Lessons in Manufacturing Education for the U.S. from Austria's Dual-Track Education System

Dr. Victoria Ann Hill, Numeritics

Dr. Victoria Hill is a Founder and Research Scientist of Numeritics, a research and consulting firm headquartered in Pittsburgh, PA. She was recently a part of a delegation of U.S. experts on Advanced Manufacturing and the STEM Talent Pipeline that traveled to Vienna, Austria as a part of the George C. Marshall Foundation's efforts to increase cooperation between the U.S. and Austria in the area of Advanced Manufacturing. Dr. Hill has worked on STEM talent issues for many years, and recently completed a year long Fellowship through the American Association for the Advancement of Science (AAAS) at the National Science Foundation in the Division of Engineering Education and Centers. Dr. Hill received her PhD in Engineering and Public Policy from Carnegie Mellon University.

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Abstract

The United States has a renewed emphasis on advanced manufacturing as an engine of economic development. Numerous reports, conferences and initiatives have been created by entities in the public, private and non-profit sectors to give guidance on this topic. The Advanced Manufacturing Partnership (AMP) is one of the most prominent of these many initiatives. Among the many related issues is the need for a highly skilled engineering workforce at the sub-Bachelor's level. Numerous studies have indicated that the U.S. has a dearth of these workers in the educational pipeline, and industry reports that many such jobs are going unfilled, in spite of the very high youth U.S. unemployment rates; (August 2013 unemployment rates for those aged 20-24 was 13%; 16-19 was 22.7%)

Austria has one of the world's lowest unemployment rates, including one of the lowest youth unemployment rates (August 2013 rates for those aged 15-24 was 8.6%). While it is understood that many factors are involved, a significant element is the country's dual-track education system, in which students at relatively young ages; 14 or 15, can choose to enter into a combined academic and vocational training program. Austria uses a well-integrated system of government, academic and trade union partnerships to make this system work.
Students learn engineering technical training skills on the job, as well as in the classroom. The result of this system is a well-trained workforce that continuously brings youth and innovative ideas into the workplace, and at the same time provides industry with the needed skills and talents to ensure a well-qualified workforce.

The lack of enough highly skilled young workers to enter into the advanced manufacturing system in the U.S. is highly problematic, and has significant impacts on the potential success of the afore-mentioned AMP initiative and others. Years ago, U.S. high schools played a role in vocational education, but this system has been largely dismantled in favor of a mostly college-bound academic track. Community colleges in the U.S. have taken up the mantle with some success, but the integration of industry and academia remains problematic with serious skills gaps. In addition, in contrast to Austria's positive relationships between trade unions, industry and the public sector, in the U.S. these same relationships have been largely antagonistic for many years.

What can we learn from Austria that could aid the U.S. in its efforts to revitalize our advanced manufacturing sector? Discussion in the paper will focus on the following:

- The resurgence of advanced manufacturing in the U.S. and the resultant need for a highly skilled engineering education workforce at the sub-Bachelor's level
- The state of career and technical education in the U.S. at the sub-Bachelor's level
- The state of career and technical education in Austria at the sub-Bachelor's level

- Pilot programs in the U.S by Austrian companies to try to create the needed skilled workforce for their U.S. manufacturing facilities
- New and unique programs that focus on the recent entrance of U.S. trade unions into the advanced manufacturing innovation ecosystem
- Lessons learned from Austria with recommendations for further study and action

Introduction

Manufacturing has always been a bellwether to a country's economic development status, and is a critical means by which countries ensure employment, maintain living standards, and support innovation and economic growth. Because of this, manufacturing and the role that public policy plays in supporting it have become important topics of discussion in Washington and throughout the U.S. This paper explores workforce and training topics related to manufacturing, and discusses the lessons that may be learned from Austria's approach to these same issues.

According to a report by the National Association of Manufacturers (NAM), *A Growth Agenda: Four Goals for a Manufacturing Resurgence in America*, "manufacturing has the highest multiplier effect of any other sector of our economy. Investments in manufacturing multiply across the economy, creating jobs and growth in other sectors.[1] Among other things, the report lays out a pro-growth agenda for the manufacturing sector, and highlights a number of policy recommendations in order to reach the identified goals. The four identified goals address issues of policy to help make manufacturing strong. They include

1. The United States will be the best place in the world to manufacture and attract foreign direct investment.
2. Manufacturers in the United States will be the world's leading innovators.
3. The United States will expand access to global markets to enable manufacturers to reach the 95 percent of consumers who live outside our borders.
4. Manufacturers in the United States will have access to the workforce that the 21st-century economy demands.

Recognizing that all of the above goals are important, it bears stating that none can be accomplished without achieving Goal #4 – ensuring access to the skilled workforce demanded by the 21st century economy. Workers skilled at the sub-Bachelor's level in engineering and technical fields are a critical component of this workforce.

