

MANUFACTURING WORKFORCE DEVELOPMENT PLAYBOOK

Preparing for the
manufacturing
renaissance
in America

SECOND EDITION

Revised
for 2016

Edited by Keith S. Campbell

Reviews

Keith Campbell's Manufacturing Workforce Development Playbook is a multi-chapter homage to the revitalization of American manufacturing and how local communities are creating programs to get the skilled workforce that companies need to build and grow. The authors recognize that workforce needs vary across regions, but they present enough knowledge so that no one has to start at square one. From creating and sustaining partnerships to building multi-disciplinary teams to just learning the translations between "business speak" and workforce and education jargon, reading this book will give you both a validation of what you have been doing right and an idea of how to move forward. The book illustrates how workforce professionals build world-class instruction and training quickly and then adapt what they have done to meet the ever-changing needs and priorities of their business partners. This is practical advice from practicing experts, and I believe that the result is something that every area with a growing manufacturing employer base, regardless of size, can use.

*Jane Oates, Vice President for External Affairs, Apollo Group, Inc.
Formerly Assistant Secretary, Employment and Training Administration, U.S. Department of Labor.*

Keith Campbell's Playbook clearly articulates the fundamental needs of today's manufacturers. It's no secret that an engaged and skilled workforce is a requirement to be a successful manufacturer. The current workforce has to have the right skill sets to keep manufacturing a viable contributor to our economy. Each puzzle piece of the Playbook highlights requirements for education, government, and industry to create long-term favorable solutions to workforce development. We are experiencing a great loss in technical talent with Baby Boomer retirements. Without suitable replacements, the future of manufacturing is suspect. Keith and his team of authors are committed to America's manufacturing prosperity.

Rob Harrison, Pepperidge Farm Plant Manager

The pipeline of talented workers is the single greatest factor in the growth and vitality of our economy. Campbell's Playbook is a thorough analysis of how the manufacturing industry is trying to close its skills gap. Campbell and his contributors prove that the best method to developing a lasting talent pipeline for manufacturing is to bring together employers, educators, and community leaders to align manufacturing education and training with industry standards.

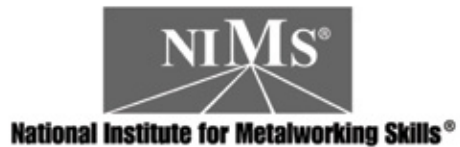
Jennifer M. McNelly, President, The Manufacturing Institute

It is easy for me to support the Manufacturing Workforce Development Playbook because it focuses much-needed attention on the hard work required by all stakeholders if we hope to keep U.S. manufacturing strong. The Playbook's message is consistent with my belief that we must all work together for an educated workforce. Together we can reach our goal of keeping creative, challenging, and exciting manufacturing jobs in the United States.

Nick Wilson, President, Morrison Container Handling Solutions

Reviews continue on the back cover

Supporters



Manufacturing Workforce Development Playbook

Keith S. Campbell

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to help fund workforce development efforts.



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in America**

Second edition
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Table of Contents

Before You Begin

p. 14

Foreword by Keith S. Campbell

Principal, Campbell Management Services LLC; Former Director, Automation, The Hershey Co.

How to approach this Playbook and solve your puzzle.

Perspectives

Why this Playbook?

p. 16

Chapter One by Daniel W. Fogarty

Director, Berks County, PA Workforce Investment Board

The critical shortage of manufacturing skills due to changes in demographics, technology, and attitudes.

Manufacturing is Complicated

p. 24

Chapter Two by Keith S. Campbell

Principal, Campbell Management Services LLC; Former Director, Automation, The Hershey Co.

There are no one-size-fits-all solutions to the workforce development challenge, but we needn't customize everything either.

Manufacturing Career Pathways

p. 32

Chapter Three by Scott J. Sheely

Special Assistant for Workforce Development, PA Department of Agriculture

Where do manufacturing workers come from, and how do they advance?

Preparing America for 21st Century

Global Competitiveness

p. 38

Chapter Four by William C. Symonds

Former Project Director, Pathways to Prosperity Project, Harvard Graduate School of Education

The Pathways to Prosperity Report from the Harvard Graduate School of Education points out where America stands on a global basis and suggests changes we need to make.

The Role of the Workforce System and How it has Changed

p. 44

Chapter Five by Edward J. McCann

*Retired, Former Director of Workforce Development & Chief Operating Officer,
Berks County (PA) Workforce Investment Board*

*The system has changed, and those of us who have always
been employed may have missed that fact.*

Table of Contents

Implementation of the Workforce Innovation and Opportunity Act: Implications for the Manufacturing Sector **p. 50**

Chapter Six by U.S. Department of Labor's Education and Training Administration Staff

Significant changes are in store for the workforce system in 2015.

Manufacturing: By the Numbers **p. 54**

Chapter Seven by Scott J. Sheely

Special Assistant for Workforce Development, PA Department of Agriculture

Data can help manufacturers justify their needs and help educators put the right programs in the right place.

Federal Programs Support Manufacturing Workforce Development **p. 62**

Chapter Eight by U.S. Department of Labor's Education and Training Administration Staff

Grants and partnerships build capacity for manufacturing education and programs.

Skill Standards, Not Curriculum Standards **p. 68**

Chapter Nine by John DeVere

Principal, Education & Training Solutions, LLC

Schools must provide a product that meets customer needs by identifying the appropriate skill requirements, not forcing students through idealized curricula.

Success in the New Economy **p. 74**

Chapter Ten by Kevin J. Fleming, Ph.D.

Dean of Instruction, CTE & Principal Investigator, NSF, Norco College

A post-high school credential, and not just college, is a better message.

Training and College Credit **p. 82**

Chapter Eleven by Carol Adukaitis, Ed.D.

Director, Pathways for Career Success, PA State System of Higher Education

According to best practices, students should obtain college credit for workforce training and prior knowledge.

The Role for Industry Credentials **p. 90**

Chapter Twelve by Gardner A. Carrick

Vice President, The Manufacturing Institute National Association of Manufacturers

Manufacturing lacks industry-recognized credentials relative to other sectors. NAM is trying to change that.

Table of Contents

Competency Model Clearinghouse

p. 96

Chapter Thirteen by U.S. Department of Labor's Education and Training Administration Staff

Competency models provide industry-developed standards to guide workforce development for manufacturing workers.

PMMI's Mechatronics Certification Program

p. 100

Chapter Fourteen by Maria Ferrante

Vice-President Education & Workforce Development, PMMI, The Association for Packaging and Processing Technologies

PMMI has stepped up to create credentials for manufacturing where none existed.

The Apprenticeship Alternative

p. 108

Chapter Fifteen by Stephan Girard

Director of Workforce Development, PMMI

Competency-based apprenticeships provide added flexibility for students, workers, and industry.

Veterans—One Solution to the American Manufacturing Skills Gap

p. 112

Chapter Sixteen by Mike Aroney

Director of Operations, Impact Recon

Translating skills learned in the military to manufacturing.

Made Right Here:

Workforce Development within the Maker Movement.

p. 118

Chapter Seventeen by Bernie Lynch, Diana Polson, and Stephen Herzenberg

A new model emerges to support start-up manufacturing for the Third Industrial Revolution

Working Together for Manufacturing Workforce Development

p. 124

Chapter Eighteen by Bonnie L. Spayd

Bringing the right parties to the table for open communications can result in extremely successful programs.

A Look at the Learners

p. 130

Chapter Nineteen by Pat Reynolds

VP/Editor, Packaging World

We can't forget the students. What are their needs and opinions?

Table of Contents

Secondary School Solutions

What the Future Workforce Doesn't Know p. 142

Chapter Twenty by Simon Nance

Apex Tool Group, LLC.

Formerly Manager, Learning & Development, Stihl Inc.

Building awareness about how cool manufacturing really is.

Careers in 2 Years: Go From Learning to Earning Fast p. 150

Chapter Twenty-one by Jon Scott

President & CEO, Greater Reading Economic Partnership

A local economic development partnership promotes manufacturing careers to kids.

Community College Solutions

The Path from High School to Gold Collar Career p. 156

Chapter Twenty-two by Kevin Lipsky

Instructor, Wisconsin Indianhead Technical College

Students need guidance to help them make the choices that lead to a satisfying and successful career.

Stackable Credentials at Work for Manufacturing p. 162

Chapter Twenty-three by Emily Evans

Director, Workforce Development Bucks County Community College

A community college builds the capability to serve multiple industries and address the needs of students on multiple pathways.

21st Century Manufacturing Success Depends on Automation Technology and a Skilled Workforce p. 170

Chapter Twenty-four by Chris Paynter

Dean of Science, Technology, Engineering, Mathematics - Central Piedmont Community College

Creating a high-tech talent pipeline for Charlotte, N.C. businesses.

Utilizing a Work-based Learning Model to Bridge the Skills Gap p. 176

Chapter Twenty-five by Cheryl A. Garrison

Coordinator of Job Placement, Tri-County Technical College

A community technical college works collaboratively with local business and industry to meet the growing demand for a highly skilled workforce.

Table of Contents

University Solutions

A New B.S. Degree Program: Mechatronics Engineering Technology is a University Success **p. 182**

Chapter Twenty-six by Dr. Niaz Latif

Dean of the College of Technology, Purdue University Calumet

Universities are slowly seeing the need for applied science programs.

Manufacturing Engineering: Innovation through Model-Based Design and Integration **p. 188**

Chapter Twenty-seven by Dr. Kevin Craig, Ph.D.

Greenheck Chair in Engineering Design, and Professor, Department of Mechanical Engineering, College of Engineering, Marquette University

A look at engineering science education for manufacturing and beyond.

Industry Sponsored Solutions

Local Industry Takes Responsibility for Workforce Development Efforts **p. 195**

Chapter Twenty-eight by Paul Anselmo

President, New Century Careers

The Pittsburgh chapter of the National Tooling and Machining Association (NTMA) partners with a non-profit to develop workers for the metalworking industry.

Continuing Education's Role in Career Development **p. 204**

Chapter Twenty-nine by Jim George

Director of Education, Institute of Packaging Professionals

Examples of lifelong learning focusing on packaging professionals.

The Workforce Engagement Framework **p. 210**

Chapter Thirty by Greg Flickinger

Vice President of Manufacturing and Corporate Engineering, Snyder's-Lance Inc.

Creating a platform for ongoing success.

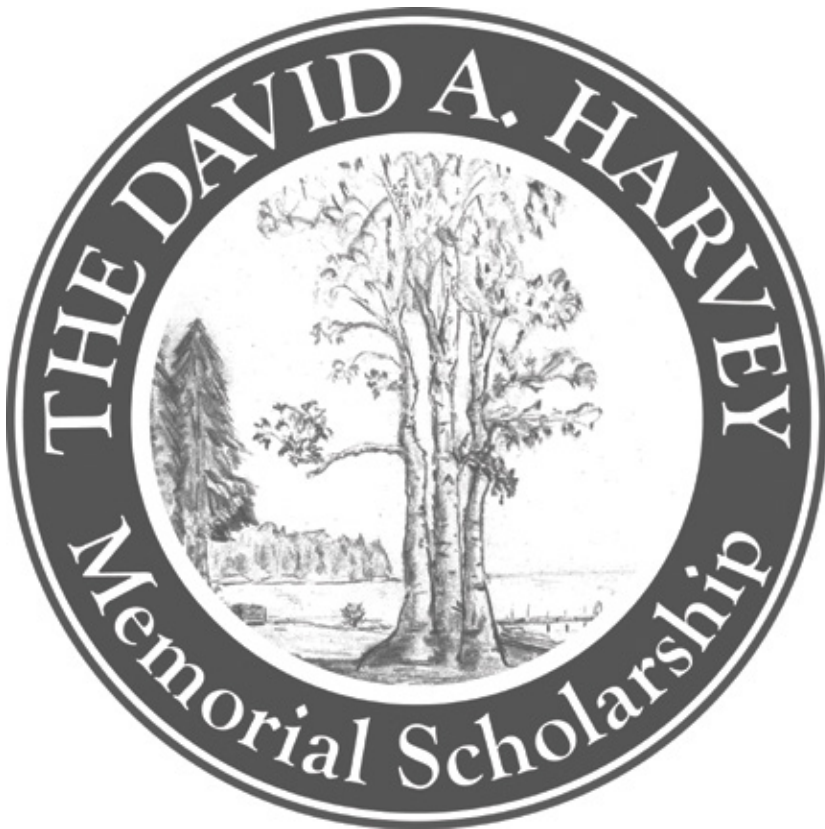
Table of Contents

Moving Forward

What I've Learned about Manufacturing Workforce Development	p. 214
Chapter Thirty-one by Keith S. Campbell	
<i>Principal, Campbell Management Services LLC; Former Director, Automation, The Hershey Co. Using many of the strategies discussed in this book, I have seen regions and companies solve their most pressing workforce development needs.</i>	
A Path Forward	p. 220
Chapter Thirty-two, A compilation of suggestions from the authors.	
<i>A list of things that you can do starting today to address your workforce issues.</i>	
Appendix	p. 226
<i>A resource list for your journey.</i>	
Benefactor Sponsors	p. 228
Educational Sponsors	p. 250
About Keith S. Campbell	p. 256

Our thanks to these organizations for their sponsorship of the Playbook. A portion of net proceeds will go to the David A. Harvey Memorial Scholarship to help fund workforce development efforts.

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Triangle Package Machinery

Before you Begin: *How to approach this Playbook and solve your puzzle*

by Keith S. Campbell

I always told both my kids and my professional staff, “If you are going to play the game, make sure you know the rules.” For example, for engineers to justify a manufacturing automation project, they had better know the rules that the VP of Finance uses to evaluate the proposal. You can’t expect to do well or win at someone else’s game unless you understand their rules.

This applies directly to manufacturing workforce development. There are at least three constituencies that need to be involved to solve the workforce development crisis in America: industry itself, the education system, and government through its national, state, and regional workforce and economic development boards. And we can’t forget the most important constituents, the customers—those workers, students, and parents of students who must navigate the choices made available to them for their best advantage.

After spending 30 years in industry and 10 years working with educators and workforce development practitioners, I can guarantee you that the rules that these groups play by are VERY different. That is not to say that any of them are bad, just different. If we are to solve this problem, each group must work to understand the other and then join together to effect change. Seek first to understand, and then to be understood.

That is why this Playbook has been prepared, first to facilitate communication and understanding, and then to solve the problem. Solving the problem is like putting together a big puzzle. Manufacturers may find workforce professionals too theoretical; workforce professionals may find educators not focused enough on employment skills; educators may find manufacturers impatient and unwilling to participate in the process; and students may find that they are the most uninformed of all. All of these viewpoints are real and may sometimes come across in chapters of this Playbook. But that is why we need to present all sides of the story, looking carefully at each of the puzzle pieces.

The early chapters of the Playbook present perspectives on the manufacturing workforce crisis and its range of solutions as seen by a particular author representing one of these constituencies. These perspectives have been sequenced to try to create a logical flow of ideas for someone who doesn’t work across these domains every day. Each author was

selected by me because, in my experience, he or she brings something constructive to the solution. Later chapters in the Playbook present real examples of how these groups have been able to cooperate to create solutions that work.

Immediately preceding each chapter, you will find a brief statement, identified with three puzzle pieces, describing how that chapter fits into the puzzle. That will be followed by the author's bio, which includes a snippet about why I chose that individual to participate in this project.

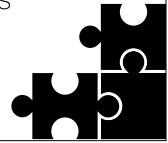
It's OK if you choose to start out in the middle of the Playbook because a topic there is of more direct interest to you. Just remember that if you hope to bring about real change, you may want to revisit other chapters before engaging with all of the parties around your table.

While the Playbook is focused upon American strategies and solutions, the first edition has been downloaded more than 3,000 times by business owners, managers, human resource professionals, educators, administrators, government officials, bureaucrats, and a host of others in every state of the United States, eight provinces of Canada and in 82 additional countries; giving evidence to the fact that workforce development is a global issue. Since release of the first edition, major legislative changes have taken place affecting workforce development in America, and the system is awaiting further direction in the form of regulations coming from Washington. This edition gives some guidance on what those regulations may look like from the staff that is writing them; but indications are, that the best practices identified in the Playbook also point toward the expectations of the new law.

Edition two has captured additional strategies and practices on apprenticeship and other work-based learning methods, the maker movement, and employee engagement; it has broadened its breadth of coverage across manufacturing segments; and it includes new case studies and success stories. We continue to recognize that there are more topics that could be covered and we know that there are many more success stories out there that could be included. Through the magic of e-publishing, we hope to continue to update the Playbook in the future, so we encourage you to send us your ideas with recommendations for additional chapters and authors, along with your critique of what you see here. You may contact me at: Campbell@PackWorld.com



Most Americans think that manufacturing is dead or dying. They see high unemployment rates. It doesn't seem logical or possible to them that there can be a manufacturing workforce crisis in America. Here, a manufacturer explains the problem that leads to the need for this Playbook. Recognizing a problem and understanding its causes are the first steps toward solving it.



Author Bio



Daniel W. Fogarty,
Director, Berks County,
PA Workforce Investment
Board, Former Human
Resource Manager,
Schroeder Industries

In considering who best to set the stage for the Manufacturing Workforce Development Playbook, I immediately thought of Dan Fogarty. Dan's father was the human resource director who, in 1974, permitted me to begin my journey into the world of manufacturing. Following in his father's footsteps, Dan has a longer-term view of manufacturing than most. His deep understanding of manufacturing enabled him to lead an eye-opening study in Pennsylvania, the results of which have become the basis for workforce development activities across the country.

When Dan wrote this chapter, he was the Human Resource Manager for Schroeder Industries, an advanced manufacturing company headquartered in Leetsdale, Pa. Schroeder is widely regarded as an industry leader in the manufacture of hydraulic filters and filter systems. Since preparing this chapter, Dan went on to replace Ed McCann, author of Chapter 5, upon Ed's retirement from the Berks County, PA Workforce Investment Board. Dan is presently Director of that organization.

Prior to joining Schroeder, Dan served as Director of the Pennsylvania Center for Advanced Manufacturing Careers from 2009-2011 under the sponsorship of the Pennsylvania Workforce Investment Board.

Dan previously held a number of human resource management positions with Pennsylvania employers: Peirce-Phelps, Inc., an electronics distributor in Philadelphia; Providian Direct Insurance in Frazer; and Carpenter Technology Corporation, a manufacturer of specialty steels, in Reading.

Dan co-chaired the Governor's Commission on College and Career Success (2005-2006) and in 2007 was appointed to the Pennsylvania State Board of Education, where he chaired the Committee on College Access and Affordability until the end of his term in 2011. Dan also served on the Pennsylvania Workforce Investment Board from 2004 – 2009 where he co-chaired the Board's K-12 Education Committee.

Dan recently has served on the Board of Directors for New Century Careers, the Parkway West CTC Manufacturing Advisory Committee, CCAC's Mechatronics Program Industry Advisory Committee, and the Southwestern PA Math & Science Collaborative.

Dan is a graduate of the University of Notre Dame, which he attended on a Navy ROTC scholarship. He has a Master's Degree in Business Administration from Saint Joseph's University in Philadelphia. Dan lives in Pittsburgh with his wife Barbe and their three children.

Chapter One

Why this Playbook?

The critical shortage of manufacturing skills is due to changes in demographics, technology, and attitudes.

by Daniel W. Fogarty

The U.S. Advanced Manufacturing Skills Gap—A Consensus and a Reality

I have a bias. I deeply believe that for ambitious individuals with the necessary skills, education, and training, **now is a great time to begin a career in U.S. manufacturing!** I come to this conclusion based on my own experience as a human resources professional working for two U.S.-based manufacturers. One is a successful multi-billion dollar specialty steel producer. The other is my current employer, a smaller advanced manufacturing firm located along the Ohio River outside of Pittsburgh.

My human resources colleagues in the manufacturing sector nearly unanimously see the same opportunities. Our reality is that, through the ups and downs of the business cycle, it has become increasingly difficult to fill good-paying manufacturing jobs because of a lack of qualified candidates, especially for the skilled manufacturing technicians upon which our modern technology-driven factories depend. My colleagues and I also share the conviction that these skills shortages will worsen over the next decade, as many of our most highly skilled workers will retire.

Having survived two bruising decades of transition caused by rising international competition, U.S. manufacturing executives that I meet with are optimistic regarding the long-term prospects of our sector. (Many of their European counterparts share this optimism and have been actively investing in North American manufacturing.) However, our worry is that our failure to address the manufacturing workforce skills gap could derail plans for long-term growth and investment here.

If the concern about the skills gap in U.S. manufacturing was confined to conversations among those of us in an outdated and declining industrial sector, perhaps we could be written off as just another narrow special interest unwilling to face 21st century economic realities. Fortunately, this is not the case. We employers are joined by most economic and workforce development professionals (and a smaller number of farsighted educators) who understand the importance of a highly productive and expanding advanced manufacturing sector to our national and regional economic well-being. These experienced professionals have worked with all economic sectors and bring an objective perspective and current

research data to support our view. Some of the best workforce development leaders and educators in the business have contributed to this Playbook.

Over the past decade, many public policy makers have gained a better understanding of the need to understand and respond to the rapidly changing workforce needs of manufacturing employers, and this was driven home to me at a very unlikely time and place. In April 2009, I represented my former employer at a manufacturing roundtable discussion convened by Pennsylvania's Department of Labor & Industry (L&I) in conjunction with the state's Department of Community and Economic Development (DCED). We were in the trough of the great recession, and like almost all U.S. manufacturing employers, we faced rapidly declining sales, yawning excess productive capacity, and a dramatic lack of work for production employees. When asked by public officials what could be done to help, manufacturers reported that our most urgent priority was to find new orders—a challenge we understood that the state agencies were not in a position to do much about. Astonishingly, a number of manufacturing employers then volunteered that at the same time they were engaged in laying off unskilled or semi-skilled production workers due to the disastrous business conditions, they were still actively searching without success to fill long-standing openings for skilled technicians! We all then described unprecedented steps we were taking to retain our most skilled technicians through the downturn. The conversation then shifted to the intermediate and long-term challenges surrounding the expected acute shortage of skilled workers we would again face once recovery was underway.

Within a year of the roundtable discussion, this is exactly where we found ourselves. By the middle of 2010, U.S. manufacturing output and employment were on the rise, with the sector serving as an engine of national economic recovery. In a bizarre manufacturing labor market, we faced a growing backlog of unfilled openings for skilled manufacturing positions while millions of out-of-work American workers lacked the necessary skills or preparation for these attractive opportunities. Worse, very few displaced workers or interested new entrants to manufacturing were enrolled in effective training and education programs to close the gap between what they had to offer and what employers need. This heart-breaking misalignment remains largely our reality today.

Structural Realities Contributing to the Skills Gap in Advanced Manufacturing

There are many factors contributing to the skills gap in the U.S. manufacturing sector, and these factors may vary by state and by region. However, my discussions with manufacturing leaders and workforce and economic professionals across the country confirm that our experience in Pennsylvania fairly illustrates why the manufacturing skills gap is a serious national problem.

While Pennsylvania's economy has evolved and diversified away from our iconic 20th century "smokestack" legacy of steel-making and other heavy industry, our modern manufacturing sector still provides direct employment to more than half a million Pennsylvanians (PA L&I). Unknown to many, manufacturing remains the largest single sector of Pennsylvania's economy as measured by Gross State Product (GSP). Perhaps even

more important from a workforce and economic development perspective, our vibrant manufacturing sector provides outsized support for employment and growth in other economic sectors. (Pennsylvania's True Commonwealth: The State of Manufacturing—Challenges and Opportunities, Hill et-al. 2011, p.1 http://urban.csuohio.edu/publications/center/center_for_economic_development/Pennsylvanias_True_Commonwealth.pdf).

Recognizing the importance of the skills shortages faced by manufacturers, L&I established the Pennsylvania Center for Advanced Manufacturing Careers (PCAMC) in 2009 under the auspices of the Steel Valley Authority (a supporter of this Playbook). I was invited to direct the PCAMC and its outreach and research activities. The center subsequently identified three key structural workforce realities that threaten the ability of manufacturing employers to realize our full potential as drivers of regional economic vitality (Critical Shortages of Precision Machining and Industrial Maintenance Occupations in Pennsylvania's Manufacturing Sector, PCAMC, 2010, p. 1 http://www.paworkforce.state.pa.us/portal/server.pt/community/l_i_advisory_council_on_advanced_manufacturing/18909). These realities are:

- a. Rising skill requirements for entry and growth in manufacturing careers.
- b. An aging manufacturing workforce, particularly in skilled technical occupations.
- c. The lack of an adequate and reliable training and education pipeline for talented new entrants into manufacturing careers.

While the needs of manufacturing employers for technical talent vary from firm to firm, there are readily identifiable skilled technical occupations that are chronically in short supply, specifically industrial maintenance/mechatronics and precision machining occupations. An appropriate supply of talented workers in these occupations would enable U.S. manufacturers to maximize critical investments in technology that allow them to compete internationally. In 2010, the center reported that Pennsylvania's manufacturing sector employed 72,000 skilled technicians in these high-paying occupations, accounting for one of every eight manufacturing jobs. The center went on to project that the state's manufacturing employers would need to fill more than 15,000 job openings in these career paths by 2020 (PCAMC, 2010, p. 4). My experience since returning to the private sector in 2011 and my ongoing conversations with other employers and economic and workforce development professionals have confirmed that these projections are essentially accurate.

In addition to these relatively measurable shortages of skilled technicians, we too often find that the larger population of less-skilled production workers struggle to adapt to a rapidly changing 21st century manufacturing environment. While we readily assist our employees in acquiring valued intermediate manufacturing skills in areas such as quality systems, process improvement, statistical measurement, blueprint reading, and basic preventive maintenance, too many production workers (both employed and unemployed) never acquire the necessary lifelong learning foundation to take advantage of available training opportunities. **The reasons for this unfortunate reality are long-standing and complex; however, as employers, we simply are not well-positioned or resourced to take on the**

challenges brought on by substandard academic preparation. I have seen that a lack of proficiency in applied math skills is the most common barrier; however, low-level reading skills and a lack of familiarity with computer technology are also often barriers to hiring and training opportunities. Finally, a lack of critical “soft skills” such as communications, teamwork, reliability, and problem-solving disqualify others from hiring and promotion opportunities. As a result of these barriers, many less-skilled production workers or potential entrants find themselves stuck in relatively dead-end jobs or experiencing long-term unemployment, while positions requiring higher-level skills go unfilled.

Modern U.S. manufacturing companies can produce substantially more output than ever before with fewer workers and must continue to do so in an increasingly competitive international economy. This success has contributed to the well-publicized decline over the past two decades of manufacturing employment, both in absolute numbers as well as a percentage of the overall workforce. These well-documented changes have had a particularly devastating impact on low-skilled manufacturing workers.

Successful U.S. manufacturers have navigated the turbulence of the last two decades by retaining their most experienced, skilled, and productive workers. Employers hold on to these talented workers to help implement process improvements and new manufacturing technology to grow and compete internationally. As a result, we now have a more-skilled but aging workforce. The center determined that a third of skilled industrial maintenance/mechatronics and precision machining workers in Pennsylvania’s manufacturing sector may retire by 2020 (PCAMC, 2010, p. 4). Manufacturing employers around the nation report facing similar demographic realities. Given U.S. manufacturing’s continued focus on productivity improvement, I am skeptical of recent predictions from some experts that our sector will see significant employment growth in the future. However, even if overall U.S. manufacturing employment levels remain relatively stable, the inevitable approaching wave of skilled-worker retirements will cause headaches for employers and tremendous hiring and promotion opportunities for replacement workers with the proper skills, education, and preparation.

Besides rising skill requirements and an aging workforce, the third structural workforce reality that puts us at risk is the lack of an adequate and reliable training and education pipeline for talented new entrants into manufacturing careers. In many ways, we U.S. manufacturing employers contributed to this reality. Unlike our competitors in exporting powerhouses like Germany and Switzerland, for many years we failed to broadly and consistently engage with high-quality technical education, internship/co-op, and apprenticeship programs. Without ongoing industry engagement, existing programs too often atrophied, failing to meet the changing technology requirements for emerging occupations or being forced to accept poorly qualified candidates just to fill seats. Many other programs shut down completely as talented youth were steered onto other career and education paths. The center was able to quantify what employers already know: The number of candidates currently completing high-quality manufacturing technology training programs is a mere trickle compared to current and future needs (PCAMC, 2010, p. 5).

We cannot underestimate the erroneous but persistent public perception that any four-

year degree is preferable to technical training for “middle-skill” manufacturing jobs. (More on that later.) This imbalance provides tremendous opportunities for new graduates, as can best be seen in well-defined precision machining occupations. Graduates of high school career and technical education (CTE) programs in precision machining throughout Pennsylvania usually earn industry-recognized National Institute for Metalworking Skills (NIMS) credentials and are often working in their career field even before high school graduation. These bright young men (unfortunately, few current precision machining graduates are women) often receive tuition reimbursement or similar direct financial support from their employers if they choose to enroll in associate degree or apprenticeship programs. Unfortunately, a similar network of credentials and internships does not yet exist for the other critical manufacturing occupations in industrial maintenance and mechatronics.

Realizing the need to reverse course, many advanced manufacturing employers have joined regional education and training partnerships to try to rebuild the necessary talent pipeline. In these efforts, we have found willing partners among workforce development professionals and some farsighted educators. Unfortunately, despite the proven employer demand, many initiatives resulting from these partnerships still struggle to enroll an adequate number of candidates who are well-positioned to take advantage of these excellent opportunities.

The Larger Challenge: Outdated Perceptions vs. Real Opportunity in Manufacturing Careers

While the structural problems I have described are significant, perhaps the biggest challenge we face in finding talented new entrants into manufacturing career paths is the outdated and false impression that our sector is dirty, dull, dangerous, and dying.

On the contrary, like most modern manufacturing companies, our facilities are clean, well-lit, safe, and home to world-class technology and equipment. When I speak with career seekers interested in manufacturing employment, I recommend that they focus their search on the growing number of “advanced manufacturers” that focus on the three “P”s of (1) innovative Products, (2) world-class manufacturing Processes and technology, and (3) highly skilled People who are curious lifelong learners.

These days, most Americans have little exposure to the advanced manufacturing sector, and young people exit high school with no knowledge of the attractive career paths the sector offers to those who have the proper preparation. I believe this occurs because parents, public school teachers, guidance counselors, and school leaders do not generally understand the opportunities in manufacturing and fail to encourage talented young people to fully explore their career and education options while still in high school. Few have had the opportunity to see a 21st century manufacturing operation, so I take advantage of every opportunity to invite educators to visit our facilities. Inevitably, those who visit are surprised by what they see and leave with a greater understanding that manufacturing jobs by and large are technology jobs. My hope is that they will encourage the right students to explore what we have to offer.

I should note that this general lack of awareness of current career options and cost-effec-

tive preparation strategies is not confined to skilled technical career paths in the manufacturing sector. Many other “gold-collar” occupations in sectors such as energy, construction, and healthcare offer excellent career paths that combine high-quality technical skills with solid postsecondary academics, often leading to technology-related associate degrees. In fact, the skills required for success in these occupations often can lead to employment in various sectors.

At the root of the problem is a deeply held article of faith in our society that a four-year college degree, regardless of field of study or actual employer demand, is the one way to career success. As a result, too many ill-advised young people are steered toward such degrees in and after high school. The great tragedy is that many young people on this path do not persist to degree completion and end up with heavy debt and few skills to offer employers. Of similar concern, many college graduates in recent years have found themselves taking dead-end jobs without career paths that don’t pay enough to repay their student loans or allow them to live independently.

There is an attractive and realistic alternative. Technical career paths can follow a “2+2+2” strategy that marries technical skills acquisition with academic achievement. Such paths start with the final two years of high school spent in a rigorous CTE program of study. Besides imparting valuable technical skills, such programs can provide the relevance necessary to motivate students to high levels of academic achievement, particularly in math and science. More and more, rigorous CTE programs provide students with the added bonus of earning college credits while still in high school that can be applied to related two-year and four-year postsecondary degree programs. Since graduates of such programs already have a sense of career direction and skills that employers seek, these young learners can often find attractive employment opportunities and become earners while they continue their education beyond high school. Even better, we manufacturing employers realize that it’s in our best interest to support talented and motivated employees financially as they pursue their educational goals through tuition reimbursement programs, pay-for-skills-and-knowledge practices (including apprenticeships), etc. Two-year degree programs now more frequently allow for extensive credit articulation toward four-year degrees in related fields (the final “2” in the 2+2+2 strategy). Imagine the career and life opportunities that present themselves to a college graduate (two-year or four-year) in his or her mid-20s with industry-recognized credentials, current manufacturing technology skills, five years of industry experience, and savings in the bank instead of a mountain of student loan debt!

A final major breakdown has been our inability to effectively connect our many military veterans with career and education opportunities in advanced manufacturing. Through firsthand experience, I know that the motivation, operational experience, and learning skills of many veterans are an excellent match for a modern manufacturing work environment. Veterans who are available and prepared to succeed in manufacturing careers are not easy to find, but we have had some notable success in the last two years at both of our facilities. Here again, veterans and the well-intentioned organizations attempting to help veterans reintegrate into civilian life too often lack knowledge of these opportunities and how to connect with relevant manufacturing training programs that can speed the transition.

The hard lessons of the great recession and our nation's subsequent slow and painful recovery have made many young people and their families open to careers in manufacturing. Our challenge is to organize all interested parties and implement effective outreach and communications strategies to get the word out to educators, students, parents, veterans, and public policy makers.

A Playbook for Closing the Manufacturing Skills Gap

Our opportunity is that a potential workforce exists to fill the good-paying and rewarding careers within the modern manufacturing enterprises so critical to our regional economies. Best-practice programs have been developed, particularly by our community colleges, that offer high-quality manufacturing training to help bridge the gap between potential candidates and the skill needs of employers. Unfortunately, many of these programs are not well-aligned with secondary education or other feeder programs and are often unknown to the general public.

Individual manufacturing employers simply cannot and will not be able to go it alone in developing the pool of skilled talent they need to grow and prosper. This is particularly true for the many small and medium-size manufacturers that create many of the best opportunities. I have learned that workforce and economic development professionals, labor representatives, secondary and postsecondary educators, and manufacturing employers are more ready than ever to do their part. What we need now is a Playbook based on proven best practices from a broad spectrum of experts. Fortunately for us, such a Playbook is found in the pages that follow. If we follow this Playbook, then my optimistic prediction that now is a great time to begin a career in U.S. manufacturing will prove to be reality for manufacturing employers and talented new hires alike.

We tend to speak of manufacturing as though it is one thing. It's not. Therefore, when we try to apply just one solution, that solution frequently misses the mark. Educators think they've done their part by offering a manufacturing program and that manufacturers aren't willing to train their employees. Manufacturers think that educators aren't listening to their needs and back away from participation. The alternative is to customize everything, which becomes impractical. Manufacturers, educators, and government must recognize the characteristics that various segments of manufacturing share in common and leverage those to provide a limited variety of high-quality solutions.



Author Bio



*Please see bio of this author
at the back of this Playbook*

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Chapter Two

Manufacturing is Complicated

There are no one-size-fits-all solutions to the workforce development challenge, but we needn't customize everything either.

by Keith S. Campbell

Manufacturing is complicated. So much so that educators over-simplify to survive while companies over-complicate, thinking that they each need a unique solution. Both are formulas for failure. We can't expect educators to customize programs for each of the thousands of types of manufacturing; and we can't expect manufacturers to be satisfied with 'universal' manufacturing training, education, and certification solutions.

Sometimes the people representing manufacturers don't themselves understand why their employees or potential employees need the particular skills that they use on the job. Students don't understand how what they are studying relates to a particular industry. Educators don't understand how different manufacturing sectors use technology differently.

One electrical maintenance employee reported to me that she had an associate degree in electronics and didn't understand why she struggled so much with her job in a confectionery plant. Only when she had the opportunity to complete an industrial maintenance program aimed at the hybrid manufacturing sector did she report that she used her training every day on the job. Job performance and job satisfaction improved so much that she introduced her teenage son to the same program.

I frequently find that the manufacturing HR people who are working with educators don't understand why their needs are different from the needs of the company down the street—or why they may be the same. As a result, they devote too much effort trying to customize a program to their "special" needs. Language is also a problem. Too often, schools get requests from manufacturers for things like "electronics" when they may mean "instrumentation" or they may mean "PLCs." Schools respond with "electronics" classes, which to them may mean semiconductor theory. This is partly an issue of specifying classes or curriculum rather than specific competencies and skills. Later in this book, we will learn more about competencies vs. curriculum. For now, let's try to understand how to simplify, but not oversimplify, manufacturing to make it easier for educators and industry to work together.

Manufacturing is not well understood

Many Americans have dismissed manufacturing as a dying industry, and as a result, they don't spend much time trying to understand it. We might all agree that manufacturing

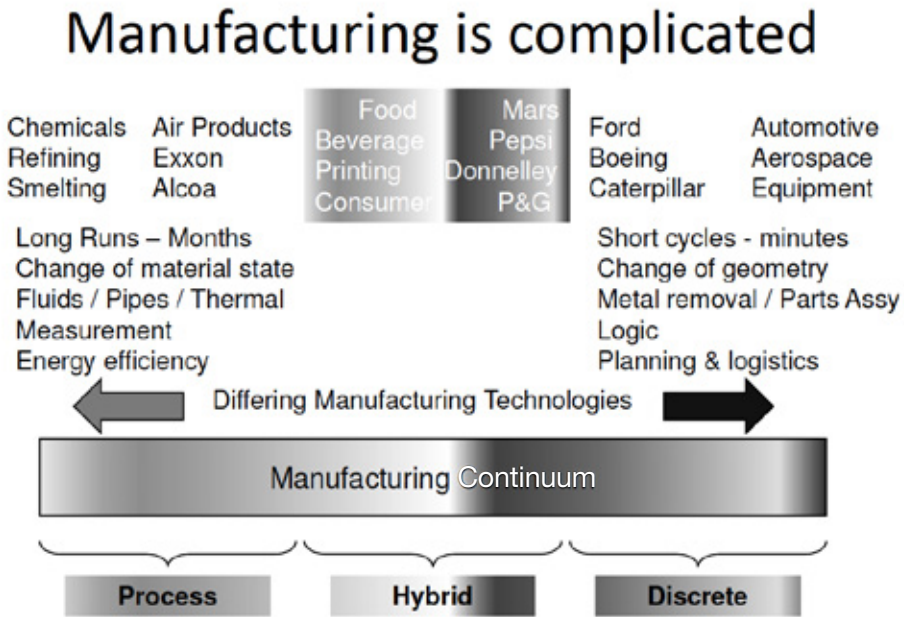


Figure 1.

somehow involves making stuff—but then we might get into some extended debate about the meanings of the words “making” and “stuff.” An illustration of this point is a manufacturers’ association meeting where a colleague and I were invited to speak on the topic of industrial maintenance and mechatronics. Before the meeting, I inquired of the attendees what kind of manufacturing they were involved in. Almost all were from the discrete sector, and the program that I was prepared to discuss was targeted at hybrid manufacturers. I asked the host if they didn’t have food, beverage, pharmaceutical, or similar consumer products companies in the area. The answer was that they did, but their group didn’t consider them as “manufacturers,” and they hadn’t been invited.

If those of us intimately involved with manufacturing have problems with our vocabulary and understanding what we mean when we speak about manufacturing, how much more difficult must it be for the general public?

Someone once described manufacturing to me this way: “It is something that takes place inside a windowless building located behind a dike that you can only pass through with the guard’s approval.” When I grew up, summer vacations involved stopping to tour manufacturing plants; in Europe, major trade fairs still include family days where parents can walk through with youngsters in strollers to see all of the latest machinery innovations. But in America today, most plants are closed to the public, and trade fairs admit no one under the age of 16. Our schools neither promote manufacturing as a career nor educate students in the necessary technical skills, preferring instead to push everyone toward a college degree in an economic society where less than one-third of jobs require a four-year degree and where only 56% of four-year college students finish within six years. Is it any wonder that we have become so uninformed about and unprepared for manufacturing?

Manufacturing is broad in scope

In seeking clarity, I set out to find out how the government defines manufacturing. This led to the Census Bureau and the North American Industrial Classification System, known as NAICS codes. The Census Bureau says, **“The manufacturing sector comprises establishments engaged in the mechanical, physical, or chemical transformation of materials, substances or components into new products. The boundaries of manufacturing and the other sectors of the classification system can be somewhat blurry”** The NAICS codes for manufacturing at the six-digit level run from 310000 to 339999 within which there are 10,537 types of manufacturers identified.

So, are we to understand manufacturing as one thing or as 10,000 different things? When we seek training, education, and certification programs, should there be one standard for manufacturing, or should there be multiple standards? Clearly a custom solution—one for each type of manufacturing, or one for each manufacturer, or one for each plant within a manufacturer’s company—is NOT a workable solution. And manufacturing is indeed too complicated for one-size-fits-all solutions, which are really lowest-common-denominator answers that satisfy no one and will not make us competitive in today’s increasingly complex and technically advanced world. Is there a useful solution?

A useful subdivision

A useful way of viewing manufacturing is along a continuum, which may in fact include 10,537 different types. Manufacturers are placed along the continuum based upon some chosen set of attributes, and the continuum is then divided into a limited number of named sectors. In my simplified model, there are three sectors identified as Process Manufacturing at one end, Discrete Manufacturing at the opposite end, and Hybrid Manufacturing in the middle (Figure 1).

Process Manufacturing

The prototypical process manufacturer will operate with long runs that could extend 24 hours per day seven days per week with just one startup and shutdown per year. There will often be a change of chemical state of the material in a vessel or reactor, and the material may be captive within pipes or other means of conveyance. Control will be of a continuous nature and depend upon measurements of physical properties such as temperature, flow rate, density, and chemical composition. Process control is frequently hierarchical and distributed with large operator interface systems in centralized control rooms that display operations that may be miles away. Systems may be redundant with automatic failover to backup processors and locations. Control may be based upon mathematical algorithms using feedback, cascade, and feedforward strategies. Money is made or lost in the plant based upon fractional improvements in operating quality and energy efficiency. Operators may be degreed engineers who are supported by technicians and trades people who operate across some extended geography. Plant design is less about individual machines and more about unit operations that are configured from

components like valves, tanks, and pumps. The design is frequently done by or closely supervised by an internal engineering staff, resulting in design details, software, schematics, and other documentation fully in control of the plant and available to the maintenance technicians who may be expected to alter any of it under appropriate supervision. Basic plant design changes infrequently (years or decades), while improvements may be constant. Think about bulk chemicals, refining, or smelting operations that might be done by companies such as Air Products, Exxon-Mobil, or Alcoa.

Discrete Manufacturing

The prototypical discrete manufacturer will operate with short cycles that might be measured in minutes. An operation may turn out many identical but individual parts during the course of a shift, or there could be very frequent changeovers to differing parts with order quantities as small as one discrete unit. There will be changes of geometry involved through material removal, material addition, bending, or assembly. Control will be largely of a sequential nature using logical operations based upon sensors that feed back position and other physical attributes. Machines will often employ electrohydraulic systems, dedicated CNC, robot controllers that coordinate half a dozen motion axes, and the PLCs that oversee sequential operations and the interlocking between adjacent operations. With frequent changeovers the rule, the primary operator interfaces tend to be local to individual machines. Money is made or lost based upon planning and logistics, getting the right things to the right place at the right time and keeping everything running. Operators load and unload machines, adjust parameters, assemble components, and compare results to drawings by making physical measurements. Plants, or the flow of materials through plants, are frequently reconfigured (months). The basic machines and workcells are designed by others, who may maintain control of the software and detail documentation, rendering it unavailable to the plant's maintenance staff. With a large variety of machines in use, routine maintenance may be done internally with troubleshooting and repair frequently done by equipment manufacturers. Think about machined parts, aircraft assembly, electronic equipment, or automobiles that might be made by small machine shops, Caterpillar, Boeing, Dell, or Ford.

Hybrid Manufacturing

The prototypical hybrid manufacturer will have continuous or batch-continuous operations that start off looking much like small-scale process manufacturing and end up looking more like discrete but continuous manufacturing requiring an intermediate level of change-over. Raw materials may be continuously blended and cooked, resulting in some chemical change. Then they proceed through a forming stage, where changes to the physical geometry may be made, and then on to packaging, where individual pieces are inspected, wrapped, and assembled into larger units with similar or dissimilar components. Control is often a mix of analog feedback control and sequential logic systems tightly integrated with general-purpose motion control and robotic cells. Systems with 100 servo axes coordinated over large distances may be common, resulting in operator workstations on the floor that interact with multiple unit operations and machines that are spread over some

distance. Money is made by balancing production efficiency and logistics resulting in mass customization. Plant design changes at an intermediate frequency (years) and may be accomplished by a combination of internal and external resources; but because of tightly integrated operations, machine software and other documentation is often available to maintenance personnel, who will be expected to troubleshoot and repair all but the most difficult and infrequent failures. Think about food, beverages, printing, or consumer products made by companies such as Mars, Pepsi, Donnelley, or Procter & Gamble.

The Economics

This classification of manufacturers may seem a bit arbitrary, and various exceptions will be plentiful to the prototypical descriptions offered above. But throughout my career, I have found this segmentation to be both meaningful and useful. Some validation is provided by looking at the economic numbers when manufacturing is segmented in this way (See Figure 2). Total U.S. manufacturing output is approximately \$5 trillion. By sector, process and hybrid each account for 31% of this output, with discrete claiming a slightly larger 38%. Manufacturing employment is 14 million persons, but the division by sector is quite different than by output. Discrete manufacturing claims 50% of the employment, with hybrid accounting for 32% and process only 18%. Total wages of \$1 trillion are also skewed, with discrete accounting for more than half of the wage base at 52%, hybrid 26%, and process 22%.

From this basic data, we can see some important facts that make intuitive sense. First, output per employee, or productivity, is much higher in the process industries, exceeding discrete productivity by almost 2 1/2 times. Second, process employees, at \$97,000, have

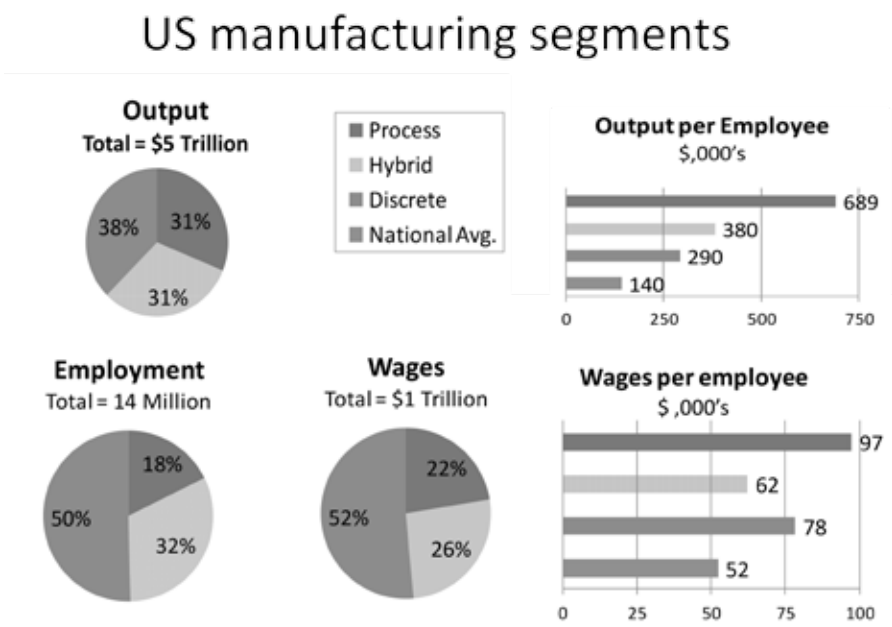


Figure 2.

Advanced Industrial Maintenance Skills Vary

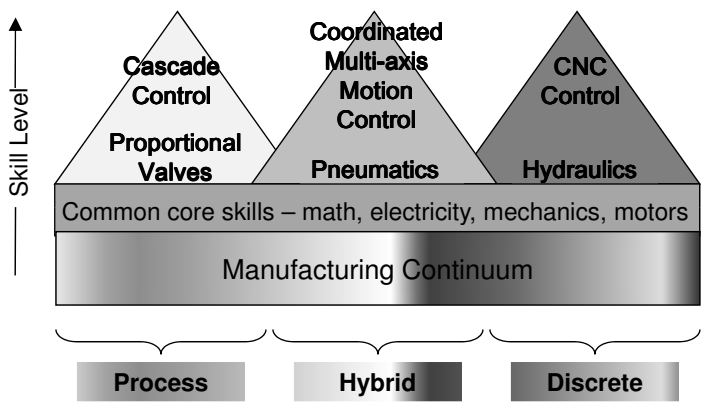


Figure 3.

the highest wages per employee. If we think about large process plants with control rooms full of distributed control systems operated by employees with some college, or maybe even a degree, this data makes sense.

Discrete manufacturing has the lowest productivity, yet the second highest wages per employee. This could be because of higher skill requirements or more changeover issues in the discrete world, or it could be a reflection of the wages that are being paid in industries that are more highly unionized. In any case, there would seem to be some significant opportunity for discrete manufacturers to improve their productivity numbers.

Hybrid manufacturers pay the lowest wages and have productivity midway between process and discrete. Many process plants went fully automated in the last quarter of the 20th century. There are certainly opportunities for continuous improvement in process plants, but many hybrid plants have not yet taken advantage of the opportunities available with new mechatronic solutions, process control, and batch automation. Real opportunities for applying advanced manufacturing automation techniques, and for worker upskilling, exist in hybrid manufacturing, leading to higher profits for owners and lifestyle improvements for workers. The difference in wages and productivity alone are enough to affect the education and training expectations of manufacturers from these three sectors.

An overarching fact not to be overlooked in this data is that manufacturing wages per employee are 50% higher than average wages overall in the economy, and manufacturing productivity is 2 1/2 times the national average. The least productive manufacturing sector is more than twice as productive as the economy as a whole.

Models are meant to be useful, not perfect

This model is meant to simplify, not to be all-inclusive. It provides rules of thumb, and rules are meant to be broken. For example, some companies may have both process and discrete operations within the same plant and not be considered a hybrid. And there may be blurring

at the edges between manufacturing and non-manufacturing. For example, utilities, mining, and agriculture will share some attributes with the various manufacturing sectors. A training program for an electric utility or a pipeline may look a lot like that for a chemical plant. A farmer using geospatial mapping and soil sensors to batch the proper amount of fertilizer to a field using mechatronic systems in a tractor may have needs similar to a hybrid manufacturer, as will a supply chain technician in an automated fulfillment warehouse.

