

18 “Overwhelming Support: U.S. public opinions on the manufacturing industry”, Deloitte and Manufacturing Institute

http://www.themanufacturinginstitute.org/~media/DD8C9A2E99B34E89B2438453755E60E8.ashx
Changing the Stigma Against Manufacturing

In recent years, our country has put forth an effort to change the public’s image of manufacturing. The federal government, state governments, schools, and the manufacturing industry have all created various legislation, programs, and events to help promote manufacturing as a career and encourage students to pursue CTE and degree programs related to manufacturing.

The Manufacturing Institute’s 2014 survey of the American public demonstrated that 80 percent of respondents believed that the national government should invest in a stronger
manufacturing industry. In addition, Americans are of the opinion that the national government should do more to make U.S. manufacturing more competitive globally\(^{19}\).

Our federal government is starting to address this public request and show further interest and commitment to changing the image of manufacturing to help increase U.S. global competitiveness. Legislation such as H.R.5587 that will be discussed below and federal offices such as the Advanced Manufacturing National Program Office (AMNPO) have demonstrated the government’s recognition of the importance of manufacturing and the growing need for skilled workers in the manufacturing industry.

**AMNPO, RAMI, and the Creation of the NNMI**

In 2011, the federal government, by request of President Barack Obama, created the Advanced Manufacturing Partnership (AMP) to facilitate the cooperation between industry, academia, and government to help develop emerging technologies, policies, and partnerships with the goal of promoting and growing advanced manufacturing in the United States\(^{20}\).

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\(^{20}\) About the NNMI, Manufacturing.gov [https://www.manufacturing.gov/nnmi/](https://www.manufacturing.gov/nnmi/)
Further stemming from the President’s request, H.R.2996, the Revitalize American Manufacturing and Innovation (RAMI) Act, was introduced to Congress in 2013. The RAMI Act was an included in the Omnibus Appropriations bill and called for the creation of a Network for Manufacturing Innovation to strengthen America’s position in global manufacturing competitiveness. Building off of the President’s manufacturing innovation initiative, RAMI led to the creation of the National Network for Manufacturing Innovation (NNMI).

In 2014, RAMI was signed into law, instructing the Secretary of Commerce to lead the creation of the NNMI and coordinate it through the AMNPO at the National Institute of Standards and Technology (NIST). The NNMI consists of manufacturing innovation institutes, each with unique concentrations, which encourage collaboration between small business, large


23 Consolidated and Further Continuing Appropriations Act, 2015, Title VII-Revitalize American Manufacturing and Innovation Act of 2014, codified at 15 U.S.C § 278s

business, and academia with the goal of helping to make America competitive in manufacturing\textsuperscript{25}. As of June 2016, nine institutes have been funded.

RAMI states that one of the purposes of NNMI is to “accelerate the development of an advanced manufacturing workforce,” and the bill includes “development and implementation of education, training, and workforce recruitment courses, materials, and programs” as allowable activities for the manufacturing institutes authorized by the act\textsuperscript{26}. Workforce development innovations are required of the institutes, and some have chosen to include K-12 education efforts in their workforce development plans.

For example, America Makes, the pilot NNMI institute, has partnered with its members to raise private donations used to give over 1,000 schools (K-12) desktop 3D printers. Another institute, Lightweight Innovations for Tomorrow (LIFT), has multiple K-12 involvement efforts. LIFT invested in a lightweight aircraft design curriculum that is now used in 22 states and reaching 25,000 students, sponsored a design competition for high school students to build market vehicles using lightweight materials, and integrated material on lightweight metals into 45 teacher boot camps run by ASM international. PowerAmerica is involved in a series of train-the-

\textsuperscript{25} National Network for Manufacturing Innovation Program Preliminary Design https://www.manufacturing.gov/files/2015/12/NNMI_prelim_design.pdf

trainer programs informing over 100 high school teachers about the institute’s work in manufacturing\textsuperscript{27}.

These efforts demonstrated by the NNMI institutes are a helpful resource in getting manufacturing into our school systems and, the institutes should be further encouraged to expand their K-12 workforce initiatives.