The lack of enough qualified workers could limit U.S. economic growth as the existing workers retire and demand for their skills keeps climbing. A number of manufacturers have difficulty filing jobs for highly trained technicians, even though their pay rates are well above regional averages. The lack of interest in these types of jobs has a variety of sources. These include discouragement to youth from older generations stung by layoffs, and an overall emphasis on "college for all" in the U.S. The unfortunate result is a mismatch between job opportunities and a skilled workforce.

At the present time, manufacturing supports 17.2 million jobs in the United States—about one in

six private-sector jobs. Approximately 9% of the U.S. workforce is employed directly in manufacturing.[2] In 2011, the average manufacturing worker in the United States earned $77,060 annually, including pay and benefits. The average worker in all industries earned $60,168.[3] Manufacturing provides a significant number of jobs for less-educated workers.[4] The value created by manufacturing in the U.S. is $1.8 trillion each year, which equates to 12.2% of national GDP, meaning that manufacturing returns $1.48 to the U.S. economy for every $1.00 invested in manufacturing; the highest multiplier effect of any economic sector.[5]

A significant constraint to growth, however, is in access to skilled labor. According to a report[6] published by Deloitte and the Manufacturing Institute (MI), 600,000 manufacturing jobs are unfilled due to a skills gap, and they believe the manufacturing workforce will expand significantly if and when workers with the skills needed for the modern manufacturing workplace are identified.

In December 2013, The Institute for Supply Management determined that economic activity in the manufacturing sector expanded in December for the seventh consecutive month, and their factory index showed that Manufacturing grew in December at the second-fastest pace in more than two years, powered growth in orders that is boosting the U.S. expansion in manufacturing.[7,8] "The conditions are in place for growth in manufacturing," said Ryan Sweet, a senior economist at Moody's Analytics Inc. in West Chester, Pennsylvania.

Another factor in the resurgence of interest in domestic manufacturing involves reduced energy costs. The U.S. is currently undergoing an economic revolution in energy production, transportation and utilization, which in turn is fueling a revitalization of multiple associated industries including advanced manufacturing and its requirements for innovations in production systems. This structural shift in the economy with energy as the driving force results in significant requirements for a workforce experienced in manufacturing, energy and engineering-related skills.

In its 2013 Talent Shortage Survey, ManpowerGroup,[9] an American multinational human resource consulting firm, indicated that 35% of employers had significant difficulty finding properly skilled employees, particularly those with technical job skills including the skilled trades, machinists and machine operators. Skilled trades, engineers, technicians and mechanics are at the top of the list of jobs that are hard to fill.

These facts have fueled a resurgence of focus on advanced manufacturing in the U.S. The Advanced Manufacturing Partnership (AMP) began at the request of President Obama as a cross-sector national effort with a steering committee in 2011 to "secure US leadership in the emerging technologies that will create high-quality manufacturing jobs and enhance America's global competitiveness.[10]

The AMP steering committee, along with the President's Advisory Council on Science and Technology (PCAST) produced the "Report to the President on Capturing Competitive Advantage in Advanced Manufacturing.[11]" The report states, "The Nation's historic leadership in advanced manufacturing is at risk. The threat to our advanced manufacturing sector places our economy as a whole at risk, jeopardizes our international trade, and, above all, undermines the

innovation that our Nation needs to thrive in the future. However, with a sustained focus, alignment of interests, and coordinated action by industry, academia and government, the Nation can retain its leading position in advanced manufacturing.[12]"

The report gives recommendations for policy initiatives, which address the country's needs in three broad categories:

1. *Enabling Innovation*,
2. *Securing the Talent Pipeline*, and
3. *Improving the Business Climate*

At the same time that many are asserting the dearth of skilled workers, a contrarian point of view would note that the increase of more than 500,000 manufacturing jobs since 2010 pales in comparison to the over 5 million factory jobs that vanished between 2000 and 2009, according to the Bureau of Labor Statistics, a loss of 31.2% of U.S. manufacturing jobs. There are many contributing factors for this, but it indicates deep concerns that there are negative impacts to our domestic innovation and manufacturing capabilities as a result of decreased investments in these areas.

There are those who argue that the decline of manufacturing is the inevitable result of economic progress, and that efforts to support domestic manufacturing are supporting inefficiencies. The MIT Task Force on Production and Innovation, or Production in the Innovation Economy (PIE) strongly rebuts this theory. This task force spent several years on interdisciplinary research investigating the links between manufacturing and innovation in the U.S. and the global economy. The researchers were essentially trying to answer one big question: "What production capabilities do we need to fuel innovation and to realize its benefits in good new jobs, new enterprises, and sustainable growth?"