The purpose of a model is to be useful. We know that Newton's formula $F=ma$ does not explain everything correctly, but in many circumstances it is still useful. **The assertion here is that this three-sector model is useful when developing manufacturing workforce training, education, and certification programs. It may be applied to the unique skill needs of operators, maintenance technicians, and supervisors.**

Manufacturing sectors affect workforce development plans

Customizing training, education, workforce development, and certification plans by manufacturing sector is a workable strategy that will increase the satisfaction of industry and the acceptance and penetration of educators as we work together to solve the workforce crisis in America (See Figure 3). It will eliminate the need for educators to create a customized program for every plant or company. It will facilitate the use of industry-recognized credentials by eliminating the need for every kind of manufacturer to find or develop their own. It will allow companies to achieve the critical mass necessary to influence local and national decisions about education and workforce development. Recognizing that a small food company, a large automated warehouse, and a fertilizer plant share similar competency needs for their workers will allow them to collectively approach their workforce agency and local high school technology center or community college to develop higher-quality programs that meet the needs of a wider customer base for the education provider. That is not to say that schools shouldn't make customized training for individual employers. But it is to suggest that if they start with the right plan for the sector, the customization should be minor.

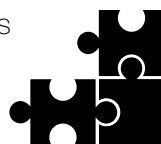
Leveraging manufacturing sectors

As a manufacturer, your operations may be unique, or they may be only like those of your competitors with whom you don't wish to collaborate. But the underlying technologies and attributes of your process, hybrid, or discrete sector have you sharing much in common with other manufacturing companies in that same sector. Leverage your sector to influence automation vendors, educators, software providers, and others.

As a provider of products or services to manufacturers, don't assume that one size will fit all. Identify the sectors of your customers, and start out by testing the hypothesis that a solution customized for a particular customer's sector will meet most of the needs of any customer within that sector.

Once both manufacturers and suppliers recognize and simplify manufacturing by sector, the task of developing plans, strategies, and winning solutions will become less challenging and the results more useful.

Workers arrive at a manufacturing job having traveled many different routes. Just as the previous chapter points out that there may be different preparation required depending upon the manufacturing segment one works in, this chapter points out that the characteristics of that preparation may need to vary depending upon the path being taken to that career. Although the knowledge and skills obtained may be the same in the end, the strategies for obtaining the knowledge and skills may vary widely for a full-time high school student, a returning-to-the-workforce mother, a veteran, the long-term unemployed, an incumbent worker, or an ex-offender. Understanding the pathways issue is essential to creating the programs that meet the most needs. While an “all of the above” approach might be desirable, it is not the place to begin.



Author Bio



Scott J. Sheely,
Special Assistant for
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As I was winding down my involvement as Executive Director of the OMAC Packaging Workgroup (OPW), I was invited to a regional meeting on manufacturing skills development, a topic that aligned with OPW’s PackLearn initiative. I decided to attend, only to find that the meeting had been canceled, and that Scott Sheely and I had not been told. As a result, we bumped into one another in the hallway outside the room that the meeting was to have been held in, introduced ourselves, complained about the meeting being canceled, and then sat and shared ideas about the need for advanced skill development in manufacturing. That was 10 years ago, and Scott and I have been working toward common goals ever since.

Scott J. Sheely was the Executive Director of the Lancaster County Workforce Investment Board, one of 22 such boards in Pennsylvania from 2000 through 2015. Vocationally, he has worked as the human resources director of a large mental health agency, the operations manager of a nursing home chain, the associate pastor of a church, and the owner of a regional wholesale jewelry business. A graduate of Franklin and Marshall College in government, Wright State University in mental health counseling, and United Theological Seminary in pastoral counseling, Scott is currently a doctoral candidate in adult and workforce education at Penn State University and, just recently took a position as Special Assistant for Workforce Development with the PA Department of Agriculture.

With many partners, he was the founder of the Food Manufacturers’ Training Consortium of Southcentral PA, the Industrial Maintenance Training Center of Pennsylvania, and the Mid-Atlantic Mechatronics Advisory Committee. Scott was the chief architect of the Mechatronics Competency Model that was adopted by the U.S. Department of Labor. He has worked closely with PMMI as that organization builds out the components of its mechatronics industry credential.

Chapter Three

Manufacturing Career Pathways

*Where do manufacturing workers come from,
and how do they advance?*

by Scott J. Sheely

Over the last several years, career pathways have become increasingly popular frameworks for talking about the variety of career options that are available to people who are preparing to enter the job market or looking for work after an employment dislocation. They use occupations as a kind of roadmap for job seekers, and many have been organized in “ladders” or “lattices” showing occupational progression.

Characteristics of Pathways

Pathways are nearly always referred to in the plural. Any one job has multiple ways that people find the knowledge and skills to perform it. In the same way, any pathway often leads to many jobs that make use of the knowledge and skills acquired.

Extending the pathway metaphor, these theoretical constructs also help us understand the “on-ramps” and “off-ramps” as people move through the lifelong learning that is required to proceed along the pathway. Veterans, dislocated workers, new workers, ex-offenders, and others will bring different knowledge and skills to the pathway at particular times in their careers. As the pathway model is applied, it needs to account for these different talents that the learner brings and allow them to move ahead with additional knowledge and skill acquisition.

If done most effectively, career pathways must also reflect the needs of employers and recognize the reality of the way people progress through levels of the work environment. They are just as important for incumbent workers as for entering workers, particularly at a time when employers in the U.S. (and around the globe) are dealing with the talent shortage that will develop as the Baby Boomer generation changes its relationship to work over the next several decades.

Industries like manufacturing and construction that rely more on on-the-job training rather than those such as healthcare, which require more academic credentials and licensing, will have very different pathways.

As we look at all forms of education today, it is clear that formal education is more valued than hands-on or tacit education...the kind that comes from sitting next to and observing a journey person welder, mechanic, installer, or operator. Tacit education, along with

foundation skills and some basic didactic knowledge, forms the basis for training many of the middle-skill jobs that will be in short supply over the next two decades as the new demographic-based dislocation moves into full swing.

Identifying a Pathway

Through a process of analyzing secondary occupation data, it is possible to identify pathway concepts that can be further developed into pathway models. Typically, the researcher examines occupational projections and organizes them into categories that can be tested for wage and skill progression. A regional economy normally contains six to eight of these pathway models.

For example, in Lancaster County, Pa., which has a very large manufacturing sector that includes food processing, metal fabricating, printing, and packaging, we have identified from the occupational data a Production Career Pathway that looks like this:

- Entry-level
 - Industrial Truck and Tractor Operators (Forklift Operators)
 - Hand Packers
 - Inspectors and Testers
- Intermediate-level
 - Single trades
 - ◆ Machinists
 - ◆ Welders
 - ◆ Heavy Tractor-Trailer Drivers
 - ◆ Maintenance and Repair Workers
 - Machine operators
 - ◆ Printing Press Operators
 - ◆ Print Binding and Finishing Workers
 - ◆ Food Batchmakers
 - ◆ Packaging Machine Operators
- Upper-level
 - Industrial Machinery Mechanics
 - Mechatronics Engineering Technologists
 - Supervisors of Production Workers

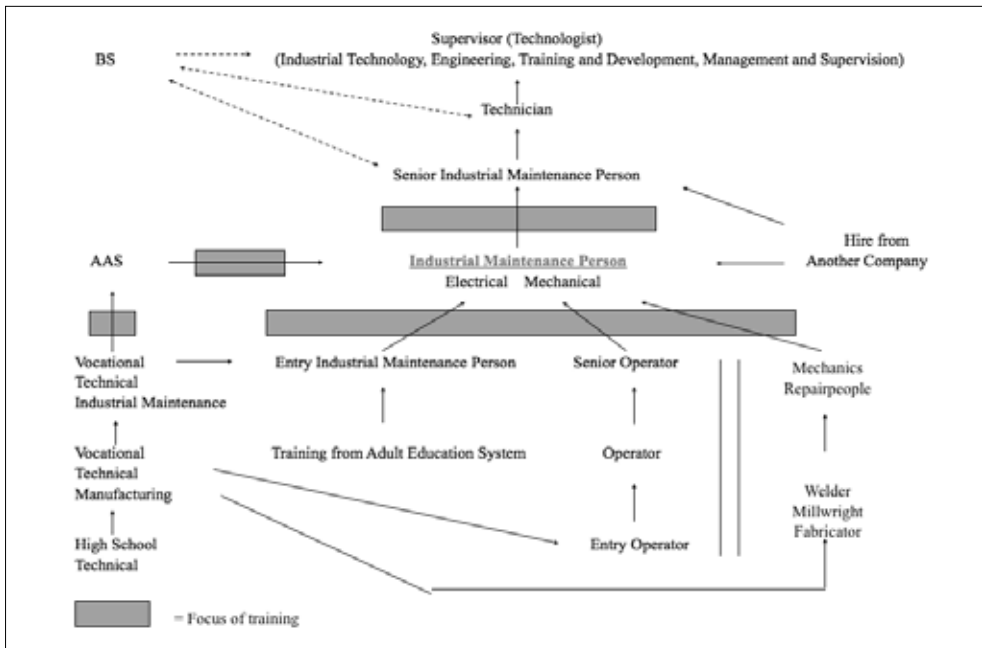
Levels show a clear wage and skill progression, and the occupations associated with the levels are projected to grow in the region over the next decade. This is the theoretical pathway model.

Pathways in Practice

However, to bring the model alive for practitioners, one needs to add other information that needs to be collected from the industry. We invited 25 industrial maintenance supervisors from mid-size to larger manufacturers to a focus group to tell us about the multiple

pathways that people use to become an Industrial Machinery Mechanic or Mechatronics Engineering Technologist (or several other job titles commonly associated with the Industrial Maintenance Technician cluster of jobs).

They told us a much more nuanced story about pathways that are illustrated on the chart below.



- We began with the assumption that many people enter the pathway through formal education, beginning with high school technical programs that articulate to postsecondary training, which flow people toward jobs in the Industrial Maintenance Technician (IMT) cluster. We found that fewer than 15% of people actually enter jobs in that cluster by this path and, from the commentary from supervisors, that many people who do come through these educational programs still need a great deal of on-the-job training to be fully functional.
- Supervisors spoke in a positive way about people who attain some level of technical education in maintenance either at the secondary or postsecondary level, get experience in a small to mid-size manufacturer, and come to work with a larger manufacturer with a broader level of knowledge and experience. Hiring people from other usually smaller companies is another way that people move along this pathway.
- Another clear trend in talent development that takes place along the pathway involves identifying people with maintenance knowledge and skills in the machine operator ranks

and offering them ways to take on maintenance tasks on the job. Many companies spoke of making operators “machine owners,” allowing them to take on preventive maintenance functions that may then lead to an invitation to do more in the maintenance area.

- Finally, companies have been very involved in taking single trades such as welders, millwrights, electricians, and others and adding additional skill training to make them into the multitasked technician that is required in industrial maintenance. Several of the supervisors spoke about welders’ abilities to do maintenance tasks because of their ability to think three-dimensionally, read blueprints, and fabricate.
- We also found out one other thing. When our friends in higher education pushed the idea that IMTs eventually needed a bachelor’s degree, the supervisors in the room dismissed that notion. They admitted that a bachelor’s degree might be good if maintenance people become trainers or supervisors or managers; but for practitioners, there was no value added in further formal education.

With our interest in workforce development, we also asked the focus group to share their opinion of where further training would be most applicable. There was near consensus that training for higher-level skills required for the IMT cluster should build on a solid base of experience rather than the other way around.

This insight was pivotal as the workforce and education system in Berks and Lancaster Counties in Pennsylvania build out a systematic approach to skills acquisition along the Manufacturing Career Pathway.

- People already on the job (incumbent workers) become the focus of higher-level skill training in industrial maintenance and mechatronics. A network of employers identifies candidates who participate in a program of online instruction and laboratory practice culminating in testing that stresses troubleshooting skills.
- Schools and workforce organizations prepare potential employees to join the Manufacturing Career Pathway at lower levels. However, they encourage people to participate in skill training (blueprint reading, hand and power tools, safety, forklift operation) that lays a foundation for future training and progression down the pathway.
- Veterans are able to bring skills from their military service and find a place along the pathway where they can be applied.
- In a similar way, persons who have experienced a dislocation from a job can find ways to use the skills that they bring and additional skills that they may acquire at various levels along the pathway.
- Many other people, including those reentering the community from prison and those transitioning off of welfare, can learn skills that qualify them for entry into lower-level jobs on the pathway as their “on-ramp” to better jobs in the future.

In Summary

Career pathways allow the individual to see a plan that becomes their pathway to the future and establish what they, as individuals, must do to move into it and along it. Career pathways allow educators and workforce planners to target training to the areas where it is

needed as people move through the system. Career pathways help employers to not only identify the skill training that their incumbent workforce needs, but to also evaluate the knowledge and skills of their prospective workforce as they hire into it.

However, to be useful, pathway models must be tested and be informed by the reality of the work world as they are put into practice.

The most commonly thought of pathway to a career, and arguably the most effective one, is a direct pathway from high school to higher education to work. Most parents want their children to graduate from high school, go to a prestigious university, and enjoy a good-paying career. But unfortunately, in the 21st century, this expectation is increasingly not being met. We need to change the national dialog about higher education and recognize that there are alternative strategies that lead to a student's success. The facts are staggering. The solutions were well known to American planners at the end of World War II, but rejected. We need to rethink the school-to-work pathways if we want more students to achieve success, if we want to revitalize manufacturing, and if we want to give a dynamic boost to our economy.



Author Bio



William C. Symonds,
Former Project Director,
Pathways to Prosperity
Project, Harvard Graduate
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One of the most telling and comprehensive reports on the state of workforce preparation in America was published by the Harvard Graduate School of Education in 2011. I first saw a presentation on the report in late 2012 at a community college near Pittsburgh. The facts presented paint a picture different from the one that many Americans assume. The solutions suggested are at once both simple in concept but challenging in execution. Who better to summarize this landmark report than the Project Director, William Symonds.

Dr. Symonds helped launch the Pathways to Prosperity Project at the Harvard Graduate School of Education in 2008, and he served as its director through June, 2013. He was the primary author of the seminal report issued by the project in early 2011: *Pathways to Prosperity: Meeting the Challenge of Preparing Young Americans for the 21st Century*. Since the report's release, Bill has spoken in 40 states. He was also the principal organizer of a national conference held at Harvard in March, 2013, called, "Creating Pathways to Prosperity." Symonds is now working to create the Global Pathways Institute to help lead a national movement aimed at preparing all young Americans to lead successful lives. He also continues to speak to groups around the country about how we might help young people build successful careers.

Prior to coming to Harvard in 2007, Symonds spent nearly 25 years as a senior correspondent and bureau chief with *Business Week* magazine. During his career at *Business Week*, he covered businesses in virtually every industry leading bureaus in Pittsburgh, Denver, and Boston, as well as in Italy and Canada. He also served as *Business Week's* chief education correspondent for many years.

Chapter Four

Preparing America for 21st Century Global Competitiveness

The Pathways to Prosperity Report from the Harvard Graduate School of Education points out where America stands on a global basis and suggests changes we need to make.

by William C. Symonds

Even though the U.S. economy is continuing to recover from the Great Recession, it is clear that we still lag behind many nations in preparing young people to lead successful lives as adults. Evidence of this failure is seen everywhere—from the staggering levels of youth unemployment/underemployment to the millions of young people who drop out of high school or college before earning a degree. This epidemic has become so pervasive that it now touches virtually every family in America. And if we don't develop effective solutions to this crisis, it threatens to undermine the future strength of our economy.

This failure has especially serious implications for manufacturing. One of the key reasons so many young people are struggling to find good jobs is the huge disconnect that's developed between education and the needs of industry. Business leaders increasingly complain that many high school and even some college graduates don't possess the skills they need in today's economy. Nowhere is this "skills gap" more apparent than in manufacturing. Indeed, as I've traveled to 40 states speaking about this problem over the past three years, I've heard repeated complaints from manufacturers about the problems they're facing filling skilled jobs. This issue has come up everywhere from rural New England to the Midwest to the Pacific Northwest. And it's clearly a big problem. A 2011 study by Deloitte and the Manufacturing Institute estimated that 600,000 manufacturing jobs were unfilled because of this skills gap, with the shortages especially acute among skilled production workers.

A major reason we confront this predicament is that in recent years, the U.S. has put enormous emphasis on one pathway to success—attending and graduating from a four-year college—while de-emphasizing alternative pathways, including career and technical education (CTE). In sharp contrast, some other leading nations have taken a much more balanced approach, by offering young people multiple pathways to success. Some of the most prosperous countries in central and northern Europe, as well as Australia and New Zealand, have developed high-quality systems of what they call vocational education and training (VET). These systems offer young people rigorous programs of study designed to

prepare them for a career in their chosen industry. VET often includes an apprenticeship at a company in the industry. Germany, Switzerland, and Austria have developed especially strong VET programs aimed at preparing young people for manufacturing—a key reason why Germanic manufacturing continues to be so globally competitive.

The Pathways to Prosperity report, which was published by the Harvard Graduate School of Education in 2011, argued that the U.S. had much to learn from these other countries about preparing a globally competitive labor force. True, the U.S. cannot aspire to simply import foreign approaches, such as the German dual-apprenticeship system. But I and my co-authors argued that we could build a much more effective American system of pathways to prosperity—one that would better serve both young people and American industry. Since the publication of the report, I've helped develop a list of some of the critical steps the U.S. needs to take to develop vibrant pathways systems. These recommendations—which I'll discuss toward the end of this chapter—are highly relevant for those concerned about the manufacturing workforce.

To be sure, change is never easy, and perhaps no sector is more resistant to change than education. But the Pathways report advanced two compelling reasons why the U.S. should embrace fundamental change. The first is that our national approach to preparing young people is clearly failing to prepare many of them for success. Though we've spent hundreds of billions of dollars trying to prepare schoolchildren for college, only 30% of young adults actually earn a bachelor's degree by their mid-20s. Tragically, many young people go to college, but drop out before graduating, leaving with no degree but often with a huge student loan debt. This scenario is so common that the U.S. now has the highest college dropout rate in the industrial world.

Meanwhile, the U.S. lost its long-standing leadership in education. As the Pathways report points out, the U.S. led the world in education by virtually every measure for a full century—from the mid-19th century through the 1960s. During this period, the U.S. made astonishing gains in educational achievement and attainment, which in turn laid the foundation for spectacular growth in U.S. prosperity. Yet over the past generation, the U.S. has fallen behind many other nations in educational attainment and achievement. A major reason for our decline has been our adherence to the goal of “four-year-college-for-all.”

The second reason that we need to change is the overwhelming evidence from other nations that there is a better way to prepare young people for successful lives as adults. As the Pathways report documents, some of the world's most successful countries have embraced a “multiple pathways” approach to education and youth development. These countries have strong universities, just as the U.S. But they've also built vibrant VET systems, which have become the pathway of choice for many young people. In northern and central Europe, 40% to 70% of young people opt for the VET system beginning in about tenth grade. While these systems vary from country to country, they typically combine classroom and workplace learning over three years. These programs culminate with the student earning a diploma or “certificate” that has real meaning in the labor market. In Germany, which has the best-developed system, students can choose among VET programs in 350 different occupations. And in Switzerland, students can choose from among more than 200.

While many Americans still view CTE as a substandard or second class option, the best of these foreign VET programs are models of rigor and relevance. A VET qualification in Germany or Switzerland is often every bit the equal of a technical degree that might be awarded by a U.S. community or technical college. And unlike the typical U.S. community college program, the Swiss and German VET programs include an extensive apprenticeship. Students studying manufacturing thus have an opportunity to apprentice with such world-class manufacturers as Siemens, BMW, and Mercedes.

Recent international research suggests there are three major benefits to high-quality vocational education. The first is that for many adolescents, combining work and learning is more effective pedagogically: in other words, the students actually learn more. That's partly because they don't have to wonder about the relevance of what they are being asked to learn, since it is so clearly aimed at preparing them for a career. In sharp contrast, countless U.S. high school students become bored with a curriculum they find largely irrelevant, and a significant number of them go on to drop out. A second benefit is that because foreign VET students are more engaged, they are more likely to remain in school until they graduate. This is one reason why the U.S. has slipped behind many nations in graduation rates.

The third and perhaps most impressive benefit is that vocational education helps young people find jobs in their chosen careers. Learning for Jobs, a 2010 study completed by the Organization for Economic Cooperation and Development (OECD), studied vocational education in 17 different countries, including the U.S. It found that countries with the strongest VET systems—including Switzerland, Germany, Austria, the Netherlands, and Norway—have much lower levels of youth unemployment than the U.S. or other countries with weak vocational education. Youth unemployment has remained under 10% in these exemplar countries, even as it's exceeded 50% in Spain and Greece. In the U.S., youth unemployment has been hovering between 15% and 20%, yet it's compounded by the fact that the percentage of young people in the labor force has dropped to the lowest levels in recent American history.

Developing a more effective American approach will require a fundamental cultural change—a move away from our over-emphasis on four-year college and toward a more holistic, multiple-pathways approach. In the fall of 2013, I helped convene a number of leading business and education organizations to develop a “vision” for a new Global Pathways Institute that aims to promote this new approach. This is the vision statement that we adopted: *“We are committed to creating an America in which all young people are prepared to lead productive and successful lives. We believe that providing young people with high-quality multiple pathways is the best way to help them discover and develop their potential and achieve economic independence. Achieving this vision will require creating a world-class pathways system in which industry collaborates with education to better define the skills needed to compete in the global economy, develop programs that will equip stu-*

dents for success, and provide ample opportunities for work-based learning. We believe this will help rebuild the middle class, increase social mobility, and promote the dignity of work, while strengthening American competitiveness and the U.S. economy.”

Achieving this vision will require that we embrace several core principles. Four are especially important:

- 1.** First, we must make career guidance a far more central part of school—and thus strive to provide every student with high-quality guidance. Today, many young people receive little or no guidance, and so not surprisingly end up making poor decisions. Good guidance would encourage young people to explore possible careers, to become excited about their future, and to then develop realistic pathways plans. Effective career guidance is an especially promising answer to the skilled-labor shortages in manufacturing. Because so many American manufacturing jobs disappeared in recent decades, many parents have developed a negative view of manufacturing, and so discourage their children from even considering such a career. That’s true even in places where the economy is dominated by manufacturing. Take Fond du Lac, WI, a medium-sized city whose economy is built around manufacturing. In 2011, the area Association of Commerce did a survey of the workforce, and found that 51% planned to retire in 15 years. At the same time, they also surveyed area high school students, and discovered that many students have a negative perception of manufacturing. In fact, only one-third said they would even consider taking a manufacturing-related course. This suggests that Fond du Lac will face a severe skills shortage in coming years unless it can reverse these negative perceptions among young people and their parents. Better career guidance is one obvious solution.
- 2.** Second, we need to ensure that all young people have access to multiple pathways to success, including high-quality CTE. True, we already have some world-class CTE programs, including some that prepare students for careers in manufacturing. Wichita, KS—a city located in the midst of the largest geographic center of aircraft manufacturing in the U.S.—has established the National Center for Aviation Training to prepare students for this industry. Similarly, Francis Tuttle Technology Center in Oklahoma City is sometimes called the Taj Mahal of CTE. It offers excellent programs in advanced manufacturing, precision machining, CNC programming, and many other in-demand areas. The problem is that these exemplars are more the exception than the standard. Whether a young person has access to high-quality programs thus often becomes an accident of geography—where they happen to live. We need a far more determined effort to take the best programs to scale.
- 3.** Third, we must engage employers in this vital work. The best foreign VET systems depend on the heavy involvement of leading employers. That shouldn’t be surprising. Who knows more about the career opportunities in manufacturing than the people who already work for manufacturers? Employers can enlist their employees to talk to students about these opportunities in manufacturing, and to serve as mentors to students interested in manufacturing. In addition, manufacturers should invite counselors,

school administrators, and teachers to visit their facilities, so they can learn more about the industry. Manufacturers must also work closely with educators to help develop programs of study designed to produce the well-trained workers that companies need.

4. Finally, employers must join with educators to dramatically increase opportunities for “work-based learning.” Work-based learning refers to learning that takes place at the place of employment. It can range from brief exposures such as job shadowing to full-blown apprenticeships. The OECD’s Learning for Jobs report provides abundant evidence of the value of work-based learning. Given the bias against manufacturing careers, it is especially important in manufacturing. Again, there are some wonderful examples of good work-based learning. Wisconsin, for instance, has a long-standing Youth Apprenticeship program, under which high school juniors and seniors complete up to 900 hours of work-based learning. The results are impressive. Over 75% of youth involved in youth apprenticeships continue their education at one of Wisconsin’s impressive technical colleges, or at a university. And more than 80% work in their field after graduation. The Youth Apprenticeship program has also encouraged some students to complete high school, rather than drop out. In Waukesha, Wis., Generac Power Systems launched “Second Chance Partners” to allow high school students to work and learn in manufacturing facilities. More than 80 other manufacturers have now joined this program. Even though many of the students who sign up for this program are struggling with conventional academics, 90% of those who enroll successfully complete the program, and many go on to find jobs in manufacturing.

The beauty of these four principles is that they can be adopted and implemented in a willing district, city, or region—without waiting for the rest of the nation to get on board. Manufacturers who are concerned about the skills gap can enlist like-minded companies and then work with educators to expand career guidance, improve programs that prepare students for manufacturing careers, and expand opportunities for work-based learning. This is an extremely promising strategy for recruiting and preparing the manufacturing workforce of the future. So stop complaining about the skills gap, and get engaged in solving the problem!

The full Pathways to Prosperity report may be found at: http://www.gse.harvard.edu/news_events/features/2011/Pathways_to_Prosperty_Feb2011.pdf

The workforce system, what many of us think of as the “unemployment office,” gets involved with many of the workers who don’t follow the direct school-to-lifelong-career pathway. But the workforce system has changed dramatically. It has evolved from a supply-focused system trying to rid itself of its supply of unemployed workers to a demand-focused system trying to meet industry’s demand for an appropriately skilled workforce. One approach is to improve the skills of existing workers, driving our economy and creating entry-level jobs as others move up. The workforce system is well positioned to serve as a neutral arbiter between industry and educational institutions, whose grant funding may depend upon the endorsement of the local workforce agency. Workforce agencies also have significant influence on the flow of students from industry or unemployment to high-priced training programs upon which schools depend. Industry and education is well advised to always have their workforce partners at the table and to leverage their influence and advice.



Author Bio



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I have been fortunate to have had continuous gainful employment since graduating from college. As a result, my last personal contact with the workforce system was over 30 years ago with what was then the “unemployment office.” After 30 years in manufacturing, I was reintroduced to the “workforce system” as I began to promote technology education. I quickly learned that I had no idea about what the workforce system had become. Ed McCann became a valuable mentor for me as I learned about the system and its culture. Ed offers a quick wit, deep insight, and a rapid grasp of new ideas. I am often surprised to hear him articulate complex new ideas in extremely simple ways, and you are never left with any doubt about where Ed stands on an issue. Who better to reflect upon the changing role of the workforce system and to advise manufacturers on how to utilize it to their best advantage?

When Ed prepared this chapter, he served as Director of Workforce Development and Chief Operating Officer for the Berks County Workforce Investment Board in Pennsylvania. Ed has since retired. He is a graduate of Lehigh University with graduate work at Pennsylvania State University, and he has nearly 40 years experience in the planning and management of workforce development programs. He is a charter member of the National Association of Workforce Development Professionals (NAWDP); he served on that organization’s Board of Directors for 18 years and as Chairman of the Board for 3½ years. He is a Certified Workforce Development Professional. Ed continues to be active in local, state, and national organizations, including NAWDP, the PA Workforce Development Association (PWDA), the Greater Reading Economic Development Professionals, the Berks Advisory Board for the Ben Franklin Technology Partnership, and the Government Affairs Committee of the Greater Reading Chamber of Commerce and Industry. In 2009 he was named Partner of the Year by the PA Economic Development Association (PEDA) and received the H. G. Weisman Award for Leadership from NAWDP.

Chapter Five

The Role of the Workforce System and How it has Changed

The system has changed, and those of us who have always been employed may have missed that fact.

by Edward J. McCann

To paraphrase the Oldsmobile ads of a few years ago: “It’s not your father’s Workforce Development System anymore.”

The truth is, however, that it never really was. There were, to be sure, visible manifestations of what was purported to be a Workforce Development System. But in truth, what we had after 50-plus years of federal and state initiatives was a hodgepodge of “siloe” programmatic approaches, each of which operated fairly independently and each of which had, over the years, assembled its own constituencies inside and outside of Congress to defend itself against any attempt to change it.

Now, that’s not to say that these programs did no good or that they were not staffed with capable and conscientious people. But they weren’t a “system.” The individual elements didn’t talk much to each other. They had little authority to make any changes at the local level, and input from the “outside,” especially from employers, was often both perfunctory and minimal.

So the state employment services, the vocational-technical schools, the community colleges, the various community based organizations, and other “service providers” did what they could do, as well as they could. The planning and operations of the successive iterations of federally funded “employment and training programs” did so as well, with all of them coming together, if at all, around whatever version of advisory committees and planning bodies for the total “comprehensive” federal programs were then in place. If anyone thought of a connection with economic development, it usually didn’t go much further than trying to recruit for new employers or occasionally an attempt to include some commitment of federal “training funds” along with state incentives on an “offer sheet” to a prospect without running afoul of the federal law.

Good things were done, but probably very few of them to the complete satisfaction of those who really wanted a Workforce Development System, nor was there much of a strategic or long-term community workforce development focus.

But there’s good news for those who have that kind of inclination, which I suspect includes most employers, a whole lot of people who have worked in the current configuration, and certainly economic development professionals. These folks fully understand

that the most significant way they can distinguish their areas from others—whether next door or in a global market—is by the quality and competitiveness of their labor force.

The first piece of good news is that a number of things have changed. One is that the Workforce Investment Act (WIA), the latest in series of federal legislative interventions, reflected a belated realization that those responsible for putting a “local” system together had to be independent of those who delivered direct services. They had to be “honest brokers” or “neutral brokers” if we want to avoid offending anyone. The other was that, even without any real “command and control” authority, the new Workforce Investment Boards (WIBs) were nevertheless given a broad charge of authority to bring together elements to improve the workforce. They didn’t all do it immediately, and some may not even have done it over time, but gradually it occurred to a lot of them that they could.

The “One-Stop Career Center” concept has also made a contribution. To be sure, putting these configurations together has not been a completely flawless process. I am reminded of an old friend who had seen this attempted before and concluded, “Coordination and cooperation are unnatural acts performed by non-consenting adults.” A bit overstated, of course, but not without an uncomfortable ring of truth.

Well, the “One-Stops,” under whatever “brand name” the states chose to give them, haven’t turned out to be all that bad, except in the rare instances where someone was determined to make them bad. There may still be remnants of rear-guard obstructionism here and there, but it’s not really a serious condition anymore. Remarkably, when all those local actors were encouraged and even empowered to work together and to see the world in a larger context, they started to do so, often adding a local or regional vision and some more-effective operating processes to the basic structure encapsulated in federal and state legislation.

A number of things helped this process along. Labor market data got better and was packaged in more comprehensive and usable forms, both by the various state “data shops” and by research-based private for-profit providers that followed the traditional entrepreneur’s model of finding out what people needed and selling it at a reasonable price. Newly emerging jobs in areas like healthcare, information technology, and industrial automation were defined and classified with skill sets, and related Knowledges, Skills, and Abilities (KSAs) were codified.

“Cluster” or “sector” partnerships were created, and relatively small amounts of incentivizing funding leveraged input from employers. This led to much better understanding of their workforce requirements and an enhanced capacity to communicate those requirements to educational and training providers. More and more, these efforts often include better assessment systems like WorkKeys®, which produce a common language across employers, educators, and workforce intermediaries.

Economic development discovered that a race to determine who could produce the cheapest labor was a poor substitute for the ability to deliver a workforce with the education and skill levels that could demand family-sustaining wages in growing industries. Perhaps even more important, the resulting dialog between workforce development and employers led to a new and broad-based understanding of the critical need for “middle-skill” jobs.

While substantial parts of the educational system remained loyal to the traditional off-the-shelf academic credentials with a baccalaureate degree at the pinnacle, discussions with employers, often facilitated by local WIBs, have now made many converts to a multiple-exit-point model. Such a model provides either a younger person entering the labor market or a displaced worker or even a working incumbent with industry-valued credentials sufficient to qualify for middle-skill, well-paying jobs with prospects for advancement. Credentials under such a model may also be articulated to advanced standing in new associate degree-level programs and/or updated apprenticeships, which in turn might be accepted as credits toward Bachelor of Science degrees.

Parents are starting to see that this kind of regimen might have considerable advantages over a four-year degree that may have limited salability, usually accompanied by a sizable student loan debt.

So, do we now have a Workforce Development System? In many areas (and remember that labor markets, as Tip O'Neill used to say about politics, are local) we do, or we do at least in the leading industries. What's more important, however, is that we can now see that if we're not there yet, we can get there. If no one else has started the requisite conversation, we can start it for them.

The important thing to remember is that the "system" we're looking for has to be organic and market-driven. Many of the current complement of workforce development practitioners have long complained about the essential schizophrenia of federal policy. It seems that government can never seem to decide if their investment in workforce programs is intended to produce and maintain the most skilled and competitive labor force we can possibly produce to give us an advantage in global markets or to ameliorate the perceived disadvantage of certain segments of our population whether defined by employment status, income level, or other demographic markers.

That vision can be clarified by frank discussions, led and facilitated by employer-driven but broad-based boards who see their task as defining a real strategic position that both puts all the current available assets together and advocates for positions that could close all remaining gaps. That might include consolidation of some of the multitude of different programs that the U.S. Congress has brought into existence over the years and more flexibility and fungibility for the funding that supported them.

So we look at youth programs not primarily as income transfers to poor kids but as instruments to encourage high school completion and ties to advanced education, all combined with valid career information and training. We look at unemployment policy not as a simple income support on a cyclical basis but possibly also as a real reemployment system tied to skill development. We build incumbent worker skills and system upgrades with sectors or cluster industry partnerships tied to decisions made by empowered consortia of employers.

The workforce system looks at what's needed for a whole variety of customers—for younger people entering the labor market or trying to move ahead in it; for dislocated workers looking to reenter the labor force; for companies still struggling with skill gaps even in a time of high unemployment; for career and technology schools, community

colleges, or proprietary schools trying to put in place the quality programs that they can honestly market as the means to a brighter future; and for the economic development organizations that want their areas' economies to attract and grow companies that can compete in global markets.

To drill down into the needs of one class of customer, let's enumerate some of the topics employers find themselves looking for answers to and look at areas where the public workforce system, WIBs in particular, could help.

Recruitment

There's a common misconception that all the job-seeker customers this system attracts have chronic and largely self-initiated problems that make them unattractive prospects, and further, that those are precisely the kind of referrals an employer is likely to get from it. That was never completely accurate, and it certainly isn't now in a time where reliable long-term employees displaced by economic conditions, aspiring recent college graduates, returning highly motivated veterans, and others like them are competing in a very loose labor market. The Workforce Development System has not only a lot of capable job-seeker customers available, but also both the means and imperative to help you find them.

Assessment and Screening

The system can work with recognized and highly effective assessment systems (like WorkKeys®) but also with other valid assessments and testing modalities that fit your organization's needs. Some may be a part of a universally available "package;" others something to be negotiated. Talk to them about it.

Training

For individual job seekers who need it, the system usually has at least some funding to facilitate and pay for training, including, in some cases, skill upgrades for your current incumbents. Again, tell them what you want, ask them what's available, and find out if there's anything they can get for you.

On-the-Job Training

Having trouble finding someone who has everything you need? It happens even in times of high unemployment. The system can reimburse you for some of the added costs of bringing new hires up to your expected levels of productivity while you train them.

Finding the Right Education and Training Providers

The Workforce Development System knows the assets in your community. They can act as a "neutral broker" between training institutions like career and technology centers, community colleges, private proprietary schools, and higher education to find the right match either short or longer term.

Technical Assistance

The same kind of brokerage function can help you with access to higher-education research institutions or government and economic development agencies.

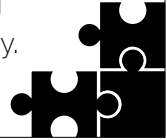
Communicating With the K-12 or Higher Education Systems

In many communities, this is a major concern of the Workforce Development System, and you'll be able to join with your colleagues to clarify your needs and the skills and behaviors employees must have to keep your company in the community and growing. Your voice is imperative, but the common voice of the business community can be even better. And, you could be part of the solution.

So go to your local workforce system representatives (WIBs) and ask them what they're doing to define what your community needs and to launch your community's conversation. This Playbook contains a myriad of examples of what can and has been accomplished after communities have opened up the discussion around manufacturing. As the conversation proceeds, see if you have the old or the new version of the Workforce Development System.

In the previous chapter, Ed McCann described the evolution of America's workforce development system that has, since 1998, operated under the terms of the Workforce Investment Act (WIA). That enabling legislation expired in 2003 and Congress continued to operate the system through the annual appropriations process. In July 2014, WIA was replaced by the Workforce Innovation and Opportunity Act (WIOA) which authorized almost half a trillion dollars in expenditures over the next five years. The U.S. Department of Labor was to have issued final regulations in January 2015 to implement the Act by July 1, 2015, and we had hoped to be able to report on best practices and benefits coming out of WIOA by the second edition of this Playbook. At this point in time (August 2015) DOL has issued guidance for the implementation, but final regulations are not yet completed, and many of the parties who might have contributed to a chapter on WIOA are continuing with the implementation process.

Staff at the Department of Labor's Employment and Training Administration (ETA) have provided general information on the Act's hallmarks that will be important to manufacturers. An informed reader will note that WIOA now requires many of the best practices described in first edition of the Playbook, providing indication that Congress and the agencies implementing legislation do take notice of things that work and adjust accordingly.



Author Bio

I was first introduced to the DOL and the ETA at a meeting in Washington, D.C., about half a dozen years ago where the topic of discussion was competency models for manufacturing. The staff of the U.S. Department of Labor's Employment and Training Administration is responsible for implementing the department's mission that is to contribute to the more efficient functioning of the U.S. labor market by providing high quality job training, employment, labor market information, and income maintenance services primarily through state and local workforce development systems.

Chapter Six

Implementation of the Workforce Innovation and Opportunity Act: Implications for the Manufacturing Sector

Significant changes are in store for the workforce system in 2015.

*by U.S. Department of Labor's
Education and Training Administration Staff*

The Workforce Innovation and Opportunity Act took effect on July 1, 2015. ETA and its multiple federal partners – Department of Education, Department of Agriculture, Department of Housing and Urban Development, and Department of Health and Human Services – are developing guidance to assist States in meeting their statutory obligation to develop a multi-year strategic plan to establish strategies that close the skill gap and help workers and businesses succeed. The new legislation emphasizes **sector partnerships**, career pathways, cross-program data and measurement, and the importance of job-driven investments.

Under WIOA, the revitalized workforce system will be characterized by three critical hallmarks of excellence of importance to the manufacturing sector:

- The needs of business and workers drive workforce solutions;
- One-Stop Centers (or American Job Centers) provide excellent customer service to jobseekers and employers and focus on continuous improvement; and
- The workforce system supports strong regional economies and plays an active role in community and workforce development.

Across the system, continuous improvement is supported through evaluation, accountability, identification of best practices, and data-driven decision making.

The Needs of Businesses and Workers Drive Workforce Solutions:

Businesses inform and guide the workforce system and access skilled talent as they shape regional workforce investments and build a pipeline of skilled workers. This engagement includes leadership in the workforce system and active participation in the development and provision of education and training, work-based learning, career pathways, and industry sector partnerships. Jobseekers and workers, including those individuals with barriers to employment, such as individuals with disabilities, as defined by WIOA, have the information and guidance to

make informed decisions about training and careers, as well as access to the education, training, and support services they need to compete in current and future labor markets.

One-Stop Centers (American Job Centers or AJCs) Provide Excellent Customer Service to Jobseekers, Workers and Employers, and Focus on Continuous Improvement:

One-Stop Centers and partners provide jobseekers, including individuals with barriers to employment, such as individuals with disabilities, with the skills and credentials necessary to secure and advance in employment with family-sustaining wages. Additionally, AJCs enable employers to easily identify and hire skilled workers and access other supports, including education and training for their current workforce. Further, rigorous evaluations support continuous improvement of AJCs by identifying which strategies work better for different populations; states, local areas, and training providers remain accountable for performance; high-quality, integrated data informs policy maker, employer and jobseeker decision making; and training providers are accountable for performance using the data and evidence.

The Workforce System Supports Strong Regional Economies:

Meeting workforce needs is critical to economic growth. State and local workforce development boards—in partnership with workforce, economic development, education, and social service organizations at the state, regional, and local levels—align education and training investments to regional civic and economic growth strategies, ensuring that all jobseekers and businesses can access pathways to prosperity.

While the final regulations governing WIOA will not be published until early in 2016, ETA is issuing “operational guidance” during the April 2015 – December 2015 period to assist the states and local officials in implementing the important provisions of the law. These advisories may be found at http://wdr.doleta.gov/directives/All_WIOA_Related_Advisories.cfm

This will be available on www.doleta.gov/wioa when officially published. Other policy direction and technical resources for the implementation of the new law can be found on this site as well.

ETA also sponsors another WIOA-related website – Innovation and Opportunity Network (ION)— that is a community of people, practitioners, programs, partnerships, and stakeholders that strive for capacity building in the public workforce system. The manufacturing community in the United States is encouraged to visit—and contribute—to ION. This site can be found at <https://wioa.workforce3one.org/>



Someone has said, “In God we trust. All others bring data.” In our Internet age, we have all become acutely aware of how important data about us is to those trying to get us to buy something. Data is not foreign to manufacturers, but perhaps they’ve never thought about how data may be obtained and used to influence workforce development decisions. Similarly, educators may not have considered using data to help them decide what types of programs are needed in their area and how big “sales” could become. Grant providers react to data, but are too infrequently presented with good data, if any at all, and too infrequently follow up to see if results predicted by the data are achieved. Those trying to solve the manufacturing workforce development problem need to think more like data-driven marketers. The tools are available, and in the hands of someone skilled in their use, the data can lead to compelling arguments.



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*Please see bio of this author with the chapter:
Manufacturing Career Pathways*



Chapter Seven

Manufacturing: By the Numbers

*Data can help manufacturers justify their needs
and help educators put the right programs
in the right place.*

by Scott J. Sheely

As we begin to formulate strategies to address manufacturing workforce development issues in regional economies, experience dictates that planners should look at the employment and output data first to determine the nature and scope of the manufacturing cluster with which we intend to work.

In building the infrastructure that will form the framework for whatever partnership is formed, planners first need to look at the place of manufacturing in the entire economy. Often, the issue of scale (or being large enough to do something significant) requires one to look at not only the industry locally, but also at other contiguous (and sometimes non-contiguous) areas. We also need to inquire as to the nature of the manufacturing networks in the local economy and the larger regions, if that is a factor. Some sense of the compatibility of skills between manufacturing and other industries in the region helps to define career pathways to keep the manufacturing talent pipeline full.

This chapter will briefly address where to find the data and how to analyze it in a way that helps program planners think about what is needed in their areas.

The Place of Manufacturing in the Regional Economy

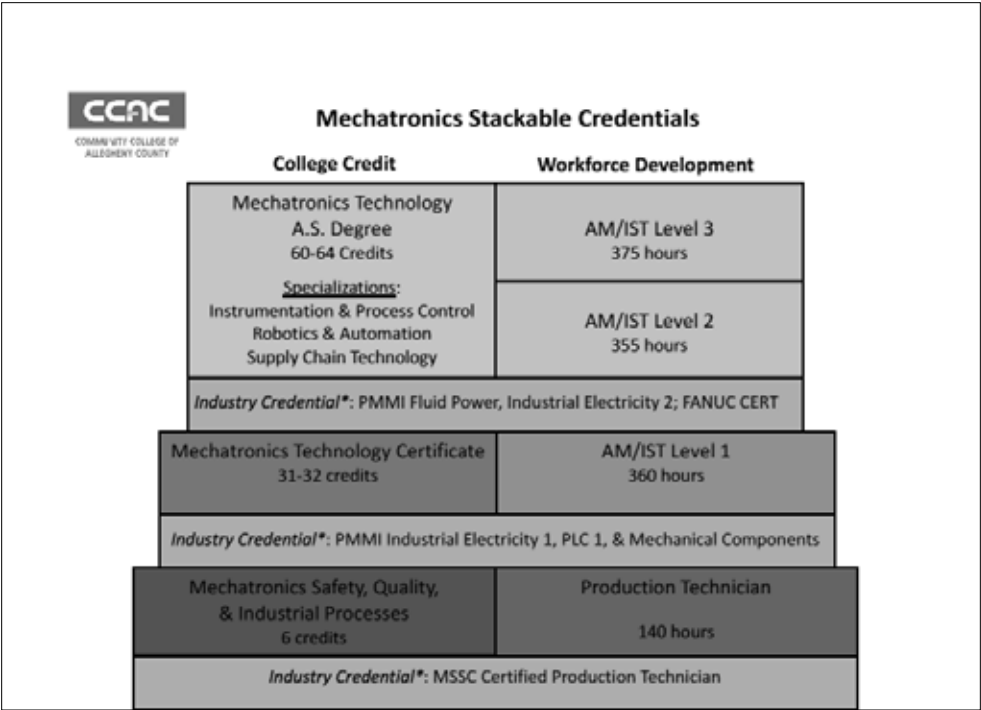
When we compare manufacturing to other industry sectors, we have found it useful to plot the information on a chart that makes interpretation easier.

One important factor involves the way one looks at the industries themselves. Some people use the standard government taxonomy, which is the North American Industrial Classification System (NAICS), while others develop their own cluster concepts. We have developed our own based on the way that Michael Porter and others talk about clusters: a core industry that includes the supply and distribution chains and other organizations that support the cluster. We have used 20 cluster concepts, which have pretty much stayed the same over the last 15 years, and that usually account for 98% to 99% of all employment in a region.

Over the years, we have found it useful to look at manufacturing as an agglomeration of several clusters—agriculture and food processing; metals and metal fabricating; chemicals, rubber, and plastics; communications (printing); and bio-manufacturing—rather than one mega-industry of manufacturing.

Charting can be done on a retrospective (backward-looking) basis using data that is publicly available from the Bureau of Labor Statistics of the U.S. Department of Labor. It is also possible to do a bubble chart based on prospective or forward-looking data by using data provided by proprietary sources such as Economic Modeling Specialist International (which is our provider).

For each industry, we normally look at three variables: size, expected growth, and competitiveness as measured by location quotient. Then we plot them out. We use the bubble chart feature of Excel and connect the size of the industries to the size of the bubbles. We plot those on a chart where the Y-axis is projected growth, and the X-axis is the location quotient.



Here is an example of a bubble chart of the Lancaster County, Pa., regional economy, which looks at the economy going forward from 2013-2023.

Notice how three of the four manufacturing-related industries have a location quotient above two. This means that they are concentrated at a rate that is two times the national average (which would be one). These industries are highly competitive among their national competitors. Also, see that two of the four are expected to lose employment in the 10-year period. These are also two industries (agriculture and food processing and chemicals, rubber, and plastics) that are highly automated and where technology is taking the place of workers. None of the four industries is very big when it comes to total employment.

Compare this chart to one similarly constructed for greater Myrtle Beach, S.C. (Waccamaw Workforce Investment Area, which includes Horry, Georgetown, and Williamsburg Counties).



Here, one barely sees any manufacturing, with hospitality and retail dominating in size, competitiveness, and growth.

On the surface, a planner might say that Lancaster County is a better place to set up a partnership to work on manufacturing skill attainment because of the large concentration of manufacturing-based industries. But let's hold that thought for a minute.

Manufacturing in the Bigger Region

Often, we need a certain level of scale to be able to develop structures to serve employers in the way that they want to be served. Areas with a smaller workforce may need to look beyond their local area to see whether manufacturing occurs elsewhere in the region. Larger concentrations of manufacturing may be a part of even bigger concentrations in a larger geographical area that may be capable of even larger-scale projects.

Typically, we use the On the Map tool from the U.S. Bureau of the Census to determine the "laborshed" of the region. In other words, what are the average drive times and the directions around which commuters move? Lancaster County is in a very dense laborshed that actually includes heavy commuting from the east (Chester County), west (York County), and north (Lebanon and Berks Counties). Very few commuters come from across the state line in Maryland. The Waccamaw Workforce Investment Area has strong commute patterns from the west (PeeDee Workforce Investment Area) and some to the south (Charleston metro area).

Commuting patterns lead us to look at the regions where there are strong commuting connections to see where manufacturing may or may not appear. In the case of Lancaster County, we find that Berks, Lebanon, and York Counties, all contiguous to Lancaster County, also have high concentrations of manufacturing, enough to think of a major manufacturing

super region with one of the heaviest concentrations on the East Coast. In the case of the South Carolina region, we found some additional manufacturing in the areas to the west and south, enough to think that the region was not only about hospitality and retail.

The Nature of Manufacturing Networks

Bubble charts give us a general sense of the place of manufacturing in the regional economy. Commuting patterns paint a picture of how our regional economy fits into other economies that are connected. We now have to develop an understanding of the interconnectedness of the manufacturing cluster, both in the local area and in any other contiguous regions if that is a factor.

We find that this is the time to drill down in the data and look for cluster “drivers”: industry segments usually at the six-digit level of NAICS that outperform other manufacturing segments. We normally go back to the same statistics as above—size, projected growth, and projected concentration (competitiveness)—to find the segments in manufacturing that are outperforming others.

With the results, we are able to build a cluster from scratch that is significant in the area. In Lancaster County, this was the basis of forming the agriculture and food processing; metals and metal fabricating; chemicals, rubber, and plastics; communications (printing); and bio-manufacturing clusters that further break out manufacturing in the area. These four groupings are large, growing, and have above-average concentration (competitiveness).

We find it useful to take these more fine-tuned clusters and look further at their supply chains in the hope of finding connections among the industries in the cluster and among other clusters in the economy.