\textit{The Hollings Manufacturing Extension Partnership (MEP)}

The MEP is a program made up of regional centers that assist small, U.S.-based manufacturing companies in “identifying and adopting new technologies\textsuperscript{28}.” These centers are connected to their communities, and most do not have robust K-12 involvement programs due to other pressing priorities. However, those that do are driven by key individuals or stakeholders. For example, Jack Pfunder of the Pennsylvania MEP center created the Lehigh Valley Student Video Contest titled “What’s So Cool About Manufacturing?” to encourage middle school students to show their peers how interesting manufacturing can be. This contest gives students the opportunity to get involved with local manufacturers and record their experiences to be presented as an “educational and cool” video. The videos are then uploaded to YouTube and voted on by the community. Since its start in 2013, the Lehigh Valley Student Video Contest has

\textsuperscript{27} \url{https://www.manufacturing.gov/files/2016/02/2015-NNMI-Annual-Report.pdf}

\textsuperscript{28} \url{https://www.fas.org/sgp/crs/misc/97-104.pdf}
expanded to include 30 participating teams, and surrounding communities have inquired about how they can get involved in creating a similar program\textsuperscript{29}.

\textit{The Strengthening Career and Technical Education for the 21\textsuperscript{st} Century Act}

In June of this year, H.R. 5587, the Strengthening Career and Technical Education for the 21\textsuperscript{st} Century Act, was introduced to Congress as a reform to the Perkins Act, which authorizes educational activities in the career and technical education space. The Carl D. Perkins Career and Technical Education Act of 2006 authorized funding to help build on the efforts of states in part to: develop rigorous academic standards, design activities intended to integrate academic, career, and technical instruction, link secondary and post-secondary education, and increase state and local flexibility to provide services which improve CTE\textsuperscript{30}. Over $1 billion is appropriated to fund CTE programs every year.\textsuperscript{31}

\textsuperscript{29} Dream It. Do It. Pennsylvania  \url{https://dreamitdoitpa.com/video-contests/}

\textsuperscript{30} Carl D. Perkins Career and Technical Education Act, National Alliance for Partnerships in Equity  \url{www.napequity.org/public-policy/frontline-legislation/carl-perkins-career-technical-education-act/}

H.R. 5587 plans to deliver methods by which states can improve CTE and prepare students for the high-skills jobs that manufacturing employers need to fill\textsuperscript{32}.

**ApprenticeshipUSA**

In the 2016 Fiscal Year spending bill, the President signed into law funding for apprenticeships. The Department of Labor (DoL) used the $90 million to help fund ApprenticeshipUSA to expand apprenticeship in the USA. This program invests in state apprenticeship strategies, grants and scholarships for students pursuing apprenticeships, and innovations in industry partnerships\textsuperscript{33}.

While apprenticeships are not all in manufacturing, the public’s hesitance towards apprenticeships offer a unique parallel to the public’s perception of manufacturing. The manufacturing sector can learn from how ApprenticeshipUSA is spreading awareness about their program and what it has to offer.

**State Policy**

State governments have also been active in promoting CTE. The Manufacturing Institute released a report in November 2014 entitled “State Responses to the Skills Gap.” Policy efforts


\textsuperscript{33} “FACT SHEET: Investing $90 Million through ApprenticeshipUSA to Expand Proven Pathways into the Middle Class”, White House website \url{www.whitehouse.gov/the-press-office/2016/04/21/fact-sheet-investing-90-million-through-apprenticeshipusa-expand-proven}
demonstrated in this report show how states have encouraged student pursuits in CTE and improvements to technical education programs.

The report groups these policies into five categories: dual enrollment, industry credentials, industry partnerships, credit articulation, and comprehensive state strategies\(^{34}\).

**Dual Enrollment**

Dual enrollment allows students to receive all of their high school graduation requirements while concurrently taking post-secondary level courses. CTE dual enrollment courses act similarly to AP courses in that students gain post-secondary experience while still working toward their high school diplomas. However, certain barriers weaken dual enrollment participation. In some locations, the cost of post-secondary education courses is not covered by state governments; thus students and/or school systems are left to cover the enrollment costs themselves. This decreases the likelihood of school systems encouraging their students towards dual enrollment. However, certain states have shown initiative in creating promising programs that promote and encourage dual enrollment for CTE students. North Carolina, for instance, through part of SuccessNC, implemented their Career & College Promise which gives high school students the opportunity to earn transferable college credit or industry credentials through a community college at no cost to them\(^{35}\).

\(^{34}\) “State Responses to the Skills Gap”, Manufacturing Institute [http://www.themanufacturinginstitute.org/Research/Public-Policy-Series/Public-Policy-Series.aspx](http://www.themanufacturinginstitute.org/Research/Public-Policy-Series/Public-Policy-Series.aspx)

\(^{35}\) Success NC [http://www.successnc.org](http://www.successnc.org)
Industry Credentials

Certifications allow students to leave school with industry-recognized skills that can help them get a job. Involving high schools in the credentialing process lets students become certified while finishing their high school requirements, so they can leave high school and enter the labor market already qualified. As industry credentials become more ubiquitous in the labor market, opportunities to become certified need to become just as prevalent. While communication between industry and education systems can be strengthened, several states have worked at aligning their school systems’ curriculums with industry needs. Florida passed the Florida Career and Professional Education (CAPE) Act in 2007. The CAPE act helps interested students have a high school diploma, industry recognized credentials, and a solid career-path by the time they graduate\textsuperscript{36}.