Two books that have emerged thus far from the MIT PIE research efforts include *Making in American: From Innovation to Market*,[13] and *Production in the Innovation Economy*.[14] The books argue that learning and innovation takes place as companies actually produce goods; as prototypes become demonstrations and then commercial products, and as firms figure out how to scale up and scale down products, and create more efficient supply chains. Company processes, both production and non-production based, are not static, and when production is outsourced, the potential for innovation, and for additional profits and jobs, is significantly reduced. Another key theme of the MIT PIE research is that "the loss of companies that can make things will end up in the loss of research that can invent them."[15]

The Austrian Dual Education System

When considering how to ensure a steady stream of the right kind of skilled workers for the "Innovation Economy," it is helpful to examine what other countries have done. One such country is Austria. Austria is well known for its strong industry sector of Small and Medium Enterprise (SME) firms that focus on precision machining, metals, motor vehicle parts, and which require a high level of skilled labor at the sub-Bachelor's degree level.

The Austrian dual education system; meaning both vocational and academic pathways, is regarded as one of the most efficient in the world in terms of meeting labor market demands and in keeping employment high and unemployment low. Unemployment in Austria was 4.8%[16] in November 2013, with a ten-year average unemployment rate of 4.31%.[17] The U.S. unemployment rate in November 2013 was 7%, with a ten-year average of 6.8%.[18] More significantly, youth (16-24) unemployment in Austria in November 2013 is 8.6%, with a ten-year average of 7.61%. [19] This is the lowest youth unemployment rate in the E.U., and is largely a result of the excellent integrated vocational training system. This compares to the U.S. youth (16-24) unemployment rate in November 2013 of 14.1%, and a ten-year average of 14.21%.[20] Austria, Germany and Switzerland, all of whom have strong apprenticeship programs tend to have much lower unemployment rates than those without them.[21]

Essentially, Austria's manufacturing ecosystem involves innovative industrial policies, vocational training and supportive relationships between government, banks, civil society and trade unions in order to promote economic prosperity. Their system of education calls for government, industry and trade unions to work together to provide students with the proficiencies needed to be successful. Eighty percent of all Austrian students in upper secondary education are in vocational training. [22]

The close relation of trade unions, industry and business in Austria is in sharp contrast to that of the U.S., where historically there exist very adversarial relationships between the three entities. In addition, the latest figures of the percentage of wage earners who belonged to a trade union are 27.8% in Austria vs. 11.3% in the U.S.[23]

In Austria, compulsory education begins with a four-year primary school beginning at age six. Five-year-old children may attend non-compulsory preschool. Primary schools are designed to impart a "comprehensive and well-balanced general education, thus fostering the children's social, emotional, intellectual and physical skills and abilities.[24]" Because Austria feels so strongly about education, they invest significantly greater than the OECD average per student.[25]

After primary school students make a choice to attend one of two types of four-year secondary schools; one, which is designed to impart a general education, the other is more highly academic-focused one. At the completion of four years of secondary education, pupils can then choose from another set of education and training pathways, which also may either be technical and vocational or more academic in nature. Students from either of the two primary education tracks can enter into either of the secondary education tracks. The vocational training programs (VET) are provided in the dual system through apprenticeship training, in conjunction with VET schools or VET colleges.

During students' ninth year of schooling, those interested in the vocational track or apprenticeships take a pre-vocational school program, which qualifies them to transition into apprenticeship training. This year includes company visits and practical days at training workshops in order to get a feel for the type of career they might have. During this pre-vocational school year, students are offered specific guidance and preparation to help them to choose a career pathway. Students then apply to specific programs, which may involve interviews at companies for particular apprenticeships.

Apprenticeship programs begin upon completion of nine years of compulsory schooling, and consist of a combination of training at an industry enterprise along with in-classroom vocational schooling, whose task is to impart general education content and to complement the occupation-specific knowledge and skills which apprentices are taught in the industry enterprises.

Students also have the option to complete a program at what is called a VET College beginning after the eighth year of schooling. These programs, like apprenticeships last for between one and four years. There are many different types of VET colleges, including business schools, schools focused on engineering, management, tourism and fashion. Graduates of these schools qualify graduates to practice the occupations concerned based on the program completed. It bears stating that Austria has many more requirements than the U.S. for certifications and diplomas. It is not possible to get many jobs without the necessary qualifications, which of course provides additional incentive to complete the necessary programs.

Austria's dual vocational education ensures that young people are smoothly integrated into the skilled labor market through apprenticeships and vocational training. Apprentices begin working in companies for pay while they are still in upper secondary school, beginning at approximately age 15. During their apprenticeship they gain not only theoretical knowledge during their classroom training, but by working side-by-side with older workers in their chosen firm they have significant on-the-job work experience by the time they complete their apprenticeship. Essentially the student and the firm create a social partnership in which the company is willing to take on and train new apprentices and the student agrees to learn and apply the knowledge that she is gaining in the firm. In this exchange, both parties benefit; the student gains knowledge and skills and the firm gains a skilled new worker, who also has the ability to bring new ideas and youthful enthusiasm to the firm. A great strength of the dual vocational training is the combination of theory and practice, where learned skills can be directly applied in a work situation. The application of theory to practice has been shown to be a prime motivator to additional learning.