- Agriculture and food processing is closely connected to the agriculture production part of Lancaster County, which ranks as one of the top-20 agriculture-producing counties in the country.
- Chemicals, rubber, and plastics is closely tied to the packaging required for the agriculture and food cluster and bio-manufacturing cluster and to building products (flooring and ceilings) required for the construction industry.
- Certain parts of the metals and metal fabricating cluster have strong ties to agriculture (agriculture equipment).
- Machine shops are subcontractors for many metal fabricators.
- Many industries within clusters are in another industry’s supply chain. Many clusters are also in the supply chains of other clusters.

Career Pathways

It should be no surprise that, as we look at these relationships, we also see interrelationships between the knowledge and skills within the network that we describe above. Knowledge and skill flow freely across clusters and industries. We sometimes see them in occupational job titles that are shared. A material handler is a material handler whether working in a printing business or a metals manufacturing plant or in the fulfillment center

of a large distributor. Carpenters and electricians are found in nearly every industry sector. Information technology workers also keep the data flowing in every aspect of every cluster.

Often the trick for planners is a willingness to look below occupation titles to the knowledge and skills that the job requires. The O*Net occupational information system maintained by the U.S. Department of Labor is very helpful in doing comparisons among occupations. We also suggest that the reader look at my earlier chapter on Career Pathways that is a part of this publication for more detail.

In Myrtle Beach, we were able to not only find affinities among manufacturing jobs in other counties in the region, but we also found a great deal of overlap in the hospitality sector, where someone needs to maintain the elevators, the heating and ventilation systems, and other features of the infrastructure for the sector. In fact, many of these jobs have an 80% or better compatibility rate with the jobs in manufacturing.

For Lancaster County, nearly every manufacturer tells us that they will always hire someone who grew up on a farm over someone who did not because the work ethic and the skills that are part of the agricultural lifestyle make such a person an attractive hire, from welding to construction to lubricating equipment. Skills are portable, prized by industry, and move across industries and clusters.

Summary

In summary, if you are a manufacturer involved in developing partnerships to address workforce pipelines, we strongly recommend that you start with the numbers:

- Understand the place of manufacturing in your regional economy so that you get some sense of its overall contribution to gross regional product.
- Explore the issue of scale using commuting patterns. If your manufacturing economy is too small, you may need to think on a bigger geographical scale. If your manufacturing economy is too big, you may need to concentrate on a sub-sector that is thriving while, at the same time, looking for opportunities to take that sub-sector to a broader geographical area.
- Supply and distribution chain analysis may help you to understand the complexity of the relationships in manufacturing.
- Career pathways speak to the way that people acquire knowledge and the way that skills move across clusters. Planners and ultimately the people who will be the implementers of career counseling and training need to become conversant in the language of skills.

For Myrtle Beach, this analysis led to an understanding that the region was more than “just hospitality.” Not only was it a part of a larger region that had a significant number of good-paying manufacturing jobs, but it also had jobs with similar skills embedded in the hospitality industry. Any knowledge and skills training programming that was developed could prepare people for jobs in both (and other) industries.

In Lancaster County, the Lancaster County Workforce Investment Board has used this process to:

- Prioritize agriculture and food processing; metals and metal fabricating; communications (printing); and bio-manufacturing as well as automotive services; healthcare (long-term care); and construction as its priority industries in its strategic planning.
- Select representatives of those industries who are champions for the sector to serve on the Board.
- Annually produce a list of the “Top 100 Hot Jobs in Lancaster, PA,” which is widely used to do career education in the community.
- Develop within the PA CareerLink of Lancaster County, which is the comprehensive One-Stop Service Center for the area, an intensive workforce readiness program along with a robust curriculum to prepare people to enter the manufacturing workforce.
- Attend to the needs of the manufacturing industries in the area by forming the Center for Manufacturing Excellence to work on the training needs of the incumbent workforce.
- Collaborate with PMMI to develop a national certificate program in industrial maintenance and mechatronics through the Industrial Maintenance Training Center of North America, an affiliate of the Board.

Every area will have different needs. However, to build the right system, at the right scale, in the right geography, and with the right curriculum, we need a foundation of good data to provide us with foundational information.



In the chapter Manufacturing: By the Numbers we were shown the importance of data for helping to justify and establish developmental programs. The following chapter describes a variety of resources available to communities seeking to create workforce development programs, including sources of data. Examples of programs that have been funded may be looked at as best practices for their success in obtaining grant funds, and presumably for successful implementation of the funded programs. Ongoing support for improving operations is also available through agencies such as the Manufacturing Extension Partnerships (MEPs) that exist across America.



Author Bio

Please see bio section of chapter 6



Chapter Eight

Federal Programs Support Manufacturing Workforce Development

Grants and partnerships build capacity for manufacturing education and programs.

*by U.S. Department of Labor's
Education and Training Administration Staff*

Investing in Manufacturing Community Partnerships Program

The Investing in Manufacturing Communities Partnership (IMCP) program is an initiative designed to revolutionize the way federal agencies leverage economic development funds. It encourages communities to develop comprehensive economic development strategies that will strengthen their competitive edge for attracting global manufacturer and supply chain investments. Through IMCP, the federal government is rewarding best practices, coordinating federal aid to support communities' strong development plans and synchronizing grant programs across multiple departments and agencies. Non-designated communities nationwide can learn from the best practices employed by these designated communities to strengthen American manufacturing.

There have been two rounds of awards under IMCP. A listing of grantees (announced in 2014 and 2015) can be found at <http://www.eda.gov/challenges/imcp/>.

As part of IMCP there are several online resources that are now available to communities regardless of whether they apply for designation. These include an IMCP Census data tool <http://www.census.gov/fastfacts/imcp/> that permits communities to assess and track themselves as a manufacturing community. The tool gathers the most relevant U.S. Census Bureau economic and demographic data and presents it by county for six major areas, enabling assessments of regional business ecosystems. The tool also combines states and county data from multiple surveys and datasets into a single table for each assessment area.

The eleven Federal agency partners, including DOL/ETA, have also developed a "playbook" <http://www.manufacturing.gov/imcp/index.html> that identifies existing Federal planning grant and technical assistance resources and catalogues best practices in economic development. Following the playbook's three-step approach can help communities attract and expand manufacturing business and workforce opportunities.

The three steps:

- **Backbone:** Build an organizational backbone with the insight needed to strengthen manufacturing and fully support the work that follows.
- **Assessment:** Conduct a community self-assessment of the local industrial ecosystem (i.e., the whole range of physical, capital, and human resource components needed for manufacturing activities) to identify current strengths and deficiencies.
- **Tune-up:** Develop a comprehensive and transformational tune-up strategy that can be sustained over time.

The IMCP playbook authors do offer this counsel: *“As your community prepares to attract new manufacturing investment, as well as improve support for existing manufacturing businesses and workers, please keep in mind that manufacturing is only one component of a larger business ecosystem. It is important to build a competitive strategy that supports all aspects of this broader business ecosystem.”*

The “Workforce and Training” section of the Playbook presents a number of important lines of inquiry or assessment. The “Strengths, Weaknesses, Opportunities, and Threats” section contains these considerations:

- What occupations or workforce skills are more heavily concentrated in the region as compared to state and national averages? Are these growing or declining? How can these skills be leveraged? Are any workforce shortages anticipated that need to be addressed?
- What are the requisite skills and average compensation for employees in relevant fields and how many currently reside in the region? How many employees could be added to the workforce via training programs?
- What is the nature of engagement of Workforce Investment Boards (WIBs), employers, community, and labor organizations? Are there local WIBs or other workforce intermediaries that would be willing to help facilitate work-based learning such as internships and apprenticeships?
- What local community college centers and other training programs exist that specialize in the attributes being considered in your analysis? Are industry-defined competencies available or can they be developed? Is there capacity for training/certifying people in these skills?
- Are training partnerships with community colleges being developed? To what extent do these institutions currently integrate R&D activities and education to best prepare the current and future workforce? To what extent do postsecondary partners engage with feeder programs, such as those in secondary schools?
- What are the short- and long-term human resources challenges for the local economy along the region’s proposed development path? What is the local unemployment rate for key occupations in the KTS? Are any local efforts underway to get the long-term unemployed back into the workforce?

The Playbook also lists more than two dozen helpful links—from Apprenticeship to Workforce3one—that provide valuable content for workforce preparation in the manufacturing sector.

Collaboration between Local Workforce Investment Boards and the Manufacturing Extension Partnership Program

The Employment and Training Administration has encouraged the public workforce system to collaborate with the U.S. Department of Commerce’s Manufacturing Extension Partnership (MEP) program to provide assistance and support to small and medium-sized manufacturing firms with the ultimate goal of supporting economic growth while preserving and creating jobs.

Issued in 2007, ETA’s guidance notes the MEP Centers and local Workforce Investment Boards (WIBs) regularly work with many of the same public and private partner organizations at the state and local level including, but not limited to: Trade Adjustment Assistance Centers (TAA for Firms) and U.S. Export Assistance Centers, sponsored by the Department of Commerce; Small Business Development Centers (SBDCs), sponsored by the Small Business Administration (SBA); local and regional economic development organizations; community colleges; local chambers of commerce; labor organizations; and trade associations.

Over the years, MEP Centers have worked with WIBs and workforce agencies across the country to help manufacturers find and train workers, strengthen companies, and avoid layoffs. MEP Centers work with multiple state partners, including WIBs, to assess companies facing challenges and identify business opportunities, cost savings, training, re-training, and re-deployment opportunities to ensure that companies remain competitive in an ever-changing global economy. Strategies to address manufacturers’ challenges might include identifying new markets for existing products, reducing costs through process improvements, reducing waste or energy use, re-training workers for new technologies and processes, and/or implementing innovative growth strategies.

The guidance, including a toolkit, can be found at http://wdr.doleta.gov/directives/corr_doc.cfm?DOCN=5270

Discretionary Grants-in-Aid with Focus on Manufacturing and Other Sectors

While most of ETA’s funding is distributed to state and local workforce development agencies by statutory or regulatory formula that is not open for competition. The Workforce Innovation and Opportunity Act (WIOA) introduces no change to this funding approach.

ETA, however, also awards a significant portion of funding through competitive (or “discretionary”) grants to support a variety of priorities in employment and training programming and services each year. These opportunities are announced through formal Solicitations for Grant Applications (SGAs), which are published in the Federal Register, on ETA’s Grants and Contracts website, and on the Grants.gov website.

Many recent grantees have focused on the advanced manufacturing sector in their workforce preparation and training activities given their assessment of need and

opportunities in the sector. A complete listing of grantees over recent years can be found at http://www.doleta.gov/grants/grants_awarded.cfm which can be scanned for manufacturing references.

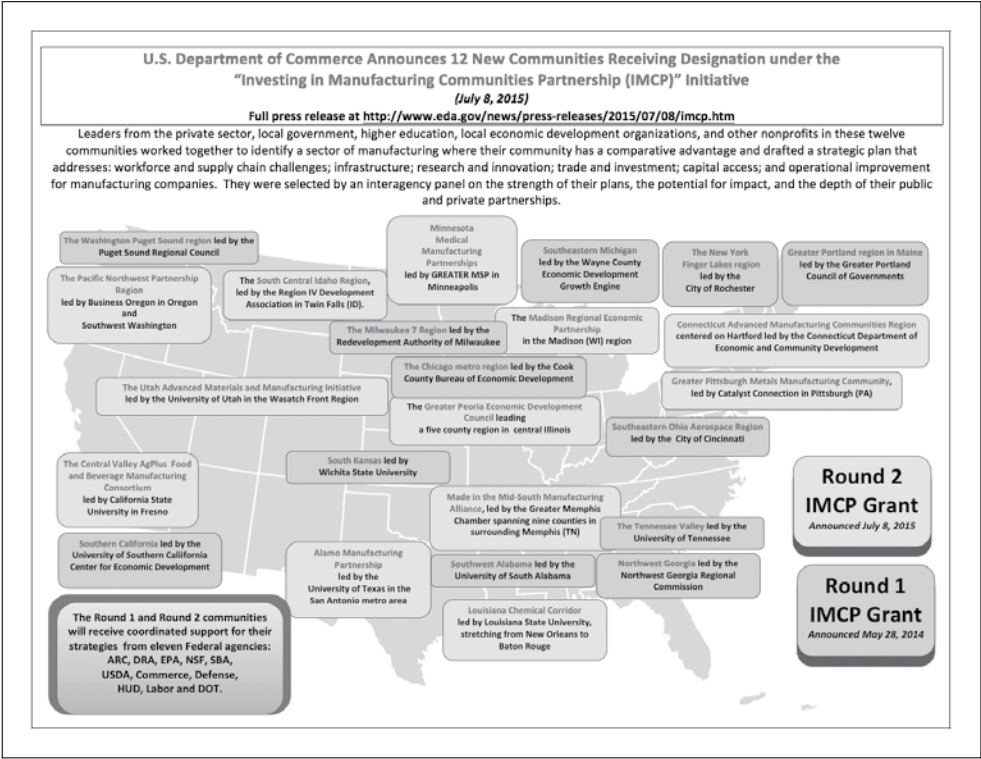
ETA has conducted four rounds of funding under the Trade Adjustment Assistance Community College and Career Training (TAACCCT) program competition for the nation's two-year institutions. Under TAACCCT, the agency has created a free and open online library called SkillsCommons containing free and open learning materials and program support materials for job-driven workforce development. The Open Educational Resources (OER) are produced by community colleges across the nation benefiting from the TAACCCT funding; these can be found, reused, revised, retained, redistributed, and remixed by individuals, institutions, and industry.

SkillsCommons.org is designed and managed by the California State University and its MERLOT program under a cooperative agreement. The California State University/MERLOT team works with other TAACCCT partners to support the TAACCCT grantees in the creation and contribution of quality OER that are stored in the SkillsCommons online library.

The CSU-MERLOT strategy is to develop SkillsCommons.org services to:

- Capture and preserve instructional and program support materials produced and/or used by TAACCCT grantees to deliver their innovative workforce development programs
- Enable discovery of the SkillsCommons.org materials so others can easily reuse the materials to accelerate and expand access to workforce development programs.
- Build communities with members from higher education, industry, and local, regional, state, and national organizations to assure the quality and growth in the collection of free, open, reusable and effective instructional and program support materials
- Build sustainable organizations and services enabling the longer term returns on the TAACCCT investments.

The user can type “manufacturing” in the search box to obtain a listing of catalogued courses for review.



When we think of what someone is about to study in school, we think about curriculum. We look at a list of course titles, and if the courses sound like they teach the right thing, we nod approvingly. But should the goal be that we studied mechanical systems, or should it be that we acquired the skills to correctly align and tension a chain drive or to specify a gearbox? Appropriate skills for a career may be obtained through many different curricula. On the flip side, many different curricula may leave one wanting for the required career skills. By focusing upon skills rather than curricula, one can readily adapt programs to the pathway needs described in earlier chapters and provide a result that is more acceptable to students and employers.



Author Bio



John DeVere,
Principal,
Education & Training
Solutions, LLC

John DeVere was one of the first educators that I encountered as I embarked on my quest to promote technology education for American manufacturing. John was introduced to me because others told me that “he gets it.” Over the years, I observed John living up to that compliment as he encouraged educators and others to step outside of their boxes and try something new. One of those new ideas was to focus on skills rather than curriculum, and then to find a way to grant college credit for skills achieved.

John has more than 25 years of experience at the community college level in teaching, curriculum development, planning, evaluation, and administration. Prior to retiring, he was Vice President of Workforce and Economic Development at Reading Area Community College. During his career he was: Chair of the Articulation Committee for Advanced Manufacturing; member of the Advisory Council for the Pennsylvania Statewide Performance Accountability System for Career and Technical Education; member of the Tech Prep Advisory Committee for Pennsylvania Southeast Region; Project Director for Accelerated Training for Process Analyst funded by the Pennsylvania Department of Community and Economic Development; and a member of the Mid-Atlantic Mechatronics Advisory Council.

In his past position, he oversaw the college’s Manufacturing Technology, Information Technology, Occupational, and Adult Literacy programs. He is a member of the Berks County Workforce Investment Board and participates in their Training Committee. He is a trained DACUM facilitator and has served as a consultant for workforce development curriculum to state agencies, higher education institutions, and secondary education institutions. In his last position at RACC, he oversaw the design, construction, furnishing, and equipping of the Schmidt Training and Technology Center, a “world class” advanced manufacturing and information technology training facility serving south central Pennsylvania. Prior to joining RACC’s staff, John worked in quality assurance and research and development in the chemicals industry. He has spent time as a high school science teacher, too.

Since retiring from public education, John has formed Education and Training Solutions, LLC. He provides feasibility studies, focus group facilitation, training needs analyses, DACUM profiling, curriculum development, facility planning and design, equipment specifications, strategic planning, outcomes assessment, staff development, and project management.

Chapter Nine

Skill Standards, Not Curriculum Standards

Schools must provide a product that meets customer needs by identifying the appropriate skill requirements, not forcing students through idealized curricula.

by John DeVere

By examining the history of American higher education and the evolution of granting college credit for liberal arts, career preparation, and skills training programs, we can gain insight into why change from a curriculum focus to a skills focus is so difficult in many American colleges and universities. Schools that have successfully made this transition are finding that their programs are valued by industry and their students are in high demand. Examples of such programs will be found elsewhere in this Playbook.

The history of American higher education tells us that institutions began offering degree programs in the 1600s. These colonial colleges were modeled after Cambridge and Oxford, and like these British universities had a religious affiliation focused on spiritual teachings. After the Revolutionary War, Thomas Jefferson became a proponent of state education that was based on scientific exploration rather than religious teachings and indoctrination. This included teaching using the lecture method, which laid the foundation as to how higher education was to be delivered at colleges emerging across the expanding U.S. The Morrill Land Act of 1862 was responsible for the rapid growth of American higher education that included the building of new colleges and expanding disciplines at existing preeminent universities. While a weak economy at the turn of the century stymied growth, prosperity after World War I caused college attendance to nearly double.

As higher education expanded and flourished, one of America's wealthiest philanthropists, Andrew Carnegie, became worried about faculty pensions. The solution he successfully pushed, with the largesse of his foundation, led to the creation of the credit hour, which has become the de facto standard of measuring academic work. He never intended the time-based credit hour to be used to measure student learning; he saw it as a means to create a free pension plan for underpaid faculty so they could retire at a reasonable age. In order to opt in, the Carnegie Foundation required colleges to adopt the time-based standard: one credit hour for each hour of faculty-student contact time per week over a 15-week semester (Carnegie Unit), with most bachelor's degrees consisting of 120 credits.

However, the foundation warned about the inadequacy of the credit hour as to measuring student learning. To further institutionalize this measurement, for the sake of convenience, the Carnegie Unit was adopted by the U.S. Department of Education as a means to establish financial aid awards, thus influencing how college credit classes were structured and still are today.

Following World War II, the Serviceman's Readjustment Act (GI Bill) resulted in another rapid increase in enrollments as veterans enrolled in colleges. A large number of people who would not have previously considered higher education entered college as it became a "licensing agency for middle-class Americans who wanted to enter professions." It was because of this surging optimism that the college degree came to be viewed as the ticket to upward mobility that it remains to this day.

In 1948, the Truman Commission suggested the creation of a network of public, community-based colleges to meet local needs. This was due to the demand for education and job-training programs as post World War II industries created jobs that required new knowledge and skills. By the 1960s, 457 two-year public community and technical colleges were opened. This trend continued, and at present there are over 1,100 community and technical colleges in the U.S. For most community and technical colleges, the mission includes the following program offerings: credit programs that enable students to transfer to baccalaureate programs after completing their first two years, credit programs that prepare students for careers, and noncredit skills training that enables students to gain employment or be promoted to higher-level positions. According to the faculty who control the curriculum through shared governance (faculty have the responsibility to determine the appropriate curriculum and procedures for student instruction), these three endeavors are quite different.

Transfer programs mirror the education that takes place at four-year institutions. The courses, many of which are liberal arts, that make up these programs of study are structured just like those offered for the bachelor's degree. The curriculum standards that faculty establish for such courses come from their own experiences while earning advanced degrees. These standards are subject matter-based and reflect the faculty's own classroom learning or academic research. Added to this is the time required for classes to meet according to the Carnegie Unit described above. This model sets the stage for establishing curriculum standards for all courses that are awarded college credit.

Career programs differ from transfer programs in that the curriculum standards are established by faculty who are professionals with expertise in an occupational niche. Faculty members often hold licenses or professional certifications and subscribe to accrediting agencies, which dictate certain curriculum requirements. For example, the Accrediting Board for Engineering and Technology (ABET) recognizes accreditation from the Engineering Technology Accreditation Commission (ETAC), or the National Accrediting Agency for Clinical Laboratory Sciences (NAACLS) recognizes accreditation for Medical Laboratory Scientist. In order for courses in these programs to be approved for credit and degree status, they must be sanctioned by a governing body, including faculty representing all academic departments. Some courses termed general education requirements, which are usually

liberal arts in nature, become part of the curriculum through this process. Thus, the driving forces for establishing curriculum standards still come from within the institution with some guidance from outside organizations.

Noncredit skills training differs from credit-granting degree programs in that the standards are established by outside businesses and industries. Employers, solely or collectively, identify a skill set needed for a given occupation. Often the skill sets are recommended or endorsed by a trade organization or certifying body. For example, the National Association of Manufacturers (NAM) endorses the following skills credentials: National Institute for Metalworking Skills (NIMS) – Machining Level 1; Manufacturing Skills Standards Council (MSSC) – Certified Production Technician; and The Association for Packaging and Processing Technologies (PMMI) – Mechatronics Certificate/Industrial Electricity 1. The college then develops a training program designed to meet this identified need. Industry-recognized skills credentials are awarded to those completing such training and passing an assessment. Seat time requirements are not relevant because the outcome is to be able to perform identified skills that can be transferred back to the work place in short order. Since college credit is not granted, the colleges' governing bodies, including faculty, need not approve such programs.

Having identified needs for specific skills training from industry, progressive community and technical colleges throughout the U.S. have created two-year career programs by incorporating such skills training into their credit curricula. They have established program advisory councils consisting of key employer representatives and workforce development leaders to identify appropriate skills needed for a given occupation. Credit course outlines have been developed by incorporating the identified skills into competency-based learning outcomes. (In order to address the issue of required class meeting time for granting college credit according to the Carnegie Unit, they have utilized its definition: One laboratory credit hour requires at least two hours of supervised or independent laboratory work per week over a 15-week semester.) Germane general education courses required for a two-year career program have been added to supplement the skills-based courses. The entire complement of courses, which makes up the two-year degree, has been vetted by the colleges' faculty and governing bodies and approved. Where required, these programs of study have been submitted to the state's department of education for review and approval. The bonus to students is that they can simultaneously earn nationally, statewide, or locally recognized skills credentials while pursuing the two-year degree, since such are embedded in the credit curriculum. In some cases, these two-year degrees have been articulated with four-year degree programs affording students the opportunity to also pursue a bachelor's degree. The bonus to educational institutions is that the same faculty can deliver the noncredit skills training and credit courses simultaneously, thus maximizing instructional resources.

As more and more technology makes its way into American manufacturing, the need to include skills training in community and technical college degree programs has become evident. Rather than looking within the institution to establish new curriculum, community and technical colleges need to be cognizant of the rapid advancement in manufacturing technology and turn to the customer (manufacturers) of its product (skill-trained

graduates) for curriculum input. Manufacturers need to play an active role in this process by volunteering to serve on community and technical colleges' career programs advisory boards and communicating their skills training needs. Competency-based instruction (active learning through hands-on skills mastery and the ability to troubleshoot systems) needs to be added to traditional didactic instruction (passive learning through reading, lecture, problem solving, and examinations) as a way to deliver student learning. Faculty need to change, too. They need to recognize that the skills training needed to support and grow our manufacturing economy is as relevant and important as the subject matter woven into traditional transfer and career programs.

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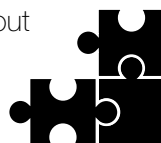
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In an earlier chapter, we learned about how planners need to rethink the pathways available to students as they move through the education system and on to work. But we already have some of these alternatives in place, and students are not taking advantage of them. In a region where CNC machinists are well paid and highly sought after, CNC machine shop classes, which are free to local high school students, are being closed down for lack of students. Guidance counselors are not informed on manufacturing careers, and parents remember too vividly when cousin Joe was laid off from a steel mill. Students need to be better informed about alternatives for their future and how these alternatives can give them a competitive advantage as they seek success.



Author Bio



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A year or two ago, I wrote in [OnTheEdgeBlog.com](#) that I believe that America needs to change the dialog surrounding higher education. Recently, a colleague pointed me to a video on the web that truly made that case and backed it up with numerous facts and references. With the design of this Playbook underway, I immediately contacted the video's author and asked if he would be a contributor. Kevin Fleming agreed, and our dialog is continuing.

Dr. Fleming currently serves dual roles at Norco College (CA) as the Dean of Instruction, Career & Technical Education, and as the Principal Investigator for the National Center for Supply Chain Technology Education funded by the National Science Foundation. In addition, Dr. Fleming is the Managing Partner of Telos Educational Services, an international consulting firm that provides marketing research and organizational strategy with expertise in the educational sector. Dr. Fleming has been facilitating workshops and conducting leadership training sessions accompanied by numerous conference presentations and published articles.

Previously, Dr. Fleming analyzed industry trends to provide economic development and labor market research through the Centers of Excellence for the California Community College system, the largest public educational system in the world. A true entrepreneur, Dr. Fleming has also co-founded three companies in different service sectors (West Coast All Stars LLC, Green LMI, and Living The Ritual) and serves on the advisory boards for Paragon, Inc. and California Baptist University's School of Education.

Chapter Ten

Success in the new economy

A post-high school credential, and not just college, is a better message

by Kevin J. Fleming, Ph.D.

Education is core to our economy. But to guide our educational systems and maximize future income, we must understand the misalignment between education and our workforce.

In my pursuit of higher education, I have earned two bachelor’s degrees, two master’s degrees, an industry certification in GIS, and a Ph.D. In total, this has cost me over \$200,000. I’ve done all of this because I believe formal education is important. Part of this belief came from seeing charts like this, which shows on average that a person with a college degree earns far more money than the average person without a high school diploma.¹



This perception that higher earnings come with having a four-year degree has fueled a “college for all” philosophy. It has caused educators and parents to encourage going to the university—any university—to major in anything in pursuit of future job security, social mobility, and financial prosperity.² This philosophy has increased college enrollment, resulting in 66% of high school graduates in this country enrolling in higher education right after high school.³ That’s two out of three. Initially, they are deemed the successful ones.

But what you won't see advertised is the reality that most drop out, and only a quarter of those who enroll will finish a bachelor's degree.⁴

Only after these few graduate do many of them start exploring careers.⁵ It is here that they discover that their degree may not have prepared them for the world of work.⁶ You may be well educated, but not every degree is direct preparation for employment.⁷ My bachelor degrees were in philosophy and psychology; I didn't want to be a therapist, and I couldn't secure work with the philosophy company. It is this misalignment between degrees and job skills causes half of university graduates to be underemployed in what are called gray-collar jobs.⁸ That is, they're in positions that do not require the education they have received, at a cost that is more than they can afford.⁹

Conventional wisdom suggests that a university degree guarantees a higher salary. But with rising education costs, a shrinking job market, and the oversaturation of some academic majors in the workforce, this old advice is now a myth for a majority of students.¹⁰ The economy and the world have dramatically changed. Over the last three generations, we've gone from 13% of the population stepping into a college classroom, to 60% attending some form of higher education.¹¹

In 1960, when taking into account all jobs in the American economy, 20% required a four-year degree or higher, 20% were technical jobs requiring skilled training, and 60% were classified as unskilled.¹² But what's the right percentage to meet the labor market demand for tomorrow? In 2018, Harvard University predicts only 33% of all jobs will require a four-year degree or more, while the overwhelming majority will be middle-skilled jobs requiring technical skills and training at the credential or associate degree level.¹³ Yet our national mantra is that all students need a university degree. It is time to break our national addiction to the bachelors degree.

A four-year degree may have many benefits, but think about people you may know who, from an economic perspective, inefficiently spent time and money to get a degree that perhaps they didn't really need for the career they are in.¹⁴

The true ratio of jobs in our economy is 1:2:7.¹⁵ For every occupation that requires a master's degree or more, two professional jobs require a university degree, and there are seven jobs requiring a one-year certificate or two-year degree. The jobs requiring a one-year certificate or two-year degree are technician jobs in very high-skilled areas that are in great demand.¹⁶ This ratio is fundamental to all industries (except for government and education where the university degree is still perceived as equating with competence and ability). This ratio was the same in 1950, the same in 1990, and will be the same in 2030.¹⁷

The hope for encouraging university education is that as the number of university-trained workers increases, the demand for their services in the workplace will increase as well. Unfortunately, this is not so. The whole pie may get bigger as the labor force and the economy grow, but the ratio will not change.¹⁸ The reality is there will not be more professional jobs available within the labor market.¹⁹ And some professional jobs have been replaced by technology, or are being outsourced.²⁰

Well-intentioned attempts to send more and more students straight to the university will not change the types of jobs that dominate our economy, nor will a "college-for-all" mentality

mask these labor market realities.²¹ The “college-for-all” rhetoric that has been so much a part of the current education reform movement is often interpreted as “university for all.” This message needs to be significantly broadened to, “a post-high school credential for all.”²² This would be a more accurate message. Because today, students at various educational levels have left school without employable skills, setting up our children for failure and costing them and taxpayers millions.²³ All while the labor market is desperate for highly-trained, skilled technicians.²⁴ So how do you position yourself for high-wage, in-demand jobs?

Let’s say you were considering a career as either an electrician or a business manager. You would find that the average annual income for electricians is \$51,000, only about half of the \$105,000 average wage for management occupations.²⁵ So at first glance it looks as if getting a bachelor’s degree in business is a no-brainer, but adding skills and ability into the picture adds a whole new dynamic. What if you have the potential to become an excellent electrician, but lack the skills and ability to be an excellent manager? Then you should be looking at projected incomes toward the bottom of the pay scale for managers and toward the top for electricians.²⁶ You would then discover that electricians near the top of the pay scale make around \$86,000, far higher than the income of a manager near the bottom of the pay scale at \$52,000.²⁷

Now, this is just one example, but the concept is true throughout all industries.²⁸ The claim that you will make more money with an increased amount of education is not necessarily inaccurate, it’s just incomplete.²⁹ That advice is based just on the averages. But no one is perfectly average. Everyone has unique skills, talents, and interests. In fact, the income for the top individuals in a wide variety of skilled jobs that require an industry credential or two-year degree is far higher than the average income for many occupations that require a four-year degree.³⁰

Nationally, associate degree earners range between \$27,000- \$68,000, while bachelor’s recipients earn between \$34,000- \$97,000.³¹ But this data only accounts for the 25th percentile to the 75th percentile of full-time, adult workers. This means 25% of associate degree holders earn more than \$68,000 annually, and 25% of bachelor’s degree holders earn less than \$34,000!

Our world has changed, and in this new economy, the university degree is no longer the guaranteed path toward financial success as it was for previous generations.³² And even if you do earn one, that education alone may not be enough.³³ In today’s highly technical knowledge-based economy, having hands-on skills and perfecting what you’re good at can be more valuable than getting a degree in “something” simply to get one.³⁴ Employers want to know what you can do, and what you can do well; not just what degree hangs on your wall.³⁵ Since new and emerging occupations in every industry now require a combination of academic knowledge and technical ability, we need to ensure that we’re also guiding students toward careers and not just to the university.

Before a student you know enrolls in classes or decides what they want to do next in their professional life, step one is self-exploration.³⁶ In addition to their interests, really help them to analyze their talents and strengths. Everyone has unique gifts or abilities. Step two is career exploration; understand the jobs available and the income ranges they pay (not just

the average salary) and evaluate the specific skills they require. Helping them to identify an area that appeals to their abilities, skills, and to the labor market just may be their first career. And then you can help them develop a tentative career plan complete with multiple training and education options.³⁷ The key is to align one's interests and abilities with their first career choice—and then outline education and training that they'll need to receive; not the other way around.³⁸ This alignment will help bring everyone's future into focus, and ensure their position at the top of the pay scale in their chosen career.

What all this data shows is that success in the new economy is as much about acquiring the knowledge, skills, and abilities needed for in-demand occupations as it is to be well educated. Both paths may work, but education combined with technical training is how you ultimately secure a competitive advantage in the new economy.³⁹ Community and technical colleges are in the ideal position to provide over 70% of tomorrow's workforce with an education combined with applied technical skills, industry-driven credentials, and specific preparation for employment.⁴⁰ Being a skilled craftsman or technician is highly valued. Investments in career education programs in high schools and community colleges will help all students obtain an education that includes technical training and preparation for the workplace. Ultimately, this is how all students can be successful.

In the new economy, both education and technical skills are the new currency. Will you be ready?

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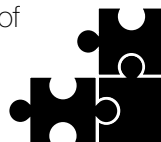
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It is a common misperception that vocational education is not a pathway to college and that industrial training is not a substitute for a college degree. Both of these have been proven wrong. The degree completion rate for students entering college from a vocational education program is about twice that of students entering from an academic high school program. Progressive educators have crafted systems whereby students may alternate from school to work to school to work without penalty. Students may leave high school with a significant number of college credits under their belts—for free—and may transfer credits from one institution to another. Incumbent workers may translate existing skills to credits, through testing and examination, and may obtain credit for training programs sponsored by their employers. Students may supplement that training with general education requirements, leading to a degree, sometimes with their employer's financial support. All of these solutions offer alternative means for students and workers to obtain a college degree that is built upon employment skills.



Author Bio



Carol Adukaitis, Ed.D.
Director, Pathways for
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State System of Higher
Education

As I've traveled around Pennsylvania to discuss manufacturing technology education, one person who has consistently offered positive encouragement has been Carol Adukaitis. Carol encourages dialog among stakeholders and is an advocate for new ideas and new technologies.

Carol is Director, Pathways for Career Success at the PA State System of Higher Education (PASSHE). This initiative is funded by the Department of Community and Economic Development (DCED) and managed by PASSHE to develop 2+2+2 seamless articulated curricula from secondary to postsecondary schools in emerging technologies to supply industry with trained and certified workers to compete in a global economy.

She has served as Director, Advanced Manufacturing STEM Academies; Director, Health Sciences STEM Academies; and Director, Girls in STEM Academies. She was the Co-Principal Investigator for the National Science Foundation award, Advanced Manufacturing: Establishing Foundations for Education and Career Pathways from Middle School through College. Carol has provided leadership to a number of other PASSHE projects, including Project Lead the Way funded by the Society of Manufacturing Engineers Education Foundation.

Carol holds a Doctorate in Education from Temple University, a Masters in Business Education from Bloomsburg University of PA, a Bachelors in Business Education from the University of Delaware, a Superintendents and Principals Certification from Lehigh University, and an English as Second Language Certification from Penn State University.

Chapter Eleven

Training and College Credit

According to best practices, students should obtain college credit for workforce training and prior knowledge.

by Carol Adukaitis, Ed.D.

Advanced manufacturing is crucial to America's economic vitality and includes many occupations that pay above family-sustaining wages. In my state of Pennsylvania, the Commonwealth's manufacturers must have access to a larger pool of skilled workers to remain competitive in the global economy. As reported by the PA Center for Advanced Manufacturing Careers Statewide 2010 Report (www.paworkforce.state.pa.us), Pennsylvania's manufacturing sector faces three distinct challenges:

- An aging workforce currently holding key manufacturing positions
- The lack of an effective talent pipeline
- Higher skill requirements for modern manufacturing

Low-skilled employment opportunities are disappearing, and our economy is shifting to a knowledge base that requires more American workers with postsecondary credentials. This chapter will focus on identifying established strategies that allow students who are more mobile and nontraditional to earn postsecondary credentials that will save them time and money while utilizing the prior learning experiences they may already have. These strategies reward the student for knowledge, skills, and abilities rather than time spent in the classroom.

The Need for Training, Certificates, and Degrees

The U.S., and Pennsylvania in particular, will not be able to meet the skilled labor needs of 2018. In a 2010 report titled, "Help Wanted: Projections of Jobs and Education Requirements Through 2018," Anthony Carnevale, Director of the Georgetown University Center on Education and Workforce, projected that employers will need 22 million new workers with postsecondary degrees by 2018 ... or we will fall short by 3 million workers without a dramatic change. This translates to a deficit of 300,000 college graduates every year now through 2018.

Lack of degree completion negatively affects Pennsylvania's economic growth. The Lumina Foundation's 2013 Report, "A Stronger Nation Through Higher Education," stressed

that Pennsylvania's economic future depends on producing more college graduates. Half of all jobs, 51%, require some postsecondary education, though not necessarily a bachelor's degree, even though more than half of all Pennsylvanians lack the skills to perform them. The disconnect leaves many adult Pennsylvanians competing for the jobs available to those with only a high school education.

Nontraditional Student is the Normal

Most of the processes of our postsecondary institutions, from scheduling classes to availability of financial aid, were designed around the assumptions that the learner is a traditional 18 to 22-year-old, full-time college student who attends one institution through degree completion. According to the National Center for Education Statistics (NCES), 73% of students today fall into one or more of the following categories:

- Have delayed enrollment in postsecondary education beyond the first year after high school graduation
- Attend part time
- Are financially independent from their parents
- Have dependents other than a spouse
- Are a single parent
- Have no high school diploma or GED

Mobility is a reality for many students and requires higher-education policies that support credit transfer. Many students enter college with learning they gained at other postsecondary institutions, military training, or in the workplace. Too often, institutions have not recognized this transfer credit, resulting in wasted student time and effort and additional monetary expenses and college debt. According to the Center for American Progress, "Degree Completion beyond Institutional Borders (2010)," more than 60% of college students transfer at least once in their undergraduate programs. Secondary students are arriving on college campuses with postsecondary credits, such as articulated, college in the high school, and AP. Such students also arrive with skills learned from work and life experiences. Military personnel are transitioning to civilian jobs after serving in Iraq and Afghanistan. Undergraduate and graduate students are stopping in and out of college or graduate school for financial, family, health, or work reasons.

The problem has been most postsecondary institutions' credit policies assume most or all of a student's credits were earned at one institution. Colleges and universities make it difficult to transfer learning across institutions, and they are too reluctant to recognize that learning may have occurred outside of the classroom. Those Pennsylvania postsecondary institutions that created articulation agreements that transfer credits among institutions differed significantly from institution to institution. Also, such agreements were not well publicized to institution counselors, admissions staffs, or students, and they only applied to general education or elective credits.

Articulation Agreements

Articulation agreements in Pennsylvania had typically been between secondary to two-year postsecondary (2+2) or postsecondary two-year to four-year institutions that allowed a college to treat another college credit as equal to its own. A Pennsylvania workforce initiative called 2+2+2 Workforce Leadership Grants was funded in 2003 under Governor Ridge's administration through the Department of Community and Economic Development (DCED) and managed by the PA State System of Higher Education (PASSHE). This program was instrumental in developing seamless articulated curricula from secondary to two-year and four-year postsecondary institutions in emerging technologies.

These articulation agreements are formal policies between two or more regional educational institutions specifying specific courses, amount of credits, and a time limit for articulating the credit. Institutions are responsible for educating their staff, counselors, advisors, admissions officers, any others responsible for student advising, and especially students enrolled in the courses. This awareness is designed to provide transparency of the credit transfer process.

Statewide, there are 28 DCED-funded 2+2+2 projects, 14 in advanced manufacturing. These include seamless career pathways in additive manufacturing/3D printing, advanced manufacturing and materials, applied engineering technology, nanotechnology, electronics, plastics and polymer technology, mechatronics, and robotics.

The 2012 Governor's Manufacturing Advisory Council Report Recommendations to Encourage Growth in Pennsylvania's Manufacturing Sector listed the 2+2+2 Workforce Leadership Program, currently named Pathways for Career Success, under strategies to increase the workforce pipeline in manufacturing. The report recommended expanding and replicating proven models such as the 2+2+2 program in developing a consistently qualified and highly skilled workforce.

PA Statewide Program of Study (POS) Secondary CTE to Postsecondary Articulation of Credits

The Carl D. Perkins Career and Technical Education Improvement Act of 2006 required the development and implementation of career and technical Programs of Study (POS). Programs of Study incorporate secondary education and postsecondary education elements, and they include coherent and rigorous content aligned with challenging academic standards and relevant career and technical content in a coordinated, non-duplicative progression of courses. These courses align secondary education with postsecondary education to adequately prepare students to succeed in postsecondary education leading to a high-priority occupation. This includes the opportunity for secondary education students to earn postsecondary education credits through articulation agreements with participating postsecondary institutions, which could lead to an industry-recognized credential or certificate at the postsecondary level or an associate or baccalaureate degree. Students attending career and technical institutions that are Program of Study career pathway-certified can earn up to nine college credits toward a community college certification or degree while in high school.

PA College Credit Transfer System—Secondary to Postsecondary

The Pennsylvania Transfer and Articulation Center system identified 49 courses in six disciplines that are guaranteed to transfer among 34 participating institutions, and it created a Transfer Credit Framework advising tool along with an interactive website and marketing campaign. To inform the public about the transfer system and to make them aware of articulation and transfer opportunities across the Commonwealth, PDE created the Pennsylvania Transfer and Articulation Center (www.patrac.org), a one-stop online portal for transfer students, administrators, and advisors/faculty. The site contains information about the Transfer Credit Framework, transfer course equivalencies, college profiles for the participating institutions, searchable databases, and transfer planning assistance. The challenge for students is to seek out any vertical credit transfers from secondary to postsecondary institutions.

Courses listed in the Transfer Credit Framework represent the type of coursework that is generally completed during the first and second year of a four-year degree program. Completing courses in these categories is a good choice for students who are undecided about the major they wish to pursue or the institution to which they plan to transfer. The Transfer Credit Framework allows students to transfer up to 30 credits of foundation courses to any of the participating colleges and universities and have those courses count toward graduation. Certain majors have specific requirements prescribed by external agencies. It is the student's responsibility to work with an advisor to select appropriate courses as they relate to the major.

In addition to the mandated community colleges and universities, voluntary participation in the transfer system by private colleges and universities and state-related institutions is allowed under the law. In addition to the 14 community colleges and the 14 PASSHE universities, Carlow University, Lackawanna College, Lincoln University, Neumann University, Pennsylvania College of Technology, and St. Francis University participate in PA TRAC.

The statewide transfer system does not address major-specific courses or program-to-program articulation, which would allow a student to transfer an entire degree as opposed to individual courses. The system is also limited in that only 28 of more than 100 institutions of higher education in Pennsylvania are required by law to participate.

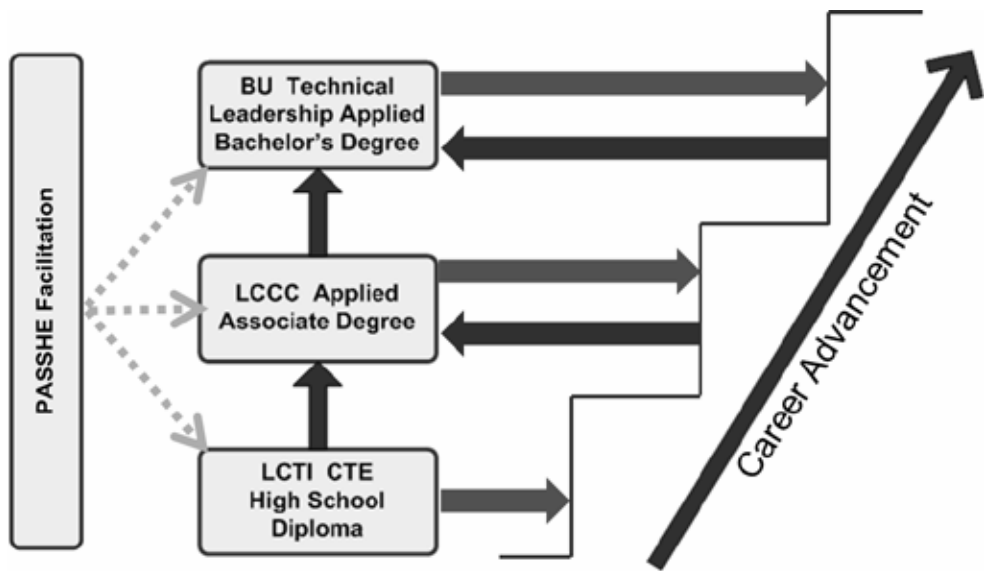
Career Ladder from CTE to A.A.S. and B.A.S.

The Commonwealth recognized the need for a 2+2+2 career ladder available to professionals with technical skills learned either at a career and technology center or on-the-job to continue their education for an industry certificate, or a two-year and/or four-year degree. The Associate of Applied Science (A.A.S.) degree was viewed as a terminal degree. Graduates were previously limited in career advancement possibilities. In 2010, a collaborative 2+2+2 partnership between the Lehigh Career and Technical Institute (LCTI), Lehigh Carbon Community College (LCCC), and Bloomsburg University (BU) offered an innovative, affordable career pathway with a new A.A.S. and Bachelor of Applied Science (B.A.S.) in Technical Leadership degree option to meet workforce needs. **The career and technology education becomes a new college prep pathway.**

The B.A.S. and PASSHE Collaborative

PASSHE Strategic Initiatives 2010 is grounded in the system's mission to be among the nation's leading systems of public universities, recognized for (1) access and affordability of excellent undergraduate and graduate education; and (2) responsiveness to state, regional, and national needs through quality academic programs, research, and service. The Bachelor of Applied Science (B.A.S.) supports the PASSHE Strategic Initiatives 2010 to transform students and the learning environment, resources, university-community relations, and PASSHE's role in determining the Commonwealth's future.

The new degree provides educational opportunities with stackable skills, competencies, and credentials. It also serves the needs of Pennsylvania's workforce and employers. For students, it is an affordable and flexible pathway.



The Technical Leadership B.A.C. degree program is designed to build on expertise obtained in over 30 different associate degree programs at LCCC. The Pennsylvania Community College system will serve as a linchpin for a seamless grade 9-16 educational pathway.

In summary, articulation agreements are common between specific regional Pennsylvania secondary and two- and four-year institutions. Pennsylvania can strive to develop and expand these agreements statewide to facilitate degree completion for the mobile student.

Prior Learning Assessment

Prior Learning Assessments, or PLAs, measure what a student has learned outside of the college classroom. PLA methods determine what the student knows and evaluate whether the learning is college-level and how many college credits are equivalent for that learning. Credits earned through PLA are closely tied to learning outcomes rather than measures of seat time.

Students who earn credits through PLA often save time by not having to take courses in subjects they have already mastered. Additionally, PLA assessments typically cost

less than a student paying tuition for the actual course or credit hour. Unfortunately for students, the PLA is not universally available, is often accepted in limited ways, and/or is not accepted in transfer.

PLA Assessments make it possible for students to earn credits for prior learning through various assessments:

- Individualized student portfolios. Students are provided specific learning experiences and outcomes from which to prepare and document a portfolio equating learning to college course(s). Faculty with specific subject matter expertise can evaluate the portfolio and determine whether credit is granted.
- Military training for college credit. The American Council on Education (ACE) may conduct these evaluations www.acenet.edu/. ACE publishes credit recommendations for formal instructional programs. Employers often work directly with local postsecondary institutions to evaluate the company's training for college credit.
- Apprenticeship training associated with trade associations may evaluate training for college credit. The National Joint Apprenticeship and Training Committee (NJATC) may work with community colleges to review credit opportunities. www.njact.org
- Customized Exams, also called challenge exams, verify end of course learning.

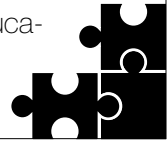
Standardized exams may include:

- Advanced Placement Exams, or AP exams
- College Level Examination Program Exams, or CLEP exams

A renewed focus of improving not only the access but completion of postsecondary certificates and degrees among students can benefit Pennsylvania in a number of ways. These strategies will boost working adults' education and help states become more economically competitive. In addition, employers' demand for skilled U.S. workers will continue to grow over time helping employers in high demand find it easier to compete globally. Boosting workforce development increases regional economic development. The relationship between levels of education and economic performance is becoming stronger over time.



Many of the services that we receive are performed for us by individuals who have obtained a certification that is given by an industry group or by the government with oversight by an industry group. These include lawyers, doctors, accountants, medical and dental assistants, nurses, clergy, contractors, electricians, plumbers, pest control technicians, etc. These credentials indicate to an employer or to a customer that the credentialed individual has demonstrated a level of skill and/or knowledge that qualifies him or her for the job being performed. With a few exceptions, credentials have not been a requirement of working in manufacturing, although some manufacturing segments, such as machining, do make some use of credentials. Vocational high schools are frequently required by law to offer an industry-recognized credential for any program of study that they offer. A condition of receiving federal grant dollars for manufacturing education is that the programs of study must lead to a recognized credential. It should be apparent, given these conditions, that credentials take on a whole new meaning for manufacturing. Manufacturers that want the educational system to support their needs will have to deal constructively with the credentials issue.



Author Bio



By Gardner A. Carrick,
Vice President,
The Manufacturing Institute
National Association of
Manufacturers

I first met Gardner Carrick when a colleague of mine and I visited the National Association of Manufacturers (NAM) headquarters in Washington D.C. Gardner embraced the message that we hoped to deliver about the need for multiple strategies for manufacturing workforce development. He has provided encouragement and support for many of the efforts going on around the country, and he and I will periodically show up on the same program or in the same meeting where this topic is being discussed.

Gardner Carrick is the Vice President of Strategic Initiatives at The Manufacturing Institute. He leads the Institute's research activities, including partnerships with internationally recognized consulting firms and the production of a regular series of reports on the issues and challenges affecting the U.S. manufacturing sector. Gardner also leads the Institute's efforts with the U.S. military to assist transitioning personnel and is responsible for the workforce and education outreach activities in several states.

Prior to joining the Institute, Gardner worked at the U.S. Department of Labor's Employment and Training Administration where he served as the Project Director for a \$325 million initiative focusing on talent development in 39 regions across the country. The project worked to integrate the workforce development, economic development, and education strategies of a region to create the talent base required to drive economic growth. He managed a team of more than 100 staff and consultants working on the project.

Gardner also served as the Communications Director for the agency. He was responsible for developing outreach materials describing the programs and services offered by the Labor Department, writing speeches for the Assistant Secretary, expanding the agency's web presence, and managing special projects on recruiting and developing talent for the construction industry.

Prior to joining the U.S. Department of Labor, Gardner was a Senior Associate at TATC Consulting, a Washington, D.C.-based firm focused on providing expertise to federal and state agencies on employment and education-related issues.