Industry Partnerships

Partnerships between schools and industry help give students on-the-job training. Industries can come into the classroom to provide relevant classes, and schools can provide students with hands-on education in actual industry settings. This experience better prepares students for the workforce and gives industries a steady flow of trained and certified workers. In 2013, Indiana legislatures passed the Indiana Works Councils and Indiana Career Council to better integrate

\textsuperscript{36} CAPE Secondary, Florida Department of Education http://cdn.fldoe.org/workforce/fcpea
education and industry. Since the Councils’ start, $4.3 million in grants has been awarded for innovative CTE curricula. They also offer an Innovative Work-and-Learn grant to encourage innovative work-and-learn models where industries and schools partner to create challenging and effective hands-on career training for students\(^\text{37}\).

*Credit Articulation*

While students may take classes for dual credit in high schools, there are certain situations where these classes do not transfer; thus the students do not receive credit for the classes they have taken. This can seriously affect students attempting to transfer to 4-year institutions or technical colleges when their time, effort, and money are seemingly wasted. Certain states have implemented credit articulation agreements to make credit transferring easy and guaranteed within the state. For example, Colorado has created Advanced Credit Pathways which allows high school students to transfer approved CTE credits to Colorado community colleges. This system helps align secondary and post-secondary curriculum and ensures coordination to avoid course duplication resulting in credit transfer failure\(^\text{38}\).

*Comprehensive State Strategies*

Certain states have taken a different, more comprehensive strategy. The common goal is still to solve the skills gap problem and fill technical industry jobs with trained workers. Oregon state

\(^{37}\) Indiana Works Councils [http://www.in.gov/irwc/index.htm](http://www.in.gov/irwc/index.htm)

\(^{38}\) Colorado Advanced Credit Pathways [http://www.coloradostateplan.com/acp.htm](http://www.coloradostateplan.com/acp.htm)
legislators have established the state’s 40-40-20 Goal declaring that by 2025, 40 percent of Oregon residents will have a bachelor degree or higher, 40 percent will have an associate degree or postsecondary credential (including an apprenticeship), and 20 percent will have obtained a high school diploma or its equivalent. The state has passed much legislation in the hopes of reaching this goal including a CTE revitalization grant, work based learning programs, dual credit opportunities, and a Connecting to the World of Work program39.

Manufacturing in Schools

In addition, many schools around the country have taken it upon themselves to promote manufacturing in their curricula. Certain schools have created manufacturing programs that start teaching technical skills at a young age to better prepare students to be career ready by the time they graduate. Many of these schools are building manufacturing labs to allow students to have hands-on experience on advanced manufacturing equipment, and some are using specialized curriculum programs geared toward manufacturing and engineering.

The National Science Foundation (NSF) recently partnered with the University of Virginia’s Schools of Education and Engineering along with Charlottesville Public Schools to launch the Buford Engineering Design Academy. This academy is a laboratory school for advanced manufacturing and is the first public school to become part of the Commonwealth of

39 Oregon Department of Education www.ode.state.or.us/home
Engineering Design Academies. This is the first of similar lab schools to be set up in Charlottesville\(^40\).

Project Lead the Way (PLTW) has also been active in helping to bring manufacturing into school systems. PLTW creates STEM curriculum programs that are used in hundreds of schools across the country. Their curriculum in computer integrated manufacturing is particularly impressive in helping students gain the skills they need to help fill the industry skills gap after they graduate. This class is designed to teach students the “high-tech innovative nature” of today’s manufacturing\(^41\). PLTW created one manufacturing course used by Wheeling High School in Wheeling, IL, and it is now being used in roughly 800 schools nationwide. Wheeling is exemplary in its manufacturing program; Wheeling’s PLTW course has helped turn out hire-ready manufacturing workers from its graduates for over six years\(^42\).

Hopefully, as legislation, knowledge, and awareness progresses, more high schools across the country will pursue adding more manufacturing concepts into their curricula.