Because of this close integration, each of the parties feels much more responsibility to work together for the good of all. To minimize unemployment and layoffs, companies are willing to keep workers on the payroll even in times of economic downturns; they place a high value on keeping the skilled workforce that they have because they have invested a great deal in each worker. They believe that only companies with highly qualified employees will be competitive in the long run.

As noted in *21st Austria: Opportunities for Growth: A Global Dialogue on Business in Austria, Europe and the Emerging CESEE Region,*[26] Austria's growth and development in spite of a slumping global economy is due to the flexibility of Austrian companies in response to new circumstances and challenges through their Small and Medium Enterprises (SME) "hidden champions." The German author and strategy consultant Hermann Simon coined this phrase and attributes the success of hidden champions to a number of factors including "a highly skilled labor force thanks in Austria's case to the dual system of apprenticeship and vocational education," and "outstanding in-house innovation and research. [27]"

Simon writes that hidden champions pay special attention to the education and well-being of

their employees and enjoy very low workforce fluctuation.[28] During periods of economic downturns, companies are willing to keep highly skilled employees on, in anticipation of needing them when the economy improves. Because many of their employees have been trained in-house in apprenticeships, they have invaluable knowledge and skills that are not easily acquired on the open labor market. According to Dr. Simon, the three countries with the most robust apprenticeship programs; Germany, Austria and Switzerland, have more than 55% of all hidden champions worldwide, even though these countries comprise just 1.5% of the world population.[29] The fact that apprentices are highly integrated into the workforce during their training negates any skills gap that might occur by being trained elsewhere. As a result of the heavier emphasis on apprenticeship programs, however, there is a lower percentage of university students in Austria when compared to the U.S., and a lower percentage of individuals entering the job market looking for on-the-job training.

In spite of the apparent benefits to the Austrian apprenticeship model, which takes students in their mid-teens and places them inside an actual factory for much of a workweek, it is unlikely to be adopted in its existing state by the U.S. educational system. There is likely little appetite for apprenticeship programs that begin at age 15 due to concerns about student tracking, child labor laws, institutionalized class systems and safety issues. At the same time, the Austrian model has a number of appealing qualities that can be contextualized for the U.S. education system. Examples of this will be discussed further in this paper.

The U.S. model of Skilled Labor Education at the Sub-Bachelor's level

We begin our discussion of skilled labor education at the sub-Bachelor's level by examining the history of broad educational policy in the U.S., including the concept of vocational education, now often called career and technical education (CTE).

The responsibility for K-12 public education in the U.S. has historically been delegated to individual states and local communities as a result of the Tenth Amendment to the U.S. Constitution. This has prevented the federal government from setting a national curriculum or from being able to make sweeping changes to education policy across the nation. Where the federal government has been involved is in the commissioning of educational policy reports, in legislative action for programs in which individual states may participate, and more recently in attempts to provide incentives for schools to meet certain academic standards.

As a result of industrialization in the late 19th and early 20th Centuries, there was interest in bringing the German and Austrian-style apprenticeship system to the U.S. This resulted in the National Apprenticeship Act of 1937, also called the Fitzgerald Act, which even now governs apprenticeship programs. The Fitzgerald Act was designed "to promote the furtherance of labor standards of apprenticeship…to extend the application of such standards by encouraging the inclusion thereof in contracts of apprenticeship, to bring together employers and labor for the formulation of programs of apprenticeship, to cooperate with State agencies in the formulation of standards of apprenticeship.[30]" One key component of the Act states that apprentices may not be younger than 16.[31]

One of the first national commissions on education produced the report "*Higher Education for American Democracy*[32]" in 1947, which is more commonly called the Truman Commission Report, as it was initiated during President Harry Truman's term of office. At the end of World War II, President Truman and others recognized how important a well-educated populace was to the maintenance of democracy. The advent of biological and atomic weapons during the war also was a prime impetus for a national focus on education, particularly post-secondary education, in order to maintain and further U.S. weapon supremacy at a global level.

The Truman Commission Report was a groundbreaking report that sounded the call for a number of changes in post-secondary education, including changes to the discriminatory practices and income inequalities that prevented many deserving students from furthering their education. One of the most prominent outcomes of the report was the establishment of a network of public community colleges, which were to be free of charge for "all youth who can profit from such education,[33] and which helped to shape the form of two-year degree institutions in the U.S. These community colleges are critical components in the current state of skilled training programs.

In 1983, publication of "*A Nation at Risk*[34]" sounded the alarm that our educational system was failing to meet the national need for a competitive workforce. The most damning statement in the report was the following: "If an unfriendly foreign power had attempted to impose on America the mediocre educational performance that exists today, we might well have viewed it as an act of war.[35]" This report had a huge impact on educational policymakers, who began to seriously consider how to ensure that U.S. students had the requisite skills and competencies needed in the rapidly changing global economy.