Chapter Twelve

The Role for Industry Credentials

Manufacturing lacks industry-recognized credentials relative to other sectors. NAM is trying to change that.

by Gardner A. Carrick

The presence of industry-defined credentials has been common in the economy going back hundreds of years. Guilds of craftsmen in Europe defined who could participate in their occupations and what skills were demanded. Organizations like the bar association and the medical board played similar roles for professional occupations. As the administrative and regulatory state grew in Western economies, some of these credentials became licenses, required by law to practice in the field. The success of these licenses was in ensuring defined levels of quality for specific occupations, particularly those affecting public health.

For many industries though, state-regulated licenses are neither appropriate nor desirable. But the interest in having defined and recognized levels of quality for employees still exists, particularly for those occupations that require technical skills and where educational degrees are not suitable proxies for skill attainment. These industries are where we have seen the development and acceptance of industry-based certificates and certifications. Two examples are easily recognized by the general public:

1. The National Institute for Automotive Service Excellence created its ASE certification for auto mechanics in the early 1970s to help the public identify competent repair technicians. Today, the ASE logo is found in auto repair shops around the country and is used by employers in marketing materials to signal a trusted level of quality.
2. The largest information technology companies like Microsoft, Cisco, and Oracle have established IT certifications for their specific products. Those companies have products used by millions of people, but the companies do not directly employ those who service and maintain their products (compared to the model used by Xerox, which offered end-to-end services with great success for several decades). To ensure competence and expertise of independent IT service professionals, the company created certifications, and in some cases academies, to train individuals. These IT certifications are now widely recognized and demanded by companies in the field.

While industry-based certifications have flourished in both mature and new industries, they have never taken hold in manufacturing. This may seem odd because manufacturing

is a natural candidate for such credentials in that it requires millions of employees with technical skills. It has a lot to do with the way manufacturing companies have organized and prepared their workforce for more than 100 years.

Manufacturing was traditionally an industry in which individual companies trained their own workers. Young men would find work at the local mills after some level of secondary schooling and enter a traditional training program. The jobs were physically demanding but relatively unskilled, so the training programs could be very short in duration before the men would be put to work on the line. A much smaller percentage of young men would enter a formal apprenticeship program run by the company for skilled positions like machinists or mechanics or electricians. These apprenticeships would last several years until individuals became fully proficient in their discipline. In all cases, individuals would expect to spend their entire career at that company that originally trained them, so the need for a portable or recognized certification simply did not exist.

This system was extremely effective for companies large and small across the U.S. for more than 75 years. But by the late 20th century, competition from foreign companies began to have a sizable impact on U.S. manufacturers. Companies sought to reduce labor and overhead costs while adopting new principles like lean manufacturing, which preached a focus on core competency and the elimination of non-critical functions. At the same time, a more activist federal government adopted employment policies that created obstacles for internal training programs, especially if testing was involved that led to selection or promotion. The result was that most of the formal training programs were eliminated. The consequences of these actions were not immediately apparent.

During the first decade of the 21st century, the U.S. lost one-third of its entire employment base in manufacturing, more than 6 million positions in total. This meant that experienced labor was readily available for companies that were hiring. But it was also around this time that manufacturing jobs began to change. The widespread adoption of automation and robots and the integration of information technology all but eliminated the unskilled positions in manufacturing and greatly changed the skill sets required for skilled positions. The existing workforce developed these new skills in tandem with the changes to the industry, but there no longer existed either a pipeline of new entrants into the industry or a system to train those entrants in the advanced technical skills now required in the industry. The talent supply chain did not exist to respond to an increase in demand.

Policymakers, education officials, and even the general public were not overly concerned because it was assumed that U.S. manufacturing was irreversibly declining. This was not entirely true, as total output continued to grow, but certainly the number of jobs in manufacturing was on a steady decline and comparisons to agriculture were often heard. But beginning in 2010, a confluence of events, including rising global costs and risks, and significant energy finds in the U.S., began a resurgence of American manufacturing. Jobs in manufacturing in the U.S. have increased for four consecutive years for the first time since the 1960s, and manufacturers everywhere are complaining of significant shortages of qualified applicants for skilled positions.

Unfortunately, manufacturers are unable to simply restart the apprenticeship and

training programs that were eliminated in years past. The expertise to run such programs has been lost, and the cost to run them is prohibitive for most companies under constant global competition. Community colleges and technical schools are now filling that void. In addition to the many existing programs across the country, several hundred million dollars have been awarded from the U.S. Department of Labor to expand and improve manufacturing education offerings. This includes traditional programs like welding and machining and newer programs like mechatronics that combine the disciplines of mechanical systems, electronic systems, logic controls, and others into an interdisciplinary approach needed particularly for industrial maintenance positions—maintaining and servicing the robots and machines that replaced unskilled positions.

As manufacturing education and training programs are now being conducted by third parties, the need to ensure a consistent level of quality emerges. This is a natural opportunity for widespread adoption of industry-based credentials, and it is where the National Association of Manufacturers (NAM) and The Manufacturing Institute are making a significant impact.

The Manufacturing Institute is the education and training affiliate of the National Association of Manufacturers and has been charged with improving manufacturing education programs across the country to solve the skills gap that manufacturers face. The primary means of accomplishing this goal is through the NAM-Endorsed Manufacturing Skills Certification System.

Anticipating the need for an industry-recognized set of credentials, in 2008, The Manufacturing Institute reviewed every certificate, certification, and credential related to manufacturing education and evaluated them against a set of criteria. Were those credentials: 1) nationally portable, 2) industry recognized, 3) third-party validated, and 4) data-driven? After applying these criteria, the institute identified 15 organizations that met that standard of quality and, through NAM, endorsed their credentials. The goal of this approach was to bring order to a chaotic credential market. Now, manufacturing companies would know which credentials were backed by quality processes and could have confidence in the skill levels of individuals possessing such credentials. And since many of these credentials are “stackable,” companies can use them across a range of higher-level occupations, and employees can use them to advance in their careers.

For any industry-based credential to be useful though, it requires both a critical mass of individuals possessing such credentials and a critical mass of employers recognizing and preferring such credentials in their hiring and human resource practices. The Manufacturing Institute chose to begin this process by focusing on the supply side, specifically community colleges and technical schools. If the traditional manufacturing education programs like machining and welding at those schools could begin to offer the NAM-Endorsed credentials, that would raise the quality and consistency of those programs and quickly increase the number of individuals possessing such credentials.

Fortunately, the work done by The Manufacturing Institute was occurring at a time when major foundations in the education arena were seeking to improve the quality of programs and redefine the measures of completion. The institute was able to obtain early financial support from the Bill and Melinda Gates Foundation and the Lumina Foundation for Edu-

cation to fund the integration of NAM-Endorsed credentials into traditional manufacturing education programs at community colleges. Students would now earn credit toward an associate degree while simultaneously earning one or more industry credentials from the NAM-Endorsed list.

The early success of this approach in raising the quality and consistency of manufacturing education allowed the institute to work with the U.S. Department of Labor to make the use of NAM-Endorsed credentials a requirement for any institution seeking grant funds for manufacturing education. From four original community colleges in 2009, there are now more than 200 schools offering the Skills Certification System as a standard part of their programs. And in 2013, more than 115,000 certifications were awarded nationwide.

The rapid success in building the supply side of the industry-based credential market now allows The Manufacturing Institute to focus on the demand side of the market. As discussed above, manufacturers have no history with industry-based credentials and have been cautious in adopting them across their workforce. But ongoing, significant challenges in attracting qualified applicants for available positions continue to plague the industry. This has led individual companies in regions across the country to begin working with their education partners and asking for NAM-Endorsed credentials. It has also enabled The Manufacturing Institute to move beyond support from education foundations to direct funding from the industry to expand industry-based credentials, including General Electric and the Alcoa Foundation. But more is required from manufacturers to reach a critical mass of participation where industry-based credentials can become an enduring standard in the manufacturing sector.

The shifting of responsibility for training the future manufacturing workforce from companies to schools still requires the participation of manufacturers. Manufacturers must recognize that schools may not apply federal grant funding to programs where credentials are not available and offered. In many states, credentials are also required by law to be offered for most high school career and technology programs. **Manufacturing segments that choose to sit out the credentialing process will find funding and programs being diverted to other segments.** From activities as simple as asking those schools to offer industry-based credentials to providing internships to students who earn those credentials, manufacturers' involvement with the training providers is critical to the long-term success of this arrangement. NAM continues to promote the Skills Certification System to its membership, and The Manufacturing Institute partners with state and local associations to reach a wider audience of manufacturers.

Through industry-based credentials, the manufacturing sector has the opportunity to elevate and standardize the education programs offered by community colleges and technical schools across the country. Credentials also carry a prestige that conveys respect on both those individuals who have earned the credential and the occupations that demand it. Building an effective talent supply chain for technical careers requires industry-based credentials, and the NAM-Endorsed Manufacturing Skills Certification System is the solution for the U.S. manufacturing industry.



The preceding chapter describes NAM's Manufacturing Institute's efforts at developing industry sponsored and industry recognized credentials for manufacturing employees. The new Workforce Innovation and Opportunity Act requires that federally funded educational programs lead to a credential. Industry must agree on what the standards are for a credential, and then educators must provide programs that teach to those standards. Competency models are a mechanism for documenting those standards, and the Competency Model Clearinghouse is a U.S. Department of Labor initiative to provide a publicly accessible record of industry-developed standards.



Author Bio

Please see bio section of chapter 6



Chapter Thirteen

Competency Model Clearinghouse

Competency models provide industry-developed standards to guide workforce development for manufacturing workers.

*by U.S. Department of Labor's
Education and Training Administration Staff*

Background

As the federal partner in the public workforce investment system, the Employment and Training Administration's role is not to set or enforce workplace standards. Standard-setting is more appropriately a function of business and industry, thereby ensuring that a standard is tailored to an industry, region, or individual employer's need. ETA's role, rather, is one of information broker—providing information, tools, and resources about competency models and their value for supporting workforce development initiatives.

As part of this role, ETA sponsors the **Competency Model Clearinghouse (CMC) website**. The goal of the clearinghouse is to inform the public workforce investment system about the value, development, and uses of competency models.

A competency model can be defined as a collection of multiple competencies that together define successful performance in a defined work setting. A model provides a clear description of what a person needs to know and be able to do—the knowledge, skills, and abilities—to perform well in a specific job, occupation, or industry. Competencies often serve as the basis for skill standards that specify the level of knowledge, skills, and abilities required for success in the workplace. Skill standards in turn form the basis for measurement criteria to assess competency attainment. A competency model differs from a set of skill standards in that skill standards define levels of skills (or competencies) required in a given job or role, while competency models typically do not.

In response to workforce challenges, ETA and industry partners have collaborated to develop and maintain dynamic models of the foundation and technical competencies that are necessary in economically vital industries and sectors of the American economy. The goal of the effort is to promote an understanding of the skill sets and competencies that are essential to educate and train a globally competitive workforce.

There is a distinct relationship between competency models and “career clusters.” Each career cluster is a grouping of occupations and broad industries based on commonalities, which are then further sub-divided into between two and eight career pathways.

The career clusters and the Industry Competency Models both identify foundational and technical competencies, but their efforts are not duplicative. The career clusters have a greater emphasis on elements needed for curriculum performance objectives, measurement criteria, scope, and sequence of courses in a program of study, and the development of assessments. The Industry Competency Models focus more on competencies needed for performance in the workplace and do not go into the same level of detail. As such, they are designed to be used together. The CMC industry pages include Related Links to career cluster reports and lists of related credentials. See www.careertech.org/career-clusters/ for more information about career clusters.

Advanced Manufacturing Competency Model

The competency model framework for Advanced Manufacturing was developed through a collaborative effort involving the Employment and Training Administration (ETA) and leading industry organizations (Manufacturing Institute, Society of Manufacturing Engineers, and National Council for Advanced Manufacturing).

To ensure that the model reflects the knowledge and skills needed by today's manufacturing workforce ETA worked with its industry partners to update the original model. Completed in April 2010, the updated model contains new information on Sustainable and Green Manufacturing, as well as updated key behaviors in several competency areas. The model—and the summary of changes—is available at <http://www.careeronestop.org/CompetencyModel/competency-models/advanced-manufacturing.aspx>.

While the advanced manufacturing competency model was developed largely with discrete manufacturing in mind, the Mechatronics Competency Model developed in partnership with PMMI-The Organization for Processing and Packaging Technology and the Mid-Atlantic Mechatronics Advisory Council, was developed specifically to meet the need for multi-skilled maintenance technicians in the hybrid manufacturing space. It is available at <http://www.careeronestop.org/CompetencyModel/competency-models/mechatronics.aspx>.

Another two dozen competency models, listed by industry sector, can be found at <http://www.careeronestop.org/competencymodel/>.



In the two preceding chapters, both NAM and DOL have made the case for industry credentials. Such credentials have been lacking for manufacturing, especially in the food, beverage, and consumer products segments. With industry-recognized credentials assuming more importance with regard to educators' ability to offer programs and obtain grant funding, and with PMMI's members seeing the workforce crisis in America affecting both themselves and their customers, PMMI decided to do something about it. For advanced machines to be successfully deployed in manufacturing, manufacturers must have the skill sets necessary to operate and support those machines. To address these issues, PMMI embarked upon creation of a suite of stackable credentials aimed at the needs of their members' customers—the hybrid manufacturing segment.



Author Bio



Maria Ferrante,
Vice-President Education
& Workforce Development,
PMMI, The Association for
Packaging and Processing
Technologies

I have worked with Maria Ferrante since the early days of the OMAC Packaging Workgroup when Maria chaired the PackLearn Committee, helping to educate the workforce on the vocabulary associated with the emerging use of coordinated axis motion control. Maria and I shared the experience of 9/11 in Las Vegas and opted to continue with a meeting that we had planned for that day, determined not to let whomever was behind that tragedy interfere with progress.

Maria has spent 20+ years researching, writing about, and engaging with the packaging and processing industry. As Vice President of Education & Workforce Development at PMMI, she works with industry and academics on programs to develop a qualified, skilled workforce for the packaging and processing supply chain. Since taking over PMMI's education efforts, Maria has initiated efforts such as PMMI's Mechatronics Certificate program, eLearning technical training courses, and JumpStart, which is PMMI's latest outreach to educate, engage, and excite youth about careers in packaging and processing. You can reach Maria at mferrante@pmmi.org

Chapter Fourteen

PMMI's Mechatronics Certification Program

PMMI has stepped up to create credentials for manufacturing where none existed.

by Maria Ferrante

The Challenge

PMMI's role in supporting and encouraging packaging education dates back to 1966 when the association recognized the importance of developing a constant pool of new talent to support innovation in this dynamic industry. Throughout the years, PMMI's support of education and workforce development has taken on many shapes and forms—from offering scholarships and grants to providing educational books and materials to now developing e-learning courses, mechatronics credentials, and soft-skills training. As the industry landscape has changed and PMMI's focus has expanded, PMMI's educational offerings have evolved with it.

In 2008 as the economy took a downturn, the industry began to feel the shortage of skilled labor, and the pressure to develop new talent mounted as many of the more experienced workers began preparing for retirement. Most manufacturers were focused on making product, and too few invested in any type of knowledge management system to capture the expertise that was potentially walking out the door. To compound the situation, manufacturers began to add automation to their packaging and processing lines, but they were discovering that the next generation of workers did not have the right skills to support the new technology.

Manufacturers have told us the lack of skilled, qualified workers continues to affect their ability to maintain production schedules, restricting their ability to expand operations. More than 82% of manufacturers report a moderate or serious shortage in skilled production workers. More than 75% of manufacturers say the skills shortage has negatively affected their ability to expand.

And it appears this shortage is not improving. Over the next decade nearly 3.5 million manufacturing jobs likely need to be filled. The skills gap is expected to result in 2 million of those jobs going unfilled, according to the National Association of Manufacturer's Skills Gap Report. Manufacturers also expect a greater challenge in hiring engineers, with 45% of companies expecting fewer qualified applicants. Manufacturers of all sizes feel the pain. PMMI heard this challenge from both its member companies—packaging and processing equipment manufacturers and technology providers—as well as the end-user (consumer

packaged goods manufacturers) community it serves. This lack of skilled workers and the challenge to identify them led PMMI to look at the situation closely to see if we could help.

Why mechatronics?

In 2008, PMMI teamed up with the Mid-Atlantic Mechatronics Advisory Committee (MA-MAC), an industry group representing end user and equipment manufacturers that's headquartered in the Lancaster, PA, area. Joining this effort were PMMI member companies and professors from several PMMI partner schools to address this issue.

The group met at Purdue University Calumet where we discussed the skills shortage and began to formulate a plan to address it. The group discussed the types of skills needed according to the different types of workers (i.e., operator, maintenance mechanic, machine designer, etc.). The group looked at work that was done by the National Center for Integrated Systems Technology (NCIST) through a U.S. Department of Labor grant, and used this as a first step to identify the skills required in the packaging and processing industry.

As the group fleshed out the skill sets, we determined that mechatronics was the best way to describe the complete set of skills. The group agreed on the following definition of mechatronics: Mechatronics is the synergistic application of mechanical engineering, electrical engineering, controls engineering, and computer science to create useful products. It is a skill and knowledge set used by mechatronics engineering technicians to assure the automation that drives modern manufacturing delivers its potential for higher productivity and output.

We identified 23 skill blocks that could be handled as stackable credentials and that are needed in manufacturing from the operator level up to the engineering technologist level. (See chart on page 91)

What are the PMMI Mechatronics Certification Tests?

Based on the original work done in 2008, PMMI took a leadership role in developing skills standards customized for the hybrid manufacturing space where the majority of packaging and processing companies operate. A professional test development firm was hired to assist with the process of developing fair, balanced, industry-driven, third-party-validated tests. In 2009, work began to develop the Level 1 tests, which include some of the base skills required by virtually all manufacturers.

One of the challenges we faced was diversity within the packaging and processing industry. Machinery builders need one set of skills, end users of packaging equipment have a different set of needs, while technology providers have their own needs. Even within organizations there are differences. For example, a machinery manufacturer needs engineers to design and develop equipment but also needs service technicians with skills like those of industrial maintenance mechanics at end-user companies. As more PMMI member companies are being asked to act as system integrators, mechatronics skills increase in importance. In addition to core technical knowledge, these maintenance and service technicians need to know how to troubleshoot.

In an attempt to develop a credentialing program that would be meaningful and adapt-

able to the packaging and processing industry, it was decided that this certification system should be modular in nature—meaning a professional working in the field would take only the tests pertinent to their position. They could add on additional certifications as needed and as their job responsibilities increased.

PMMI recruited subject-matter experts from industry as well as educators to help develop each test. The first test, Industrial Electricity 1, was launched in April 2010. The detailed competencies for this test are published on the www.pmmi.org website, and curriculum developers around the country are able to use these competencies to develop consistent and rigorous training that the packaging, processing, and other manufacturing industries are seeking.

This partnership between PMMI, industry, and educators has played a significant role in the success of this program. Several of PMMI's partner schools are working to build these tests into their curriculum. To help in this process, we have extended discounted educational pricing to these schools to make it easy and cost-effective for them to offer the tests to all students.

Where are we now?

Currently PMMI has completed seven of the 23 tests originally identified and continues the test development process year-round. All tests are available online, and all competencies are published at www.pmmi.org/mechatronics.

Mechatronics Certification Tests Now Available Online:

- Fluid Power 1
- Industrial Electricity 1
- Industrial Electricity 2
- Motors and Motor Control
- Mechanical Components 1
- Programmable Logic Controllers (PLCs) 1
- PLCs 2

Work will be completed on Mechanical Components 2 in early 2016. We are also developing a hands-on test to complement the suite of Level 1 core competencies (Fluid Power 1, Industrial Electricity 1, Mechanical Components 1, PLCs1). This hands-on test is in direct response to industry requests for a tool to evaluate not only skills and knowledge but also the ability to apply skills and knowledge to real-life scenarios.

PMMI's Mechatronics Certification program has been added to The Manufacturing Institute's Manufacturing Skills Certification Systems (SCS) offerings. The Manufacturing Institute is a 501(c)(3) affiliate of the National Association of Manufacturers (NAM).

The Manufacturing Institute established SCS to develop the nation's science, technology, engineering, and math (STEM)-capable workforce for advanced manufacturing. Among the goals of the partnership with PMMI are:

- To align these nationally portable, industry-recognized credentials with educational curricula and pathways in grades K-12, and in community colleges' and four-year colleges' programs of study, that lead to high-wage, high-growth technical careers.
- To provide information on these educational pathways that lead to advanced manufacturing or automation career pathways, to help connect students and workers to lifelong learning and advancement opportunities.
- To ensure that advanced manufacturing employers and automation professionals recognize the value of these credentials in their recruitment, screening, and hiring processes by recognizing, preferring, or requiring nationally portable, industry-recognized credentials.

In 2009, PMMI's skill standards for mechatronics were added to the Competency Model Clearinghouse of the U.S. Department of Labor (US DOL). www.careeronestop.org.

The U.S. Department of Labor published a hybrid-industry, packaging-oriented mechatronics competency model that may be used by industry, government, and education to provide guidance on the skills for a multi-skilled technician in a world-class packaging facility.

PMMI worked closely with MAMAC, the Industrial Maintenance Training Center of Pennsylvania, the Lancaster County Center of Excellence in Packaging Operations, and a consortium of schools involved in packaging and/or mechatronics education to create this model.

Where are we going?

PMMI's Mechatronics Certification Program continues to grow and expand. We are always looking for industry professionals to help with test development. This year we launched PLCs 2 and are currently working on the test for Mechanical Components 2.

We are also working with schools around the country to educate them about the program and encourage them to develop curriculum to prepare students for these tests.

In northwest Indiana, educators at Purdue University Calumet (PUC) are making the corporate-collegiate connection and implementing a \$2.74 million U.S. Department of Labor (DOL) Trade Adjustment Assistance Community College and Career Training (TAACCCT) grant. The grant, which supports training for displaced workers, requires participants to earn a nationally recognized credential, and Purdue University Calumet has chosen PMMI's Mechatronics Certification.

With this grant, PUC will provide cutting-edge training to northwest Indiana residents who are eager to fill important jobs and make valuable contributions to the region. The TAACCCT grant and the integration of PMMI's Mechatronics Certification program will support training for more than 300 individuals as mechatronics technicians and industrial machinery mechanics.

Additional schools in other states such as Florida, Pennsylvania, Washington, Minnesota, Wisconsin, and Illinois are working to build the PMMI Mechatronics Certification into their curriculum, some with assistance from other TAACCCT grants.

Lastly, PMMI has worked in partnership with the U.S. Department of Labor to establish

National Apprenticeship Guidelines for mechatronics technicians based on PMMI's Mechatronics Certification. These guidelines are available to help employers create apprenticeships and internships to develop the next generation of skilled workers.

What does this mean for you?

Through a series of assessments that are based on industry-developed competencies, PMMI's Mechatronics Certification program helps you advance the skills of your team. The tests assess your workforce for the core technical skills and real-world application needed in today's manufacturing environment. PMMI's Mechatronics Certification is recognized by the U.S. Department of Labor and endorsed by the NAM's Skills Certification System.

These tests allow both new and incumbent workers—entry-level operator through technologist—to demonstrate the skills needed for high-growth, technology-intensive manufacturing jobs. Mechatronics certification tests are ideal for industrial maintenance staff and can provide many benefits to your workforce:

These certifications help workers:

- Improve skills
- Stay competitive
- Advance in their career
- Test and validate their knowledge—particularly helpful to those reentering the workforce or transitioning from a military to civilian workforce

Invest in your workforce. Get your workers the training they need to fill your critical manufacturing positions—and retain those workers!

Employers can benefit from using these certifications as a hiring and career advancement tool. We encourage employers to use our certification program as an incentive to reward individuals who master new skills. This helps employees overcome their resistance to change and keeps them excited about the influx of new equipment or new technology coming into the workplace. Moreover, giving employees recognition, financial rewards, or other benefits for earning these certifications can be a powerful incentive for them to stay with your company. Employees are more likely to stay when they have tangible evidence that their expertise is appreciated. The results will become obvious. Your company will have better-trained, more-experienced employees and lower employee-turnover expenses.

There are many ways that manufacturers can integrate the PMMI Mechatronics Certification program into existing human resource practices:

Use the program to screen individuals during the recruiting and hiring process to help prioritize the applicant pool.

Inform current employees about the value of continuing education using the program, encourage participation to build their skills, and help qualify them for advancement opportunities.

Add language to job postings to highlight your desire to hire workers who have passed

industry-recognized skills assessments.

Incorporate the tests into the performance appraisal process as an objective way to measure technical strengths and identify weaknesses.

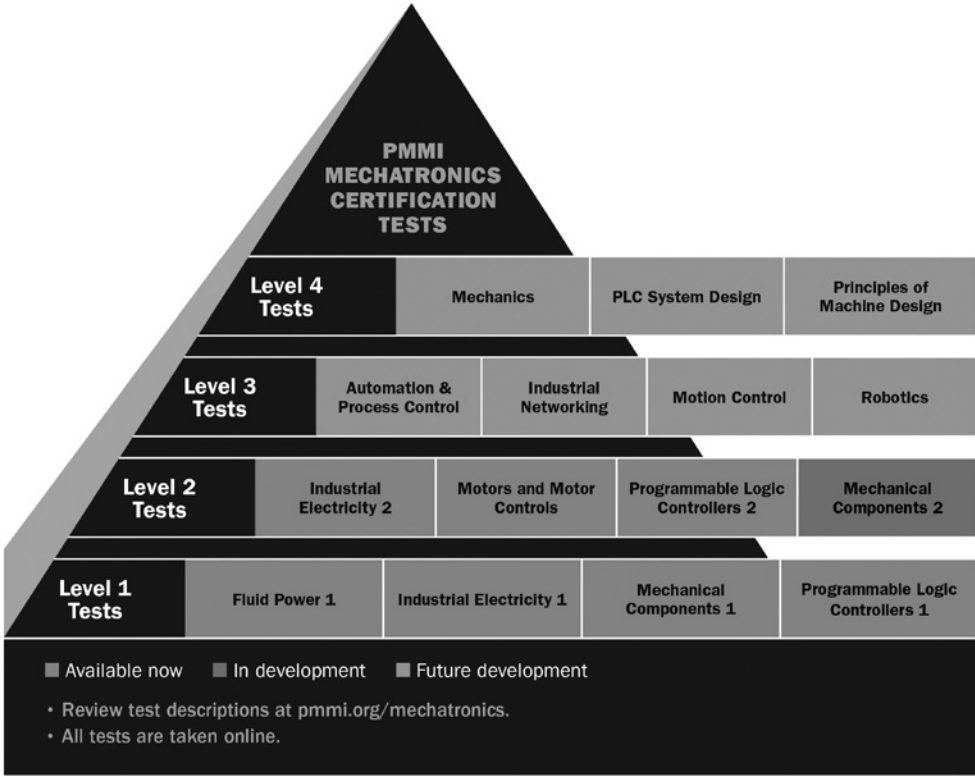
Workers in transition who earn the PMMI credential can gain a competitive edge, strengthen their ability to be mobile in the workforce, and compete for higher-level jobs and move to in-demand careers.

Finding effective training for the skills is starting to get easier. PMMI continues to develop a network of schools that we know prepare students for our tests, and we continue to grow this network all the time. One of the best ways for you to make sure your workers are getting the training they need is to partner with local technical schools and colleges. PMMI has a list of mechatronics partner schools on our website, and we can also help you assess whether or not a school has a program that meets your needs—just contact us. We are also willing to introduce a school to our certification program, providing guidance and assistance as they work to develop the right curriculum to meet the needs of our industry. Let us know, and we will reach out.

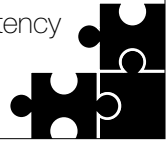
How you can help

PMMI's Mechatronics Certification is a reflection of industry needs—and can only grow and develop through active industry participation. We know that the development of the technical workforce is a common problem across all manufacturing—whether you are a large consumer packaged goods company or a mid-size machinery manufacturer. Working together we can continue to develop these tests, use them as a hiring and advancement tool, educate schools that we work with about the certification, and encourage them to build these tests into their training programs.

If you are interested in working with PMMI on this important initiative, contact Stephan Girard at sgirard@pmmi.org or call 571 612-3196.



The Obama administration has set goals to increase the use of apprenticeships in America. Historically, apprenticeships have been time-based. More recently, competency-based apprenticeships have become available for use. These provide flexibility for those with previously acquired skills and knowledge to move through a program at a faster pace and provide a different type of assurance for employers that apprentices are actually retaining the knowledge required of them. Apprenticeships may be “registered” with the federal or state government or “unregistered” where the employer assumes more control. Paid internships may also closely resemble apprenticeship, and some confusion exists over the differences between the German apprenticeship model, apprenticeship as historically practiced in the U.S., and internship. The following chapter explains a competency based model apprenticeship program sponsored by PMMI that can be used to address any of these situations.



Author Bio



Stephan Girard,
Director of Workforce
Development, PMMI

Stephan Girard reminds me that it was during his first week as an employee of PMMI that we first met, and we have been working closely together on workforce development issues ever since. Stephan has been involved in training and workforce development for almost 20 years. He has been with PMMI since 2008 and is Director of Workforce Development. He works with industry and academics on the development of certification tests for the mechatronics program to help develop a skilled workforce. He also works on the certified trainer and e-learning programs. Prior to PMMI, Stephan worked for training organization focusing on technical certifications.

You can reach Stephan at sgirard@pmmi.org

Chapter Fifteen

The Apprenticeship Alternative

Competency-based apprenticeships provide added flexibility for students, workers, and industry.

by Stephan Girard

As college costs continue to soar and entry-level jobs with good pay are scarce, more students are looking for alternatives. One option gaining traction is the paid apprenticeship where a student works for a company and learns a trade or profession. What most people don't realize is that there are currently more than 800 fields where someone can become an apprentice. These include a broad range of fields from medical, pharmaceutical, aviation, information technology, and mechatronics.

Apprenticeships are hardly a new concept. They have been a way to train individuals for skilled trades for hundreds of years. In America, the practice began in early colonial times and continues today. In 1917, the Smith-Hughes Act was passed whereby the federal government provided funding and created regulations for apprenticeships. Over the years, apprenticeships have evolved as the American economy changed and additional regulations were instituted, but education and on the job training remain their main components. In the U.S., registered apprenticeships have decreased since the late 1960s as the popularity of vocational schools and colleges increased. While other factors such as the economy and overseas manufacturing also played a part, the decrease in apprenticeships contributed to fewer skilled trades entering the manufacturing workforce.

Historically, apprenticeships have been based on hours completed working for the sponsor company as well as training. They range from 2,000+ hours of on the job training and 180 hours of education per year to five years (depending on the apprenticeship and industry). At the end of the program, the apprentices reach the level of journeyman. The recent resurgence of interest in apprenticeships has coincided with an increase in available competency based apprenticeships. The U.S. Department of Labor (DOL) defines a competency as, "an observable, measurable pattern of skills, knowledge, abilities, behaviors, and other characteristics that an individual needs to perform work roles or occupational functions successfully." While the competency based apprenticeship is still comprised of education and on the job training, "it is premised on attainment of demonstrated, observable, and measurable competencies." Another difference with competency-based programs is that apprentices may accelerate the rate of achievement/completion.

With the skills gap widening and the estimated number of unfilled future manufacturing jobs rising, the DOL has begun to incentivize a resurgence of apprenticeships in the U.S. In December 2014, the DOL announced it was investing \$100 million for the development of registered apprenticeships in new high-skilled, high-growth industries such as advanced manufacturing which includes mechatronics. This investment is intended to expand partnerships between industry, businesses, community colleges and training organizations to train workers in the skills they need. One grant requirement is that the apprenticeships must be aligned to career pathways for further learning and career advancement. This means that an industry recognized certification must be embedded in the apprenticeship for it to qualify for grant funding.

One such apprenticeship program is the National Apprenticeship Guidelines for Mechatronics Technicians which was approved by the DOL in November 2014. At the heart of these guidelines are the PMMI Mechatronics Certifications which are national, third party, portable credentials created by manufacturing industry professionals and educators. These certifications are also part of The National Association of Manufacturers' Skills Certification System. The certification tests, which are modular in nature, are used to confirm the apprentice's knowledge and skill as they move through each learning objective of the program. Companies have the option of registering the apprenticeship with the DOL or they can use the guidelines as a roadmap to develop their training program.

Competency-based apprenticeships provide a great alternative to the traditional college experience. Unlike college students who have no assurance of employment and likely have to accumulate debt that will take many years to pay back, apprentices are paid a salary and benefits as they work and attend classes. The apprentices gain valuable real world work experience as they get an education. This experience, along with a National certification, prepares individuals for in-demand, high-tech advanced manufacturing jobs such as industrial maintenance mechatronics technicians. The apprenticeship not only leads to gainful employment, it provides apprentices with the foundation for personal and professional growth.



The last couple of years has brought special focus to the importance of employing our returning veterans. Many of these vets have served as skilled technicians, operating under extreme pressure in their military roles and have demonstrated the ability to perform under pressure. However, they lack information on the availability of manufacturing jobs. They may be unfamiliar with the language of manufacturing, and the technical language that they have used in manuals and system documentation is unlike that used in industry. There are opportunities for dramatically reducing the length of the educational pathway for these veterans by simply looking at the gaps between their skills and the skills required in manufacturing and focusing on them. The following chapter shares stories of successful transitions from the military to manufacturing.



Author Bio



Mike Aroney,
Director of Operations,
Impact Recon

As the flow of the Playbook developed, I realized that we needed to include a chapter on bringing veterans into the workforce. One day, out of the blue, an e-mail showed up in my inbox with a proposal to get the word out about the veteran's suitability for jobs in maintenance and reliability. I must admit that I had never heard of the Society for Maintenance and Reliability Professionals, but as we dug into it further, it looked like a great opportunity. Industrial maintenance technicians and CNC machinists have been identified in some areas as the most in-demand occupations for manufacturing. Vets come out of service with a lot of maintenance experience, and Mike Aroney seemed like the right person to tell this story.

Mike retired from the United States Navy in 1994 after a career flying the F-4 Phantom and F-14 Tomcat. He is a graduate of the Naval Fighter Weapons School (TOPGUN) and the Italian Naval War College. Immediately upon retiring, Mike served as Associate Director of Organizational Development and Deputy Director of Corporate Planning for the Navy Exchange Service Command, a Fortune 500 retail company. Mike left NEXCOM in 2000 to become Director of Change Management for Naval Sea Systems Command's five-year maintenance and reliability process reengineering project called NEMAIS (Navy Enterprise Maintenance Automated Information System). In 2004, Mike joined Life Cycle Engineering, a manufacturing and engineering consulting company, as Director of Operations and then Manufacturing Maintenance & Reliability Principal, where he led the leadership and change management practice. He joined Allied Reliability Group in 2008 as a Manufacturing Maintenance & Reliability Principal and then Director of Operations of its talent acquisition business unit—IMPACT RECON—in 2013.

In this role, he has worked in more than 100 plants around the world in multiple industry verticals. As Director of Operations for Allied Reliability Group's Talent Acquisition business unit, Mike guided his team to identify and find talent to meet the maintenance and reliability needs of the manufacturing industry in North America. His specific interest was in matching up the talent brought with the service men and women transitioning from the military to fill these manufacturing positions.

Mike is also an adjunct Professor of Management for Cambridge College, and Faculty Academic Advisor and adjunct Assistant Professor of Aeronautical Science for Embry-Riddle Aeronautical University. He is a 1977 graduate of Columbia University, and holds advanced degrees from Old Dominion University and Embry-Riddle Aeronautical University. Mike resides in Charleston, S.C., with his wife Kathy and three of their five children, and he enjoys bird hunting, fly fishing, kayaking, and gardening.

Chapter Sixteen

Veterans—One Solution to the American Manufacturing Skills Gap

Translating skills learned in the military to manufacturing.

by Mike Aroney

In July of 2013, I was at a Hire America's Heroes conference in Alameda, CA, speaking to veterans and high-level service members about men and women from the military finding work in manufacturing, specifically in the maintenance and reliability industry. After explaining that the 12 different manufacturers that I represent were looking to hire individuals with experience fixing equipment and preventing future failures, a surprised Coast Guard Command Master Chief asked me if the veterans need to get a college degree for these jobs. He thought—like so many higher-ups in the military—that transitioning service-men need a college degree to compete for any jobs in the civilian sector.

I described to the crowd the role of a reliability engineer—how he or she is responsible for keeping the plant and its equipment running to achieve production objectives—to which the Master Chief exclaimed, “That’s what my guys do everyday! I had no idea these opportunities existed.”

There are thousands of qualified veterans who worked as maintenance technicians or reliability engineers in the service fixing aircraft carrier equipment or combat vehicles, and there are hundreds of thousands of open positions in manufacturing for skilled workers. But these jobs are hard to fill, and the veteran unemployment rate remains high. With the skills gap in the manufacturing sector in the U.S., I believe it is imperative that we connect veterans to these jobs. Manufacturers are looking to fill these positions with experienced veterans, but service men and women are unaware of these jobs. We must enable veterans to move quickly into these roles rather than leave it up to chance at military job fairs.

The U.S. Manufacturing Skills Gap

Fewer and fewer young people are pursuing careers as “skilled workers” or workers that have the specific knowledge to fill a trade or craft job such as a maintenance technician or plant engineer. Our high schools and colleges deglamorized trades and put an emphasis on earning a four-year university degree. While there is certainly value in earning a degree, trade skills have fallen by the wayside, and young people, for the most part, simply are not looking into these types of jobs. There are hundreds of training and certification programs that young people could pursue in addition to a college degree, but they do not receive the proper attention.

A report by the Organization for Economic Cooperation and Development showed that America's labor force is falling behind the rest of the world when it comes to skill level. According to the study, "Countries with lower skill levels risk losing in competitiveness as the world economy becomes more dependent on skills." The report summary goes on to note, "Of the three skills domains, and comparing the U.S. with other countries, the U.S. performance is weak on literacy, very poor on numeracy, but only a little worse than average on problem solving in technology-rich environments. Broadly speaking, the weakness affects the entire skills distribution, so that the U.S. has proportionately more people with weak skills than some other countries and fewer people with strong skills."

This lack of skilled workers affects manufacturers' ability to properly staff their facilities. A survey by the Manufacturing Leadership Council reported that 27% of manufacturing companies have difficulty finding workers for production and operation in North America. According to the council, this concern will persist in the future: "Looking ahead five to 10 years, however, the percentage of respondents expecting a high degree of difficulty in attracting talent in North America jumps to 35.9 percent."

Employers have been complaining for years about not being able to find enough skilled workers. It's nothing new that manufacturing companies are struggling to fill positions with skilled workers or that these positions are sometimes going unfilled, but this lack of trained workers is only going to get worse. More and more companies are building plants in the U.S. in order to simplify and cut cost on their supply chains, increasing the number of facilities in the country. At the same time, the Baby Boomer population, whose members currently fill many roles in manufacturing, is set to retire in the next five years. There are thousands of open positions now, and the expectation is for that to increase 100-fold.

The Demand for Maintenance and Reliability Professionals

As a recruiter for manufacturing companies, I noticed over the years that employers are not familiar with the entire sector of maintenance and reliability, but they acknowledge its importance and its absence from their operations. Employees with a background in maintenance and reliability (M&R) are skilled in fixing equipment and machinery, but they're also good at monitoring this equipment to prevent future failures and planning to fix something when there is a failure. By focusing on reliability, manufacturers have a safer plant with fewer incidents and a more productive facility because assets are performing at the best possible level. Years ago I joined GPAllied as a consultant, helping companies improve production and get materials out the door to consumers. These manufacturers began to talk about the need for skilled workers with experience in maintenance and reliability, and out of this demand, the recruiting division of GPAllied was created. GPAllied bought a headhunting company, which became Impact Recon, to specialize in finding these skilled workers. Over the past two years, Impact Recon established its ability to find talent for North American manufacturers and is now Allied Reliability Group's talent acquisition arm.

Companies were all saying the same thing: they were starting to see the importance of maintenance and reliability technicians, and they realized that they didn't have employees with these skill sets. They didn't have employees who could not only repair equipment but

also monitor its efficiency and predict future failures. They realized that their operational standards did not match the most highly regarded best-practice metrics as set by the Society for Maintenance and Reliability Professionals (SMRP), but they did realize the need to hire these types of workers.

It is in a company's best interest to hire workers who keep equipment running at optimal levels and improve productivity. I worked as an M&R professional consultant in the civilian sector for the past 18 years, helping manufacturers improve their asset reliability. Since the late 1990s, best practices have been implemented in the field of asset reliability that directly translate to reduced operating costs and increased capacity. If the equipment is broken, it isn't producing, and it costs more money to fix it than it does to keep it running. Organizations like SMRP provide best practices and professional standards to help companies standardize their practices and improve asset reliability, and it is necessary to have a reliability engineer around to implement best practices and avoid equipment failures.

Maintenance & Reliability in the Military

The military service is an ideal place to learn physical asset management skills. After I retired from the navy, I continued to work with the military helping to implement the Navy Enterprise Maintenance Automated Information System (NEMAIS), which supported the restructuring of the forces in the early 1990s to combat terrorism through a rapid strike force. An important part of this initiative was reducing waste and cycle times for repairing the navy's ships. If equipment was broken, then it wasn't producing, and the military was losing money. One of the main problems was that there were numerous departments and offices that were not communicating or coordinating. Maintenance would show up to fix or perform maintenance tasks on a ship, cut the side of the hull, complete their task, and then seal up the side of hull, only to have another crew stop by shortly afterwards to fix a part in the same area of the ship and once again cut into the side of hull. Coordination was a nightmare.

Aside from the floor of a manufacturing plant, there is no better place to learn about maintenance and reliability than in the service. From experience, I can say the military does not always have the best maintenance programs, but through working in the service, veterans learn how to improve these programs and what mistakes to avoid. Working with NEMAIS, I worked to coordinate thousands of tasks by implementing reliability processes and using condition-based maintenance (instead of time-based) to more accurately plan for equipment malfunctions and failures.

Navy veteran Darrin Wikoff, who currently works as a senior technical advisor with Allied Reliability, created his career through his experience in the Navy. As a machinist mate second class in submarine warfare for nine years, he was responsible for the coordination of nearly 50 electrical and mechanical technicians and the execution of preventive maintenance on Navy submarines. Using a new preventive maintenance routine, he saved the navy over \$300,000 annually in shipboard maintenance and was awarded a Navy Accommodation award.

After retiring from the military, Wikoff earned a maintenance position with an oil and gas drilling company by helping them identify potential problems in one of their factories.

Using knowledge from his time in the service, he walked the floor of the plant with his potential employer and pointed out maintenance deficiencies and was later hired on as their technical consultant.

The Veterans' Struggle

Finding a job, much less finding gainful employment, has been a struggle for veterans in recent years. In the past five years, veterans have struggled more than the average population to find jobs and build their careers out of the service. This struggle has been particularly difficult for young veterans age 18 to 24. The Bureau of Labor Statistics showed that the unemployment rate for this group averaged 20% in 2012. The civilian rate for the same age group was 15% during the same period. This disparity has been consistent over the past five years.

Veterans are not prepared to enter the civilian world, and their military leaders are ill-equipped to help them find work in the civilian sector. Skills learned in the service often do not match up with civilian job requirements, even though veterans are often very qualified. The problem is military job descriptions do not match with the civilian sector job descriptions, and employers do not know how to interpret military skills and experience. The military also does not train soldiers to leave the service and build careers outside of the military. It's not interested in spending millions of dollars to prepare soldiers for a civilian career. It's interested in training soldiers and keeping them in the service. Superiors in the military also are not necessarily qualified to help vets find jobs, because they've been in the service themselves for so long. Someone who has made a career in the military does not have the best advice on building a career outside the military.

Consequently, most veterans are being told that they need to get a college degree to compete in the workforce, but there are other—often better—options, such as training or certification programs. The Coast Guard Command Master Chief at the Hire America's Hero conference was telling his men that they needed a college degree because he was told that a college degree was the best option for veterans. While a college degree would certainly improve a veteran's career, going back to school for four years is often not an option for these men and women, who often already have families.

In the early 1990s, Alan Knight retired from the army where he worked as a mechanic, repairing electrical and turret systems on M1 Abrams tanks, and struggled to find work before settling for a job as a truck mechanic making \$6.50 an hour. Working as a civilian mechanic, he had to take on a second job, and his wife had to get a job, just to have the same income as when he was in the military. He was told that he should get a college degree, but like so many other veterans, going back to school was not a feasible option when he needed an income immediately.

Many veterans qualify for open positions in manufacturing already, and a certification or training program would validate their skills. SMRP offers two certification programs—the Certified Maintenance and Reliability Professional (CMRP) and the Certified Maintenance and Reliability Technician (CMRT)—that comprehensively cover a wide variety of maintenance and reliability topics and show employers which candidates are the most qualified.

Certification programs are more affordable and take less time than getting a degree from a university. Veterans could also get a certification, start working, and plan to attend college down the road. The Department of Veterans Affairs also actually reimburses the cost of the CMRP exam, and the Society offers the exam at a discounted price to veterans.

The Role of Veterans

Alan eventually found a job as a plant maintenance mechanic, started a career in reliability as a vibration analyst, and built a career in reliability engineering. Alan and the hundreds of other veterans who worked with machinery or ran maintenance programs on combat vehicles or aircraft carriers are perfect additions to manufacturing companies looking to increase productivity. I know of at least 20 companies in food and beverage, metals, pharmaceuticals, mining, packaging, pulp and paper, housing material, and automotive sectors looking for these additions.

More important than their experience, veterans assimilate and adapt quickly, learn fast, and think on their feet to troubleshoot and solve problems. And they are used to putting in long days when necessary. They also know how to use and leverage the latest technology. They have a great work ethic, are predictable, team-oriented, and focused on the mission. They have been trained to maintain sophisticated equipment in harsh conditions and keep it running to achieve a common objective. Veterans are leaders. They quickly move into supervisory positions and thrive.

The problem is that while companies are looking for veterans with M&R skills, veterans are unaware of these job opportunities. I believe that educating veterans about these jobs is a crucial step toward decreasing veteran unemployment and solving the skills gap crisis in the manufacturing industry in the U.S.

Alan Knight



Darrin Wikoff



As a tinkerer with my own home wood, electronics, welding, grinding, machining, paint, and auto shops, I can get really excited about the concept of a makerspace. Unfortunately there are none within a commutable distance of my home. That aside, I also recognize maker shops as useful tools for manufacturing workforce development and regional economic development. Just as major research universities have business incubators focused upon R&D, why can't community colleges mimic the commercial makerspaces and become business incubators focused upon manufacturing, making makerspaces more widely available? The following chapter provides a glimpse of how the maker movement supports workforce and economic development.



Author Bio

In my travels across the country, working with economic development agencies, workforce boards, high schools, and colleges, a visit to Pittsburgh introduced me to my first makerspace and to the team of people who co-authored this chapter. Bernie Lynch is the principal of Strategic Development Solutions and founder of Made Right Here in partnership with Carnegie-Mellon University, the Pennsylvania AFL-CIO, the Three Rivers Workforce Investment Board, Keystone Research Center, and Keystone Development Partnership. Diana Polson served as a member of the Made Right Here program team and as an “internal evaluator” and liaison to the independent third-party evaluator for the U.S. Department of Labor (DOL) Workforce Innovation Fund (WIF) grant that launched Made Right Here. Stephen Herzenberg is Executive Director of the Keystone Research Center and served as a member of the design team and the Internal Evaluator for the project’s U.S. DOL WIF grant.

Chapter Seventeen

Made Right Here: Workforce Development within the Maker Movement.

*A new model emerges to support start-up
manufacturing for the Third Industrial Revolution*

by Bernie Lynch, Diana Polson, and Stephen Herzenberg

Kinetigear, a startup company based in Pittsburgh, Pa., has had enormous success on its most recent product—BOXZY. The company has quickly become the most funded Kickstarter campaign in Pittsburgh’s history, raising \$1.2 million dollars for its product and business development, much beyond the stated goal of \$50,000. The start-up has created a desktop makerspace called BOXZY—a cube-shaped CNC Mill, 3D printer, and laser cutter machine in one device, about 18 inches along each side. The success of its crowd-funding campaign speaks to the need and desire of at-home makers and manufacturers to have their very own additive and subtractive manufacturing capability that is sophisticated, precise, and affordable.

We are at the dawn of what some are calling the Third Industrial Revolution, in which digital tools—CNC machines, 3D printers, laser cutters, and other devices that make things from digital files—will re-make manufacturing in profound ways. Devices like BOXZY will soon sit next to computer printers in homes across the country. Rather than going to a store or buying something online, individuals will be able to download a file from the Internet, press print and make the products they need within their own homes in the course of a few hours.

If you can’t imagine how a home-based manufacturing plant would work, take this as an example: Your two-year-old gets a hold of your reading glasses while you are preparing dinner. Before you know it, you step on your frames and crack them in half. Rather than researching where to buy a replacement and the store hours, and finding the time to go to a local eyeglasses store, you trek up to your home office, find the digital file for your glasses frames and press print. Before you can finish dessert, your new frames are upstairs in your 3D printer.

New digital technologies will be disruptive. They will and are changing the way we make things and obtain products. They will change the way established manufacturers do business and will make way for small manufacturers and individual makers to launch new businesses making small-batch customized products for their social networks and selling things on sites such as Etsy, Amazon, and Bonanza. No longer will the tools of making—the

means of production—be predominantly in the hands of large factories and moderate- or large-scale companies.

The promise of the Maker Movement—a movement of do-it-yourselfers who value shared tooling and communal production spaces, often termed maker spaces—is to get the tools of making into the hands of everyday people. As broad access to tools—the democratization of tooling—spreads, how might manufacturing companies, community members, government, and individuals pivot to meet and greet these changes, rather than fall victim to them? How do we acknowledge and embrace these changes and connect them to the existing workforce and economic development ecosystem? One project in Pittsburgh, Pa. has begun to answer these questions: Made Right Here.