\(^{41}\) Project Lead the Way  [https://www.pltw.org](https://www.pltw.org)

K-12 Involvement Programs

Manufacturing industries and institutes have also been working hard to promote manufacturing to the public and get students involved in manufacturing education. Manufacturers across the country have been welcoming students into their facilities to show what manufacturing assembly lines are really like. The maker movement has been growing and encouraging students to dive in and build something. Scholarships, internships, and competitions entice students to consider manufacturing as a satisfying field of work.

Manufacturing Day (MFG Day) is an event held annually nationwide where manufacturers open their facilities to the public to show exactly what manufacturing is by providing resources for manufacturers to plan and host events for the public. MFG Day’s mission is to address the labor shortage, connect with younger generations, and change the public image of manufacturing. Deloitte and the Manufacturing Institute published the results to a survey conducted from the 2015 MFG Day. The survey found that 62 percent of participants were more motivated to pursue a career in manufacturing, and 71 percent of students were more likely to tell friends and family about manufacturing after attending an event.

43 MFG Day [http://www.mfgday.com](http://www.mfgday.com)

Manufacturing Day℠ at a glance

Developing positive perception of manufacturing with students

- 90% Activities/tours were interesting and engaging
- 84% More aware of manufacturing jobs in my community
- 81% More convinced manufacturing provides careers that are interesting and rewarding
- 62% More motivated to pursue a career in manufacturing

Developing positive perception of manufacturing with educators

- 91% The activities/tours were interesting and engaging
- 93% More convinced it provides careers that are interesting and rewarding
- 88% More aware of manufacturing jobs in my community

Spreading the word

71% of students are more likely to tell friends, family, parents or colleagues about manufacturing after attending an event

Figure 8: Deloitte, the Manufacturing Institute portion of: MFG Day survey results\(^{43}\)
The Manufacturing Institute launched its “Dream It. Do It.” network in 2005 to help improve the image of manufacturing. This network gathers manufacturers across the country to become ‘manufacturing ambassadors’ who work to hold events for students and introduce them to manufacturing as a career. The Manufacturing Institute offers launch guides, how-to support, and marketing materials to help the manufacturers hold successful events45.

Policy Ideas and Evaluation

I. NAE Should Analyze Federal, State, and Local K-12 Manufacturing Education Efforts

In 2009, after legislators prioritized adding more engineering and technology content into STEM education, the National Academy of Engineering (NAE) released a report analyzing “Engineering in K-12 Education.” The report included examples of current and past engineering-related curricula K-12 implementation efforts in U.S. and other nations. It further reviewed the impact of engineering in K-12 education and addressed curriculum, policy, and funding issues46.

45 Dream It. Do It. Manufacturing Institute

With the Obama Administration placing a priority on U.S. manufacturing global competitiveness and the negative impacts caused by the public perception of manufacturing, a timely report created by the NAE on manufacturing efforts in our school systems is needed. Similar to the 2009 “Engineering in K-12 Education” report, I recommend:

The report should review the present scope and impact of K-12 manufacturing-related education. It should cover the present state of manufacturing and analyze the need for an increased focus on manufacturing education. It should include examples of current international, national, state, and local examples of manufacturing-education implementation efforts and also address curriculum, policy, and funding issues.

II. Amend and Authorize the Strengthening Career and Technical Education for the 21st Century Act

H.R.5587, the Strengthening Career and Technical Education for the 21st Century Act, is an important step in helping to get manufacturing into schools. The bill increases flexibility for states to use federal funds to “support CTE programs that are focused on unique and changing education and economic needs or state-based innovation.” The act also works toward aligning CTE in schools with in-demand jobs by supporting innovative learning opportunities, building partnerships with employers, and encouraging public input. The bill supports work-based
learning, the integration of CTE with state-led job programs, and encourages employers to get involved in the construction of CTE and goals set by the state.\textsuperscript{47}

Under the act, I recommend adding the following to help improve the image of manufacturing:

- Specific language stating that manufacturing should be an allowable activity for inclusion in formulated CTE curricula and programs. This slight change would give manufacturing a better chance at being recognized and implemented into schooling systems.

- A portion of the bill’s authorized grants to be used “…to identify and support innovative strategies and activities to improve career and technical education and align workforce skills with labor market needs\textsuperscript{46}” should prioritize manufacturing in CTE innovations when considering grant applications. This would give districts with a strong manufacturing presence a greater opportunity at receiving the resources needed to grow their programs.

III. Create a Manufacturing in CTE Exemplar Database

There are currently many champions who support bringing manufacturing into the school systems as described previously. Many programs already promote cooperation between

\textsuperscript{47}The Strengthening Career and Technical Education for the 21st Century Act, Bill Summary”, Education and the Workforce \url{http://edworkforce.house.gov/uploadedfiles/bill_summary_-_strengthening_cte_for_the_21st_century_act.pdf}
education and manufacturing. These programs are great working models of manufacturing in CTE that serve as best practices on structure and implementation of any future CTE initiatives looking to align manufacturing and education.