Realizing that CTE had a large role to play in creating a skilled workforce, during the Clinton Administration, then-Secretary of Labor Robert Reich began efforts to establish a comprehensive school-to-work system, which resulted in the School-to-Work (STW) Opportunities Act of 1994.[36] This Act was a response to concerns that there was too large a gap between what students were learning in high schools and the skills that they would need in their future careers. The concept was for each state to have access to Federal funding in order to create comprehensive school-to-work transition programs. Many of the STW programs, however, have been watered down to being less about actual CTE training, and more about job shadowing; spending a short amount of time with an actual worker in a potential career field. State and local legislators have also raised concerns about the issue of child labor laws or jobs with hazards for minors. In addition, recent years have seen increasing emphasis on "college for all" and a focus on higher academic standards for all students in large part as a result of standards-based education reform.

High schools, which in years past offered vocational courses such as wood and metal shop, drafting, business courses and auto repair have focused on attempts to ensure that all students meet the same minimum academic standards. Penalties for schools whose students do not meet academic standards can be meaningful. In addition to the pressure that standardize testing brings, there is also concern that "tracking" students into vocational-type study in high school can be seen as barriers to opportunity.

Much of current thinking in education is focused on working towards national academic

standards for everyone, rather than having multiple pathways to different types of careers and skillsets. Many states are enacting statewide high school graduation exams to verify that students across all gender, ethnic and income groups have the same skills and competencies. Recent American education policy under the "No Child Left Behind Act[37]" had as an official goal the elimination of the achievement gap between populations. While the goal is admirable, it also had the effect of discouraging any alternative pathways to career tracks other than an academic one. In some states, critics are questioning whether this policy fosters success for all or creates massive failures, as in many states high percentages of students do not meet the desired academic standards.

The decentralized nature of U.S. public education creates a situation such that each local school district and/or state may have a different means by which they provide or don't provide CTE education to their students. This is in stark contrast to the Austrian system, which has a nation-wide coordinated effort to provide multiple education pathways, including CTE, to its citizens. While are a few examples of U.S. high schools who are beginning to re-emphasize CTE programs, or who are working cooperatively with community or technical colleges and/or industry partners, U.S. CTE at the sub-Bachelor's level takes place primarily in one of two places, often with significant overlaps between them:

1. Apprenticeships
2. Two-year colleges, including community colleges and private technical schools

U.S. Apprenticeships

As mentioned previously, registered U.S. apprenticeships are governed for the most part by the Fitzgerald Act. The U.S. apprenticeship system is highly decentralized. The U.S. Department of Labor Employment and Training Administration Office of Apprenticeship is responsible for regulating the registered apprenticeship programs in the U.S. to ensure that they meet Federal and State standards. As also previously mentioned, students must be at least 16 years old when entering into an apprenticeship. In reality, very few apprentices are younger than 18, and in contrast to apprenticeships in many countries, in the U.S. only about one if five apprentices are under age 25, and the average age is 30.[38]

Registered U.S. apprenticeship programs are sponsored by an entity, which could be an individual business or an employer association, may involve labor/trade unions, educational institutions, community-based organizations or other stakeholders, and may be subject to collective bargaining agreements. Many apprentice programs are called "joint" apprenticeship, as employers and labor unions administer them jointly. Apprenticeship sponsors have wide discretion over the program curriculum and mode of training, and the relatively high age of entry into most apprenticeship programs means that the programs have not historically been on the radar of American education policymakers. A registered apprentice agreement clearly defines the work and training processes that the apprentice will undergo, the hours that they will work, and the wages that they will be paid.

Many of the more than 800 registered occupations are manufacturing-related, and are in demand in the advanced manufacturing realm and in the 21st century workforce. When the apprenticeship

is successfully completed, the apprentice will receive a "Completion of Registered Apprenticeship" certificate, an industry-issued, nationally recognized credential that identifies proficiency in an apprentice occupation.[39]

In a typical apprenticeship program, apprentices work about 32 hours per week under the supervision of a master tradesperson, and spend another 8 hours in classroom training doing course work that includes math, verbal and occupation-specific content, all the while receiving pay and benefits. In general, apprenticeship programs are free, with minimal fees for books and/or tools. The majority of U.S. programs require 3-4 years to complete. Individuals completing such a program are considered highly skilled workers and are sought after by employers. Am example apprenticeship program is that offered by the Aerospace Joint Apprenticeship Committee (AJAC), which was designed to fill a shortage of aerospace and advanced manufacturing workers in Washington State.