Made Right Here

Made Right Here, a program that grew out of the New App for Making It in America Project and funded by a U.S. Department of Labor Workforce Innovation Fund grant, is a consortium of key sector partners in the greater Pittsburgh region, which is now scaling nationally into cities across the United States. The goal of Made Right Here is to ensure that the products of our research universities and start-up companies will be made locally or domestically, and to build a systemic framework to support that outcome. The project trains unemployed, underemployed, and dislocated workers in a makerspace on a range of digital tools and with the production knowledge necessary to become valuable employees for a hardware startup's first, second, and third hires. A makerspace is a place where people from the community gather to make/create/build things, share resources and tools, network and collaborate on projects. Makerspaces have a variety of tools that can be used by community members, from 3D printers and Arduino to saws, welding machines, and laser cutters. Individuals and groups make things out of metal, wood, electronics, plastic, cardboard, and more.

While mature manufacturers struggle with the skills gap, many hardware startups and university spinoffs duck the gap by defaulting to overseas manufacturing for small- and large-batch commercial production, partly because financing and expertise in scaling complex production processes can be found overseas. While there has been recent movement towards reshoring, the United States risks continued manufacturing job losses if startups continue to meet next-generation technology production needs overseas. This will further deplete U.S. skills, know-how and ability to meet its own production needs. Without a hardware and product startup ecosystem that encourages and teaches startups to manufacture locally with a knowledgeable workforce, our ability to innovate and compete in the future will be compromised and ultimately affect national security. In addition to training individuals for jobs in making and manufacturing, Made Right Here gives startup companies the technical support they need to manufacture locally or in partnership with other domestic suppliers.

Made Right Here connects the worlds of education, workforce development, economic development, business development, and community development by serving this unserved marketplace of start-up local manufacturing. The program is preparing our

network cities to pivot towards the Third Industrial Revolution in several ways. First, the project is connecting the maker movement with manufacturing workforce development to solve manufacturing's image problem and get young people and others excited about earning a living through making. Over the past decade or more there has been much talk about manufacturing's image problem alongside unsuccessful efforts to solve the problem through marketing alone, while ignoring wages, employment security, or the lack of "coolness" of manufacturing jobs (relative to IT, lab technicians in health care, etc.). Training in a makerspace attracts young people to the world of making and manufacturing. Made Right Here's National Apprenticeship Program includes a progressive wage ladder, along which individuals move up to a family-sustaining wage as they increase their skills through on-the-job training.

Second, while the maker movement fuels innovation and creativity, produces entrepreneurs, and connects makers with each other, there is not currently a structured ecosystem and infrastructure that intentionally supports startups to grow and manufacture locally. Made Right Here does just that and focuses specifically on local production and connecting to local supply chains. This startup support network will grow local jobs and spur economic development.

Take Kinetigear's BOXZY as an example. Made Right Here's project staff has been giving technical assistance to Kinetigear on its prototype since the company's inception a year ago and has added production-support services since the start-ups successful \$1.2M Kickstarter which enabled the company to gear up for manufacturing. Our guidance has focused on expanding the new company's vendor connections, obtaining price quotes, introducing the company to regional contract manufacturers and material suppliers and specifying materials needed. BOXZY is growing at an incredible pace, but needs support as it scales. The company has hired eight of Made Right Here's trainees for short-term assembly contracts and expects to hire five to 10 new full-time permanent hires from among Made Right Here trainees if possible.

Third, offering job training on the digital tools of the future within a maker space naturally connects unemployed job seekers with the entrepreneurs and makers of the future. By conducting training in a local maker space, trainees are learning alongside entrepreneurs, startups and other makers which both encourages peer-to-peer learning and broadens trainees' social capital and access to job opportunities.

Made Right Here's maker space training takes the best principles from the maker movement—learning-by-doing, hands-on training, peer-to-peer learning, and open source sharing—and applies it to job training. The project trains individuals on a range of digital tools, training for a breadth of knowledge program as individuals must prove competency on five tools, one design software and with three materials. Made Right Here aims to create employees ideal for startups first, second, and third hires, where they are often needed to be proficient in a number of methodologies of making during prototyping and first orders. Participants are also trained in production knowledge, teamwork, communication, innovation, and professionalism (all qualities that our startups desire).

Made Right Here does human and virtual matchmaking and job placement with

participating startup companies as well as mature manufacturers in our regional manufacturing ecosystem and network called the Maker Bench. Individuals who are hired via the program become part of the registered US DOL apprenticeship program, the Maker Professional earning a completion certification under its New National Standards.

As an example of Made Right Here's training success, take Jean Frye. She joined the Maker Professional project in January of 2014 bringing her experience as a former diesel mechanic. In the apprentice program, Jean took classes in CNC, the Shop Bot, laser cutting and industrial sewing. From the skills that she learned led to five on-the-job training placements—with the final one, a full time permanent position at start-up local manufacturer, Abram's Bed making beds for special need youth and adults. Jean reports, "I became a displaced worker and found the Maker Professional program. Getting involved in the program gave me some more hope that I can find something. It gave me confidence to try out things that I thought I might want to try out or might want to do. [After being trained in the program] I work at Abram's Bed... so I think it was having the field of production machinery available to me that was the biggest help in terms of being able to find a job."

Jeremy Showalter entered the Pittsburgh-based Maker Professional program at age 25 with a GED in hand. He had only been able to find odd jobs doing auto body repair and construction. His mom accompanied him to the Maker Professional training open house, and expressed skepticism about manufacturing training, fearing it would not lead to a full-time job. Jeremy entered the program, learned new skills and was connected to a nearby transportation manufacturer. He started out at \$14.50 per hour and, within six months, earned \$17 per hour and then more than \$20 per hour. With overtime, he now makes more than \$70,000 per year with great benefits, belongs to a union, and is going back to school to receive his B.A. (paid for by his employer). He report the Maker Professional training has allowed him to climb out of deep debt.

Conclusion

Made Right Here is much like a startup itself, having designed, trialed, tested, iterated, and improved the program during this two-year innovation phase. The project now has a "product" that other cities seek in order to adequately prepare their workforce, startups, and manufacturers to pivot towards the Third Industrial Revolution in a singular solution methodology. Expanding to cities across the U.S. will allow Made Right Here to embrace, grow and use the energy of Maker Movement to further advance our country's making and manufacturing capabilities, knowledge, and capacity. The Maker Professional program will train the makers and manufacturers of the future for family-sustaining jobs, ensuring that we have a workforce capable of using the most cutting edge digital technologies and able to make things at a professional level. Through startup training, technical assistance, connection to the local supply chain, and access to a qualified workforce, this program will interrupt the cycle of U.S. hardware startups going overseas to meet their production needs, therefore growing a new generation of local manufacturers and expanding opportunities for local contract manufacturers.



There are scattered about the country some outstanding examples of how the strategies discussed above have been put to work to develop education and training programs that meet the needs of students and manufacturers. This chapter looks at one such successful program to show what industry, education, and government can accomplish. This program was initiated to fill a skills gap in the incumbent workforce of a group of consumer products companies. It has since grown to include programs for multiple manufacturing segments, serves students coming through multiple pathways, and has served over 100 companies. Not only does this chapter provide great recommendations for educators, manufacturers, and government—it also provides some insight into the value of people who understand the problem firsthand and have passion for solving it.



Author Bio



Bonnie L. Spayd,
Director of Business &
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When you want advice on how to do something, the best advice comes from someone who has been successful at doing it. Bonnie runs one of the most successful industrial maintenance, mechatronics, and manufacturing programs that I have come across at the community college level. It was for that reason that I asked her to write a chapter on how manufacturers and educators can work together to solve the manufacturing workforce crisis.

Bonnie Spayd is currently employed as the Director of Business & Industry Programs for The Schmidt Training and Technology Center at Reading Area Community College. In her position, she is responsible for developing and delivering a continuum of credit and noncredit programs specifically in workforce development, business, industrial maintenance, mechatronics, machine tool, and information technology geared to local and regional business and industry, to dislocated, under-employed workers, and to credit-seeking students. She is the credit advisor for the A.A.S. in Mechatronics Engineering Technology. Prior to joining RACC's staff, Bonnie worked in business development for The Manufacturers Association of Berks County, in engineering/quality control/quality assurance/sales and marketing communications for a safety products manufacturer, and in production and supervision for a pharmaceutical reagent manufacturer. She holds a B.S. and M.Ed. in Biological Science from Kutztown University.

Chapter Eighteen

Working Together for Manufacturing Workforce Development

Bringing the right parties to the table for open communications can result in extremely successful programs.

by Bonnie L. Spayd

I grew up in a small country town about 10 miles east of Reading, Pa., which was cited in a 2011 newscast with Tom Brokaw as the poorest city in America. According to the Brokaw report, 41.3% of the residents lived below poverty. As a “tween” in the late 60s/early 70s, I lived on a block of 10 to 12 single-family homes where no one was rich but everyone was comfortable. In my neighborhood, one or both of your parents worked at either Carpenter Technology (large steel manufacturer), DEKA Battery (large battery manufacturer), AT&T (large electronics manufacturer), or The Dana Corporation (large truck body manufacturer). My dad worked for Carpenter Technology. Life was pretty darn good.

As kids (aka “The Race Street Gang”) we knew each other K through 12. Our families stayed put because our parents had solid, well-paying, 30+-year careers in manufacturing. I entered college in 1980, majored in biology, graduated in May of 1984, and in that same month started my first “real” job in production for a local pharmaceutical reagent manufacturer. It wasn’t that I was lucky; that was the way it was. Manufacturing jobs were plentiful; I had choices upon graduation.

Higher ed did its job and educated me well in science. I learned a good work ethic from my parents. What I didn’t know was anything about working in manufacturing. Even though I graduated with a Bachelor of Science degree in Biology, and I certainly learned about microbiology, chemistry, and immunology, I had no clue about working in a clean-room and about how one small “gowning” oversight could contaminate an entire product that could cost the company tens of thousands of dollars. I had no clue that a customer could be lost if the order was incorrect or not shipped on time; or that there were SOPs and GMPs; or that production equipment (even back then) was semi-automated, had controls, and was expensive to repair and maintain. And if equipment wasn’t operating, product wasn’t being produced, customers weren’t getting their orders, the company wasn’t getting paid, and I might not have a job! Thank goodness for the “buddy system.” It was common in manufacturing then to “buddy up” the new hire with an incumbent. Your first three to six months were spent learning the specifics of your job and the company environment.

I worked in manufacturing for another 16 years until the large safety product manufacturer

where I was employed began to exhibit signs of unhealthy profit and loss. Offshore competition was driving down product pricing. Sales employees were resigning and not being replaced. Production equipment was aging. Manufacturing technology was J-curving. New equipment was being purchased, but few of our maintenance employees understood the new technology and controls. Even our best industrial and process engineers struggled to keep production running. By 2000 we merged with a larger competitor, and by 2001 the doors were closed on that plant. More than 300 employees (many under-skilled) were now out of work.

I was fortunate. I quickly found a job, but this time not in manufacturing; I found a job in the service sector. As manufacturing jobs continued to decline, the local community college (Reading Area Community College-RACC) was working through the outcomes of focus group studies with local manufacturers, educators, workforce-investment boards, and community organizations to determine if the Reading region needed an “advanced” technology center. Technology for the purposes of this new education center was defined as manufacturing, specifically maintenance and information technology. In 2006 I was hired by RACC as Director of Business and Industry programs. What we quickly realized was that if a company was still in “production” and holding its own, it was likely because it was using automated manufacturing equipment to make things smarter and faster. The solution for American manufacturers to make products competitively with the global competition had been found; meanwhile, however, a perfect storm had been brewing.

- 1.** The instrumentation and computer controls technology in manufacturing production/packaging equipment had been advancing rapidly.
- 2.** A large portion of knowledgeable manufacturing workers (Baby Boomers) were aging and retiring.
- 3.** We had not encouraged our younger generations to pursue manufacturing-related technical educations/careers.

Currently, if you are a manufacturer that is growing in production, upgrading equipment, or in need of hiring any type of technically skilled worker, then the storm is on top of you right now. Companies that don’t invest in technology, in faster and smarter equipment, and in a technically skilled workforce will soon find themselves in the same position as my former employer—with their doors closed!

This Playbook is about manufacturing workforce development. I have come full circle for the need of this Playbook. I am technically educated, I have worked in numerous manufacturing jobs/careers, and I am now responsible for preparing students and incumbents for technical manufacturing jobs and careers. It is imperative for me to be part of the solution in keeping manufacturing strong and healthy in America. The technology center for which I am responsible has been hugely successful in establishing processes for educators and manufacturers to work together to develop a technically skilled workforce. Starting with no manufacturing programs at all in 2006, we have established a world-class manufacturing training center and have trained, retrained, or educated more than 1,800 students in advanced manufacturing skills working with more than 110 companies in our immediate area. A student graduating from our

75-credit A.A.S. program in Mechatronics Engineering Technology can carry up to 75 of those credits directly into one of several major universities toward a bachelor's degree, or he or she can go to work starting at a base salary of \$50,000 to \$60,000 and probably earning six figures after a short time with just an associate degree. When the state asks our industrial customers to comment on our programs, they have responded with comments like this from one plant manager from a food company: "We've spent over six figures on training with RACC so far and plan to keep spending. What more do you want to know?" I believe that the recommendations that follow have been proven by us as solutions to the workforce problem, and I hope that they will assist you with your quest to develop your manufacturing workforce.

Recommendations

Manufacturers and Suppliers to Manufacturers

Invest in your current workforce; do what you can to keep the technically skilled workers that you currently employ. Get your employees into technical training courses and programs. Pay for it or provide tuition reimbursement, and give your employees the time to learn and complete the courses/programs. Don't expect employees working 60 hours a week to make the time out of their own to get to school; it's simply unrealistic.

Let your employees apply on the job what they are learning. If you send an employee for controls training, then let them have access to apply those learned skills on your equipment. My students tell me one of the biggest de-motivators is when their employer sends them for training and then doesn't let them use it.

Find an educator or technical school that can pre-assess your incumbent employees' needs and then customize the training for those employees. It will save you time and money and will keep employees engaged and challenged.

Find an educator or technical school that teaches using both theory and hands-on skills with current equipment/technology. The technology center at RACC puts equal emphasis on students understanding the theory as well as the hands-on skills. Integrated systems troubleshooting is the undercurrent in all of our courses and programs. A solid understanding of industrial mechanical, electrical, instrumentation, and computer controls theory is essential for teaching efficient troubleshooting.

Assist in helping your local educators/technical schools to define skills, courses, and programs that fit your needs. But then put your money where your mouth is. And If you assist in curriculum design, then use it for your incumbent and new hire needs.

Don't be afraid to give younger graduates of a good theory and hands-on technical program/degree a chance at employment. While certainly less experienced on the floor, likely they will be exceptional in controls and computer technology, and when paired with your existing workforce, the sharing can produce exponential results.

Reinstitute the "buddy" system. Yes, it will slow down your most experienced employees, but after a few short months your "newbie" will be more independent and autonomous.

Use internships to introduce non-industrial workers to the industrial world.

Pay wages that are competitive in your area. Tie in a bonus or incentive for performance if you can. We all want to believe that employees won't jump ship for a little extra money, but the truth

is that they will, and they'll do it for as little as 25 cents an hour more.

Encourage your kids, nieces, nephews, grandkids, neighbors to pursue manufacturing-related education and careers.

Educators at the postsecondary, technical school, community college, and university levels

Think differently. Stop with the "here's what we have to offer," and ask your local/regional manufacturers what they need. Then implement it!

Hire staff/instructors/faculty that can "walk the walk" and "talk the talk." I hire engineers as well as production and maintenance professionals who have worked in industry. Manufacturers like to communicate with people who understand them. Comments I hear from incumbent employees sent for training are that they like that my instructors understand what it is like to work in industry; we keep it real.

Think less like an educator and more like a business. Do your research but then act quickly; manufacturing is fast and needs fast response.

Stay current. Keep your fingers on the pulse of your local manufacturing needs and trends and then adjust/add them into your courses, programs, and offerings. I have partnerships with my manufacturing customers; my instructors tour their plant operations to learn what's new and how to relate our curriculum to their specific needs.

Teach hands-on skills in addition to theory. Students usually learn and retain better by doing, and it is just more fun!

Understand that manufacturing workforce development does not mean "check your brain at the door"-type program offerings. Technical students need to be proficient at reading, writing, and at a minimum pre-algebra. At the same time, understand that educational success can be found in programs and certificates other than a two- or four-year degree.

Offer choices that appeal to all possible customers: individual courses, certificate programs, custom courses and programs, credit and CEUs, stackable credentials, two- or four-year degrees. For example, I have short individual courses (25-hour basic hydraulics, 25-hour intermediate hydraulics, 20-hour basic pneumatics, etc.) that roll up into a 170-hour/five-credit industrial mechanical certificate program that when combined with a 120-hour/four credit industrial electrical certificate program and an 80-hour/two-credit industrial programmable logic controller certificate program results in completion of an Advanced Manufacturing Integrated Systems (AMIST) Level 1 certificate program. Completion of this AMIST Level 1 certificate program can get students an interview for an entry-level maintenance job or a paid maintenance internship. Completion of RACC's four levels of AMIST certificates plus 23 general education credits earns a student an A.A.S. in Mechatronics Engineering Technology.

Offer your courses and programs in a flexible manner with day and evening options. Manufacturing is typically a three-shift operation! My programs are offered in four labs that are open five days a week during the daytime and three to four days a week in the evening. Students can come into their lab anytime the lab is open. They access their theory, which is delivered via a computer multimedia program, and do their hands-on skills via the lab equipment. They get one-on-one instruction and can work at a pace that is comfortable for their learning style.

Rather than focusing on general education courses, offer degree-seeking students “core” technical courses immediately that can lead directly to employment in the field of study. For instance, I will advise students to complete our AMIST Level 1 Certificate program (Industrial Mechanical, Electrical, and Programmable Logic Controls) in their first two semesters if they need to work while attending college. Successful completion of this certificate will prepare the student for entry-level maintenance employment or a paid maintenance internship with several local manufacturers. The student is employed while attending college, the manufacturer has an entry-level employee from a validated program, and the college has student retention—win-win-win!

Offer workplace ethics and life skills courses (what is manufacturing, getting to work on-time, teamwork, conflict resolution, banking 101, budgeting 101).

Partner with other educators in upward and downward articulation of courses and credit. RACC has several “Technical Academy” agreements with local Career and Technology Centers to offer “dual enrollment” for up to 27 college credits in the RACC Mechatronics Engineering Technology A.A.S. for students in high school.

Partner with local school districts, organizations, and local industry in hands-on career exploration workshops and camps. RACC is conducting Hands-on Career Exploration Robotics camps for young people in the Olivet’s Boys and Girls Clubs. Students learn the integration of mechanical-electrical-controls systems, assemble a robot, and then demonstrate to industry representatives and parents the operation of their robot.

Partner with your local industry for internships and hiring of your students. This will help you recruit more students into your programs. Parents especially like to pay for education that can almost guarantee employment! RACC has an intern partnership with a large manufacturer where upon completion of the AMIST Level 1 Certificate program, the student completes an application for employment, gets an interview with the employer, and likely gets a paid internship opportunity.

Encourage your kids, nieces, nephews, grandkids, and neighbors to pursue manufacturing-related education and careers.

Workforce boards, career-link counselors, government agencies, professional organizations, foundations

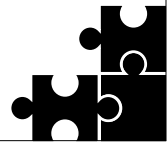
Look and apply for grants and funding that can be used for technical manufacturing incumbent, displaced, and underemployed worker training and equipment purchase. Don’t seek out grants for just one or the other. Technical training hinges on current technology, which many times means equipment must be upgraded or purchased.

Assist with marketing efforts to attract middle and high school kids into technical careers. Our local Economic Partnership created a “Careers in 2 Years” campaign that has generated a positive outreach into schools’ marketing technical education. www.careersin2years.com Check it out!

Serve as the vehicle to instill cooperation among educators and industry. Get all relevant players into the same room.

Encourage your kids, nieces, nephews, grandkids, and neighbors to pursue manufacturing-related education and careers.

We mustn't forget that education is really about the students, and we have learned in previous chapters that there are lots of different types of students on different paths. We wanted to hear what students have to say about their preparation for entering the workforce. Instead of asking a group of students to prepare a chapter, we sent *Packaging World* editor Pat Reynolds to interview six students about their goals and experiences. Here's what he learned.



Author Bio



Pat Reynolds,
VP/Editor,
Packaging World

I have known Pat Reynolds for many years, dating back to my days in industry. He has been a mentor to me as I made the transition from industry to blogger. When I suggested that Pat prepare this chapter, I knew that he would be able to capture and convey the issues that are most important to students.

Pat Reynolds has been a packaging journalist since 1983. He was part of the small group who launched *Packaging World* in 1993, and he was named VP/Editor of the magazine in 2002. Pat's career has taken him to countless packaging operations, technical conferences, and converting plants, not only across the U.S., but internationally as well. He's addressed packaging conferences in the U.S., Japan, and France and has judged numerous packaging competitions. Pat holds a B.A. in English from the University of Illinois, an M.A. in English from University of Wisconsin, and an M.A. in Anglo-Irish Literature from University College Dublin.

Chapter Nineteen

A Look at the Learners

We can't forget the students.

What are their needs and opinions?

by Pat Reynolds

Elsewhere in this book you have a chance to hear from a number of talented and passionate people who are all active in one way or another in trying to address what's come to be known as the skills gap. As widely disparate as their backgrounds and viewpoints might be, nearly every contributor to this book agrees that whatever solution to this problem we as a society come up with, one thing it must include is a major reset in the American education system.

Fortunately, that education reset is well underway in Pennsylvania, where a coalition of workforce development professionals, government agencies, manufacturing companies, and educational institutions has put in place a number of highly focused and successful programs dedicated to developing the manufacturing workforce. It's important to note, too, that these are aimed not at just one demographic but at several, including these five all-important ones:

- Young people who've barely even sampled the workforce
- Incumbent workers who seek to improve their readiness for the workforce
- Displaced workers hoping to return to the workforce
- Military veterans whose unique circumstances sometimes complicate entry or reentry into the workforce, and
- Ex-offenders who have paid their debt to society and view meaningful employment as the key to becoming a contributor to the betterment of that society

Right from the earliest planning stages we knew that this Playbook would be incomplete if it didn't include the perspectives of some of these students. We also wanted to look at students who are taking different pathways to the workforce. So we talked with six students from two Pennsylvania schools in order to give this book at least some element of their experience, their point of view.

By the way, our focus on Pennsylvania is not to say that other regions or other states are devoid of success stories when it comes to innovative approaches to workforce develop-

ment. These just happen to be stories that come out of the Keystone State. By all means tell us of any that you know about in your neck of the woods.

“At the age of 51, I was looking for training that would improve my chances of getting a good job. I had experience at a building supply business, but when that business went downhill, I took a job driving a school bus. Then I saw an article in the newspaper about adult education at the CTC. I went to an open house, liked what I saw, and decided to enroll. That was early in 2013. In June of 2014, I hope to be certified in Electro-Mechanical Engineering Technology.”

That’s how Darryl Lindemuth of Litiz, Pa., describes his recent experiences at the Lancaster County Career & Technology Center. I met him and two of his classmates, both 18-year-old high school seniors, in March 2014, when I visited the school’s Mount Joy, Pa., campus. But before describing any further the remarkable impact that the CTC is having on these three lives, it’s helpful to step back a bit for some background and context.

For starters, Pennsylvania has 67 of these CTCs, one for nearly every county. All programs offered are approved by the Pennsylvania Department of Education, and some, like the Lancaster County CTC, are accredited by the Commission of the Council of Occupational Education. They offer comprehensive technical programs—advanced manufacturing, agro-science, construction technology, culinary arts, information technology, and visual commu-



At the Lancaster County Career & Technology Center in Mount Joy, PA, *Packaging World* Editor Pat Reynolds (far right) talks with Electro-Mechanical Engineering Technology Instructor Christopher Smith. Looking on are CTC students (from left) Alexander Nolan, Darryl Lindemuth, and Zachariah Hostetter.

nications—to a range of students. They tend to vary from county to county when it comes to what their focus is and just how they operate, because the idea is to have them support local conditions, local needs, and the local job market. But all of them are super-focused on making sure that the people of Pennsylvania are job-ready first and well-rounded second.

I was born and raised in Chicago, in the benighted state of Illinois, and I still call Chicago home. My state is where disgraced governors who go to jail have become painfully common, and where the 8.7% jobless rate as of March 2014 was one of the highest in the nation. So when I read about solidly grounded, practical, and job-generating programs like the ones that Pennsylvania has in place, I feel like I'm reading about some parallel universe. In Pennsylvania they're making a difference, and they're making it now.

But getting back to the Lancaster County CTC. It consists of four campuses, but since I only talked with people at the Mount Joy campus, this account will focus on that campus alone.

The constituents served by the CTC come in several flavors, but high school seniors are by far the most numerous group in the program's population. (No, at the age of 51, Darryl Lindemuth is not a high school senior, but we'll get back to him shortly.) Basically the idea is that while it's essential for high school students to complete the general education courses that make them well-rounded and functional members of American society, there's also time in that four-year high school window to concentrate on technical career training that will make them far more job-ready than would otherwise be the case. So each of the 16 high schools in Lancaster County sends anywhere from 10 to 100 seniors from their home high school to the CTC. They still "walk" with their home high school classmates when it comes time to put on the cap and gown for graduation. But the CTC becomes their full-time school. For some, it might mean a 22-mile ride on a school bus twice a day. But that's just part of the CTC package, and from everything I heard and saw, nobody has a problem with it.

In their nine-month CTC stint, these seniors have considerable latitude in picking which technical training they want, from agrosience to culinary arts. Our interest here, of course, is in the manufacturing workforce, and students who make that their focus can take courses like these:

- Electro-Mechanical Engineering Technology
- Industrial Mechanical—Hydraulic
- Industrial Mechanical—Pneumatics
- Industrial PLC (SLC500) Programmable Controllers
- Industrial Electrical Program
- Sheet Metal Technology
- Welding Technology

Keep in mind that the state of Pennsylvania is riddled with manufacturing companies making everything from food and beverage products to high-tensile steel to pharmaceuticals. Internships and co-ops at some of these firms are also a part of the Lancaster County CTC experience. So when high school seniors graduate and have a certificate in Electro-Mechanical

Engineering Technology from the CTC, they can more than likely begin working in a good field as soon as they've returned the cap and gown they rented for their graduation ceremony.

If quick entry into a good job in the manufacturing workplace was the only option that CTC graduates had, the program would be a winner. But the beauty of the CTC is that there are at least three other pathways students can pursue:

- They can enter a four-year university to pursue a Bachelor's Degree in Engineering, but rather than spending four years, they will only need to spend three because the courses they've taken at the CTC qualify for college credits. Think of the money they save and the debt they don't incur. And think of how employable they'll be when they finish their four-year degree because of the foundation they laid at the CTC.
- They can enter a two-year program at a community college and emerge with an associate degree—and they might even have 25 hours of college credit under their belts thanks to the coursework taken at the CTC.
- They can earn a two-year associate degree at a community college and then earn a bachelor's degree in just two years at a Purdue, or Penn State, or the University of Illinois.

So how does 51-year-old Darryl Lindemuth fit in? He fits in because the Lancaster County CTC also offers adult education. Adult learners fall into one of two categories. They're either incumbent workers who seek to improve their skills, or they are unemployed workers looking to return to the workforce with better skills. The incumbent workers sometimes get tuition reimbursement from their employers. As full-time workers, it's not possible for them to attend school full time, so they often earn their certification in Electro-Mechanical Engineering Technology over three or four years. They can pick whatever pace suits them.

The only pace that suits adult learners who are unemployed, like Lindemuth, is ASAP. They want a job now. And since the high school seniors are proceeding full time along a path that lets them complete their mechatronics certification in nine months, Lindemuth and adult learners like him are allowed to join the full-time 18-year-olds because that way they can get their certification in just nine months.

"I'm fine learning along with the high school students," says Lindemuth. "They respect me for what it is I'm trying to do at the age I'm trying to do it."

He also appreciates that much of the coursework is of the e-learning variety, which means he doesn't always have to go to the campus to make progress on his certification. "I was never a very good student academically back in high school, but here I find myself doing even better than I had anticipated," he says. "It's less book work and more hands on, and the e-learning part adds even more flexibility. When I do need help, the teachers here are great."

Among Lindemuth's 20 or so classmates are 18-year-old Alexander Nolan, who hails from Donegal High in Mount Joy, and Zachariah Hostetter of Ephrata High School in Ephrata, Pa. Both are finishing their last year of high school at the CTC, which means they are getting for

free the coursework that costs Lindemuth about \$8,000.

When asked what it's like to have a 51-year-old classmate, Nolan says it's perfectly fine by him. "We find ways to help each other," he says. "Besides, he's a reminder to us younger guys how valuable this program is and how practical it is in terms of entering the workforce. If an experienced guy like Darryl is here, there must be something to it."

Kirk Schlotzhauer, Director of Programs for Post Secondary Education in the Lancaster County CTC, also sees the inclusion of adults and high schoolers in the same program as beneficial. "It brings an element of mentorship into the program," he points out. "Darryl's been out there in the workforce, and the kids tap into some of what he's experienced. There are usually about three adult learners to 20 high schoolers."

When Nolan first arrived at the CTC, he was more interested in the work his father excelled at in the construction business. So the courses he was thinking of taking ran along the lines of framing, electrical wiring, and carpentry. But once he got wind of the Electro-Mechanical Engineering Technology Program, he switched gears. "Ever since I was little I've been interested in how things work," he says, "and here we learn about PLCs, ladder logic, motor controls, wiring, and other things I like and am good at."

Nolan knows exactly what he wants to do with the certification he earns from the CTC. "I'm not looking at college," he says. "With my AMIST Level 1 Certificate, I'll be able to land a good job. I'll be able to show that I've worked with pneumatics and motor controls, that I've wired things together."

The Advanced Manufacturing Integrated Systems Technology Level 1 Certificate he refers to is the recommended starting point for workers engaged in multidisciplinary industrial maintenance operations. It was originally created by the National Center for Integrated Systems Technology under the auspices of the U.S. Department of Labor. It provides training in three areas: mechanical technology, electrical technology, and PLCs. The training includes both theoretical and hands-on learning using real industrial equipment. Students completing this program will have mastered the knowledge and skills to perform basic industrial maintenance operations in many typical manufacturing plants.

Like Lindemuth, Nolan is a big fan of the hands-on opportunities so abundant at the Mount Joy campus. "I learn better that way," he says.

The hands-on hardware trainers that Nolan finds so helpful are abundant in the Mount Joy labs. Made by Amatrol Inc. of Jeffersonville, Ind., they're part of a comprehensive learning system that includes hard-copy and online components, too. These learning systems make it easy to teach and assess the CTC students. One system is dedicated to pneumatics, another to PLCs, another to mechanical drives, another to wiring, and so on. They're quite sophisticated, too. Take the one designed for pneumatics, for example. Thanks to an electronic fault-insertion system, 45 different faults can be inserted from a computer into the system to allow learners to perform troubleshooting procedures. Whatever the advanced manufacturing sector might need, the CTC has a hardware trainer to teach it. But Nolan emphasizes that these hands-on elements of the program are just one way of learning.

"E-learning is also extremely helpful," he says. "If there is equipment we don't physically have in a classroom, there's a simulated version of it available on the computer. So you still

get a good sense of how to work with such equipment. The e-learning also brings flexibility into the equation. You can make progress in a course while you're at home."

Hostetter is the same age as Nolan, and he heard about the CTC through his high school principal and counselors. "They said it's like a high school diploma on steroids because it certifies you as someone with the skills that employers out there are looking for," he says.

The career pathway Hostetter has chosen is not the same as Nolan's. "I plan to go to college and major in electrical engineering or mechanical engineering," says Hostetter.

Like Nolan, Hostetter knew little about the electro-mechanical engineering being taught at the CTC at the outset. "But I always wanted to be an engineer, so the mechatronics taught here is perfect. I also hope to get a co-op [Cooperative Education] in the next few months to further increase my skills. It's like an internship except that you get paid."

When Hostetter graduates from high school, he will have a big financial leg up on peers who enter a four-year university program without having spent a year at the CTC. He'll find that some of his CTC credits will transfer as college credits, thus shortening the number of years and dollars he needs to spend in getting his bachelor's degree. According to Keith Campbell, the manufacturing workforce development consultant who spearheaded this Playbook, this is one reason why CTCs are increasingly being looked at as a logical beginning to a four-year university degree in engineering. "Historically," says Campbell, "this has not been the case."

One last note about the Lancaster lads before moving on to Reading and postsecondary education. I had to ask the two 18-year-olds what their peers thought of their decision to spend their senior years at the CTC (mechatronics, process analysis, pneumatics, almost no girls) rather than their home high schools (girls, pep rallies, senior ditch day, girls). Hostetter didn't miss a beat.

"They see us as knowing what we're going to be doing with our futures. Mostly they wonder what it is we do here. They seem to wish they'd taken this option, too."

About 35 miles northeast of Lancaster, perched on the Schuylkill River in Berks County, is RACC: Reading Area Community College. It provides the following: associate degree; career-focused training; transitional coursework; skills training for business and industry; personal enrichment programs; and public service activities.

Our focus here is on the Schmidt Training and Technology Center at RACC, which provides training in manufacturing technology, senior leadership, information technology, workplace readiness, and workplace literacy. And this time we're not talking about high schoolers or adult learners seeking certification alongside of high schoolers. This time we're talking about college students like Frank Gustus, Wendy Benson, and Kory Koehler.

Gustus knows plenty about the manufacturing workforce. He was an accomplished machinist with a GE aviation manufacturing division in Wilkes Barre, Pa., for 16 years. But he wanted to enhance his skill set, so he did some online research and found that RACC was the place for him. He looked into tuition reimbursement but discovered that a change in

policy at his current employer had just recently eliminated it for all but those at management levels. Undeterred, he enrolled at RACC anyway and arranged to pay his own tuition.

He found RACC to be just what he wanted. But it meant driving from his Mount Carmel home to Reading in the morning (53.2 miles), from Reading to Wilkes-Barre for work (76.4 miles), and then from Wilkes-Barre to his home in Mount Carmel after his shift (61.9 miles). For about three months he endured this 190-mile commute. Then he caught a break.

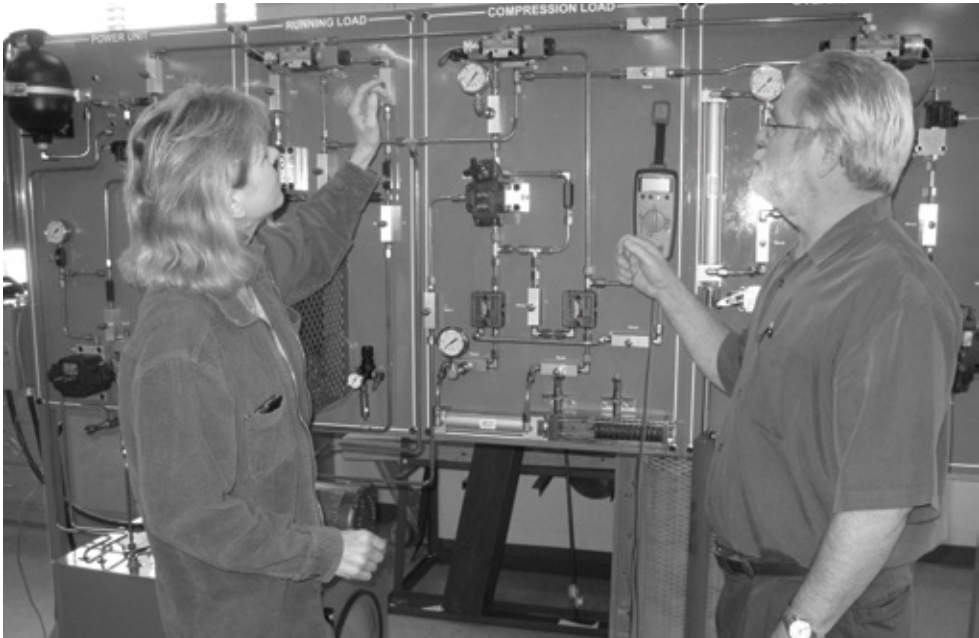
“Bonnie referred me to Carpenter Technology right here in Reading, and they hired me as a machinist,” says Gustus. “I also moved from Mount Carmel to a town close to Carpenter Technology in Reading. And Carpenter is reimbursing me for my tuition costs. Not only that, but they also they compensated me for what I had already paid on my own.”

The Bonnie he refers to is Bonnie Spayd, the Director of Business and Industry Programs at the Schmidt Training and Technology Center of RACC (see her chapter in this Playbook). As for Carpenter Technology—or “CarTech,” as everyone in Reading calls it—it’s a Reading-based manufacturer of specialty metals, including super-alloys, ultra high-strength steels, stainless steel, and titanium alloys.

“Had the RACC scheduling flexibility not been there, I could never have gotten started, not with all the commuting I did,” says Gustus. Even now with his greatly shortened commute, Gustus says the availability of the labs is one of the things he likes best about RACC: any time Monday through Friday between 7:30 a.m. and 3:30 p.m. and Monday through Thursday between 5 p.m. and 9 p.m. “You don’t have to pick a quarter or a semester where



Packaging World Editor Pat Reynolds (second from right) and Keith Campbell (far right), the editor of this Playbook, visited the Schmidt Training and Technology Center at Reading Area Community College in Reading, PA. Joining them in this classroom conversation were Bonnie Spayd, the center’s Director of Business and Industry Programs, and Frank Gustus, a degree-seeking student at the center.



Among the degree-seekers enrolled at the Schmidt Training and Technology Center is Wendy Benson. Here in one of the center's labs, she tells *Packaging World* Editor Pat Reynolds how a hardware training module fits into the program.

the course you need is offered," says Gustus. "All you have to do is show up. You work on your own, but the teachers are there to help when you need them."

As a full-time employee who can only pursue his education on a part-time basis, Gustus figures he needs about four years to finish his certification as a maintenance technician. As of March 2014, he was about halfway there. He's already applied for an opening in the ranks of Carpenter's maintenance technicians. "With my background and now these credentials from RACC, I can go pretty high on the pay scale. It's been a big juggling act to some extent, for me and my family. I'm 42, and my kids are six and three. I'm working 10- to 12-hour days and usually spending three mornings a week here at RACC. Luckily, I now live about 15 minutes from school and work."

One final observation on Gustus and his manufacturing career pathway. A 2010 report by the Pennsylvania Center for Advanced Manufacturing Careers made it clear that in the state's manufacturing sector, there is a critical shortage of both CNC machinists and industrial maintenance technicians. Gustus will be fully certified as both when he leaves RACC.

"I wanted something in the Reading area. And I wanted to be all but guaranteed a job once I graduated. I also wanted to find something I really want to do. I may be starting a little late in the game, but I have lots of years left to work, and life is too short to be stuck in a job you can't stand."

So says Wendy Benson, a native of Bradford County, Pa., and a stay-at-home mother of five for the last 13 years. With her youngest now heading for kindergarten, she wants in on the manufacturing workforce.

Benson could have returned to Penn State University, where she had completed two years in the Horticulture Program. Horticulture was no longer attractive to her, she says, because her research told her there weren't enough jobs in that field. "Still, if I was going to return to school, I wanted to make it work at Penn State," she says, "partly because I knew I had those credits there. I went to Career Services and asked them who is hiring and who is paying. They said engineering. I knew my science and math are excellent, so I figured I'd look into engineering."

But she gravitated toward RACC rather than Penn State University because the program is so much more flexible and because it's located so close to where she lives. She decided to get her feet wet by taking a course in computer technology and IT.

"Whatever path my career in manufacturing follows, I think it's a safe bet that it's going to involve IT," she says. "It was only after I got here that I became aware of what they offer in mechatronics. As I started asking staff and students more about it, everyone said, 'Talk to Bonnie,' so I did. She took me for a tour of the mechatronics lab, and as soon as I saw that, I knew this was the program for me.

"First of all, it's so near where I live. And remember, I have five kids. This program lets me do a lot of the schoolwork through e-learning, so when we had all those snow days this year and the kids were at home, I was home with them. But I was able to keep progressing with my coursework. I'd jot my questions down and get them answered by the teachers when the snow allowed me to get to the campus. Could I have found a way to make it work in a more traditional college or university setting? Maybe. But this is so much better. I started in January of 2014 and hope to be done around June of 2015."

Like the Lancaster County CTC, RACC has just as many, if not more, of the hardware trainers that make learning come alive in the learner's hands. "I don't know how you can teach this subject matter any other way," says Benson. "You can look at a book, you can do the simulation on the computer. But until you experience it in your own hands, how do you know how much pressure you need to connect and disconnect a pneumatic hose?"

When asked how this training will help her in the workforce three to five years down the road, her answer is simple enough: "All I can say is that as I look at job offerings in the region, what they are looking for is exactly what I'm learning here. They make it very clear that they prefer an associate degree like the one I'll earn here at RACC."

If she has one concern it's that the field she seeks to enter is basically populated by guys who grew up tinkering with machines and motors and all things mechanical. Lacking such a background, she wonders if that might somehow hold her back. But in the short time she's been at RACC she already recognizes that the teachers in the program are all extremely experienced in what it's like to be on the plant floor of a manufacturing enterprise. "I'm counting on them to clue me in," she says.

The teachers she mentions were handpicked by Spayd. "They're classified as noncredit adjunct faculty," says Spayd. "Many are engineers or former maintenance engineers. Some

are still employed as maintenance technicians/engineers in industry.”

The one thing a teacher at the technology center at RACC is *not* is an ivory tower academic. Spayd feels strongly that those who train today’s manufacturing workforce must have firsthand knowledge and experience of what it’s like to be a manufacturer. She herself spent 16 years in manufacturing.

“Had I not had autonomy in hiring the instructors here, I might have had a difficult time coming on board,” she says. “Don’t get me wrong, RACC has some very good credit faculty members here. But for this program, that was not what I needed. I needed teachers who came from manufacturing.”

As our interviews at RACC drew to a close, one question Spayd put to Benson was this: How do we encourage more women to take a look at manufacturing as a career choice? Benson’s advice was to get into the middle and high schools and engage girls more aggressively at that young age.

Twenty-year-old Kory Koehler is about half the age of Gustus and Benson. Unlike them, he enrolled at RACC right out of Wilson High School in West Lawn, Pa. But he’s been perfecting his technical chops for some time now. Hanging with the cycle and dirt-bike crowd didn’t hurt. He also launched a summertime business called Evergreen Asphalt Maintenance that had him painting the line stripes in parking lots. Perhaps most significant, he enrolled in Project Lead The Way electives in each of his four years of high school. A leading Science, Technology, Engineering, and Math (STEM) initiative in more than 5,000 schools nationwide, Project Lead The Way provides a world-class curriculum as well as teacher guidance—all aimed at improving the quality of STEM education in our schools.

“Project Lead the Way gave me the opportunity to learn new technologies like CNC, CAD, 3D printing, and modern manufacturing techniques,” says Koehler.

Koehler says he considered a four-year bachelor’s degree at places like Penn State or Carnegie Mellon, but RACC’s focus on mechatronics proved irresistible. He hopes to graduate in the summer of 2014 with his Associate in Applied Science degree in Mechatronics Engineering Technology.

Koehler’s pathway to the manufacturing workforce has already begun in earnest. He works as a junior service engineer three days a week at Precision Machine Tool Solutions, a seller of CNC machines based in Sinking Spring, Pa. When he first started looking into RACC, he wasn’t aware of how flexible the program was. But now it’s one of the things he likes best. “Getting my Associate Degree in Mechatronics Engineering and Technology is very important to me, but because RACC is set up the way it is, I can balance education with other aspects of my life,” he says. “I can get my coursework in at my own pace while holding down what’s practically a full-time job.”

Just because he’s employed as a service engineer and on his way to an associate degree does not mean that Koehler has ruled out a bachelor’s degree.

“In five years I see myself continuing to work in manufacturing and using skills developed

at RACC,” he says. “But I hope to have completed or to be pursuing a Bachelors Degree in Engineering at Penn State Berks, as well. Why limit myself to service work? And what if I don’t want to be working with my hands when I’m 50 or 60?”

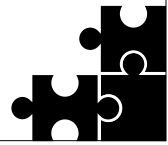
Before saying goodbye to Koehler and letting him get back to the coursework and labs right outside the conference room we sat in, I asked him to sum up what he liked best about his career path. He said he liked that it allowed him to hold down a good part-time job while pursuing his postsecondary education. But even more important, he said, is that because he has a job, he is able to take what he learns at RACC and apply it in the real world every day that he walks through his employer’s door.

“That’s what’s going to make it stick,” he says. “In my particular case, when it comes to learning, if I don’t use it, I lose it.”



Kory Koehler (left) enrolled in the Schmidt Training and Technology Center at Reading Area Community College right out of high school. As he explained to *Packaging World* Editor Pat Reynolds, he plans to graduate in the summer of 2014 with his Associate in Applied Science degree in Mechatronics Engineering Technology.

Individuals and individual companies can make a big difference. Companies sponsor their own science and engineering fairs and encourage employees to serve as team coaches and judges. We collectively have much to gain as an economy by developing an adequately skilled workforce for manufacturing, but in the final analysis, it is the manufacturers themselves that have the problem, and it is up to them to influence policy and take direct action to solve it. Summer manufacturing camps are a tool that has been used by workforce agencies and others. This chapter describes how one manufacturer took on the task of developing such a camp for kids.



Author Bio



Simon Nance,
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I first met Simon Nance at The Automation Conference in 2013 where he was a speaker. He is partially responsible for the creation of this Playbook, because his talk excited others throughout the conference to raise issues of workforce development. It seemed that no matter what the topic of a conference session, the questions always came back to workforce issues. After pointing out that peculiar trend to the sponsors, we jointly decided to develop this Playbook. And given Simon's enthusiasm for the topic, we had to have him share his experiences in the Playbook.

Simon Peter Nance started his career as an industrial engineer in aerospace manufacturing, working predominantly on process improvement. In 2003, he joined STIHL Inc. as an engineer in charge of the employee suggestion and process improvement program, and in 2005 he became the Manager of Training & Development. By uniquely applying engineering techniques he re-established the educational systems at STIHL Inc. With the expanded role of Manager — Learning & Development, Simon broadened the on-site programs at STIHL Inc. and set world-class standards for Manufacturing Technical Training, Employee Development, Business Skills Training, and Regional Workforce Development. Through STIHL Inc. and in partnership with Dream It Do It Virginia, Simon created an annual manufacturing summer camp program for youth that has received national recognition and continues to expand.

Simon is a graduate of Worcester Polytechnic Institute with degrees in Industrial Engineering and Humanities, and he has his MBA from Averett University. With specialties including instructional design, technical writing, process improvement, and industrial engineering applications, Simon has changed the common approach to the learning arena into a discipline of "brain engineering." Additionally, he is a certified instructor for courses in critical thinking and teaches classes on presentation skills, teambuilding, and supervisory skills. In 2014, he joined Apex Tool Group and is now their Global Learning & Development Manager. Simon continues to actively support national and regional efforts to build a skilled workforce and is a proponent of apprenticeships and the skilled trades. He thrives in his roles as a public speaker, teacher, and coach, but his most rewarding role is at his home, as a husband and a father.

Chapter Twenty

What the Future Workforce Doesn't Know

Building awareness about how cool manufacturing really is.

by Simon Nance

The workforce of the future comes from the parents of today. Right now, parents, teachers, counselors, and many trusted advisors of our youth (the workforce of the future) have an incorrect perception of what manufacturing is and what modern manufacturing looks like. The 17 additional resources listed at the end of this chapter can correct those perceptions and start a new way of thinking that will have a lasting impact on our youth—our future workforce.

I wanted to have a positive impact on our future workforce when I realized how wrong perceptions were about manufacturing. I did this at a meeting of industry leaders in Hampton Roads, Va., in 2008; I encourage you to do the same. The next time you are with a group of proponents of manufacturing jobs and the skilled trades, ask this question: “Who among you has children?” Wait for hands to go up. Then ask, “Who among you is OK with your children not going to college?” Watch what happens with the hands. Since 2008, I have done this a few dozen times in a few dozen groups, and I have found that it creates a bit of confusion in many peoples’ minds. If you have been studying the generational differences in the current workplace, you may already know the history that has built up to the current perceptions of education, career success, and what a “job” should look like. Asking parents about their kids draws out two major discrepancies that can be reconciled through better perspectives on manufacturing.

The first is a disparity between the concept of going to college and the concept of having a successful career—or more accurately, having a “good job.” The second is the dissonant idea that jobs in the trades have little or nothing to do with intelligence and income. The analysis of data for college graduates, employment rates, salaries, and other related analyses (these analyses are important, and workforce development decisions should be based on this data) is the business of other chapters. Here we are looking at the business of perceptions; here are two. For college graduates currently employed, the perception is that a greater amount of the workforce is of similar educational level—“Everyone went to college, right?” For employees who have good jobs (let’s say a skilled trade position such as a machinist) and do not have a college degree, at least three perceptions exist: “College graduates have better jobs than me,” “My kids have to go to college to be better off than

me,” and “I am worse off because of my job and degree level.” Some data will support these perceptions, other data will refute them. The issue with these perceptions is that they associate college, rather than skill, with success. Not to mince words, I will encourage any youth to strive to go to college; I will first, however, encourage them to get a job to build (or realize talent in) a work skill.

The numbers behind these perceptions may show the truth of the past and help us logically develop policies and programs and make decisions about our future. But when we think about success for our children, our emotional desire for better successes for our progeny skew our logic and let us hope for better tomorrows than the numbers may predict. You can’t convince me to have my kids go into the trades because of average salaries or predicted job growth. The logic doesn’t follow—desire for their success is based on emotion. Using emotions, however, my kids can convince me to fully support what they want to do when they grow up (be an astronaut, for example) because they think it is a cool thing to do.

So how do we make our kids think manufacturing is a cool thing to do? Have them attend a Manufacturing Technology Summer Camp. The original Manufacturing Technology Summer Camp was conceptualized in 2009 and developed at STIHL Inc. over a two-year period. In 2011 it was first run at STIHL in Virginia Beach, Va. Since then, in partnership with Dream It Do It Virginia and the Virginia Council on Advanced Technology Skills (VCATS), the Manufacturing Technology Summer Camp concept has grown to a statewide initiative.

The Manufacturing Technology Summer Camp’s goal is to ensure that students are properly introduced to modern manufacturing through tours, presentations, small projects, and a competitive manufacturing activity. The camp is a four-day process where middle and high school students learn how to design and execute a manufacturing process, brainstorm and make decisions, and work as members of a manufacturing team. They also create production plans, improve processes, and learn quality assurance techniques.