I recommend that there be a database containing exemplars in CTE manufacturing programs, partnerships, and policies to be run by the Office of Career, Technical, and Adult Education (OCTAE) housed in the Department of Education. This database could be mirrored on the AMNPO website, www.manufacturing.gov, and would include the workforce development programs being developed at the institutes in the NNMI. The database should be a public source where states, districts, and industries can list and find examples of successful CTE programs. The goal for this database would be to help communities use the listed examples as templates for the creation of new CTE initiatives uniquely designed to fit their educational and industrial needs.

IV. Publicize Current Efforts in Manufacturing CTE

The best way to change the public’s image of manufacturing is to reach a greater percentage of the population and inform them about the high paying and rewarding careers in manufacturing. Publicizing the efforts that have been demonstrated by industry, schools, and governments by using social media, advertising, and word of mouth will start to change the perception of manufacturing.
A. Manufacturing Day

MFG Day is a carefully coordinated effort by associations and government programs such as the Fabricators & Manufacturers Association, International (FMA), the National Association of Manufacturers (NAM), the Manufacturing Institute, and the Manufacturing Extension Program (MEP). The event has also partnered with the Science Channel, ISM, and Edge Factor for marketing, media, and strategic content planning. These partners have all worked hard at pooling their resources and talents to make MFG Day a success.

Since its pilot in 2012, MFG Day has turned into an annual event that has seen a continual increase in awareness and participation, and this year’s event is well on its way to reaching its goal of 3000 event hosts nationwide with half a million participants. While MFG Day is promoted as a one-day event, its sponsors also encourage participants to host manufacturing events in their community and continue their media presence all year long in order to continually work at changing the public’s perception of manufacturing.

In order for the image of manufacturing to change more completely, I recommend efforts similar to MFG Day efforts:

48 MFG Day http://www.mfgday.com

49 Zara Brunner, MEP marketing and communications team
There be a coordinated media campaign to cross-promote the manufacturing education efforts of institutions supporting U.S. manufacturing such as NAM, OCTAE, MEP, and AMNPO. By combining each of their resources, the information about these efforts will reach a greater percentage of the population. This cooperation between the media and communications offices of each institution would also have the ability to lower media expenditures for each agency by reducing wider-spread campaigning costs.

B. The Ad Council’s Education Campaigns

The Ad Council works at creating targeted campaigns to raise awareness of social issues by using studies, research, media, and, most notably, public service announcements (PSAs). One such example is their 2007 “KnowHow2Go” campaign. This campaign sought to raise awareness among low-income Americans about their options for attending college. The campaign’s long-term goals were to encourage more students to be informed about college, to be better prepared academically, to apply to college, to receive financial aid, and to enroll in a post-secondary institution. The Ad Council used television, radio PSAs, billboards, social media, statewide campaigns, and coordinated media through other national organizations.

Between 2007 and 2011, $185,000 was donated in media support. A national tracking survey of the target audience of students found that the respondents’ expectations of getting a college degree increased from 51 percent to 63 percent. The percentage of students that believed they were doing what was needed to go to college increased from 42 percent to 54 percent. Students who said they were familiar with the courses they needed to get into college
increased from 70 percent to 82 percent, and 34 percent of students said they were taking the needed steps to prepare for college in 2011 compared to 26 percent in 2007\(^5\).

To improve the image of manufacturing:

Manufacturing stakeholders could partner with the Ad Council to create a campaign for students promoting the consideration of CTE and manufacturing degrees similar to the Ad Council’s college access campaign. Creating advertisements, partnering with educators and industry, creating interactive websites, and reaching out on social media will help to get more students involved in manufacturing CTE. The Ad Council targets specific audiences and fits their campaigns to appeal to those audiences. Utilizing the Ad Council’s resources and experience to reach out to students would be beneficial to manufacturers wishing to close the skills gap and improve public perception.

Conclusions

Manufacturing is important to our nation’s economy and stability, and while our society believes manufacturing to be crucial, manufacturing jobs remain unfilled. The public seems to have a negative image of manufacturing, and it is affecting the manufacturing workforce. In order to address the problems caused by the negative perception of manufacturing, many institutions have taken to working with school systems to get students involved with

manufacturing. These efforts are showing success, but more can be done to raise the awareness of these efforts and reach the goal of changing the manufacturing image.