In FY2012, over 147,000 individuals entered the apprenticeship system, over 358,000[40] apprentices were working at various stages of their apprenticeship, and over 59,000 graduated from the apprenticeship system.[41] These figures have been declining significantly over the last 20 years, in spite of the fact that a number of reports have recommended expanding apprentice training, including the Organization for Economic Development and Cooperation (OECD) *Off to a Good Start: Jobs for Youth*, 2010.[42] In addition, the budget for the national Office of Apprenticeship is quite small, and some experts feel that the funding provided to the Office is inadequate to properly market, monitor and provide the assistance necessary to aid firms in setting up apprenticeships.[43]

There are those in the U.S., however, who are making the case for expanded apprenticeship programs to fill the numerous skilled worker job openings that remain unfilled. In a matched study examining the returns to various types of education, the returns to apprenticeship programs far exceeded those to more traditional two-year community college programs.[44] In addition, employers in general overwhelmingly rate apprenticeships as having positive effects on their business. According to experts, job gap problems "lie not with college-educated engineers or graduates with general bachelor's degrees but in the dearth of skilled machinists, welders, robotics programmers and those who maintain equipment.[45]" These same authors state that in addition to the needs of domestic firms, foreign firms who wish to expand operations to the U.S. complain about an inadequate number of skilled workers for intermediate-level technical occupations.

The Urban Institute has published a number of pieces about the value of apprenticeships. In *Expanding Apprenticeship: A Way to Enhance Skills and Careers*,[46] Robert Lerman argues that apprenticeships can increase youth employment through training programs that combine paid work-based learning with classroom instruction, and reduce the skills gap between what is learned through education and what is needed by industry.

Community Colleges and/or Technical Schools

As traditional apprenticeships and high school vocational programs have declined in size and

scope, community colleges and technical schools, as well as on-the-job training have largely taken on the task, and the majority of current CTE takes place at the post-secondary level. The American Association of Community Colleges (AACC) has been at the forefront of programs to provide sub-Bachelor degree programs that match workforce needs with workforce training. The creation of training programs that have been accredited by nationally accepted entities increases the value to the worker and gives evidence of their competencies and skill sets. Accreditation issues exist, however, as technical schools' accreditations are not always accepted by either employers and/or two- and four-year colleges, if individuals wish to continue their education after receiving a certificate of diploma.

Community colleges and technical schools have the ability to provide students with the opportunity to learn in-demand skills with a fast track to the workforce through certificates and degrees. Programs at these schools include various types of engineering technician, engineering technologist, and others that have significant relevance in the manufacturing arena. The programs may last for a period of weeks, months or years, and result in a certificate, a certification, or an Associate's Degree.

For some types of credentials, the current focus is on "stackable" credentialing; meaning that individuals can build upon them to continue their education, but at the same time gain work-ready skills, and create a career pathway for individuals. The National Association of Manufacturers (NAM) and its research arm, the Manufacturing Institute (MI), have endorsed a broad series of stackable credentials for a wide variety of jobs in manufacturing. The credentials have been created in conjunction with employer needs in order to verify competencies. Stackable credentialing from NAM/MI is available in mechatronics, machining and metalworking, engineering technology and many other fields. Coursework and testing is conducted at a number of colleges and technical schools throughout the nation. A number of other trade associations have similar stacked credentialing systems.

Community colleges hold great promise for being vehicles for training workers for good jobs. Funding for community colleges comes mainly from individual states, which subsidize tuition to be affordable. According to the National Center for Education Statistics, average annual tuition at community college is under $2,300, which is significantly below average in-state tuition of $8,100 at four-year public colleges, and $25,000 for four-year private colleges.[47]

Examples of Innovative CTE Programs in the U.S.

Blum, USA

An Austrian company, Julius BlumGmbH produces hinge, lift and runner-systems and the appropriate assembly tools for the cabinet making and furniture industry. The company has a long history of high-quality vocational training in Austria, offering apprenticeships in high-tech occupations. In order to fill positions in their U.S. subsidiary, Blum, USA, they have exported their apprenticeship training, albeit in a slightly different form. One of Blum's biggest problems in setting up their U.S. subsidiary was in finding the highly skilled workforce that they needed.

They realized that the best solution to their workforce problem was to train their own workforce. Consequently, in 1995, Blum USA began its apprenticeship program in the U.S., called Apprenticeship 2000. The Apprenticeship 2000 program is a 4-year technical training apprenticeship program that works in cooperation with other firms and educational institutions. Apprentices can choose between career options includingTool and Die Maker, Electronics Technician, CNC Machinist, Machine Technician, Mold/Plastics Technician or Welding Fabricator.

The Blum program works in conjunction with a number of North Carolina high schools along with North Carolina's Central Piedmont Community College (CPCC) system, which is designed to provide "high-quality, flexible pre-baccalaureate and career-focused educational programs and services which are academically, geographically, and financially accessible."

Their apprentices invest 8,000 hours in training, including 1,800 hours of classroom work. After four years of this training, apprentices earn an associates degree in Mechatronics Engineering Technology as well as a journeyman's certification from the North Carolina Department of Labor, and are guaranteed jobs with the company with whom they have done their apprenticeship.

Since 1995, Apprenticeship 2000 has grown to include a consortium of eight companies who have joined forces to provide similar training, and has evolved from an original trainer/trainee format to its current mentoring-based curriculum. Apprenticeship 2000 has successfully graduated 116 students, and has 49 current apprentices in training.