On the first day, students learn about their team members and about the camp competition and production systems they will use. Each team builds the essential machine for that production system and tests its capabilities. On the second day, students construct a manufacturing process for each of the different types of products the team will make in competition. Building these prototypes gives them the knowledge and skill necessary to have the production system work well. On the third day, teams receive their product demand, which is used to determine how to balance manufacturing operations to produce the required number of products in the two-hour competition. On the fourth day the teams compete in front of family, friends, judges, and other guests, using their production systems to manufacture the required quantity of different products.

Each day of the camp has four or five activities, at least one presentation from a sponsoring company or organization, a factory tour, and a review and recap of lessons learned by the students. As the camp has developed and evolved, the documents and reference materials have become more standardized, and in the past three years, the camp has become something that any manufacturing company or group of companies within an industry can host. For example, STIHL hosts a camp based on machining and assembly, using a three-ax-

Some different pieces of media coverage highlight STIHL's camp since 2011:

2013 STIHL Manufacturing Technology Summer Camp

<http://wtkr.com/2013/07/18/kids-attend-manufacturing-summer-camp-in-virginia-beach/>
http://www.wavy.com/dpp/news/local_news/va_beach/stihl-hosts-manufacturing-camp-for-students

2012 STIHL Manufacturing Technology Summer Camp

<http://www.stihlusablog.com/2012/08/stihl-inc-hosts-manufacturing-camp-for.html>
<http://www.workforce.com/article/20130305/NEWS02/130309972/stihl-instills-manufacturing-skills-into-high-school-students-learning-via-summer-camp#>
http://www.stihlusa.com/information/corporate/press/july26_stihl_manufacturing-camp_events/

<http://hamptonroads.com/2012/07/camp-students-learn-business-manufacturing>

2011 STIHL Manufacturing Technology Summer Camp

<http://www.wvec.com/home/Stihl-Incorporated-Summer-Camp-125593648.html>
<http://ireport.cnn.com/docs/DOC-636203>
<http://beldenblog.com/stihl-re-tools-summer-camp/>

is CNC tabletop mill. A printing company in Virginia uses printers, cutters, and presses to put together direct mailing packets for distribution; a bottling company can use tanks, valve manifolds, and conveyors to produce filled containers. The camp design is universal, but it takes some effort to make it work.

The first year we ran the camp at STIHL, five student teams, each led by a volunteer coach and a team assistant, spent three and a half days preparing for and working in a manufacturing competition that built three different kinds of clocks. In following years, we built printed circuit boards, robot chassis, flashlights, and lamps. Though the products have changed over the years, the camp design and the principles experienced each day stayed the same. Each group spent the first day building their team and constructing, programming, and testing a three-axis CNC engraving mill. Yes, all that on the first day. On the second day, team members learned a number of manufacturing operations from drilling to tapping to painting to assembly. They were also given materials to construct prototypes of the three different clocks. This is the day that the hands-on activities showed what it takes to turn raw materials into finished goods. Production requirements were given to the teams on the third day, as well as a schedule for shared resources, such as a drill press and a paint booth. Teams needed to create a balanced production plan for the two-hour competition on the following day. The two-hour manufacturing competition started with raw materials for 20 clocks on each team and ended with three teams completing the production requirement and one team being judged the winner.

Camps cost between \$200 and \$2,000 per team, depending on the types of machines

used, the products being made, and the industries hosting them. Each team of between three and seven students needs a coach and a team assistant, and the host company will need a core team of at least three to administer the camp. It takes about 200 or more man-hours to prepare and execute those things, some as simple as notes to participants. But it all needs to be done precisely. Thirty different letters and e-mails go out to student participants, volunteers, and parents between announcement of the camp in the late winter and running of the camp in the summer. Efforts to get sponsors and industry and academic partners takes time and gumption, as does setting up scholarships and other awards for the winning students.

So why put forth so much effort? Why spend hours and dollars to have students see manufacturing for four days? Because showing our future workforce what it takes to turn raw materials into finished, salable goods makes an impact that lasts a lifetime. But don't take my word for it; these are notes from a few parents in response to the daily updates sent home by the camp host at STIHL:

Thank you for providing Adam and his fellow campers with an amazing experience last week! It was fascinating and inspiring to watch the kids as they worked on their projects; worked in teams; and worked through the roadblocks that presented themselves along the way. My husband and I (both mechanical engineers) were equally impressed by the beautiful, clean, modern campus and facility. I hope that you will continue the camp program in the future. I'm sure you know what a challenge it is to interest 15- and 16-year-old kids in ANYTHING that doesn't appear in a digital form. And so the fact that they were all there, all working together and all feeling great about themselves and their teams speaks volumes. - Amy Zelenka

I just wanted to thank everyone involved in the STIHL manufacturing and technology camp. It was an excellent program and a great opportunity for high schoolers to be part of the camp. My son, Pieter, enjoyed everything and is now convinced he will become an engineer in the future. - Louise Honig

I can't tell you how pleased I am that STIHL is putting on this program. As a local business owner, it is very difficult to find good people with technical skills and a clear understanding of what it takes to work as a team, to think about "the process of production," and to take pride in what they do. My son Perry came home yesterday with a profound respect for STIHL and what your company has accomplished; moreover he is excited about a future in industrial engineering as he is particularly mechanical and computer oriented. My thanks to STIHL and all involved in this most worthwhile program. - Robert Bloch

I really enjoyed my day there helping at camp! The tour and your entire facility is amazing. It was my first experience in a factory! I am forever changed. I found myself thinking about all that I learned and about everything I used at home and what goes into making it... WOW. So, not only are you impacting our kids, you are also impacting your volunteering parents too! - Helen Voorhees

As encouraging as the new perspectives from these parents were, a note I received from a parent who has since volunteered as a coach has been an inspiration for me and for STIHL to share this camp with any company that wants to make a real lasting impact on their future workforce and on their communities.

I would like to say “Thank You” for letting Zach attend the Manufacturing Camp the past two years. I’m sure you are not aware, but the camp has made a big difference in Zachary’s life. Prior to the camp last year, Zachary had difficulty with group work in school. This past school year, his teachers reported that he has had no difficulty with group work. In addition, this past school year, Zach has taken responsibility for his learning and did so well that he earned the status of Honor Roll for three out of the four quarters. He has also done so well that he no longer used any accommodations or modifications for his Autism and no longer qualified for any Special Education Services. In fact, Zach did so well in his classes that he will be taking advanced courses next school year (Algebra II/Trigonometry, Physics, and A.P. English 11), in addition to Engineering Technology. This past year, he was at the top of his class in the 3-D Modeling & Simulation Program at his school

Zachary plans on going to college at VA Tech, with a major in Engineering. This past Spring, he was chosen to attend the Spring Fling program at the Virginia Tech College of Engineering, and he will be invited back to VT every semester until graduation, for various events and activities at the VT College of Engineering.

Zach’s attendance at the camp played a part in all of his success. Since the first camp, he was able to envision life beyond high school, and what he needed in order to achieve those goals. Zachary has become determined to fulfill his dream of becoming an Engineer. Thank you very much for giving my son the opportunity to participate in the STIHL Manufacturing Technology Summer Camp the past two years. I will be forever grateful! – Brenda Lamb

Changing perceptions of what manufacturing is—what manufacturers can do—is vital to the manufacturing renaissance we are starting to experience. The impact we (manufacturers) can make by something as simple as opening our doors to students, so that they can see the reality of making things, can do more than build excitement in our future workforce, it can forever change lives.

Taking action right now starts with the right perspective, then the right first step. These 17 additional resources are a sampling of some amazing work across the nation that creates new perceptions of manufacturing and what it takes to make our future workforce great. There are undoubtedly many more resources out there. If you take half of your day and become familiar with these, you will be empowered to make some real changes with your new perspective.

Websites & Web Resources:

Edge Factor

<https://edgefactor.com/home>

How It’s Made

<http://www.sciencechannel.com/tv-shows/how-its-made>

Max & Ben’s Mfg. Adventures

<http://www.westernnc.edu/maxandben/>

Dream It Do It Virginia

<http://www.dreamitdoitvirginia.com/index>

Tooling U

<http://www.toolingu.com/shortage/>

The American Innovator

<http://theamericaninnovator.com/>

Advanced Manufacturing Portal

<http://manufacturing.gov/welcome.html>

Reports and Whitepapers:

VMA: Definition of Advanced Manufacturing (see .pfd)

Brookings, Metropolitan Policy Program “The Hidden STEM Economy”

<http://www.brookings.edu/research/interactives/2013/the-hidden-stem-economy>

McKinsey Study on Education to Employment

<http://mckinseysociety.com/education-to-employment/report/>

Organizations / Educational Foundations:

Manufacturing Skills Institute (Virginia Manufacturers Association)

<http://manufacturingskillsinstitute.org/>

Manufacturing Institute (National Association of Manufacturers)

<http://www.themanufacturinginstitute.org/>

ASM Materials Education Foundation (ASM International)

<http://www.asminternational.org/foundation/about>

Nuts Bolts & Thingamajigs (Fabricators & Manufacturers Association, Intl.)

<http://www.nutsandboltsfoundation.org/>

SME Education Foundation (Society for Manufacturing Engineers)

<http://www.smeef.org/>

FIRST Robotics

<http://www.usfirst.org/>

National Institute for Metalworking Skills (NIMS)

<https://www.nims-skills.org/web/nims/home>



To adequately fill the educational pipeline for manufacturing jobs, kids need to be informed in their middle school years. In some countries, students are put onto a track that leads directly to manufacturing. In our country, kids are given wide latitude to choose their track, and many do so with very limited information and with little thought to the practical realities of someday needing to support a family. While many programs have been undertaken under the banner of STEM (science, technology, engineering, and math) initiatives, these are more likely to be directed at those who are in advanced placement programs and sometimes overlook that group referred to as “the forgotten middle half.” Innovative approaches are being tried to properly inform students and parents across the board, and these approaches are resulting in success. This chapter shows how a regional economic development agency tackled the issue.



Author Bio



Jon Scott,
President & CEO,
Greater Reading
Economic Partnership

In the course of a year, I visit quite a few community colleges and career centers. While many schools have been successful at bringing adult learners into their manufacturing programs, it is far more rare to see a strong pipeline from high school into a community college program targeted to manufacturing careers. When I see a such a pipeline, or I see a change in a pipeline from year to year, I always inquire about what changed. Such an inquiry led me to find out about the Careers in 2 Years program in Berks County, Pa. And everyone I asked about the influx of high school students told me, “You need to speak with Jon Scott.” Not only did I do that, but I also reached out to him to share his success in the Playbook.

In June 2004, Jon Scott was named President and CEO of Greater Reading Economic Partnership (GREP).

Jon previously spent 10 years as President of Time Warner Cable’s Eastern Pennsylvania Division and later as President of Time Warner’s Binghamton, NY, Division.

At Greater Reading Economic Partnership, Jon uses his leadership skills and management experience to mobilize the multiple resources of the Greater Reading and Berks County economic development community. His goals are to retain existing business, attract new industries, and foster a competitive business environment through aggressive marketing aimed at creating sustainable and diverse employment opportunities for current and future generations.

He currently serves on the Greater Reading Young Professionals Advisory Board, the Foundation for Reading Area Community College, and the Penn Corridor Initiative. During Jon’s time in Berks County from 1989 through 1999, he served on the board of directors for many not-for-profit organizations, Jon also has been honored with several awards in recognition of his outstanding service to the community. Jon served as the Co-Chair for the Ride to Prosperity that was unveiled in June of 2010, and he assists in forming the economic development roadmap for the Greater Reading region.

Jon received a Bachelor’s Degree in Political Science from Kalamazoo College in 1973. He and his wife, Vee-Vee, reside in Wyomissing, Pa., and they have two daughters: Genevieve, who is a visiting fellow at Yale University, and Lily, who recently graduated from Bryn Mawr.

Chapter Twenty-one

Careers in 2 Years: Go from Learning to Earning Fast

A local economic development partnership promotes manufacturing careers to kids.

by Jon Scott

Several years ago, it was becoming apparent that there was beginning to be a “skills gap” between existing manufacturers’ job requirements and the skill sets people had—particularly younger individuals finishing high school. This problem became apparent to the Greater Reading Economic Partnership (GREP) in Berks County, Pa., as its staff constantly spoke with area manufacturers. Over the course of these conversations, there were some predominant themes that seemed quite illogical:

- Unemployment was still relatively high.
- Existing and outstanding manufacturing companies had high-paying job openings they were having difficulty filling.
- There were not enough people applying for jobs that had all of the requisite skills for careers, such as computer numerical control, welding, and mechatronics.

As GREP learned more about this dichotomy, it was clear that there was a significant perception problem influencing individuals that would choose a Career and Technology Center (CTC) or a community college. Too many individuals felt they had little choice. Even if they were not sure about the direction they wanted to choose for their profession, they felt they had to go to a traditional four-year liberal arts school. One of the root causes of this dilemma was that people still perceived CTCs as “vo-tech,” which was stereotyped as suitable for troublesome students or slow learners. GREP decided that it needed to shatter this erroneous myth.

Its staff worked with a local integrated marketing agency, Reese, which immediately understood the core issues and developed a full multimedia marketing, advertising, and public relations campaign called Careers In 2 Years (CI2Y). At its core, CI2Y had to make vo-tech cool and change the outdated perceptions for a better appeal. While students were a key target audience, so were their parents and educators who serve as key influencers and gatekeepers.

Therefore, it was critical to change their attitudes and beliefs about career technology education. Through visuals and testimonials, the CI2Y campaign needed to reinforce technical training as a viable career path that is just as rewarding as the traditional collegiate route.

Getting career and technology training could be the first step toward someone's future, a mid-step, or the last step in formal training along anyone's career opportunity ladder. What is truly important is realizing that there are many ways for people to garner "stackable credentials," including various certificates as well as degrees. There is a true constellation of programs available for people today.

New Realities Shape the Message

There are several things that helped begin to shape the components of the message for CI2Y. First of all, today's workforce has very different training and educational requirements compared to 30, 40, and even 50 years ago. Also, with the technological boom, our world has changed dramatically. As a result, we needed to fundamentally shift how we think about the types of training and education needed to prepare people for careers appropriately. Today's manufacturers need people with more than just brawn. Employees need to be able to use both their hands and their brains simultaneously.

Another factor considered is that almost half of today's college graduates have extreme difficulty in not only finding a job, but also finding one within their major. There's a significant percentage of students from traditional colleges burdened by a huge amount of debt, frequently five to six figures, before they step foot on the job. Recently, this has been highlighted as a potential national dilemma.

With CI2Y, students can reduce the amount of debt immensely. They may start in a CTC and advance through an apprenticeship before they graduate high school, giving them a great advantage.

CI2Y offers a new dynamic to begin changing perceptions. Today's model of education looks much different than the traditional "ladder-climbing model"; it's more cyclical with multiple entry and exit paths to provide a well-rounded, growing career. CTCs and four-year college degrees can coexist to provide the appropriate degrees and skills that workers need for continuous education and a productive career. CTCs train you for different skills and roles, which can be started at all different entry points. Working adults can use CTCs to advance their current skills and their careers with relevant training. CTCs also are ideal for retraining adults or veterans who choose a new career path.

CI2Y Campaign Appeal: Learn to Earn

The CI2Y campaign materials directed people and traffic to three specific websites: Reading Area Community College, Berks Career and Technology Center, and Reading Muhlenberg Career and Technology Center.

The branding for CI2Y was specifically created to appeal to younger audiences with its edgy, bold look, and empowering feel. The campaign materials were developed in both English and Spanish, with some materials featuring acronyms frequently used in texting—practically a language of its own. CI2Y's fully integrated campaign included a large focus on web, electronic marketing, social media, and digital ads—allowing the performance of each message and medium to be well-tracked and measured. Public relations tactics included news releases, editorials, and speaking engagements that gained exposure and promoted

CI2Y among local business and educational leaders. CI2Y's campaign materials included websites, digital and print ads, flyers, posters, direct mail, billboards, and high-definition videos. Thirty-second commercials also ran on cable networks and in well-targeted movie theaters as trailers.

The energetic, fast-paced videos and edgy ads depicted modern manufacturing environments more accurately—clean, high-tech, and essentially hip to work in. They featured a “Learn to Earn” message and showed people in great jobs that pay excellent money. Local-area average salaries were featured too, and typically were at least 25% higher than the average salaries of college graduates. CI2Y focused on very specific, available jobs in local manufacturing companies, including welding, mechatronics, robotics and automation, precision machining, machine shop technology, and computerized drafting technology.

The Game Changer

Although CI2Y is relatively new, it is already beginning to increase enrollment within CTCs. The CI2Y program was highlighted at both of the 2013 Pennsylvania Economic Development Association semi-annual meetings, and a great number of individuals from multiple counties expressed interest in using this concept to customize it for their region and their requirements.

Top executives in Pennsylvania's Department of Labor and Industry have encouraged GREP to develop a full-blown program that other counties can use throughout Pennsylvania. GREP and Reese have created CI2Y-branded templates and materials that can be customized or slightly modified to fit the needs of other locations that may benefit from the program.

GREP believes that giving people the type of training that Reading Area Community College and the CTCs provide is an opportunity for graduates to pave a smoother road to great-paying jobs. In fact, some area companies guarantee an interview and preferred screening among these graduates. Since many local companies offer educational benefit programs, once individuals land a job with a company, they will still have the opportunity to expand their formal education—including additional skills training—and can develop their career direction by pursuing a four-year degree or even a master's degree. Often the employers will pay some or all of the educational costs, further reducing personal debt.

It's important for people—especially high school students and their parents—to understand that manufacturing and technology jobs are hip, high-paying, and eminently available. In fact, we believe that until the negative perception behind CTCs and community colleges reverses, we may risk losing excellent employers who could relocate to find the labor pool they need. GREP knows it has the talent right here in its home region. It's critical to make sure there is an easy and non-stigmatized pathway for people to get the proper training.

Ultimately, the goals and metrics that are most important are the number of applications and graduates from Reading Area Community College and the area's two CTCs. Monitoring and influencing the number of people that land jobs as a result of proper training is key.

Many communities have workforce investment boards, economic development boards, and the tools. But few—if any—have established the process to initiate a conversation that leads to collaboration among the appropriate community players and organizations. CI2Y outlines the process of who to bring to the table and considerations and decisions to make, while

providing CI2Y artwork and branded tools that GREP can customize for other locations.

Over time, the CI2Y program and the solid platform it builds for local economic development will continue to solve pressing needs and help nourish its community. It will help:

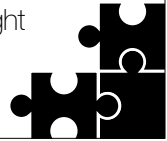
- Sustain skilled labor through two-year programs.
- Forecast future community need trends.
- Build local workforce by training and retaining skilled workers.
- Maintain collaboration between educators and manufacturers to positively affect the community's economic development—sustaining the present and planning for the future.

CI2Y has created a process that contributes to economic development that will have a significant, long-lasting impact in the community. Its process facilitates the appropriate conversations with the right people in the community. Manufacturing companies and educators in two-year degree programs and CTCs now collaborate to project their future workforce needs. In turn, educators can establish the courses to train incoming students—including working adults—in skilled labor trades.

We encourage you to visit www.CareersIn2Years.com to watch the informative and very energetic two-minute video to capture the vibe of the CI2Y program. There are also a number of resources that will give you a clear understanding of what the CI2Y concept can accomplish for students, adults/veterans seeking new career paths or further training, and the overall local economy.



Skilled manufacturing technicians have been referred to as “gold-collar” workers, reflecting the fact that they are worth their weight in gold and enjoy a special role inside most companies. Some might refer to them as shop-floor geeks. Managers acknowledge that they would be the last to be let go in a downturn, and during the recent recession, there was ample evidence of this. Many of these folks have been developed and promoted internally from other manufacturing jobs. But as the pace of technology deployment increases along with the rate of retirement, it is becoming more common for manufacturers to look to technical colleges to fill the role once played by apprenticeship, putting younger people in more responsible roles. Instructors who have been turning out these graduates for some time have a special insight into what works and what doesn’t as high school students make the two-year transition to a responsible role in industry.



Author Bio



Kevin Lipsky,
Instructor, Wisconsin
Indianhead Technical
College

I met Kevin Lipsky years ago (I can’t remember when) at a PACK EXPO trade show. Kevin has always shown his passion for helping students find careers in manufacturing, and he has taken the initiative to bring his students to Chicago or Las Vegas for networking, student competitions, and familiarization with the industry. He is a trustworthy volunteer, bringing both an industry and an educator viewpoint, when it comes time to develop certification exams with PMMI. When he heard about this Playbook, he wanted to help.

Kevin Lipsky has been an instructor at Wisconsin Indianhead Technical College for 27 years. As such, he has experienced, more than many, the changes in both educational technology and machine technology over a span of three decades. He has developed the Automated Packaging Systems Technician program at WITC to meet the needs of today’s world-class machine builders and end users.

Prior to becoming an instructor, Kevin was employed by Bemis Machinery Company, in Green Bay, Wis., a manufacturer of sterile product filling, flow wrappers, thermoformers, and pallet wrappers as a service engineer. He is an active member of the Institute of Packaging Professionals (IoPP) since 1978. He holds a Master of Science degree in Career and Technical Education and a Bachelor of Science degree in Industrial Technology, both from the University of Wisconsin Stout, in Menomonie, Wis. He was one of the first graduates from the WITC program he now teaches, a program that is unique in Wisconsin.

Chapter Twenty-two

The Path from High School to Gold Collar Career

Students need guidance to help them make the choices that lead to a satisfying and successful career.

by Kevin Lipsky

I see many students in my role as a technical college instructor. Many are recent graduates from local high schools who have little idea how to get from where they are to a rewarding and successful career. I feel that part of my role is to serve as a mentor to help these students find the best careers that leverage their interest in technology, strong technical preparation, basic skills in math and English, and their general employability skills (work ethic, attitude, etc.). Many of these good jobs are in manufacturing and are increasingly being referred to as Gold Collar Careers. This term reflects the value that employers place upon these employees who possess good technical skills, can think on their feet (troubleshoot), and work with their hands and mind at the same time. I would like to share some of what I have found useful in helping students overcome the obstacles and achieve success upon leaving our college and entering manufacturing.

But first a bit of my own story, which is relevant here and instructive because I had to deal with many of the issues and challenges that young people face today. It's a story of how I went from high school to a four-year bachelor's degree program in engineering science to being a college dropout to working low-wage jobs to discovering that there was this thing called a two-year technical college to eventually becoming an instructor in a two-year technical college program.

My story begins with graduation from River Falls High School in Western Wisconsin. Encouraged by family and friends, I enrolled at the University of Wisconsin River Falls (UWRF) for a four-year engineering science program directly out of high school with recommendations from family and university personnel. I had prepared academically for college by taking college preparation courses in math, chemistry, and physics, but I had not prepared myself mentally for a self-motivated, fast-paced course of study, nor was I used to being in the company of so few friends from my hometown. I dropped several courses and completed a few, but soon enough I was no longer working on a four-year bachelor's degree, and I didn't have much of a plan.

I decided to work for a ski area on the lift crew, and in the spring, helped build residential homes with a local carpenter since I had some previous experience with construction. My father was a professor at UWRF, and my mother taught second grade at the local

elementary school. They were not happy with their eldest son's choice of low-skill and low-wage employment. Previous jobs that I had held over several years while still in high school had helped me to develop my employability skills, such as being able to perform tasks with safety in mind and putting in effort for the pay received. These jobs provided spending money that was put into my hobbies of muscle cars and downhill skiing. I believe this background information is important to illustrate how young people are frequently treated and perceived as they think about entering a career.

My father was teaching a counseling course, and the dean of student services at WITC was in his class. The dean described a new program that had just started at the Technical College in New Richmond. My father briefly outlined for me what a technical college was, since I was not aware, and he explained the new program that was designed to train people on the assembly and repair of packaging machines. I was interested, since I worked on my own equipment and my uncle's farm equipment and enjoyed learning how things could be fixed and operated. One day, I was taken to WITC and shown the door to the lab. I saw machines and components that were new to me, but I was fairly certain that I would be able to master them with some practice. I enrolled in the program and proceeded to find out about the field of packaging.

I remember thinking that I could learn about packaging more quickly by spending time with a family friend who worked for 3M and who seemed to enjoy his career. I spent time reviewing the packaging trade journals he shared with me and getting an idea about the terms and types of products one would need to become familiar with to be successful. After my first class trip to PACK EXPO in Chicago in 1978, I was sure that the world of packaging machinery was something that I could enjoy while earning a decent living. I also felt that I had something to offer immediately to an employer while I was further developing myself through experience. After graduation from the one-year program at WITC, I found a small company that was developing a machine that would mine lead shot from trap shooting ranges, and I worked on these large pieces of machinery at several locations in Wisconsin. In the fall, I furthered my education at the University of Wisconsin Stout in Menomonie, Wis., earning a B.S. degree in Industrial Technology with a concentration in packaging. A search in a trade journal had a news release about Bemis opening a new packaging machinery production facility in Green Bay, Wis. I practiced my networking skills to find the connection who would give me a tour and help with my application and interview. I was selected as one of the two field service engineers who worked with food and pharmaceuticals in many parts of the world. I later accepted a position as instructor at WITC and began work to develop curriculum and solicit 100-plus packaging machines that could be used for hands-on training. A working relationship with employees and vendors was also a major task. To earn my instructor certification, I added a Masters in Science Degree in Career and Technical Education.

The point I'm trying to make is that while my career path, described above, was anything but neat and tidy, it turned out to be the perfect preparation for the job I accepted in 1986 and have enjoyed ever since: instructor in the Automated Packaging Systems Technician Program at WITC. In this position, I am able to share every day the excitement

of making correct career choices with students who, like me, also find manufacturing a rewarding place to forge a career.

Unfortunately, students too often arrive in my program having to overcome basic misperceptions about a manufacturing career. For example, they think that manufacturing has limited earning potential and limited room for advancement. Many students see the wages that are offered for entry-level production work as reasonable, and since these jobs do not require a commitment to getting an education, they start work without any formal training. They somehow need to be convinced that they can advance within manufacturing and earn more with some education or an associate degree. They should enroll in a college course. But too often, they see only two options: going to a university, which they reject, or going to work. The option of a certificate or an associate degree is not being presented to them.

The second misperception is that they have to delay the earning of a desirable income while they are getting their education, or they have to find a way to go to work and school at the same time, which in our college can be difficult. These are complex issues. We need to do a better job of communicating options and addressing concerns in high school to motivate and help more students transition from school to careers. Students who are self-motivated and have an innate interest in technology have overcome the difficult questions of what skill could I train for and will that lead to a reasonable income. Frequently the help they have found to arrive at those decisions has come from a network of friends and employers through conversations about what might be a good fit for the individual. I try to help students each day with their important questions about which skills they need to get hired, whether they are good enough for an employer to hire them, and which skills will an employer help them to develop later.

Another issue that I see in our rural area that is causing students to resist obtaining career training and education is where the training and the ultimate career position is located. Some students would like to stay close to home and work near familiar locations. It can be difficult for a small-town person to make a shift to the city or vice versa. It is also very important to recognize that most students need to work at least part time while at school to maintain food and shelter for themselves. Fitting the schedule of getting an education into an already complicated life becomes another impediment to their starting or completing their education.

This brings me to a misperception that society in general seems to share: that technical colleges are for the slower and more-apt-to-get-their-hands-dirty type of student. This is another perception issue that can make a student not want to enroll in a technical college in the first place. They think such training can only lead to low-skill work, and this is completely wrong.

Another group of students that I work with is returning adults who have had entry-level experiences and want some training to advance themselves into more pay or responsibility. These students almost always demonstrate a strong desire to get education and training, and most would admit that they should have made the decision to get their training and education earlier in their life. Mixing incumbent workers with newly minted high

school graduates in the college classroom helps both. The older adults see the management of time and the newer computerized methods used for training and skill development as major obstacles that require extra attention and extra effort. Students coming from high school are not easily intimidated by these obstacles, but they sometimes have a set of other distractions. The returning adult learner usually sees the high school student as a student with completely different motivation and interest areas and can be annoyed at the perceived lack of focus and attention to the coursework. The returning students differ in the way they see employment, since they may have held positions that they saw little future in and were not very happy with. This helps the recent high school students to comprehend the opportunity they have to earn a better income and become independent without having to relive the experiences of the older students, but it also requires them to perform in the classroom without the benefit of having been part of a mature organization.

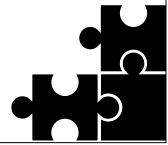
Developing a concept of a career pathway should start in the early stages of life. It seems to work well around the age of 12. For the past 15 years, I have worked during the summer sessions with 7th through 9th graders, holding sessions at the local high schools or on our college campus. I've teamed up with other college instructors or with a high school instructor and sometimes use a modified curriculum offered from the national program of Project Lead The Way (PLTW). We've found increased success by collaborating with the local 4-H and the University of Wisconsin Extension to help get the word out to potential students. We've been able to enroll students who did not have much previous experience with making things in shop class or using tools. I am not sure how much we are able to influence the ones who are not interested in shop class, but sometimes the word about what was accomplished gets out to others who are interested in hands-on courses. We've made several wood products using cutting tools and lasers, and we've built remotely controlled robots from Robot Vex kits that are able to accomplish a variety of challenging tasks. These courses were set up for two weeks and included a couple of manufacturing tours to show students how the subjects they were learning were being used in an application. They could personally see that each employee needs to have a solid set of basic skills, and that employees must demonstrate a good work ethic to hold their position.

In these summer courses, we have found it good to intermix groups with several levels of experience and to make the learning seem fun. Two things that I have learned in my years of doing these sorts of activities are that learning should be fun to be effective and that the methods used for motivating young people are similar to the ones that can be used for adults.

There is no lack of employers who want to hire newly certified technicians. Our follow-up survey of WITC Automated Packaging Systems Technician graduates from 2013 indicated 13 working in the field at an average starting salary of almost \$52,000. Given this demand, I try to help the student find his or her best employment opportunity. This is becoming easier with the use of the Internet and the electronic resume. Many employers visit our campus, and we have annual events like an interview day designed to get

students connected with the positions they would like to apply for. Students communicate today using new tools such as short videos and social networking media. Students who are looking for employment are leveraging a variety of resources, and the best of these resources seems to be other students who were recently employed. Professional and trade organizations are also very helpful with offering insight and networking, which motivates students to seek careers that pay well and offer challenges for the skills they are developing. Students need to investigate the culture of potential employers, because those who are a good fit with an organization seem to accept their roles and responsibilities the best. They develop positive experiences while availing themselves of ongoing training to truly attain a Gold Collar Career for themselves. I am pleased and proud when I see that happen, hoping that I played some small role in their success. A passion to do something that you believe in and the opportunity to do it to the best of your ability is very rewarding.

In earlier chapters of the book, we've presented the concept of stackable credentials and the importance of enabling students (potential or actual manufacturing employees) to duck in and out of educational programs as they progress in their careers. We've pointed out how the skill sets needed by manufacturing employees will differ based upon the segment of manufacturing in which they are involved. We discussed the issue of establishing college credit on a basis other than simply faculty contact hours. This chapter brings a number of these issues together and shares examples of stackable credentials at work to satisfy the needs of students and manufacturers.



Author Bio



Emily Evans,
Director,
Workforce Development
Bucks County
Community College

Since I met her a number of years ago, Emily Evans has been committed to bringing manufacturing training and education programs to a school that had virtually no manufacturing technical programs. She has pursued this goal steadily and consistently, reducing the burden by leveraging best practices from other institutions. Every time I visit her school, I see the results of this steady progress.

As Director of Workforce Development, Emily works closely with Bucks County employers to help meet their workforce development needs, assisting them with needs assessments and developing targeted, customized trainings. Bucks County Community College's Advanced Manufacturing Training Center is a direct result of developing and growing a program to meet the specific needs of the local employers.

She also oversees multiple adult education, welfare-to-work, and youth grant-funded programs and works directly with other Bucks County agencies to create new programming in these areas. She recently initiated an In School Youth program to bring area high school seniors into BCCC's Advanced Manufacturing Training Center to earn an industry recognized Production Technician certificate in preparation of a future in manufacturing. She also led the development of a Green Jobs Club, bringing juniors from multiple high schools into the College to learn about local "green" industry and sustainability programs.

She currently sits on the boards of the Bucks County Youth Council and the Bucks County International Trade Council. She is a graduate of Temple University with a degree in Communications.

Chapter Twenty-three

Stackable Credentials at Work for Manufacturing

A community college builds the capability to serve multiple industries and address the needs of students on multiple pathways.

by Emily Evans

Workforce Development at Bucks County Community College falls under the division of Continuing Education. One of our objectives is to partner with business and industry to identify needs and design training services to help them achieve their strategic objectives. It's part of our mission to support local businesses to keep them strong, profitable, and growing in Bucks County. We offer these companies customized, short-, and long-term engagements to meet their employees' training needs in areas such as leadership, software applications, and workplace skills, to name a few.

But Bucks County manufacturers, especially over the last 10 years, have echoed this consistent message, growing in volume with every year: "We cannot find individuals with technical skills, especially in mechanical maintenance." Our school struggled to meet this need. We had no labs and no space that was intended to accommodate hands-on advanced manufacturing learning. Nevertheless, we were determined that Bucks County Community College was going to participate in a broader way in manufacturing workforce development.

As time went on, we heard many of the messages presented earlier in this book about the need for educators to address the manufacturing staffing crisis. We heard this from our local workforce development board, from statewide conferences that we were attending, and from our company contacts. About this time the U.S. Department of Labor (DOL) published its manufacturing competency model, and everywhere we turned we heard about new national models, new buzz words like "mechatronics," and new models for delivery of individualized technical training. We looked at what was working well at other schools in our state. It quickly became obvious that there was no reason to reinvent the wheel. Certain regions were offering programs that were widely accepted by industry, supported by the workforce system, and looked upon favorably by agencies that provided grant funding. Curriculum was available, delivery models had been optimized, and we had access to credentials that were being offered statewide. Our task was to decide where to begin and how to leverage the good work that had been done elsewhere.

Starting out small

After consulting with our industry partners, we started with industrial maintenance. We

adopted curriculum that satisfied the requirements for the Advanced Manufacturing / Integrated Systems Technology (AM/IST) level 1 credential that had originally been created by the National Center for Integrated Systems Technology with DOL funding. Subsequently, this credential was being managed by the Industrial Maintenance Training Center of PA through an arrangement with DOL and some of our Workforce Investment Boards. It later became our good fortune that the requirements for this skill set were used in the development of the USDOL Mechatronics Competency Model upon which the PMMI Mechatronics Certifications were built. This allowed us to evolve from a credential recognized primarily in PA to a set of national industry-recognized credentials that were endorsed by the National Association of Manufacturers. It also set us up to obtain manufacturing-endorsed status through the Manufacturing Skills Institute's M-List.

Starting out small, we obtained industry trainers for hydraulics and programmable logic controllers. The training equipment came with curriculum in print, computer-based, and Internet media that covered the necessary competencies of the AM/IST credential. We rolled this equipment into our regular classroom space and hired some local industry experts as adjunct staff to teach evening courses. Industry response was gratifying and the first year we trained 25 employees from four different manufacturing facilities.

Growing to scale

In the following years we added more equipment and curriculum, which we used in regular academic classrooms. We added an AC/DC electrical trainer and a few Siemens PLCs. In general, we added one or two pieces a year, following the recommendations of our manufacturing advisory board and requests from our industry partners, while staying aligned with AM/IST. We soon filled the small traditional classroom and were running out of space. Then an opportunity came to dramatically increase our capacity in the area of advanced manufacturing via a federal DOL grant (TAACCCT). We began to search for additional space.

The lower end of Bucks County had seen great change in the past 50 years with the closing of the steel mills and some long established manufacturing facilities. The county had plenty of unused buildings, prime for resurrection. BCCC had already obtained space in a local, refurbished manufacturing facility for some renewable energy training programs, and it seemed to be a natural fit for our expanding manufacturing programs. We asked our colleagues and advisors to weigh in, and it was determined to be the best location for the trainers. Where better to locate a new Advanced Manufacturing Training Center than in the midst of an industrial plant? So we took on an additional 3,700 square feet, refurbished it to accommodate additional trainers and a small computer lab, and moved the mechanical maintenance lab from our Lower Bucks Campus to the Advanced Manufacturing Training Center, five minutes from the Lower Bucks campus in Bristol.

Adapt and leverage stackable credentials

We were following the Reading Area Community College model for AM/IST but also wanted to create smaller, more manageable blocks of learning—"stackable" credentials. For someone new to manufacturing, foundational skills/core competencies might be all that's need-

ed to get a foot in the door. But to keep climbing up the pay scale, additional skill sets are needed. We wanted to group skills in a way that made sense without duplication, and that would lead to or “stack up” to the AM/IST 1 credential. This required much advice from our advisory board, industrial trainer representatives, the IMTC subject matter experts, instructors, and our local industry partners. It was followed by hours of deliberation. We needed to support individuals coming to training from several different pathways—whether they were transitioning to a brand new career in manufacturing or simply adding a new skill set to their repertoire. It was important to make it easy for someone to build upon what they already knew and not make them start from the beginning. So we added test-outs along the way. And the needs of our local industry helped define these credentials. Cosmetics manufacturers needed production workers and mechanical maintenance technicians; pharmaceutical companies needed electrical and PLC technicians; packaging and plastics companies needed technicians with multiple skills. And all of them wanted at least a few hires that were well versed in AM/IST. The variation in local industry needs required offering credentials in multiple combinations.

How the stackable credential model works

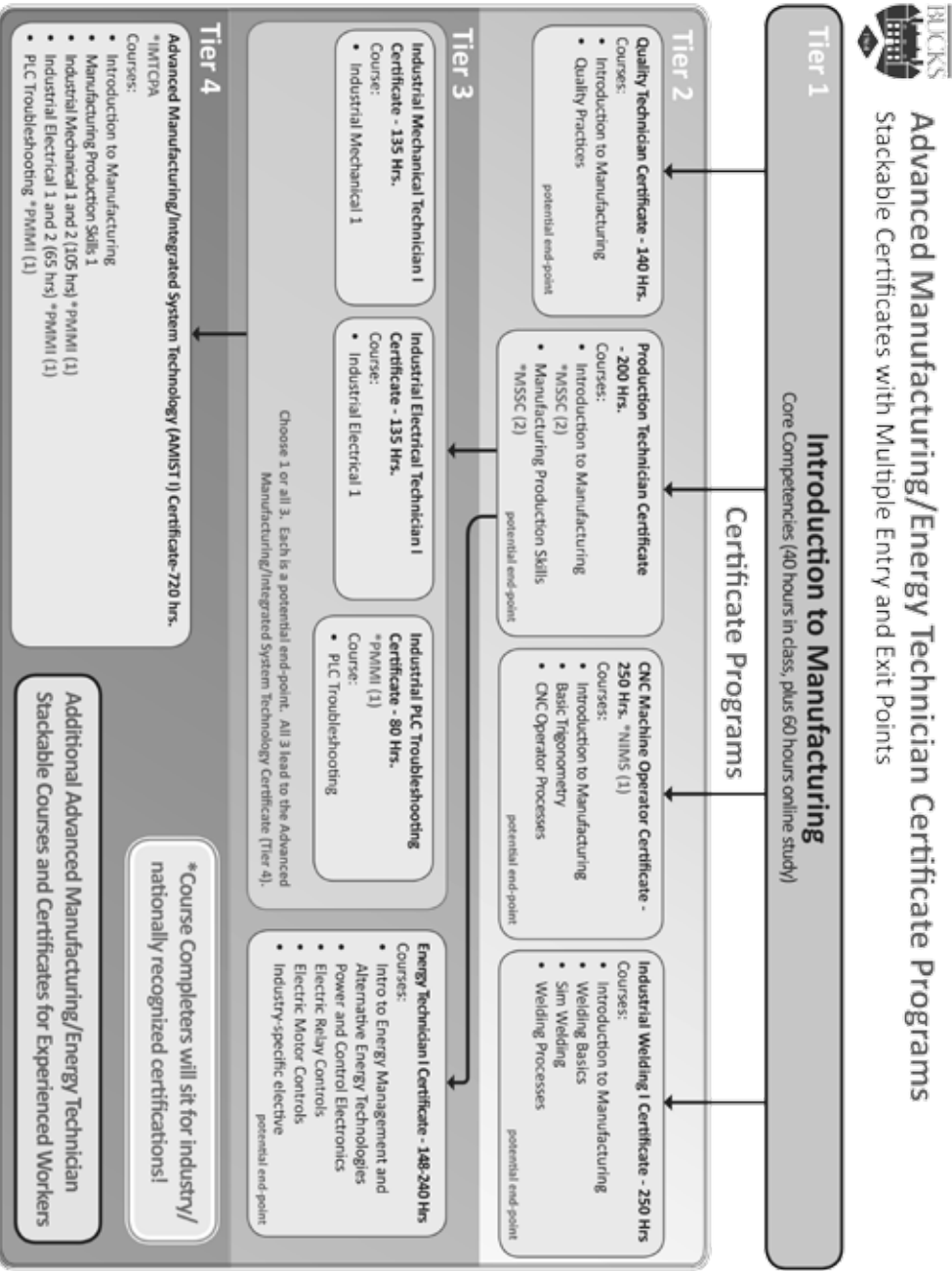
All of the certificate programs begin with Tier 1—an Introduction to Manufacturing Core Competencies, including industrial safety, basic shop math, blueprint reading, measurement tools/systems, mechanical fabrication, soldering, communication, and workplace skills (see Figure 1). Tier 2 is where students choose an entry level discipline, whether it’s Production Technician, CNC Machine Operator, or Industrial Welding 1. Production Tech is the entry to additional higher-level credentials toward the AM/IST 1 certificate and a pre-requisite for all Tier 3 programs. Each higher numbered tier builds additional skills and culminates with the AM/IST 1 Certificate in Tier 4.

All tiers require at least some computer-aided instruction plus extensive hands-on and instructor-led training in the lab. Program completers may sit for various industry-recognized credentials along the way, from the following institutions: MSSC—Manufacturing Skills Standards Council; NIMS—National Institute for Metalworking Skills; and PMMI—the Association for Packaging and Processing Technologies.

This is just one model. There are many other colleges and tech centers across the state employing similar and/or more extensive models. These are similar but locally adapted models that offer excellent credit and non-credit programs, several resulting in AS degrees. BCCC recently added an Applied Engineering Technology AS degree program, and the STEM department is currently evaluating the Advanced Manufacturing Certificate programs as a potential pathway to the Applied Engineering program.

Benefits for BCCC and the customers

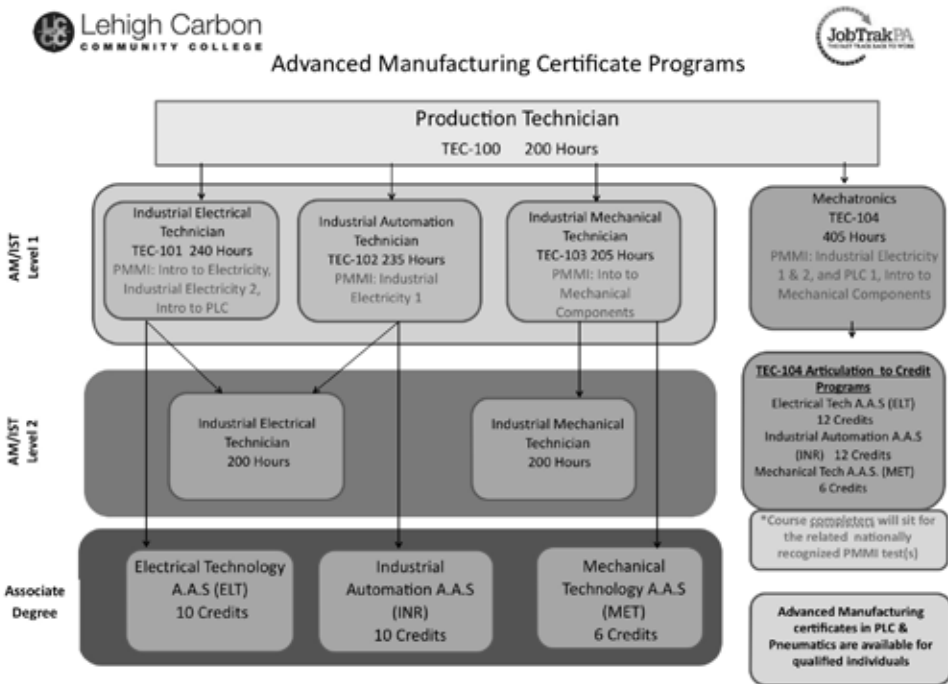
In the course of six years, we added a suite of manufacturing classes and stackable credentials that address necessary occupations in manufacturing, including: Production Technician; Production Assemblers; Industrial Maintenance Technician; Industrial Mechanic; Laborers; General Maintenance and Repair Worker; Industrial Electrician; Electro-Mechan-



ical Technician; Electronics Technician; Automation Technician; Mechatronics Technician; Industrial Instrument and Controls Technician; CNC Machine Operator; Precision Machine Operator; Assistant Machine Operator; Welder; Fabricator; and General Maintenance and Repair Workers. Because we utilize industry-sponsored and recognized credentials as the basis of our courses, it reduces the need for customization when we begin working with a new customer. The flexibility that comes with stackable credentials allows us to address the special needs of employees at various levels of their careers and of manufacturers who have differing needs because of the particular type of manufacturing they do (machine shops, pharmaceuticals, etc.)

Editor's Note:

Emily mentions other similar models in her chapter. Following are three variants.



"This workforce solution was funded by a grant awarded by the U.S. Department of Labor's Employment and Training Administration. The solution was created by the grantee and does not necessarily reflect the official position of the U.S. Department of Labor. The Department of Labor makes no guarantees, warranties, or assurances of any kind, express or implied, with respect to such information, including any information on linked sites, and including, but not limited to accuracy of the information or its completeness, timeliness, usefulness, adequacy, continued availability or ownership."

(Above) Lehigh Carbon Community College has parallel paths leading to industry credentials and/or one of three associate degrees. Stacking may be done for single-craft (electrical, mechanical) or multi-craft (mechatronics) technicians.



Mechatronics Stackable Credentials

College Credit	Workforce Development
Mechatronics Technology A.S. Degree 60-64 Credits <u>Specializations:</u> Instrumentation & Process Control Robotics & Automation Supply Chain Technology	AM/IST Level 3 375 hours
	AM/IST Level 2 355 hours
	<i>Industry Credential*</i> : PMMI Fluid Power, Industrial Electricity 2; FANUC CERT
Mechatronics Technology Certificate 31-32 credits	AM/IST Level 1 360 hours
<i>Industry Credential*</i> : PMMI Industrial Electricity 1, PLC 1, & Mechanical Components	
Mechatronics Safety, Quality, & Industrial Processes 6 credits	Production Technician 140 hours
<i>Industry Credential*</i> : MSSC Certified Production Technician	

***Where applicable, students who successfully complete these courses may sit for the related nationally-recognized credential.**

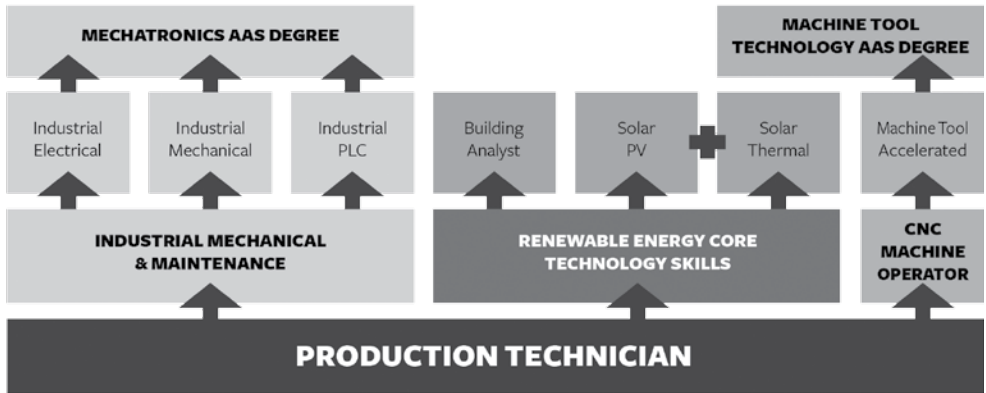
(Above) Community College of Allegheny County has parallel tracks for credit and non-credit, teaching the same skills and providing the same credentials. President Barack Obama and Vice President Joe Biden (below) recently toured the program, calling it a model for the nation.



Photo courtesy of CCAC and Joe Appel Photography.

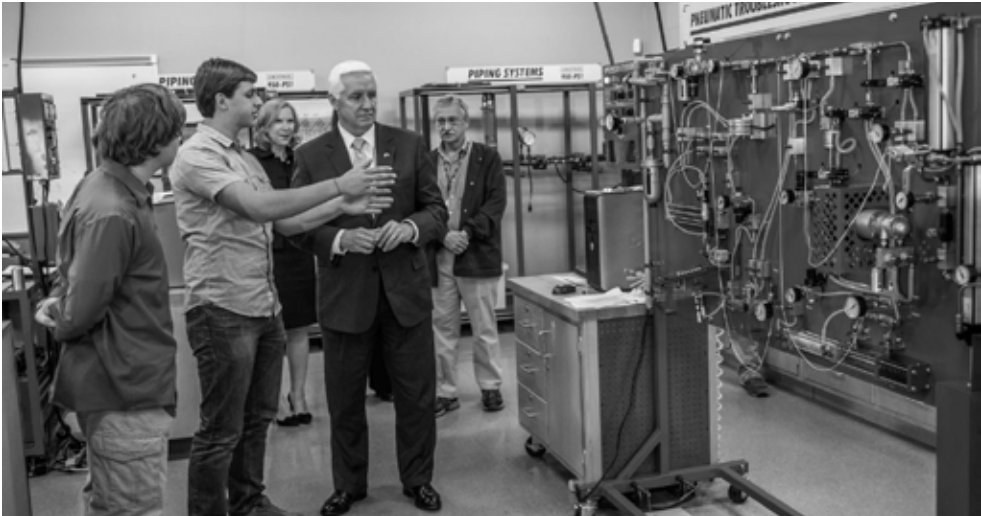


LEARN NEW SKILLS TO BUILD A NEW CAREER OR TO
MOVE YOUR CURRENT CAREER TO THE NEXT LEVEL



PROGRAMS ELIGIBLE FOR TARGETED INDUSTRY PROGRAM (TIP) FUNDING									
	Production Technician	Renewable Energy Core Technology Skills	Building Analyst & Heating and A/C Systems Technology/Skills	Solar Photovoltaic Technology/Skills	Solar Thermal Technology/Skills	CNC Machine Operator	Industrial Mechanical	Industrial Electrical	Industrial PLC
Machine Shop Technology Assistant	■				■				
Industrial Mechanics & Maintenance Technology	■					■	■	■	
Heating, A/C, Ventilation & Refrigeration	■								
Maintenance Technology	■	■	■						
Solar Energy Technology Technician	■	■		■	■				

(Above) Reading Area Community College offers multiple pathways to satisfy different industry segments, leading to credentials or associate degrees. On the same day that the President visited a community college in the Western part of PA (p. 146), Governor Corbett and Labor & Industry Secretary Julia Hearshaw were visiting a similar program further to the East at RACC (below).