National Science Foundation Advanced Technical Education (ATE) Program

An excellent model for using community colleges to train skilled workers is that of the National Science Foundation's (NSF) Advanced Technical Education (ATE) program. This program offers Federal grants to community colleges that are focused on educating technician for high-technology fields. The program encourages partnerships between educational institutions and employers to "promote improvement in the education of science and engineering technicians at the undergraduate and secondary school levels.[48] The NSF ATE program has been active for over 20 years, and has funded nearly 1,000 grants in every state, Guam and Puerto Rico.

ATE Centers build up strong relationships with local employers in order to create programs that regionally are in high demand. Across the country, NSF ATE Centers train students to be engineering and electronic engineering technicians, civil engineering technicians, mechanical engineering technicians, environmental engineering technicians and more. According to Dr. V. Celeste Carter, Program Manager of the ATE Program at NSF, student graduates are highly employable, and include many students who already have Bachelor's degrees but who want to gain more marketable skills. Many of the employers with which ATE Centers work provide opportunities for internships and on-the-job training as well. The NSF ATE program also encourages the identification of clearly defined career pathways so that students have the ability to continue their education if desired. As outstanding as the NSF ATE program is, however, it is dependent upon community colleges that often have scant extra resources, to work together with

local industry to identify workforce needs and training opportunities. They must then conceptualize and apply to NSF for consideration for an ATE grant.

New App for Making it in America

In the Greater Pittsburgh area, the New App for Making It In America is a systemic framework to enable start-ups to manufacture their products in the U.S. The framework was created with the help of a $3 million Department of Labor grant to the Three Rivers Workforce Investment Board, who is partnering with the Pennsylvania AFL-CIO, Carnegie Mellon University and local startups to help close the skills gap in technology fields – with a focus on advanced manufacturing.[49] The grant has enabled the creation of a joint apprenticeship-training program that helps workers receive the skills that are needed by startup companies, and to pair entrepreneurs with experience, unionized workers who can help business owners use best practices. Optimus Technologies is a Pittsburgh-based startup that designs and manufactures next-generation biofuel systems for commercial and industrial diesel engine. The firm partnered with the Western Pennsylvania Operating Engineering Union to create an apprenticeship program to train mechanics to maintain and install technology modified to work on heavy equipment.

City Politechnic High School in New York City

In 2008, then-Mayor Michael Bloomberg of New York City began to create rigorous career and technical education programs that would begin in high schools with pathways to continue in local community college, and several new vocational-focused high schools opened or revised their perspectives to be more aligned with the local community colleges.[50] The concept behind the reconfiguration is the realization that the need for individuals with high quality vocational training is increasing. There is a greater understanding that a general college education, while appropriate for many, is not the only pathway to a satisfying and well-paying career. City Polytechnic High School in New York City, is one of the new vocational high schools in this program. The school will offer programs in technical fields as well as college courses as part of the curriculum, and students will attend the school for five years instead of four, and graduate with both a high school diploma and an associate's degree.[51,52] While many high schools in New York City offer college courses as part of their curriculum, City Poly, as the school is known, is the first to offer programs in technical fields. The three programs available at City Poly include Civil Engineering Technology, Architectural Technology and Computer Systems Technology, and all include internships and on-the-job training opportunities.

South Carolina's Apprenticeship Carolina ™

South Carolina has one of the fastest growing apprenticeship programs in the U.S. The state has made a concerted effort to bring employers to the state that value highly skilled workers through a number of state-sponsored programs. The most prominent is called Apprenticeship Carolina™,

which "works to ensure all employers in South Carolina have access to the information and technical assistance they need to create demand-driven registered apprenticeship programs.[53]"

The state provides Apprenticeship Consultants at no charge to help companies navigate the registered apprenticeship process from inception to full recognition in the National Registered Apprenticeship System. One of the more innovative aspects to the program is that eligible South Carolina firms can receive a $1,000 direct tax credit for each registered apprentice that the company sponsors, for up to four years.[54]

A key aspect of Apprenticeship Carolina ™ involves the collaboration with the public state Technical Colleges. Registered apprenticeship programs have the option of using these colleges as the means by which apprentices receive the formal classroom portion of their education. This is optional for the sponsoring entity, but sponsors are more likely to do so when state staff members can help with making connections with participating colleges. Since the program began in 2007, an average of one new employer-sponsored apprenticeship program per week has been registered, and the number of apprentices in the state has doubled.

Labor-Sponsored Investment Funds

Within Austria's tightly integrated system of education, industry social and governmental entities are opportunities for existing firms to receive additional capital for expansion and innovation. One creative method for providing such funds to U.S. companies who agree to certain pro-community terms is the use of targeted investment funds from trade unions pension funds.

The Industrial Valleys Investment Corporation is a Pennsylvania Corporation formed by the Steel Valley Authority and its non-profit Regional Jobs Corporation and the United Steelworkers, AFL- CIO/CLC "for the purpose of investing in labor-friendly small-medium sized manufacturing firms in Western Pennsylvania and adjoining states.[55] U.S. worker pension funds provide much of the financial capital available to firms wishing to begin or expand their manufacturing facilities. These funds often finance overseas plants, mergers and acquisitions solely for the purpose of increasing shareholder equity, without concern for the overall economic benefit of the U.S.