The ability of a region to supply a skilled workforce is a key component of a company's decision-making process when trying to locate a site for a new manufacturing plant. Economic development planners have become much more aware of the importance of their educational infrastructure as they promote their region to manufacturers. On the other side, I have seen one company abandon an attempt to reopen a steel mill for lack of enough adequately skilled maintenance workers. Community and technical colleges play an increasingly important role in a region's economic success. The Charlotte, N.C., area has been notably successful in expanding its manufacturing segment, attracting a number of German companies to the area. Central Piedmont Community College has had a pivotal role in this success. German and American companies tend to have somewhat different expectations of their employees, a situation that is rooted in the differences between the German and American secondary education systems. There is also some debate about whether what the Germans refer to as "apprenticeship" should really be translated as "internship." Whatever we call it, Central Piedmont has collaborated with industry to put in place programs tuned to the needs of both German and American manufacturers.



Author Bio



Chris Paynter,
Dean of Science,
Technology, Engineering,
Mathematics - Central
Piedmont Community
College

I have visited Central Piedmont Community College (CPCC) on at least two occasions and toured the two manufacturing labs that are described in this chapter. I have worked with staff members of Chris Paynter's on test development projects, though I do not know him personally. CPCC's story is a significant one, and who better than the Dean to tell it?

Chris is the Dean for Science, Technology, Engineering, and Mathematics (STEM) at Central Piedmont Community College (CPCC) in Charlotte, NC, where he works to support the workforce development mission of the college.

To expand the advanced manufacturing sector in Charlotte and the surrounding region, Chris works closely with local industry to develop strategies that create a skilled workforce pipeline. A part of this strategy is to administer state-approved apprenticeship programs such as Apprenticeship Charlotte and Apprenticeship 2000, which model the best practices of German vocational training. Additionally, STEM at CPCC maintains ABET and NIMS accreditation in several technical programs and aligns program outcomes to industry certifications such as SMSCP, Cisco, CompTIA, PMMI and MSSC.

Widely traveled, including more than 30 countries across six continents, Chris lived for three years in Singapore before moving to Charlotte, where he attended CPCC as a college transfer student. During his free time he enjoys playing with daughter Ella, running, camping, hiking, and gardening.

Chapter Twenty-four

21st Century Manufacturing Success Depends on Automation Technology and a Skilled Workforce

Creating a high-tech pipeline for Charlotte, N.C. businesses.

by Chris Paynter

Manufacturing thrives today in the U.S. because of advanced automation technology. In industries such as durable goods, consumer products, medical devices, pharmaceuticals, and electronics, automation systems have created an environment in which fewer employees than ever before produce a high volume of superior-quality products.

The Charlotte, N.C., region has seen remarkable growth in the manufacturing sector. The region's climate, infrastructure, and proximity to major markets serves as a magnet for European and Asian companies looking to create a manufacturing presence in the U.S. Also heavily represented in the area are American-based manufacturers, large and small.

More than 20 years ago, this melting pot of manufacturing began to experience the problems associated with workforce skills lagging behind automation technology. The days of placing a help-wanted advertisement and finding job candidates ready to hit the ground running seemed to be ending. A more proactive approach was needed to find skilled employees. A number of German-owned manufacturing organizations, with a strong tradition of secondary school workforce development and apprenticeships, began to discuss among themselves ways of creating a similar "European-style" pipeline of skilled workers in North Carolina.

Fast forward 20 years. Today the local manufacturing community and Central Piedmont Community College administer a number of successful workforce initiatives, some modeled after the European style and some not, that are helping to solve the manufacturing talent-pool problem. Similar programs tailored to local needs could be replicated in every area of the U.S. The only requirement is a core group of manufacturers willing to invest time and energy in a regional workforce development effort and a local community college with technical training resources available to partner with them.

Apprenticeship 2000 – First Steps in Creating a Talent Pipeline

As stated above, a small group of German firms with manufacturing locations in the Charlotte area collectively began to discuss the need to steadily bring young, motivated, and skilled workers into their plants. The core group eventually expanded to include Ameritech,

Blum, Chiron, Daetwyler, Pfaff, Sarstedt, Siemens, and Timken. Representatives of the group approached Central Piedmont Community College, which was recognized for its educational programs in mechanical and electrical fields.

Manufacturers and educators conducted extensive discussions on what skills were needed in the short and long term for the manufacturing health of the area, including how much hands-on training would be necessary at the plant and how much and what kind of education would be needed at the community college level. The outline of a formal apprenticeship program began to be mapped out with elements stretching all the way from recruitment to employment. The North Carolina Department of Commerce joined the discussion. A formal European-style apprenticeship was launched and included:

- A coordinated, thorough recruitment process by the manufacturers of regional high school juniors
- A year of paid work study—a few hours per week—for high school seniors to work and study in the plants
- Four years of paid work study at the plants and at Central Piedmont Community College, leading to an Associate in Applied Science Degree in Mechatronics
 - Mentors at the employers monitor each apprentice's training and progress throughout the program
- An apprenticeship certification from the North Carolina Department of Commerce
- Opportunity to acquire industry certifications, including PMMI electrical and mechanical and Siemen's Mechatronic Levels 1 and 2
- Guaranteed salary, including benefits, upon successful completion of the program
- College costs paid by the employers

In 1996, the first apprentices entered the program. On the job, they received training and mentoring. One day and one evening per week they attended classes at the community college. This program has evolved over time, and today the Mechatronics Engineering Technology curriculum at Central Piedmont Community College provides the apprentices with a basic background in mechanical, electrical, CAD, basic computer skills, safety, automation, programmable logic controllers, instrumentation, hydraulics and pneumatics, mechanical drives, variable frequency drives, motors and controls, and basic electricity. The extent of the exposure in these topics depends upon the degree's curriculum track.

The latest equipment is used to provide hands-on training. Two curriculum tracks are available: the Mechanical Track and the Electrical Track. The Mechanical Track is structured to enable the graduate to focus on the mechanical aspects of a manufacturing and system design function, while gaining a solid understanding of its electrical function. The Electrical Track perspective is focused on electrical and control aspects with a solid understanding of mechanical components and their principles.

The first apprentices graduated in 2000, hence the name Apprenticeship 2000. Each apprentice in the program logged 8,000 hours of hands-on work and training. Today, there are about 100 apprentices total in the four-year program with 25 apprentices in each year's class.

Since the first class graduated, the school has continuously evaluated and improved its automation lab facilities. Today there are two labs at the school, the Integrated Systems Technology Lab and the Mechatronics Engineering Technology Lab. Together these facilities represent a more than \$2 million investment in state-of-the-art hands-on learning systems. Computer-based simulation is delivered alongside mechanical, electrical, hydraulic, and pneumatic systems. Apprentices work individually and in teams to perform lab exercises in troubleshooting, repair, and maintenance of the equipment.

The Mechatronics lab provides a systems approach to automation and is heavily used by the apprentices. The lab features Festo Didactic learning systems, which closely align with the skills employers asked for. Festo Didactic and the college have an ongoing collaborative relationship to ensure the right systems are in place to meet the ongoing needs of the local manufacturing community.

The Festo Didactic systems for the lab include an MPS-500, which is a modular production system trainer consisting of six stations around a conveyor, all of which demonstrate common operations found in industry (i.e., part sorting, testing, assembly). The stations are constructed from 10 training modules that can be separated, allowing for focused analysis. The school also installed a Didactic ProLog Factory, a logistics training system utilizing a Robotino mobile learning system with handling assistant. This system demonstrates autonomous materials handling as well as other autonomous vehicle principles. The third component is a Didactic MPS PA, a process control simulator. These systems are highly integrated and complex, where students develop the ability to read documentation and to troubleshoot. The lab also features both Fanuc and Mitsubishi robots. Funding for the labs comes from public and private grants.

Blum, one of the founding member companies, reports that it retains about 80% of its apprentices. About 10% of those in the program take additional classes and 7% graduate and move on to a four-year degree. Blum has a tuition reimbursement policy for its employees. The company has seen a rise in production efficiencies in the areas where apprentice graduates work.

Overall the apprenticeship companies find a close match with the skills that are being taught and the skills they need today. Interestingly, the employers report that the skill level of the apprentices is comparable to or higher than that of apprentices in Europe.

Apprenticeship Charlotte

In 2012, Central Piedmont Community College launched Apprenticeship Charlotte to accommodate the increasing interest among local manufacturers to implement apprenticeship programs. Apprenticeship Charlotte provides a customizable approach to implementing apprenticeship programs. In this program, the Central Piedmont Community College assists employers in tailoring an apprenticeship program to their particular business needs and work closely with employers from the initial interest stage through full implementation. This typically includes all stages such as student recruitment and initiating contact with the North Carolina Department of Commerce and the registered apprenticeship process. In keeping with a customizable approach, Apprenticeship Charlotte is designed to recruit

a broader range of students than high school seniors. There are multiple entry points for Apprenticeship Charlotte, including high school graduates, veterans, and current employees of participating companies. Given this approach, apprentices in this program are more varied in age and background than the high school seniors in Apprenticeship 2000 and are more representative of the workforce as a whole. Apprenticeship Charlotte students receive much of their training in the Integrated Systems Technology lab where PLCs, servos, pneumatics, and other technologies are taught as units. The Amatrol learning systems in this lab map to PMMI certifications. Depending on the goals of the employer, students also have access to the Mechatronics lab and that lab's systems approach.

Employers in the Apprenticeship Charlotte program agree to on-the-job learning from one to five years. Each year in the program the apprentice spends 144 hours in academic training, and progressive wage scales are based on attainment of skill levels. Some of the companies in the Apprenticeship Charlotte program are Siemens, Bosch Rexroth, and Daimler.

With Apprenticeship 2000 and Apprenticeship Charlotte, the manufacturing community and Central Piedmont Community College created the critical mass needed for automation training. Without this structure, it would have been exceptionally difficult to secure the grant funding for the two well-stocked hands-on labs.

Regional employers that are not interested in apprenticeships but want to improve the automation skills of employees can work out a flexible time to use the labs and the computer-based curricula. These employers and the school devise a modular approach to training where only those modules—say PLC programming, pneumatics, servos, or variable frequency drives—are taught. For example, one of the area's major food companies is upgrading a number of its production lines. The company is sending a significant number of employees to learn new skills in the Integrated Systems Technology Lab. The computer-based curriculum offers flexibility in scheduling time in the lab—a flexibility that accommodates the plant's work schedule.

Open Enrollment

Traditional and non-traditional students not affiliated with any particular employer also enroll in the college for the Mechatronics and other manufacturing-related programs and tracks. These students have the option of degrees, certificates, and certification training. Each of these students does a mixture of classroom and hands-on lab work. Most if not all of the degree students in the Mechatronics program receive job offers before graduation.

College administrators and staff know that the curricula are providing an optimum skill set because of the ongoing input and feedback of the manufacturing community. Representatives from manufacturers, department of commerce, and school meet quarterly to ensure that needs are being met and that programs continue to evolve as automation progresses.

Central Piedmont Community College has an outreach program to other community colleges, providing the kinds of information they can take back to their constituencies about Mechatronics training. During these outreach meetings, educators realize that to ensure successful programs, the active involvement of a local group of manufacturers is essential.



These manufacturers do not have to be focused on apprenticeships, or degrees, or certifications. They must instead come together to determine:

- The skills they think cross company lines and are vital to the workforce of tomorrow—foundational automation skills
- Determine how many of their own employees they will put through training at the community college on an ongoing basis
- Make a commitment to regularly meet with the school to discuss training needs and evaluate outcomes
- Outreach to schools and other local organizations with the message that it is vital to the community to have a vibrant manufacturing foundation and that employees with basic skills are needed to make this happen

With this local commitment, the community colleges can hire staff, fill classes, and begin the process of grant writing and development that will lead to state-of-the-art learning systems such as those offered by Festo Didactic. This type of partnership between the school, local manufacturers, and many times state agency personnel builds a foundation—a critical mass—of training that begins to sustain itself. It creates a pipeline of skilled workers who know automation. In the process, it creates the infrastructure for manufacturing growth now and into the future.

The previous chapter discusses the successful use of registered apprenticeship by industry and a community college. This next chapter looks at less formal apprenticeship models, internship, and co-op terms all as examples of work-based learning programs that achieve similar results. One example shows how a German company, BMW, works with full-time students/part-time workers under what they term an apprenticeship. A U.S. company would more likely consider this a paid internship. All can achieve the same results, but the leadership roles and the mix of involvement between employer, union, government, and school will vary depending upon the model that is utilized.



Author Bio



Cheryl Garrison M.Ed.
GCDF,

Coordinator of Job
Placement, Tri-County
Technical College

I first met Cheryl Garrison when she attended The Automation Conference to accept the 2014 David A. Harvey Memorial Scholarship on behalf of TCTC. After learning more about the programs at TCTC, I asked her to become a contributor to the Playbook. Cheryl received her undergraduate degree at Gardner Webb University and her master's degree in education from Furman University. She is currently the job placement coordinator at Tri-County Technical College in Pendleton, S.C. and is responsible for connecting students with industry for meaningful cooperative learning experiences or full-time employment. A long-time educator, Cheryl has combined her love of students and a passion for seeing them become successful working adults, with meeting the increasing demand for a skilled workforce in the Tri-County area. Through collaboration with faculty, students and industry, opportunities for co-op experiences and the placement rate of students in co-ops has increased by more than 300% during her tenure.

Chapter Twenty-five

Utilizing a Work- Based Learning Model to Bridge the Skills Gap

A community technical college works collaboratively with local business and industry to meet the growing demand for a highly skilled workforce.

by Cheryl A. Garrison

The upstate of South Carolina is booming with manufacturing and manufacturing-related careers. Tri-County Technical College which serves Anderson, Oconee, and Pickens Counties, was established in the 1960s as part of a larger technical college system that has as its mission to prepare and sustain a workforce capable of attracting business and industry to the area. The technical college system in conjunction with local economic development groups and incentives provided to companies by the state and local counties have been extremely successful in establishing South Carolina as a front runner in attracting large, very well-known companies such as Michelin, BMW, Boeing, Bosch, Volvo, and numerous others. Many smaller companies that are needed to supply these manufacturers with the products and services necessary to their production, have also located to the state.

The jobs created by all of these companies require highly skilled, well prepared employees to work in high-tech, fast-paced, global environments. Tri-County Technical College located in Pendleton, South Carolina has as its mission to prepare this type of highly skilled workforce for the local area. The growing demand for these high tech careers has necessitated that the college employ new and different ways of collaborating with local business and industry to meet this need.

I began working at Tri-County Technical College just under three years ago in the career services office as the coordinator for job placement. My role consists of helping students determine what they would like to major in through career counseling and then helping prepare them to enter the workforce by assisting with cover letter and resume preparation, interview skills, and what to expect once they are on the job. Additionally, I have the privilege of assisting students with full-time job placements as well as developing and managing the work-based learning opportunities for students at the college. Developing relationships with business and industry, college faculty and staff, as well as students, is what allows this collaborative process to work.

When I started working at Tri-County Technical College there were six companies at which approximately 20 students were employed in work-based learning opportunities. Currently, there are more than 40 companies and more than 130 students at any given time

participating in work-based learning. At our college, work-based learning is the umbrella term used for apprenticeships, co-ops, and internships. Because we are a two-year institution, the students participating in work-based learning are attending school full-time, and working in their chosen career field, part-time. Although we do have some students who receive college credit as a part of a particular course, the majority of work-based learning is not tied to a class. This model provides a great deal of flexibility in working with industry to meet their employment needs and provide students opportunities to put into practice, in a real-world environment, what they're learning in the classroom.

In an effort to meet industry needs, work-based learning opportunities for students are not tied to the beginning and ending of semesters nor are the majority of opportunities established for a set period of time. This type of flexibility allows the college to meet company needs when they arise. Although each work-based learning experience is different, most companies employ the students to work part-time while they are attending school full-time. By employing students early in their educational career, companies are able to teach students about their specific equipment, processes, and culture with the goal of hiring them full-time once they graduate.

This type of work-based learning model has been very effective at helping business and industry create a pipeline of well-qualified, highly skilled employees to bring into their facility. Because competition is steep for many of these skilled positions, companies are able to attract talented students to their facility. Students receive hands-on experience in their chosen career field, employers are able to grow and recruit a talented workforce and the college receives valuable feedback from the students and industry as to what we are doing well and where we can make improvements. This is a win for everyone!

Selected Examples of Work-Based Learning Opportunities

Michelin

The Michelin North American headquarters is located in Greenville, S.C., about 40 miles from Tri-County Technical College. Within a 60 mile radius there are six different Michelin tire manufacturing plants. Michelin has the reputation of not only producing the best tires in world but also of being an excellent workplace.

Many years ago, Michelin created the Michelin Technical Scholar Program to recruit technicians into their facilities. The program was developed in conjunction with local technical colleges. At Tri-County Technical College, the program targets students in the majors of General Engineering Technology, Industrial Electronics Technology, and Mechatronics Technology. The program has been extremely successful in the upstate of South Carolina, allowing Michelin to fill approximately 50 percent of their reliability technician positions with technical scholar graduates.

Michelin representatives come to campus to test students interested in the program. The college advertises the opportunity to students and provides a location for testing. Students can test as early as their first semester at Tri-County. To be considered for the technical scholars program, students must pass a mechanical and a mathematical aptitude test, have a GPA of 2.5, and successfully complete an interview, background check, and health

screening. Additionally, students must be enrolled full-time in one of the target majors and be able to work at least 20 hours per week at Michelin during the program while maintaining a 2.5 GPA.

Michelin Technical Scholars receive scholarships to cover the cost of tuition, fees, and books for the program along with competitive pay and part-time work. Students earn on the job training and valuable experience at one of the world's leading companies. They become eligible for entry-level employment at Michelin upon graduation with salary projections of more than \$50,000. They are able to develop invaluable skills such as time management, teamwork, and problem solving. Students will have a customized work schedule to accommodate their classes. If hired upon graduation, they will have the opportunity to add approximately 2,000 hours of formal classroom and lab training during the initial years of employment.

BMW

In 1992 BMW announced plans to build its U.S. manufacturing facility in Spartanburg, S.C. In 1994 the very first BMW produced in North America rolled off the assembly line. Since that time BMW Manufacturing has produced more than 3 million vehicles and has invested over \$7 billion in South Carolina. BMW has become a driving economic force in the state and is the largest exporter of cars made in the United States.

In 2010 BMW launched its BMW Scholar Program which is an apprenticeship program that partners with three local area technical colleges. The program allows students who are interested in manufacturing related degrees to attend class full-time while working part-time at BMW manufacturing company. This allows students to further their education while gaining valuable experience in a high-tech manufacturing environment with the potential to become candidates for full-time positions at BMW manufacturing, following successful completion of the program.

Students chosen for the scholars program will participate in one of four training paths based on their experience and their major. Prior to entering their specific path, all scholars work in production to learn the core business of building the ultimate driving machine. Logistics scholars utilize lean manufacturing skills to effectively manage material planning and delivery. Automotive scholars verify vehicle, mechanical, and electrical systems. Equipment Services scholars troubleshoot and maintain robots, conveyors and PLCs. Production scholars gain first-hand experience building world-class vehicles.

BMW recruits students coming out of high school or those entering their first or second semester of college. Students must have a minimum 2.8 cumulative GPA and be enrolled full-time at Tri-County Technical College or another of the participating technical colleges in a manufacturing related career. To be eligible for the program, students must successfully complete pre-employment testing, an interview, a physical, and a drug screen. Selected students commit to working 20 hours per week at BMW during the course of the program, which lasts just under two years.

The process is very selective and college personnel work to prepare students for what to expect. Those selected are provided tuition assistance and an hourly wage with the

potential for increases each semester based on school and work performance. There is no obligation for continued employment by BMW or the student upon graduation.

Bosch

Several years ago Bosch in Anderson, S.C., realized that they were struggling to fill their technician positions in a timely manner with the highly skilled employees that they needed. It was taking an average of six months to bring in the technicians and then even longer to get them trained on the specific equipment at Bosch. Their lead technical trainer began researching various apprenticeship, co-op, and work-based learning models that other companies had started in the local area in an effort to create a pipeline of talent into their facilities. While he discovered that each model was different, there were a lot of similarities within the programs. The companies were recruiting local technical college students from generally one of three degree programs; General Engineering Technology, Industrial Electronics Technology, and Mechatronics Technology. The students would attend class during the day and work 20-25 hours in the afternoons, evenings or on the weekends.

Bosch decided to be innovative their approach to creating the Bosch Technical Scholars Program. The program targeted night students at Tri-County Technical College since those students were rarely able to participate in work-based learning (WBL) opportunities. No one else had ever tried a WBL model for night students since most of those students were attending at night due to the fact that they are usually already working full-time. Many of them are non-traditional students and have families and responsibilities that preclude them from attending school during the day. This novel approach taken by Bosch meant that they would have a potentially more mature and focused group of students from which to recruit.

The program, by nature had to be unique. The students in Industrial Electronics Technology or Mechatronics Technology night programs would apply for the Bosch Technical Scholars Program prior to entering into their last semester at Tri-County Technical College. They would go through a series of tests and a panel style technical and soft skills interview. If selected they would begin working at Bosch as their last semester of schooling got underway. The students would work 40 hours a week for a four month period. During that time they would complete 600 hours of training with 300 hours being in a lab setting and 300 hours on the floor with a mentor who is a seasoned technician. The coordinator of the training program leads the lab instruction and coordinates with the mentors regarding the desired learning outcomes that students should receive during their training on the floor.

Students are direct hires into Bosch from day one and receive all of the benefits of a Bosch employee. They are also paid a livable wage during their training time. Often the amount that the students are paid is more than they receive at their current full-time job. The full-time hours, excellent training pay, and benefits are what allows Bosch to successfully recruit the students from the night curricula, away from their current job, and into the Bosch Technical Scholar Program. The students also receive a signing bonus that they can use to offset their tuition costs.

Once students complete the four-month training program they go through a graduation ceremony at which they make a presentation to their Bosch mentors, executive staff,

college personnel, and others about what they learned through the program. They also do a demonstration of a project that they have built during their lab time at Bosch. They are presented with a plaque and certificate of completion. The now graduates of both TCTC and the Bosch Technical Scholars program move into a technician position at Bosch. If there are no spots available, they continue to work and train until an opening occurs.

It is Bosch's goal to utilize the Technical Scholar Model to fill at least 50% of their technician needs going forward. They will recruit as their needs dictate. The program has been so successful at creating a highly skilled pool of talent that they have had other companies approach them about doing workforce training with their incumbent employees. This example of an innovative work-based learning model created by the Bosch team has changed the way that a very large, very successful local company recruits and hires for one of their most demanding positions.

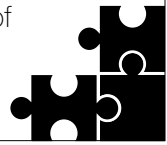
Collaboration

The three sample scholar programs discussed previously, and the numerous other work-based learning opportunities that exist for Tri-County Technical College students, are wonderful, but it requires collaboration between the students, industry, and college faculty and staff to make it all work. This type of collaboration results from building and cultivating relationships and having effective, open communication.

Part of the communication for the college involves being receptive to feedback, both positive and negative. Many of the companies that Tri-County partners with serve on advisory committees for different majors. Additionally, many of the companies that have work-based learning opportunities for students, meet with college personnel to provide feedback on what students are doing well and where there is room for improvement. One such meeting with Bosch resulted in changes to curriculum, teaching, and assessment methods in order to better prepare students for what industry needs.

Collaborative efforts often will result in business and industry making monetary and or equipment donations to the college in order to facilitate the educational process. Without this type of support, it would be even more challenging for the college to keep up with the changing technologies. By working together, the college and business and industry can help produce an educational experience that results in a well-trained, highly skilled workforce that benefits the economy and the community.

Many believe that there is insufficient focus on engineering technology in American universities. Our focus on engineering science leads to our being more theoretical and less practical; able to invent, but not to apply new technology. We are seeing an increase in the number of associate degree programs being started in areas like industrial maintenance, mechatronics, and machine tool technology, but we are not seeing a significant increase in four-year programs in this area. Purdue Calumet has been an exception, having started a B.S. Degree Program in Mechatronics Engineering Technology, at the specific request of and for the support of manufacturers.



Author Bio



Dr. Niaz Latif,
Dean of the College
of Technology,
Executive Director of the
Commercialization and
Manufacturing Excellence
Center, Purdue University
Calumet

When word came from PMMI to my associates and me that a BS in Mechatronics Engineering Technology was being developed at Purdue Calumet, it wasn't long until I had the good fortune to meet Dr. Niaz Latif. As hard as new programs are to start at the community college level, there are even bigger obstacles to overcome at a major university. Dr. Latif was taking these on one by one, and before we knew it, the program became operational.

Dr. Latif is the Dean of the College of Technology, and the Executive Director of the Commercialization and Manufacturing Excellence Center (CMEC) at Purdue University Calumet (PUC). His academic career began as an instructor of engineering at Louisiana State University-Eunice and then he served as an Assistant and Associate Professor at Northern Kentucky University. In 1999, he was appointed as the Professor and Head of the Department of Industrial Technology at Purdue University, West Lafayette and later served as an Assistant Dean for Statewide Technology Administration in the College of Technology. In 2007, he joined Purdue University Calumet as the Dean of the College of Technology. Dr. Latif is responsible for overseeing seven undergraduate degree programs, which includes a new B.S. degree program in Mechatronics Engineering Technology, and three graduate programs in the college. He has received grants from the National Science Foundation and the U.S. Department of Labor for projects related to workforce development in advanced manufacturing. Dr. Latif earned his Ph.D. from the University of Missouri—Columbia and an M.S. from South Dakota State University (SDSU) in Agricultural Engineering. He received his B.Sc. in Mechanical Engineering degree from the University of Chittagong, Bangladesh. He has authored/co-authored numerous refereed journal articles and peer-reviewed conference proceedings articles and also served as the Editor-in-Chief of the Journal of Engineering Technology.

Chapter Twenty-six

A New B.S. Degree Program: Mechatronics Engineering Technology is a University Success

Universities are slowly seeing the need for applied science programs.

by Dr. Niaz Latif

Purdue University Calumet introduced its mechatronics engineering technology baccalaureate degree program in 2008 to meet the need for trained technologists to design, build, and service the type of complex, high-speed machinery used in the packaging industry. The program combines instruction in electrical control and mechanical design and provides students with exposure to programmable logic controllers (PLCs), conveyor systems, machine vision and servo motors, control and sensor logic, as well as other technologies and various industry standards, with a primary focus on packaging machinery technology. The program prepares students for such jobs as machine designers, packaging engineers, automation specialists, and service technicians in the growing field of high-speed packaging.

How it got started

It all started with one faculty member's longtime involvement with the packaging industry. This involvement created a mutual awareness of industry workforce needs and opportunities available at an academic institution to meet such needs. This is where Nick Wilson, President of Morrison Container Handling Solutions, entered the picture. Located just across the Illinois/Indiana border in Illinois, Wilson met with faculty members in the College of Technology and actively promoted the advantage of an academic program that would produce such a workforce. The basis for creating such a program was that: 1) there is a serious need for employees with competencies in electrical, mechanical, automation, and control, and 2) no institutions in the region were addressing this specific need. The packaging machines used in this industry are usually custom-designed mechanical systems integrated with OEM electrical control products to achieve system integration for product flow and packaging (e.g., six water bottles wrapped with clear plastic). Such systems require technologists with knowledge in automation, controls, and mechanical design.

To initiate the curriculum process, a team was formed consisting of packaging industry professionals and faculty members with expertise in mechanical, electrical, controls, and automation. Wilson, meanwhile, articulated the importance of such a team to his peer

group at PMMI and convinced these industry professionals to participate in the curriculum development process. The curriculum was adjusted and became more relevant to industry. The students gain knowledge in the following areas: 1) Computer Hardware and Electric Circuits; 2) Electrical Power and Machinery; 3) Computer Aided Design and Manufacturing; 4) Manufacturing Processes; 5) Process Control; and 6) Production Design and Specifications. The program description and the plan of study are available at Purdue University Calumet's Department of Engineering Technology website at <http://webs.purduecal.edu/et/eng-tech/mtb-degree/>.

Industry-education partnerships

The initiative to develop and implement the Mechatronics Engineering Technology program was a response to the regional packaging machinery industry's expectation from the university and its leadership. The challenge was to articulate the need and justification for such a program to the institution and ultimately to the commission of higher education. Not only was it important to show industry support for the program, but also to show documented commitments from industry to sustain the program. The program was launched in 2008 and is being sustained by the generous support from industry in areas of curriculum development and enhancement, laboratory development, and internship/experiential learning for students. Of all the industry partners, six key industry partners have been significantly involved with the program. Out of these six partners, three are system integrators, two are OEM products manufacturers, and one is PMMI Media Group, parent company of *Packaging World*, the leading business-to-business magazine in the packaging space. Representatives from these six partners serve on the mechatronics program advisory board and promote the program at the regional, national, and international levels. These industries provide internships to our students, and they sponsor funded design/development projects. They have also provided state-of-the-art industry-standard equipment for laboratories and significant technical help through their full-time technical personnel.

The industry and education partnerships have resulted in the establishment of two state-of-the-art laboratories for the program and opportunities for paid internships for students in the program. The laboratories in the Mechatronics Engineering Technology program offer hands-on experience in both the electrical and mechanical areas of designing, installing, and troubleshooting the complex equipment that produces and packages items that consumers purchase daily. Students learn advanced programming techniques, interfacing automated equipment, sensor design, machine design, and troubleshooting in these labs. Total industry support for this lab exceeded \$1 million, and specific equipment donations were received from the OEMs and the system integrators (the packaging machinery industries). Some of the equipment donated includes a high-speed digital camera, labeling machine, photoeye, conveyors, automation equipment, lab simulator, inverter machine, PLCs, motors and drives, HMIs, and two complete packaging systems from two companies.

Support from professional organizations

The national professional association PMMI has been an integral partner from the very

beginning of the program development. In fact, their participation has enhanced the curriculum that is aligned with the competency levels in mechatronics as endorsed by the U.S. Department of Labor, <http://www.careeronestop.org/CompetencyModel/pyramid.aspx?ME=Y>. PMMI has provided scholarships for students every year, supported travel to Pack Expo (the annual trade show) for faculty members and students, and provided funding through their education foundation. PMMI regularly promotes the program through their national and international outreach. PMMI has provided training and technically relevant support for the faculty members and students in the program. PMMI has also provided visibility for the program through articles in the trade press and exposure at their technical conferences.

Program growth and student success

The B.S. in Mechatronics Engineering Technology program has grown significantly in recent years, from 17 students in spring 2013 to 61 students in spring 2014. Since 2009, students from the program have participated at the national design competition sponsored by PMMI, placing in the top three numerous times. The projects usually involve a packaging line problem in which the solution must take into account the environmental impact, energy consumption, ease of use, and cost considerations. This learning beyond the classroom provided students with the opportunity to solve real-world problems. The participation by students in the national design contest has promoted the program at the national level. It has also allowed students to visit with potential employers for networking, and to understand the types of jobs and job opportunities available in packaging. All team members felt the knowledge learned and the experience of seeing their future careers in front of them was very rewarding. Industry also learned about the program, as evidenced through several requests received by the program (after PACK EXPO) for student interns and graduates for full-time jobs.

Workforce development in advanced manufacturing-mechatronics technicians

After the implementation of the B.S. degree program, faculty members in the College of Technology received two National Science Foundation (NSF) grants to enhance the mechatronics-related courses and adopt modularized and alternative delivery of the courses to benefit the employees of the industry. The first NSF grant, entitled “A Mechatronics Curriculum and Packaging Automation Laboratory Facility,” supported continued research and development of the courses and facilities within the new Mechatronics Engineering Technology program at Purdue University Calumet. Five courses were significantly enhanced to implement the latest in high-speed automation equipment. In these enhanced courses, students experience an environment that is similar to that which is typically encountered in an entry-level job in the mechatronics field.

The second NSF project, entitled “Meeting Workforce Needs for Mechatronics Technicians,” has been a partnership among three universities and colleges—Purdue University Calumet, College of DuPage (IL), and Ivy Tech Community College—and the packaging indus-

try. The packaging machinery industry provided the commitment for experiential learning opportunities for all participants during the three-year project period. The project involved the course augmentation and modularization, as well as the integration and innovative delivery of experiential learning within the courses, enabling students to apply their knowledge.

Based on these successes with federal grants, the program recently (2013) received a \$2.74 million U.S. Department of Labor grant entitled “Project: AWAKE: Assisting Workforce by Advancing Knowledge for Employment” <http://webs.purduecal.edu/technology/awake/>. Three hundred participants are to be trained and certified with stacked and latticed credentials (Mechatronics Certifications) developed by PMMI <http://www.pmmi.org/Education/content.cfm?ItemNumber=1010&navItemNumber=1061>. The objectives of the project are: 1) to provide foundational skills and competencies in two similar occupations—Mechatronics Technicians and Industrial Machinery Mechanics—through developing modularized training and delivering the program at remote locations; and 2) credentialing the participants through industry-recognized (PMMI) certifications at four competency levels as endorsed by the U.S. Department of Labor. The certificates are Industrial Electricity-I, Industrial Electricity, Programmable Logic Controllers-II, and Mechanical Components. The project also provides career pathways through granting college credits of up to 12 hours toward associate degrees at Ivy Tech Community College in Indiana. The 21-week training is 16-hours per week (four hours/day and four days/week) and an additional four weeks of internship in the manufacturing industry. Individuals already working in a manufacturing-related industry will not need to go through the four weeks of internship, therefore the training will be 21 weeks.





Preparation of engineering scientists tends to be done in silos: electrical, mechanical, civil, etc. Yet on the shop floor, we are training workers to be multi-skilled, and our newest machines are mechatronic in nature, meaning that the design was an integrated effort amongst electrical, mechanical, controls, and computer disciplines. While other countries have embarked upon a more integrated and systems-oriented education, in the U.S. there is only occasionally a course or two offered on mechatronics at the undergraduate level, or you may find programs at the post-graduate level. This chapter makes the case for changing engineering science education to be more responsive to the needs of society, including manufacturing.



Author Bio



Dr. Kevin Craig, Ph.D.,
Greenheck Chair in
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Professor, Department of
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College of Engineering,
Marquette University

As I became more involved in industrial maintenance and mechatronics, the name Kevin Craig came up as one of the leading academics in mechatronics in America. At the time, he was a faculty member at my alma mater, RPI. We later shared the podium at several events, he presenting from a university perspective and I from a workforce and community college perspective.

Kevin graduated from Xavier, a Jesuit high school in New York City. He attended the United States Military Academy at West Point, N.Y., played 1st-team varsity football and baseball, and graduated with a B.S. degree and a commission as an officer in the U.S. Army. He later attended Columbia University and received the M.S., M.Phil., and Ph.D. degrees. While in graduate school, he worked in the mechanical-nuclear design department of a major engineering firm in New York City and taught and received tenure at both the U.S. Merchant Marine Academy and Hofstra University. In 1989, he joined the faculty at Rensselaer Polytechnic Institute. At RPI, he further developed his leadership and administrative skills working directly for the dean of engineering as Director of Core Engineering and as Chair of the Engineering Science Interdisciplinary Department. As a tenured full professor of mechanical engineering, he taught and performed research in the areas of mechatronic system design and the modeling, analysis, and control of multidisciplinary engineering systems. With significant continuous funding from both industry and government, he developed the Mechatronics Program at Rensselaer, which included an extensive teaching and research laboratory and several undergraduate and graduate courses in mechatronics.

Since 2007, he has written a monthly column on mechatronics for practicing engineers in *Design News* magazine. Over the past 15 years, he has conducted hands-on, integrated, customized, mechatronics workshops for practicing engineers nationally and internationally. He is a Fellow of the ASME and a member of the IEEE and the ASEE.

He was chosen in January 2008 to be the Robert C. Greenheck Chair in Engineering Design, a \$5 million endowed chair, at Marquette University. His mission is to integrate multidisciplinary design and discovery learning throughout the entire college, in all years and in all departments. He has transformed students, faculty, curricula, and facilities throughout the college and created a new engineering education mindset and culture for innovation. He was given the 2013 ASEE North-Midwest Best Teacher Award and the 2014 ASME Outstanding Design Educator Award.

Chapter Twenty-seven

Manufacturing Engineering: Innovation through Model-Based Design and Integration

*A look at engineering science education
for manufacturing and beyond.*

by Dr. Kevin Craig, Ph.D.

Background and Motivation

It is widely recognized that the future of the U.S. is increasingly dependent on scientific and technical innovation. However, the U.S. is in an innovation crisis partially fueled by a crisis in engineering education. The National Science Board of the U.S. has stated that a continuation of the status quo in engineering education in the U.S. is not sufficient in light of the changing workforce demographics and needs. The innovation shortfall of the past decade is real, and there have been far too few commercial innovations that can transform lives and solve urgent human problems. Society's problems are getting harder, broader, and deeper, and they are multidisciplinary in nature. They require a multidisciplinary systems approach to solve them, and engineers, as the solvers of these problems, need to understand the impact of their solutions in a global context. Sustainability—the ability of one generation to meet its needs without compromising the ability of future generations to meet their needs—has three dimensions: economic, environmental, and social. Key tenets of sustainability include intelligent use of resources, improvement of the quality of life, and lessening the environmental impact.

How Does A
Company
Get And
Maintain A
Competitive
Advantage
In The
21st Century?

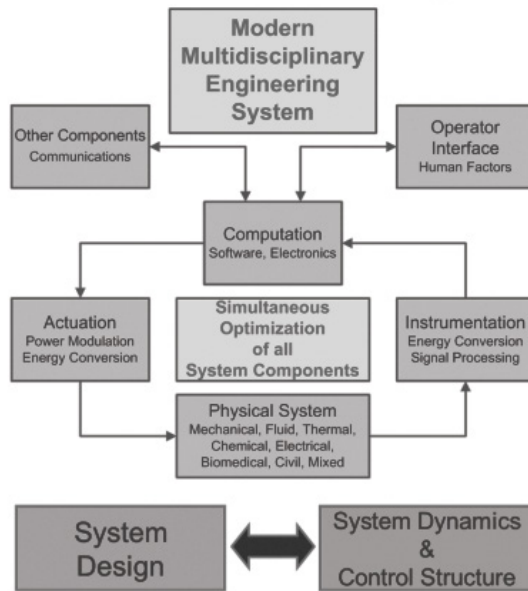


All Systems Look Like This. Who Will Design Them?

**Innovation
+
Integration
+
Optimization**

All Done
Simultaneously
from the
Beginning of the
Design Process!

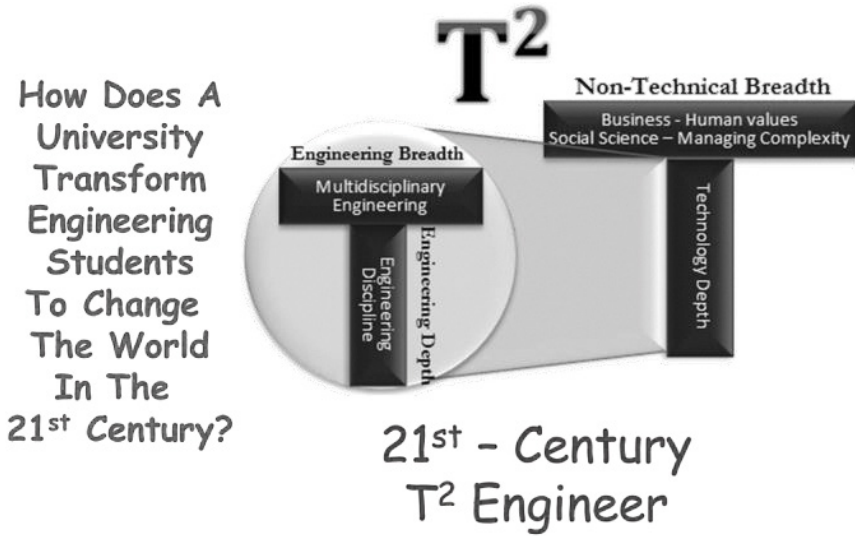
Performance,
reliability, low cost,
robustness,
efficiency, and
sustainability are
absolutely essential.



Perhaps as a result or as a cause of this shortfall, basic STEM (science, technology, engineering, and mathematics) skills are viewed as separate commodities that can be outsourced. Other countries have a competitive advantage in low-cost manufacturing and services, with excellent commodity engineers, scientists, and mathematicians available at a fraction of the cost of their U.S. counterparts. To be competitive, U.S. engineers, scientists, and mathematicians must provide high value by being innovative, which includes being immediate, integrative, conceptual, and multidisciplinary. In addition, innovation is local—you don't import it and you don't export it! You create it! Innovative solutions require a new way of thinking, communicating, and doing; they must be human-centered, technologically feasible, commercially viable and sustainable, usable from a complexity view, and sustainable in a global sense (see diagram above).

In engineering design we integrate. From the very start of the design process, we combine the physical system with sensors, actuators, computer control, and human interfaces to give it some intelligence and decision-making capability. At its very heart, system complexity is synonymous with power. However, this power can be for good or bad. If the complexity in any system is not tamed, the consequences can be devastating. In a complex system, learning how all the pieces, constant and variable, interact gives a depth of understanding that averts catastrophe. That is what we mean by human-centered design—understanding the interfaces among technology, people, communities, governments, and nature. This is what makes complexity manageable.

All complex systems have, as a foundation, fundamental principles or core knowledge that cannot be ignored. Designers of these systems must have a good understanding of those principles. However, on top of that there must be a flexibility to respond to



the problems that inevitably arise. Clearly, the typical discipline-specific engineer is not well equipped to manage such complexity; not even an engineer with multidisciplinary engineering breadth can do an effective job. Complexity demands a skill set illustrated by the T2 Engineer (see diagram above): one with technology depth and also non-technical breadth, specifically human-centered design expertise capable of managing complexity.

If a young person wants to be a complete baseball player, he must be able to field, throw, run the bases, hit, and hit with power, and all these skills must be applied in an actual baseball game. To achieve this goal, he learns all these skills at the same time, improving gradually in each one while playing actual games and, over time, develops into a complete baseball player. The result is more than just the sum of the skills learned, but a sense of confidence and savvy that makes him a winner.

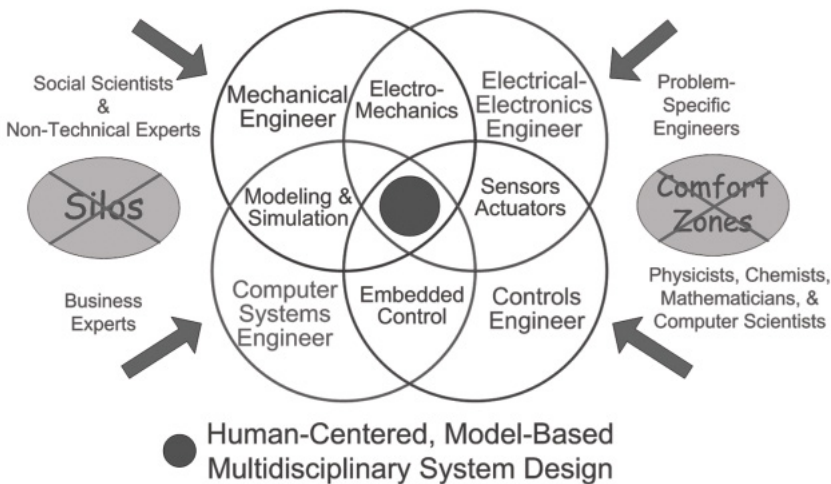
In modern multidisciplinary engineering practice, the necessary skill set includes modeling and analysis of multidisciplinary dynamic engineering systems, control system design and implementation, and sensors and actuators with the necessary electronics. Theory and practice must be in balance when mastering these skills. If “playing a game” means putting these together to create a system to solve a problem, then that rarely happens in engineering education.

We devote separate courses to each skill and



Systems Are Created By Teams. Who Will Lead This Team?

Multidisciplinary Design Team



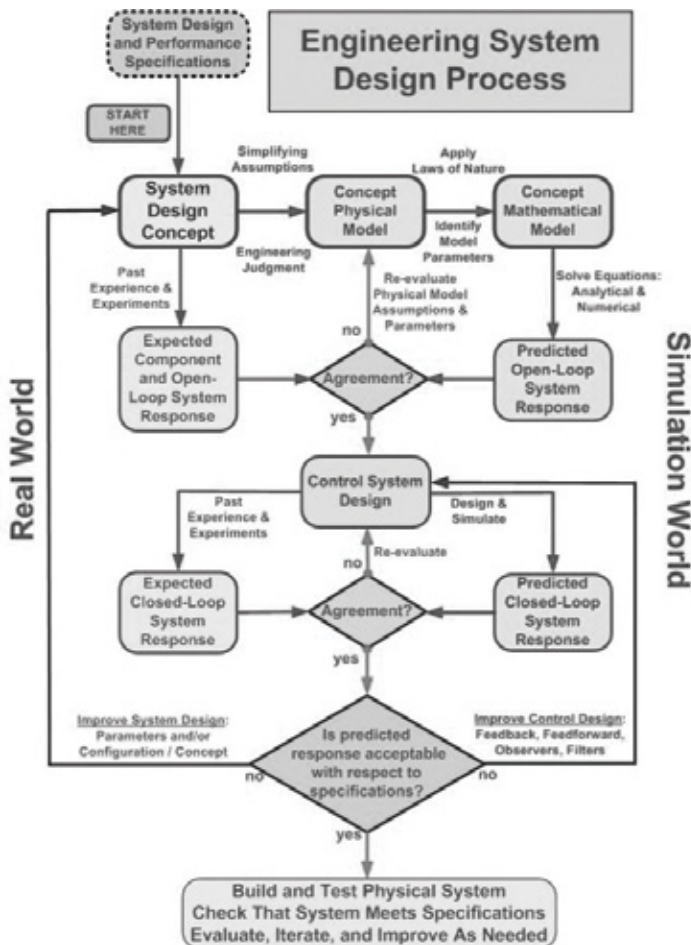
somehow think that learning each skill very well will somehow magically enable the student to graduate and critically think, integrate it all, and solve a real-world problem. This is true in both undergraduate and graduate engineering education. In the baseball analogy, this would be utter madness, yet in engineering education, it is routine, and it results in the situation illustrated in the diagram above.

The present situation then is that engineering education today is ineffective in preparing students for multidisciplinary system integration and optimization—exactly what is needed by companies to become innovative and gain a competitive advantage in this global economy (see diagram). While there is some movement in engineering education to change that, this change is not easy, as it involves a cultural change from the silo approach to a holistic approach. The required senior capstone multidisciplinary design course too often becomes a design-build-test exercise, rather than a model-based design exercise, with the emphasis on just getting something done. Students rarely break out of their disciplinary comfort zone and thus fail to experience true multidisciplinary-system, model-based design. What is needed are multidisciplinary systems courses, with a balance between theory and hardware, between academic rigor and the best practices of industry, presented in an integrated way that prepares students for true multidisciplinary-system, model-based engineering at the senior level and beyond. This then needs to be followed with an integrated graduate program that empowers practicing engineers with the latest knowledge, skills, tools, and processes.

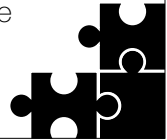
Modern mechanical engineering, which includes manufacturing engineering, now includes engineering systems, in addition to traditional mechanics and thermal/fluid engineering. The courses need to be taught in the context of modern engineering practice and real-world problem solving following the Engineering System Design Process shown in the

diagrams below. The Engineering System Design Process provides an environment that is rich with numerical and graphical analysis and design tools that stimulate innovation and cooperation within design teams. It aims to reduce the risk of not meeting the functional requirements by enabling early and continuous verification throughout the entire design workflow. The key concept in the courses is human-centered, model-based, multidisciplinary engineering problem solving. The key emphasis, in both classes and studios, is to strive to uncover the questions a student is asking himself/herself as he/she attempts to solve a problem and then give him/her the insight and understanding, based on physical principles and best industry practices, to ask the right questions.

Modern manufacturing engineering needs to embrace model-based design as the key to innovation. There can be no delay, as the rest of the world is recognizing the importance of this approach and is gaining a competitive advantage.



Local industry-driven initiatives, coupled with national credentials and willing educational providers can provide amazing results that have positive impact on a region's economy. Pittsburgh is one area where industry took the lead to develop its own skilled workforce. Today the region's metalworking industry reaches out to the poor, the underemployed, ex-offenders, incumbent workers, secondary school students and others to maintain a thriving manufacturing economy. This example also shows how the use of mature credentials in the discrete manufacturing sector has benefited the industry, highlighting the need for wider adoption of credentials in the consumer goods and other hybrid industries.



Author Bio



Paul Anselmo,
President,
New Century Careers

As I've journeyed across my home state of Pennsylvania, I have frequently come in contact with Paul Anselmo. As we have taken steps to broaden the scope of the Second Edition of the Playbook beyond the hybrid manufacturing space, Paul's work serves as an outstanding example of success in the discrete industries. Paul co-founded New Century Careers in 1999 after 20 years in public education. As President and CEO of NCC and Director of its Training Innovation Center he provides design, start-up and project management functions for all NCC initiatives and has secured and managed grants from multiple federal, state and foundation sources to operate NCC as a non-profit organization. Paul served a pivotal role in establishing the Manufacturing Industry Partnership of Southwestern Pennsylvania along with our region's four Workforce Investment Boards. The partnership is known for its strength in creating buy-in and active engagement among employer partners and includes unique initiatives such as MANUFACTURING 2000 machinist training, the Advanced Manufacturing Career Collaborative, COMPETE Incumbent worker training and BotsIQ. New Century Careers is also under contract with the Pittsburgh Chapter NTMA to administer the NIMS-Based multi-employer apprenticeship program. In 2012 New Century Careers was honored with an "Innovator and Trailblazer" award by U.S. Secretary of Labor Hilda Solis.