This new and unique concept uses the financial capital available through U.S. labor union pension funds to facilitate pro-community investments; to use union-sponsored investment funds to support domestic industrial jobs. This strategy is patterned after Canadian Labor-Sponsored Venture Capital Corporations (LSVCC), known also as Labor-Sponsored Investment Funds (LSIF), which are funds managed by investment professionals, and which invest in small to mid-sized Canadian companies. Canadian tax credits, at the Federal level and at some Provincial government levels, promote the growth of such companies.[56] Approximately 40% of Canadian venture capital is derived from LSIFs.[57]

These LSIFs offer examples of how regional investment can serve manufacturing capital requirements, create jobs, and earn returns for investors, all the while promoting economic development domestically as well.

Conclusion and Recommendations

Austria's dual vocational system has helped to create a well-functioning economy with low overall and low youth unemployment. The country has a long history of academic institutions, industry, labor unions, government and civic organizations working closely together towards a common purpose. These close ties, along with the structured apprenticeship system, significantly reduce the "skills gap" between what students learn in their formal education and what is needed in a working environment. Close government control over the requirements to practice many occupations has added to the motivation of students to complete apprenticeships.

In contrast, the educational system in the U.S. has a much more decentralized system with more local and state control. The K-12 American educational system does not have a national curriculum or Federally identified or controlled pathways to careers. In addition, labor unions and industry in the U.S. have a long history of antagonistic behavior and strife between them. Each side is extremely wary of acting in the others' best interest, as both tend to feel that any acquiescence on one side will have a negative impact on the other.

Understanding the importance of domestic manufacturing has become a prominent issue of late, with a number of Federal and academic entities involved attempting to give guidance to the Nation's policymakers. Out of these have come, among other things, the Federal initiative Advanced Manufacturing Partnership and MIT's research entitled Production in the Innovation Economy. Each of these and others have highlighted the absolute necessity of ensuring that the U.S. train enough skilled workers to attract both domestic and global firms to locate or expand their manufacturing facilities in the U.S. in order to assure American competitiveness and continued economic prosperity.

In spite of the American educational system' decentralization and lack of a cohesive and well-coordinated national policy on CTE at the sub-Bachelor's level, a number of entities are finding creative ways to address this problem. This paper has highlighted just a few of them; ApprenticeshipCarolina™, BlumUSA's apprenticeship coalition in North Carolina, the National Science Foundation's Advanced Technical Education program, along with labor unions' tentative forays into venture-capital-like efforts to encourage domestic manufacturing facilities.

What additional lessons can we learn from Austria's robust system of dual vocational training? It is clear that what works in Austria is due to a long history of entities working together for the common good. While creating a system that replicates Austria's dual vocational system is not practical, given extensive concerns about child labor, tracking and the class system and safety hazards, we can consider what success factors could be contextualized to a U.S. system.

One key lesson involves the benefits of entities working together. In the system that we have which produces trained workers at the sub-Bachelor's degree level, there are a number of players; Federal agencies or offices, trade or labor unions, employers, community colleges and technical colleges, four-year colleges and universities, State agencies or offices, K-12 school districts, parents and students. At present there is no unifying body that helps to coordinate the needs of employers with the needs/desires and training opportunities available to potential employees. Having a national entity that would work on matching these needs and opportunities,

in a manner similar to that happening with the apprenticeship concierges at ApprenticeshipCarolina™ would be one method of doing this. In addition, financial incentives such as the $1,000 tax credit to employers could be a part of this, although offering financial incentives to all coordinating parties, and not just employers, would speed the uptake of such a program. A national coordinating body would also create a one-stop-shop for foreign firms to access information to help fill their needs for skilled domestic labor. For many firms, this is an insurmountable hurdle that keeps them from locating in the U.S., even when there may be positive reasons, such as opportunities from the Buy America Act, for doing so.

As the U.S. government does not normally provide capital to firms, it is necessary to be creative about providing financing in order to promote domestic manufacturing. One method includes educating and promoting the use of Labor-Sponsored Investment Funds and other mechanisms that incentivize firms to locate or expand their manufacturing facilities in the U.S.

Austria's close ties between industry and education can also be emulated by encouraging community colleges, with the training facilities, instructors and the accreditation capabilities, to work closely with employers to create programs that workers can then use as career pathways to further their education. This ensures that programs are highly relevant to regional economies, and helps to eliminate skills gaps.

Finally, with the growing recognition that a highly skilled workforce is an essential piece of our manufacturing ecosystem, providing additional federal funding for community colleges and programs such as the NSF ATE program would help to increase the number of highly qualified skilled workers at the sub-Bachelor's level, as they are at the forefront of much of the training that takes place in this arena.

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