Chapter Twenty-eight

Local Industry Takes Responsibility for Workforce Development Efforts

The Pittsburgh chapter of the National Tooling and Machining Association (NTMA) partners with a non-profit to develop workers for the metalworking industry.

by Paul Anselmo

Industry addresses the need for workforce education: Although Pittsburgh has often been noted as a leader in the steel industry, precision machining occupations have been and continue to be critical to manufacturing in southwestern PA. New Century Careers (NCC) has established a leadership role in providing collaboration among many of our region's manufacturing workforce development assets. Approximately 4,000 manufacturing companies in the region support the aerospace, defense, medical, energy, and transportation industries. Over the years, as competition and technology increased companies needed to improve the skills of their workers and build their talent pipeline if they wished to remain competitive in the domestic and international marketplace. The increasing shortage of skilled workers threatened and continues to threaten the wellbeing of the manufacturing sector, a critical economic driver for the region. In 2010, the PA Center for Advanced Manufacturing Careers projected a need for 18,000 PA machining positions by 2020. In January 2015 a Deloitte study confirmed the urgency of the manufacturing workforce shortage that it is expected to reach two million nationwide by 2020. Over the past 40 years industry in southwestern PA has taken the lead in developing apprenticeships, pre-apprenticeships, incumbent worker training, and pipeline development programs to support the manufacturing industry and to combat the critical shortage of skilled manufacturing employees.

NTMA Apprenticeship for Precision Machining Occupations

The National Tooling and Machining Association (NTMA), a national trade organization open to small, medium, and large metal working companies, has been actively representing manufacturers at the federal and state level, and educating members in management principles, the marketing of products, and the development of training programs. The NTMA - Pittsburgh Chapter, incorporated in 1976 and comprised of small to mid-sized companies, was founded specifically to develop a metalworking apprenticeship in southwestern PA to improve the skills of the region's metalworkers. The NTMA apprenticeship program is reg-

istered through the Pennsylvania State Apprenticeship Council (SAC) and the U.S. Bureau of Apprenticeship and Training (BAT) to provide related classroom instruction to supplement on-the-job apprenticeship training provided by each of its participating companies. Upon completion of four years of classroom instruction, along with the concurrent on-the-job practical experience, each apprentice registered with the SAC/BAT will be a certified Journeyman in a specific precision machining related occupation.

In 2001 the NTMA Pittsburgh Chapter created a partnership with New Century Careers (NCC), a non-profit dedicated to the training of entry-level and incumbent manufacturing employees, to administer the NTMA apprenticeship. The NTMA Apprenticeship Steering Committee, comprised of NTMA company member representatives, sets the apprenticeship policy and works with NCC, to provide an effective apprenticeship program with a competency-based training strategy that enables apprentices to advance at their own pace, benchmarks achievement for a set of core competencies, and builds a portfolio of skills and NIMS Industry Credentials (see below) that validate acquired skill levels.

For employers the biggest expense in setting up an apprenticeship program is the related instruction and tracking of achievements. The NTMA apprenticeship program helps companies keep this cost to a minimum by aggregating the theoretical/related instruction at several central locations, and tracking apprentices' progress. The theory/related instruction is provided through partnerships with four vocational schools at various locations in Allegheny and Westmoreland Counties, to provide convenient access to participants. Classes are offered evenings from September through June. The NTMA charges a fee for the related instruction and for books, but most apprentices are sponsored by their companies. Because of the aggregation of demand among so many manufacturers the NTMA Apprenticeship program continues to be an affordable apprenticeship training solution.

The related instructional course material covers 576 hours of theoretical instruction over four years. It provides apprentices with important information on critical subjects over the first three years including: Math (Technical Mathematics, Algebra, Geometry, and Trigonometry), Blueprint Reading and Geometric Dimensioning and Tolerancing, and Machine Tool Theory. Year four emphasizes specialized knowledge in Jigs and Fixtures, Basic Die Design, CNC Programming, Integrated Systems Technology (Welding/Brazing, Hydraulics/Pneumatics, and Programmable Logic Controllers). Classroom instruction is supplemented by machine shop demonstrations and field trips to manufacturing facilities. The curricula are reviewed periodically by the Apprenticeship Steering Committee to ensure they continue to meet industry needs and cover relevant current technology. The Steering Committee did a thorough revision of the entire four year curriculum from 2010 through 2014 including the addition of Integrated Systems Technology content.

Apprenticeship admission requirements ensure that entering apprentices have the basic skills to succeed in the program. Potential candidates are given an entrance math exam to determine their eligibility for the program. Those who do not meet the entry 8th-grade, 9th-month level of math proficiency are referred to tutoring services and encouraged to reapply the following year. Apprentices who score at the 12.9 math grade-level are encouraged to test out of the first year of math, if they have the approval of their employer. Ap-

prentices with significant work experience may also try to test out of Blueprint Reading or Machine Tool Technology but to progress to the next level/year, they must achieve 80% on all sections of the comprehensive test. Apprentices are expected to attend all classes and to be active participants in class discussions. Final exams are given at the end of each year to verify achievement levels and as required by the employer apprentices must complete their scheduled OJT competencies and/or NIMS Credentials to move on to the next level.

All instructors are recruited from industry and are expected to teach the theory and craft of precision machining. To improve the effectiveness of classroom instructors a teacher training class is offered in the fall each year for all instructors, including those with instructional experience. The performance of instructors is evaluated annually by the apprentices, the school advisors, and members of the NTMA Apprenticeship Steering Committee. Equally important is the quality of the On the Job Training (OJT) trainer on the shop floor. Under a recent grant from the PA Department of Labor and Industry to improve OJT instruction, many OJT trainers participated in a special training class and achieved a NIMS OJT Trainer Credential. Promotion of such credentials for OJT trainers will be ongoing.

Competency-based – NIMS Credentials: The NTMA Pittsburgh Chapter participated in the development, validation and endorsement of national standard competencies known as the National Institute of Metalworking Skills (NIMS) Credentials. This program compliments the Journeyman certification system and certifies machinists based on standards for practical skills such as turning, milling and grinding. The NTMA/NCC partnership was selected by the National Institute of Metalworking Skills (NIMS) as a pilot site to test the efficacy of the Bureau of Apprenticeship and Training's competency-based apprenticeship model, which uses NIMS credentials as a means of verifying skill levels. To achieve Level 1 NIMS credentials, apprentices are given a blueprint to create a machined part, which must meet tolerance requirements. NIMS projects are performed at the employer's shop or a designated NTMA NIMS Lab located at one of the NTMA/Career & Technology Center (CTC) training sites. Once the part has passed an initial inspection, it is sent to the NTMA Met-Tech Committee after being inspected by the quality department at a participating manufacturing company. If the part passes inspection and the apprentice passes the online exam, a NIMS credential is awarded. NIMS credentials can assist employers in assessing potential employees, aid in hiring and placement, or validate skills for advancing, incentivizing or promoting incumbent employees. By implementing NIMS, the NTMA goal was to expose the student to a well-rounded apprenticeship program that blends practical fundamental exercises with detailed classroom theory. Apprentices are entitled to earn as many NIMS credentials as they wish at no additional cost.

Through grants from the PA Department of Labor and Industry, NIMS credentials and Tooling-U classes have been cross-referenced with the NTMA curriculum. Tooling-U is an online training system geared for engineers, machinists, press operators, assemblers, and industrial maintenance professionals. It is a user friendly, advance at your own pace program which offers over 400 different classes; it tracks learning through pre-tests, interactive lessons, and final exams. By aligning the Tooling-U modules with the NTMA curriculum, the apprenticeship can offer supplementary materials to apprentices who need extra help or

wish to expand their knowledge of a specific topic. The selection of Tooling-U classes plus specific NIMS credentials enables companies to customize the apprenticeship program to the needs of their individual apprentices.

Apprenticeship Growth & Benefits: The apprenticeship program in southwestern PA now serves over 180 apprentices from 61 different companies. Participation in the program provides both wage and promotional opportunities for trainees since apprentices typically earn pay-for-skills promotions during their apprenticeship training. Entry-level apprentices earn an average of \$22,000-26,000 in base wages in their first year of training. Upon completion of the apprenticeship they typically earn between \$30,000 and \$40,000 per year. Journeypersons can earn significantly greater wages as their knowledge, skill and proficiency continue to develop. The program has also enabled participants to advance along a manufacturing career pathway to supervisory, quality and management positions.

Apprenticeship Customization

New Century Careers can help companies to customize an apprenticeship program to better meet their specific production and competency needs in a variety of ways: (1) adding NIMS projects that reinforce a company's needed competencies to the apprentices' requirements; (2) creating a custom program that blends the NTMA related instruction at central sites with Hands-on Training, (3) providing on-line classes to customize and supplement the standard instruction and (4) Creating a company-specific Apprenticeship Program held at the company's site or at one of the affiliated training locations.

Founding of New Century Careers (NCC) and the MANUFACTURING 2000 Program

Although the NTMA-Pittsburgh Chapter's apprenticeship program was already in place, by the late 1990s industry was still experiencing a shortage and lacked a pipeline of skilled workers for precision machining occupations. High school career and technology center (CTC) enrollments in machining were down and some CTC machining programs were closing. In 1997, regional manufacturers decided to address the critical shortage of entry-level machinists and other manufacturing workers because by then they were poaching from one another to meet production demands, a futile strategy. A group consisting of representatives from Steel Center Area Vocational-Technical School, The Institute for Economic Transformation at Duquesne University and executives from 17 manufacturers partnered to create the MANUFACTURING 2000 (M2K) training program to fill these entry level positions. The initial success of the M2K program led to the founding of New Century Careers in 1999, a non-profit dedicated to the training of entry level machinists through the new Manufacturing 2000 program.

The goal of Manufacturing 2000 (M2K) was to focus on recruiting and training individuals for critical, skill-based occupations such as machinists to fill the in-demand manufacturing positions in the region. The program, now in its seventeenth year targets low income, un/underemployed individuals and continues to be free to qualified individuals. To recruit trainees New Century Careers staff holds information seminars throughout the month at its

Training Innovation Center (TIC), CareerLink facilities, and community organizations in the region. To be eligible for the training, an individual must have a high school diploma or a GED, submit two letters of recommendation, and pass an aptitude test to indicate the individual has the math, problem solving, and mechanical reasoning skills needed to succeed in the program. M2K originally consisted of 525 hours then increased to 600 hours of hands-on machining training, including an introduction to CNC (30 hours), technical math, machine theory, blueprint reading, metrology, career development, resume writing, and placement assistance. An on-site employer expo upon completion of the program and job search assistance enabled NCC to achieve a placement rate of over 75% for program completers.

M2K classes were initially held at various career and technology centers in the region. In 2004 NCC opened its Training Innovation Center (TIC) on the south side of Pittsburgh in order to make the training accessible to the inner city un/underemployed. TIC has a large shop area with mills, lathes, grinders, CNC machines as well as classroom and office areas. In 2006 TIC became a NIMS Accredited training facility. In 2009 the M2K Program and TIC were certified as a Private License School, with the ability to charge tuition; however, NCC has never done so.

M2K Modifications to Reflect the Needs of Students and Industry

Despite its success, the six month M2K program was too long for many individuals who were financially unstable and needed work and for industry, which desperately needed machinists.

Therefore M2K was modified in 2012 to offer 3 levels of training (250, 450, or 600 hours) with a NIMS credential earned at each level. Based on the NTMA Apprenticeship's positive experience with the NIMS program, NIMS credentials were incorporated more formally into the M2K program to verify the competencies of trainees. Participants have the opportunity to earn "Measurement, Material & Safety", "Job Planning, Benchwork & Layout" and either "Manual Milling 1" or "Turning Between Centers 1" NIMS credentials. The 3-level model provides a competency-based training program which enables job-seekers/trainees to enter the workforce more quickly when employment opportunities arise and can advance through the levels in less time based on competencies earned. Participants receive career planning and job search assistance including: Myers-Briggs personality tests, and conflict resolution in the work place, resume writing and interview skills sessions. Manufacturing company touring is also a critical element in the training/career awareness process. The majority of trainees find employment after approximately 400 hours of training. Since its founding, M2K has trained well over 2,000 machinists with a placement rate of 75% of program completers. Many training completers enter the NTMA Apprenticeship Program and earn advanced standing, reducing their apprenticeship from four to three years. Many program graduates have progressed along the manufacturing career pathway to positions such as inspector, group leader, supervisor, quality control, CNC programmer, and various management roles.

Rehabilitating offenders: M2K is at the core of NCC's M2K Quick Train Pilot Program in cooperation with the Allegheny County Department of Human Services and the Allegheny County Jail Collaborative. The partnership was designed, to avoid offender relapse, assist offenders with entry into the workforce, and to provide living wage, career opportunities.

The Collaborative partners provide general support services, and NCC provides the entry level job training, beginning with online Tooling U classes, live instruction and bench-work/hand tool practice inside the Allegheny County Jail. For the first time the M2K Quick Train program paired online learning with hands-on M2K machining training. Participants have the opportunity to train for over 150 hours with online Tooling-U modules and achieve 2 NIMS credentials while in the jail (Measurement, Material & Safety and Job Planning, Benchwork & Layout). Upon release, trainees receive hands on training on industrial lathes, mills, grinders and CNC machines at the NCC Training Innovation Center. Participants receive job placement assistance after 250 hours of training and continue training during the job search process and working toward earning additional NIMS credentials. Most trainees are placed with an average of 400 hours of training. The program's success is often dependent upon the offender's motivation; however completers have been placed with local manufacturing companies.

The successful pilot jail project demonstrated the efficiency and effectiveness of a condensed M2K Quick Train program by pairing online training with hands-on machining training and earning NIMS credentials. The program is now available to the general public. It shortens the training cycle, enabling trainees to enter the workplace more quickly to meet industry demand. The M2K Quick Train program follows the model used in the jail pilot project described above combined with the traditional M2K work readiness sessions and placement assistance. Although most participants are placed after about 400 hours, training can be extended to a maximum of five months and 600 total hours if needed to achieve Level 3 completion.

The M2K training team distributes participant resumes to NCC's more than 50 partner companies, holds company job expos, and assists participants with the job search. Trainees are placed in entry-level jobs with family sustaining wages such as Computer-Controlled Machine Operators, Machinists, or Production Technicians. These three job titles are on all four of our partner Workforce Investment Board (WIB) High Priority Occupation (HPO) lists as well as the state's HPO list and all positions are on a manufacturing career pathway with advancement opportunities. M2K graduates often continue education and training in a variety of ways including: (1) Apprenticeship, which guarantees pay increases and personal credentials; (2) Incumbent Worker Training which often results in pay increases, increases in responsibilities, personal credentials and sometimes advancement; (3) AS or BS degrees through Articulation Agreements between M2K, apprenticeship and post-secondary education partners, who award advanced placement credit based on the apprentices' credentials and grades.

M2K and M2K Quick Train classes are currently offered at three locations (Training Innovation Center in Pittsburgh, in Westmoreland County, and at the Allegheny County Jail) with both day and evening options. Since trainees progress at their own rate and can verify their competencies, they complete the program and are hired at different times. As soon as four or five training slots are open, a new cohort of trainees is admitted. This rolling-admission program enables M2K to graduate a cohort of trainees every five to six weeks to help meet industry's need for machinists.

M2K- Overcoming Barriers to Success: New Century Careers collaborates with other organizations such as CareerLink, The Urban League of Pittsburgh, The Office of Vocational

Rehabilitation, The Veteran's Place, Veteran Leadership Program, Goodwill, the Mon-Valley Initiative, the Pennsylvania Parole Board and other community based organizations. By collaborating with other agencies to help trainees overcome barriers to employment, NCC helps graduates enter careers with advancement opportunities that improve their lives and the surrounding community.

The M2K free entry-level machining training programs are sustained through fees paid by partner companies when hiring an M2K graduate and support from foundations, community organizations, the regions' workforce investment boards, and federal and state grants when available.

Incumbent Worker Training Programs

Due to rapid technological changes in the manufacturing industry, it also became important for manufacturing companies to upgrade the skills of their existing manufacturing workforce. In 2002 New Century Careers developed MANUFACTURING 2000 Plus to advance the skills of incumbent manufacturing employees. The training is industry-driven and can be customized to meet a company's needs. Examples of classes offered are: Blueprint Reading, Geometric Dimensioning and Tolerancing, CNC programming and OJT Train the Trainer. Open enrollment classes are held throughout the year at NCC's Training Innovation Center and can be customized and provided on-site at a manufacturing facility. With the assistance of grants from the PA Department of Labor and Industry, NCC launched The COMPETE Initiative which targeted training for small and mid-sized manufacturing companies based on an assessment of their needs and interest in training that would lead to improved business competitiveness. Training interventions focused on market expansion through innovation, process improvement, and technology integration. Collaborative training modules were developed based on over 120 on-site manufacturing company evaluations and interviews and were offered as "open enrollment" classes to manufacturing employees. By aggregating training for companies and their employees, an economy of scale was achieved making training affordable for smaller companies. NCC published electronic catalogs with training offered by manufacturers' preferred providers. Thousands of incumbent workers were trained through The COMPETE Initiative.

BotsIQ Manufacturing Pipeline Program

Despite the success of the NTMA apprenticeship and M2K pre-apprenticeship programs, there was still a growing need for developing the manufacturing pipeline. In response to that need, the NTMA-Pittsburgh Chapter, NCC, and a collaboration of workforce development organizations, manufacturing companies, and post-secondary education institutions established the BotsIQ program in southwestern PA. BotsIQ introduces high school students to the entire manufacturing process as they design, build, test, and battle 15-pound robots. In southwestern PA, the BotsIQ program is a workforce development program that encourages students to acquire the skills needed by industry, and to consider manufacturing-related careers. Our Motto is: "They're building robots. We're building a workforce!". Each participating team is partnered with a manufacturing company as a technical advisor.

Companies are encouraged to provide tours of their facilities and offer internships and jobs to BotsIQ graduating students. The program has grown from 5 participating schools and 66 students in 2005 to 61 participating schools, 78 teams, and over 1,000 students in 2015. 85% of student participants plan a STEM career. Over a ten year span, the program has had many successes with students going on to post-secondary STEM training and getting jobs in local industries while others are entering the workforce directly out of high school or while attending a local community college. Some graduates, now employed by manufacturing companies, have become technical advisors to BotsIQ high school teams. The BotsIQ program has been supported and sustained through funding from members of the Manufacturing Industry Partnership of Southwestern PA, the regional Workforce Investment Boards, regional manufacturing companies, and various foundations.

Manufacturing Industry Partnership in Southwestern PA:

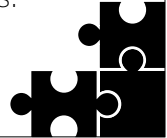
Industry's coordinated development of manufacturing workforce initiatives has been facilitated and supported by the Manufacturing Industry Partnership of Southwestern PA, which has been praised as one of the most effective partnerships in the state. The mission of the Partnership, which is managed by New Century Careers, is to provide programs and services that will continually improve the competitiveness of all sectors of manufacturing through a continuum of services from career awareness to pre-employment training and continuous lifelong incumbent worker training. The partnership was organized in response to tremendous employer demand for skilled workers coupled with awareness of an aging regional manufacturing workforce. It is comprised of a broad group of stakeholders, including four workforce investment boards, who have been collaborating since 2002 to address our short-term, mid-term, and long-term advanced manufacturing pipeline.

Conclusion

Over the past 40 years industry in southwestern Pa. has taken the lead in developing apprenticeship, pre-apprenticeship, incumbent worker training, and pipeline development programs to support the manufacturing industry and to combat the critical shortage of skilled manufacturing employees. New Century Careers has had the privilege of facilitating much of this activity since 1999. The training programs initiated by industry in southwestern Pa. have received national recognition and have even been cited as model programs in Vice President Joe Biden's 2014 Ready to Work: Job-Driven Training and American Opportunity Report. The effectiveness and the quality of the programs not only improve the skills of manufacturing employees in the region, but also provide jobs with family-sustaining wages and career opportunities for low income, disadvantaged unemployed and underemployed workers. With manufacturing as a powerful economic driver for the greater Pittsburgh region, strong workforce development in manufacturing translates to economic development for the region.



Manufacturing workforce development must be ongoing for all employees. Once good employees choose manufacturing as a career, it behooves manufacturers to keep them and to help them grow and improve. Many schools and professional organizations offer continuing education programs. This chapter looks at the rationale for using these programs, as seen from the Institute of Packaging Professionals.



Author Bio



Jim George,
Director of Education,
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Professionals

My original outline for the Playbook did not consider issues of professional workforce development beyond a bachelor's degree. Jim George correctly pointed out that, just as folks on the shop floor need ongoing development, so does the staff closer to the top floor.

Jim is the Director of Education for the Institute of Packaging Professionals, and his experience includes decades in publishing and 15 years in the packaging industry. Jim was the founding editor of *Shelf Impact!*, a franchise focusing on the marketing impact of packaging, the founding editor of *Contract Packaging* magazine, and wrote on marketing and design and other topics for *Packaging World*. Jim has led workshops on branding and package design, has been a speaker at numerous conferences, and also has organized a variety of packaging industry conferences. In addition, Jim has served as a judge for many package-design award competitions, and he has co-authored and edited packaging industry management reports.

Chapter Twenty-nine

Continuing Education's Role in Career Development

Examples of lifelong learning focusing on packaging professionals.

by Jim George

Imagine if the learning stopped. How different packaging would be. There would be no modern conveniences that today we take for granted. No squeezable food tubes, aseptic pouches, or microwave dinner trays. Or channel-specific packaging to segment target audiences or induce impulse purchases. Or e-commerce conveniences that enable and encourage consumers to customize products and packaging to make their purchase truly their own.

Everything would remain just as it was in your grandparents' grocery store 50 years ago: one flavor of Coca-Cola, available only in returnable 6-oz glass bottles, and packaged vegetables, outside of the produce department, generally sold only in tin cans.

If the learning stopped, there would be no conveniences such as smartphones or smart packaging that let consumers learn in more detail about the product or join a virtual brand community.

If the learning stopped, today's packaging lines would be churning out many products just as they did generations ago: one product in one package for the masses. Many automated or semi-automated aspects of packaging operations still would be done by hand—at great costs of labor and time-to-shelf. It would be hard to imagine the multilayer bags and containers that give packagers and designers so many options today.

Each of these advances, and countless more outside of packaging that have improved every aspect of life, occurred because someone was curious enough and courageous enough to ask why, why not, or what if. They generally came about because someone had a working knowledge sufficient that they could ask the right questions or thoughtfully challenge convention.

The odds of such a desirable outcome occurring in your company improve when people develop a broader background. They not only understand their job, but they also have a working knowledge of what those around them do and why, and how one decision can affect another.

Continuing education through institutions of higher learning and professional organizations can help close these learning gaps. One goal for students preparing for careers in packaging—or for packaging professionals wanting to get better at what they do—should be a broader-based education. Besides building technical packaging knowledge, they be-

come familiar with other areas of the business that packaging touches.

In recent years, some companies have taken the initiative to rotate members of their packaging teams through other departments. Packaging engineers, for example, spend a bit of time in the business office learning the language of finance. Then they move through marketing, procurement, and so on. Those in the other departments do the same. They all come out of the exercise with a broader knowledge of what their colleagues elsewhere in the company do, to benefit the greater good.

But more diligence is needed in continuing education. Associations and professional societies can complement the work of our educational institutions by evolving their continuing education programs. This is already beginning to happen. Continuing education no longer is limited to the traditional classroom setting. Face-to-face learning is still alive and well, but in recent years it's been supplemented by e-learning courses and webinars. Hybrid programs have begun to emerge that combine e-learning with in-person instruction or that blend independent online coursework with live Internet-based instructor-student discussion groups.

More content choices and learning options than ever are emerging to help companies guide their workforce development, and also to enhance the career growth of individuals who take their own initiative. More on that later in this chapter.

Companies are struggling universally to find value-added packaging professionals. Beyond that, demand is far outstripping supply for some types of packaging professionals, whether they possess these additional skills or not, and hiring externally is very expensive. Have you considered upgrading the skills of your existing workforce through continuing education? Your own employees stand ready to quickly build on what they learn because they're already familiar with your company.

Some companies are stepping up to help their employees plug the knowledge gap. A study of 300 U.S. organizations by Bersin by Deloitte found that overall spending on training rose 15% to \$1,169, on average, per learner in 2013.

But ironically, at a time when packaging has become more complex than ever, and packaging decisions are becoming intertwined with business decisions, many companies remain hesitant to allocate training dollars.

One question often asked of IoPP is, if my company spends potentially thousands of dollars on employee training, where's the ROI? First, let's look at this in the proper context: Continuing education is not an expense but an investment in your workforce. If one employee comes back from one training program with one idea for improving some aspect of your company's package development process, the company can be rewarded many times over for the cost of the training.

Aurion Learning offers some supportive numbers: Companies that approve e-learning and other continuing education opportunities for their workforces generate about 26% more revenue per employee. In addition, for every dollar a company spends on training, it can receive \$30 in productivity gains.

Those are benefits that fall directly to your company's bottom line. On a micro level, advancements and breakthroughs get your packaging teams noticed. Individuals step up to

become leaders, go-to people within your company who gain a reputation for solving problems. These are the types of individuals, hiring managers tell IoPP, who they want to add to their teams. They don't want someone who can merely "do the work," but a well-rounded professional who can complete tasks with an inquiring mind and be able to see the big picture. That's how innovation is born.

Here's a case in point on ROI: As explained in a report called "Quick-Changeover Packaging," written by packaging experts Brian Wagner and John Henry and published by PMMI Media Group a few years back, there are measurable, tangible costs to package changeover on a production line. In the report, Henry made the following hypothetical calculation: Assume a product runs at a line speed of 250 PPM and a cost of 50 cents per package. Further assume one 60-minute changeover per day. Cost per changeover will be $250 \text{ PPM} \times 60 \text{ minutes} \times 0.50/\text{package}$, resulting in a \$7,500 changeover, or \$125/minute. If the line normally runs 240 days per year, the annual cost to the company is \$1.8 million.

Henry teaches IoPP's Packaging Machinery: Basics seminar, in which he frequently interjects simple cost-benefit analysis discussions such as this while also providing an introduction to machinery. Just think what one employee at your company could do armed with this kind of insight, no matter the educational program. The opportunity to make a change that could save some or all of the \$1.8 million in the example above is a no-brainer when pitted against the investment for the employee's training. If you're a manager or department head who approved your employee's training, and the employee could bring you back this sort of ROI, you would be a hero within your company.

Such innovative breakthroughs and bottom-line enhancements are possible by empowering individuals and work teams to continue learning. Even if certain people within your company have packaging degrees, there is so much more for them to learn that can drive packaging's value throughout your organization and your value chain. A key unmet need in packaging education today is the interface of packaging and machinery. They may know materials, but chances are they don't understand how and why materials choices can affect line functionality and optimization. The wrong materials choice or package design may disorient individual package units on the line or could shut down the line entirely, or at the very least require slower line speeds than intended. A redesign might be required. In any event, the bottom line suffers.

There's another evolution going on in packaging where continuing education can help. Packaging issues have become business issues. A packaging professional is at a disadvantage without understanding how packaging is intertwined with business challenges, including shorter product life cycles, retail channel-specific packaging, mass customization and one-to-one customization, complex global supply chains, and ever-present pressure for higher profits. Not to mention sustainability and environmental responsibility.

Packaging operates squarely in the crosshairs of each of these challenges. It requires a different and higher level of thinking that many undergraduates coming out of packaging schools, and many who are already working on packaging teams, are ill-prepared to address. What if you encouraged your workforce to engage in a training program that would empower them to think holistically rather than linearly about packaging? In short order, you

could unleash positive results on the company's bottom line.

Perhaps you've decided at this point that continuing education would be good for your company. What next? Consider group instruction. Learning has long tended to be an individual endeavor, but over the past couple of years, IoPP has noted the increasing frequency of group learning, whether it's sending multiple people at a time from the same company through a face-to-face course or setting up a customized or semi-customized in-your-facility training program. Why the move toward group learning? Savvy managers are realizing that it's not only important for their teams to learn the correct way, but the same way. Everyone is on the same page, speaking the same language, enabling cost-saving efficiencies and innovative thinking to take root.

Where are the continuing education opportunities that can help in your workforce development? Here are few options:

- Traditional face-to-face classroom programs
- Online courses
- Online blended-learning curricula
- In-house, or at-your-facility training, customized for your needs
- Webinars

Other options exist. Write a white paper, present at a conference, attend a conference or workshop, or become a packaging contest judge in which you share your expertise and also learn from your peers.

Earlier, mention was made about continuing education and the evolution into hybrid program offerings. The concept began with MBA programs for busy executives in which one portion of the curriculum is completed online and another is done with occasional face-to-face classroom sessions. The idea being that the convenience and flexibility of offering courses that can be completed largely through independent online study, supplemented with periodic live classroom with an instructor, would be enticing to busy working professionals.

Hybrid education programs are evolving. IoPP is introducing one of them in 2014. Attendees can register to participate in a small study group. Each group member completes an online course independently over 10 weeks, at the rate of about four lessons per week. Once a week, the study group joins an IoPP instructor in an online forum to discuss the lessons assigned for completion that week. Soon, these IoPP study groups will be segmented to focus on packaging applications to specific product industries. Through this approach to blended learning, students get the best of both worlds—online education at their convenience and interaction with an instructor, which many still consider to be an essential requirement for content understanding and retention.

Undoubtedly, online training and additional forms of hybrid instruction will grow in importance as options for continuing education programs that bolster workforce development. It stands to reason: Approximately 45% of college students had taken at least one online course in 2013, double the 23% who did so in 2008, according to a report from market research company re:fuel. They are familiar and comfortable with e-learning and expect to

continue to learn at least in part through online training.

Emerging graduates and young professionals are tomorrow's packaging leaders. Companies that invest in continuing education opportunities, and encourage those in their charge to continue learning, can begin taking huge steps today to ensure their workforces are properly trained to meet the challenges of tomorrow.

For information on any of IoPP's packaging education programs, go to **www.iopp.org** and browse under the Education tab.

Employers must work with employees to constantly update their skills and knowledge and also to keep them motivated and engaged. The OpX Leadership Network has identified workforce engagement as a critical component of an organization's success, and has created the *Workforce Engagement* playbook to deal solely with that topic. Gallup estimates that actively disengaged employees cost the U.S. around \$500 billion annually in lost productivity. If true, this certainly is a critical topic.

The following chapter is taken from *Workforce Engagement* playbook. It deals with foundational issues of leadership, values, mission, vision and purpose—issues that I have spent innumerable hours working on throughout my career because of how important I have found them to be to a team's success.



Author Bio



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It is most appropriate that the concluding contributed chapter of this Playbook come from a manufacturing leader of the stature and experience of Greg Flickinger. Greg is currently serving as Vice President of Manufacturing and Corporate Engineering for Snyder's-Lance Inc. located in Charlotte, N.C. Greg has worked for Snyder's Lance for three years, focusing on transitioning the culture from a traditional structure to a high performance structure centered upon TEI (Total Employee Involvement). One of the key vehicles driving the change has been the implementation of TPM tools and methodologies. In his previous role as the Director of Manufacturing Greg's team in the Charlotte manufacturing site achieved an 11% reduction in total manufacturing cost. The improvement was gained through people and process without any significant capital projects. Along with exceptional business performance, the site also drove safety and quality performance to historical levels. Prior to Lance, Greg worked for General Mills in Strategic Technology Development focusing upon developing and launching food processing technology aimed at generating competitive advantage. Greg also worked in R&D product development as well as Headquarters Operations. In these roles, Greg had responsibility for the national launch of 11 products from concept to full production. In Greg's final three years with General Mills he served as the Plant Operations Manager at a Self Directed Work Team Plant that had implemented a number of the systems and technologies that were developed during the time Greg served in the Strategic Technology Group. During Greg's time at the plant, the team reduced their cost per case by 12% becoming the lowest cost producer in the division. Greg has multiple invention records, four patent applications and three granted patents for food production processes and technologies. Greg received his Masters and Ph. D. in Chemical Engineering from the University of Illinois.

Chapter Thirty

The Workforce Engagement Framework

Creating a platform for ongoing success.

by Greg Flickinger

The 2013 Gallup State of the American Workplace Report revealed that engagement continues to hover at incredibly low levels with only 30% of the workforce actively engaged. The study indicated that 52% of the workforce was disengaged and 18% were actively disengaged. The number of engaged manufacturing and production workers was even lower than the average at a meager 24%. Gallup estimated that actively disengaged employees alone cost the U.S. \$450-\$550 billion annually in lost productivity. The numbers in the U.S. are staggering, but the results are even worse globally, where Gallup's 2013 State of the Global Workplace indicated that only 13% of the global workforce is considered engaged.

The Alliance for Innovation and Operational Excellence (AIOE) Workforce Solutions Group [now the OpX Leadership Network] set forth to understand how to solve the engagement problem by assembling a wide-ranging group of leaders who have led transformations through the creation of meaningful and lasting workforce engagement. The objective was to understand how these leaders successfully transformed departments, factories, and divisions by nurturing engagement. How did they make the magic happen? What were the commonalities in their approaches? The culmination of nearly two years of discussion, evaluation, study, and development resulted in the AIOE's Engagement Framework. The Engagement Framework comprehensively codifies the fundamental attributes that enable the creation a culture of engagement.

A search quickly reveals that there are as many definitions for engagement as there are consultancies that will help your organization develop engagement. The AIOE group began by succinctly defining engagement as "a high degree of emotional attachment, intellectual commitment, and behavioral actions creating ownership and generating individual, team, and organizational performance." Engagement is characterized by high levels of discretionary effort, a bias for action, initiative, and pride in one's work and commensurate results. Highly engaged teams are trusting and are committed to the effort. When engagement is high, one can feel the passion and energy. Highly engaged teams are committed to the overall objective. As a result, they are generally flexible and adaptable feeling fulfillment with each step of progress towards the overall goal. Highly engaged teams are excited by the ability to contribute to the success of the organization and are willing find ways to overcome challenges. Highly engaged cultures feel valued and respected. They are always striving to find better ways to accomplish their work and are

not satisfied with the status quo. In its purest form, engagement is discretionary effort or the difference between “have to” and “want to.” The leaders who have experienced the greatest success understand that engagement is a personal choice. It cannot be instituted, mandated or managed. It clearly is not created through transactional incentives or reward and recognition programs.

Leaders who have created authentic pathways to engagement understand that success hinges upon removing the barriers, real or perceived, impeding someone from making the personal choice to engage. Engagement focused leaders understand and embrace their responsibility to create the conditions to enable engagement. The AIOE Engagement Framework serves as a guide ensuring leaders have awareness of the many facets that can either propel or encumber a person’s choice to engage. The Framework is composed of three foundational elements: Leadership, Values, and Mission/Vision/Purpose. The foundation supports the three pillars of engagement defined as Empowerment, Enablement, and Connection. Leaders can take intentional action to improve each pillar by addressing the attributes that define them. Many of the attributes are interactive and synergistic. Although they cannot be decoupled in reality, it is important to separate them to generate awareness and clarity. The deeper details of each attribute allow leaders to leverage the Engagement Framework as both a diagnostic and a roadmap for improving organizational engagement levels. To eliminate “blind spots” or bias, the Framework must be evaluated in a holistic manner by looking at each attribute through the lens of the stakeholder (employee), the environment, and leadership. It is only with a non-biased, comprehensive, and multifaceted view that an honest assessment of the barriers to engagement can be understood and addressed.

Engagement Framework Foundational Elements:

Leadership

Leadership is the prerequisite to all other components of the Engagement Framework. The framework will fail without authentic leadership that supports, models and lives it. Leadership must be committed “true believers” to catalyze cultural transformation. Various styles of leadership will experience improvement using the Engagement Framework. The leadership style that has been found to be the most effective, however, is the servant leader who is focused on growing people with performance as an outcome. The leader must be self-aware and have the courage to forgo their need to be “right” for a focus on being “effective.” Successful engagement efforts often begin by the leader themselves making significant personal change before the organization will begin to change. Leaders must continue to grow and evolve as the organization and culture grows. With this in mind, leaders may need to play the role of many different leadership styles depending upon the maturity and experience of the culture. The highly successful leader focuses efforts on developing the stakeholders by putting the needs of others before self. They willingly give their time ensuring they are “present” without distraction. They are transparent, effective communicators at all levels, freely and humbly disclosing opportunities even if the opportunities are their own. They listen, asking for and accepting critical feedback. They give credit for success to others,

but are the first to accept responsibility for issues or problems. They are coaches, mentors, facilitators, and educators who grow and develop people, but can easily hold accountability. They turn adversity into opportunities and are experts in supporting the identification and removal of barriers affecting the team. As individuals and teams grow, it is not uncommon that the leadership function can become the biggest barrier in the organization. It is for this reason that leaders must be willing to freely accept feedback and transform.

Values

Visible values are essential for true engagement to sustainably progress. Values set a clear expectation for behavior and must move beyond paper to action. Values enable two-way accountability, empowering people in the organization to hold peers and leaders accountable. Values and the commensurate expected cultural norms enable full circle accountability. Values set the cultural foundation for giving and receiving feedback. Leadership must respond positively and visibly with constructive action to the gift of feedback. One defensive reaction can derail the very trust values are in place to shape.

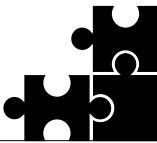
Leadership must become fully connected to the organization's "shadow values" or "pirate code." These are the unstated norms, behaviors, and beliefs deep within the organization. Associates at the action level may refer to this as "the way it really is around here." It is the responsibility and obligation of leadership to intentionally and actively align "the way things are done" with the expected organizational values. If the value sets are separated or misaligned, it will create an impassible barrier to engagement. Clear, concise, visible, and actively modeled values are a key foundational element that must be in place prior to embarking into actively developing engagement.

Mission, Vision, and Purpose

People have an inherent need to feel valued and to feel as if they are contributing to something bigger than themselves. The feeling of value, contribution, and relevancy supports emotional connection and a pathway to personal commitment. The mission, vision, and purpose must be translated to a tangible and compelling rallying cry for the team. Individual understanding and identification allows the "seeds of commitment" to develop and grow at the personal level. In public companies, leadership often speaks about shareholder value. The average associate does not connect with shareholder value, so leadership must translate the mission, vision, and purpose to a tangible stakeholder value to inspire and spark engagement. The "reason for being" must be compelling to elicit interest and motivation. Leadership must be capable of translating the overarching mission, vision, and purpose to each individual. Individual customization allows for the opportunity to elicit deep connection and the development of emotional equity.

Nurturing and developing organizational engagement is an ongoing and never-ending journey. Some leaders naturally have the magic, while others may struggle. The AIOE work has codified the holistic elements that unlock improved levels of engagement and untapped performance potential. With this body of knowledge, the only remaining barrier to creating engaged, high-performing teams will be leadership resolve and organization commitment.

After 30 years in manufacturing, I've spent 10 years on the problem of manufacturing workforce development. I've been taught a lot by many good people, some of whom have contributed to this Playbook. I may not have learned everything that others hoped to teach me, but I do have a list of things that I have learned and that I think are important for others to consider as they put the pieces of their particular puzzle together and begin to execute their manufacturing workforce development plan.



Author Bio



*Please see bio of this author
at the back of this Playbook*

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Chapter Thirty-one

What I've Learned about Manufacturing Workforce Development

Using many of the strategies discussed in this book, I have seen regions and companies solve their most pressing workforce development needs.

by Keith S. Campbell

It's been 13 years since I retired from my first career in manufacturing. For 10 of those years, I've made a second career of working with manufacturers, educators, didactic suppliers, associations, and workforce agencies to prepare an American workforce that will enable American manufacturers to compete on a global basis. Competitiveness requires that we raise our expectations for the level of technical knowledge and skill possessed by manufacturing workers from the shop floor to the top floor. I would judge that we have met with some degree of success, especially in my home state of Pennsylvania, and in other regions as well. Along the road, I have learned a lot, including most of what is contained in the preceding chapters of this Playbook. In the final chapter, we will provide you with a list of things that you can do to solve your particular workforce development challenges. In this, the next to last chapter, I'd like to share some of those most important principles and learnings.

- The first and most important thing to know is that THE PROBLEM IS SOLVABLE. And, from both a manufacturer's perspective and an educator's perspective, it needn't be solved internally from scratch.
- I am frequently struck by how much time and money is spent on curriculum development. It is a misconception that there is not adequate curriculum for manufacturing. Except perhaps for the very latest technological developments, curriculum exists in abundance in both the private and public sectors and need only be shared, albeit sometimes for a fee. If we can get beyond "not invented here," curriculum is available for presentation in conventional, computer-based, and e-learning formats to accommodate all learning styles.
- Curriculum is secondary to TEACHING THE RIGHT SKILLS. The focus must be on skill development, and there are more manufacturing skills to be taught than any student could learn in a lifetime. The challenge is identifying the right skills for the customer base without watering programs down to a least common denominator. This involves understanding the

different types of manufacturing and the skills involved in each. Manufacturers and educators need to be willing to work together to create a limited number of solutions—not a completely custom one for each company and not a single one for all manufacturing segments.

- In the process of identifying the right skills, SEEK OUT THE BEST OF THE BEST manufacturers. And then seek out both those who understand what is happening on the shop floor today and those who are thinking about what the shop floor may look like in 10 years. By the time an engineer develops enough confidence in a new technology to apply it, it works its way through the capital appropriation process, it gets installed on the shop floor, it gets started up, and it runs out of warranty and becomes a challenge for a maintenance manager, a technology can easily be 10 years old. And since education has a pace of its own, if input is not coming from those who see the future, it can easily be 15 years between the time a technology hits the market and the time it works its way into education programs. Educators should develop a strategy for quality and diversity on their advisory boards and invite participation accordingly. Manufacturers should be willing to commit their best people to the task. Consider a regional advisory board that can serve the needs of more than one institution.

- Manufacturing is so crucial to our economy and to our national security that adequately preparing students for manufacturing careers should be a national priority. As such, we should EXPECT THE PUBLIC EDUCATION SYSTEM TO MEET THE NEED of providing training opportunities for workers coming through the various pathways and for young students to fill the pipeline. I do not consider it acceptable for the education system to shirk this responsibility or for the workforce system and manufacturers to allow it. Private training serves a huge role with respect to specific pieces of equipment, specific applications of technology, and emerging technology. But basic skills to support manufacturing should be being taught from high school through the bachelor's level. If we turn to and expect public education to provide incumbent worker training (for a substantial fee), it will keep the system current on what needs to be taught. When we began our journey in Pennsylvania, we found a system that was largely unaware of how far behind they actually were. Manufacturers stepped up and invited high school and college instructors to sit in on training programs that the manufacturers paid to have developed. That started a process of updating requirements and expectations for the system.

- For operator, technician, and applied technologist development, HANDS-ON LEARNING WITH A FOCUS ON TROUBLESHOOTING is essential. Manufacturing is a hands-on enterprise. Many who opt for manufacturing careers do so for that reason and are often experiential learners. Troubleshooting has aspects of art to it, but may be taught as science. All manufacturing workers are called upon to troubleshoot at some level.

- Because hands-on learning and troubleshooting require laboratories, manufacturing programs are expensive. Whether teaching CNC machine operator skills or industrial maintenance skills, labs cost a lot of money—measured in high six and seven figures. And labs need to be updated to keep pace with technology's high rate of change. If every school attempts to meet the need, there won't be enough money or customers to go around. PLAN REGIONALLY for how to make this work at the appropriate scale. Here is a huge

opportunity for the workforce system to bring folks together for both regional economic and workforce development. Everyone can either succeed together or fail individually.

- **LANGUAGE IS IMPORTANT.** Don't get caught up in buzz-terms of the moment.

Apprenticeship is a term that is getting a lot of attention from government and German companies that have or may relocate to the U.S. What Germans mean by the word is much different from what Americans may mean by it, and my German colleagues who are well-versed in American manufacturing agree with me that the word has been mistranslated. A better translation may be internship. Government funding has been made available for apprenticeship programs. A saying of mine is "When the government funds purchasing hammers, every problem begins to look like a nail." Be careful of language and do the right thing, regardless of the funding that may be available.

- Workers come through multiple pathways to manufacturing jobs: youth from school, incumbents being up-skilled, unemployed being re-skilled, underemployed seeking to improve, ex-offenders seeking a new start, etc. Plan to address these multiple pathways, but start with a limited focus. Most of the time, I recommend that focus to be **INCUMBENT WORKERS FIRST**. Why? Because it gets at solving the crisis in the quickest possible way; it creates necessary bridges among stakeholders, including businesspeople, educators, and workforce development professionals; and it brings a customer who can pay to get new programs off the ground. High school students don't pay for career programs, and college tuition is not adequate by itself for the cost of these programs; but industry will pay for a quality program. One of my favorite quotes comes from a plant manager who was asked to prepare feedback on an industrial training program that was being offered. His feedback was, "We've already spent six figures on this training, and we expect to keep spending. What more do you want to know?"

- Training people in many of these pathways requires **FLEXIBLE SCHEDULING**. It is often cited by students as the number one factor in their being able to participate in a program. Unfortunately, financial aid rules and the desire by administrators to keep things simple, fly in the face of appropriate flexibility. Flexibility has lots of meanings: different times of day, different days of the week, high-intensity short-duration, low- or variable-intensity long-duration. This is a huge departure from our historic education model, but with the movement to massively open online courses (MOOC), we should be getting a glimpse of the future. Hands-on learning may be the primary added value that schools can offer to offset their MOOC competition. The most flexible program that I have experienced allows starting any of about two dozen courses on any Monday of the year (or other days if Mondays don't work for you), provides e-learning for knowledge development, permits students to attend labs with an instructor morning, afternoon, or evening five and sometimes six days per week, and has very limited constraints on how little or how much time (both clock and calendar time) it takes to complete. At the request of an employer, courses may be customized; otherwise, not-for-credit training and for-credit education follow the same model. Students whose employer may have customized a course, making it ineligible for credit, may make up the missing components at his or her own initiative to receive college credit.

- There is no substitute for **EXPERIENCED INSTRUCTORS**. Many times, a number of still-

working or recently retired adjuncts will be employed who have hands-on experience in manufacturing. Other times academic faculty will take summer jobs in manufacturing or work with manufacturers on solving complex problems on the shop floor. Schools that can mix experienced workers with high school or college students in the same class find that a synergy develops that is beneficial to both.

- Survey work shows that many manufacturers value associate degrees for their skilled technicians, whether those folks are programming CNC machines, performing industrial maintenance tasks, or operating control rooms. Therefore, all training should lead to college credit. Less-than-course-length modules should be stackable until the requirements of a college course have been completed. A new metric, other than student-professor contact hours, must be established for determining the amount of credit to be granted for courses that utilize e-learning and hands-on laboratories. I have seen associate degrees offered for technical coursework ranging from 300 to 1,800 hours. My own experience for programs in industrial maintenance and mechatronics tells me that 1,400 to 1,800 hours is the appropriate time required for the technical content of an associate degree consisting of 50 technical credits and 25 general education credits. This is a significant departure from the accepted rule of thumb that three classroom hours per week for 15 weeks equates to three credits, and some out-of-the-box thinking may be required.

- Schools and manufacturers should work together to GRANT CREDIT FOR SKILLS ALREADY MASTERED. A degree might require completion of a course in metrology and one in CNC milling. A candidate who has years of experience in programming and operating a milling machine should be allowed to demonstrate that he has the skill and knowledge expected of someone who has taken a milling course and be allowed to focus on the material not yet mastered. Schools have been able to develop written and hands-on testing protocols for evaluating students, placing students, testing out training programs, and being granted college credit.

- We live in a lifelong learning environment. Make the transition from school to work to school and back as easy and painless as possible. DEVELOP ARTICULATION AGREEMENTS that allow the transfer of credits between institutions. These should work both horizontally between schools that may be competitors and vertically from high school to community college to university.

- ADOPT AND USE INDUSTRY-RECOGNIZED CREDENTIALS to provide students with meaningful outcomes on the way to a broader education and to provide manufacturers with some standardized sense of the student's accomplishments. In Pennsylvania, we have 15 schools—some high schools, some community colleges, some private schools—that issue credentials standardized to the U.S. Department of Labor's Mechatronics Competency Model. These schools may issue a sequence of credentials in Advanced Manufacturing Integrated Systems Technology (AMIST) based upon an independent audit that show that students completing and passing certain programs of study will have mastered the appropriate set of competencies, including demonstrating hands-on capability and troubleshooting skill. These same schools may offer their students the opportunity to sit for industry-developed exams offered by PMMI that test the knowledge components from the

same competency model. Students who pass these exams receive National Association of Manufacturers-endorsed credentials from PMMI.

Everything that I've learned about putting workforce development programs in place may not apply in your case. But hopefully some of my experience and the experiences related by others in this Playbook will spark an idea for you—whether you are a manufacturer, an educator, or a workforce professional—that will help with solving your workforce development challenges.



The hardest part of solving a problem is often getting started. Before you put this Playbook down, here is a list of ideas that the authors of its chapters have suggested that you could do starting right now to address your workforce issues.



Chapter Thirty-two

A Path Forward

A list of things that you could do starting today to solve your workforce development issues.

a compilation by the Playbook authors

We've assembled in this Playbook information about the workforce crisis in America and how it may be dealt with from various perspectives, including those of industry, education, and government. We've included a number of examples where various groups have worked together to achieve success. We've heard from students about their needs. Now it is time to assemble all of the pieces of the puzzle that fit your particular situation and embark upon finding and implementing solutions.

I asked the author of each chapter of the Playbook to think about things that readers could do immediately (today) to begin the journey that leads to the availability of an adequately skilled workforce, capable of supporting a manufacturing renaissance in America. You will find some of those ideas here. I encourage each reader to pick out at least one action from the preceding chapters or the following list and to complete it TODAY. If you wish to suggest other potential actions for future editions of this Playbook, please e-mail the editor.

Actions for Manufacturers

- Schedule a visit to your local high school, career center, community college or university to gain insight into their program offerings and skills training capabilities for both students and adults.
- Volunteer to serve on a school's industry advisory board to assist with establishing skill needs, advising on curriculum, and evaluating lab equipment.
- Invite teachers, administrators, and guidance counselors to tour your factory to see what manufacturing is all about.
- Talk with your staff about ways you could hire teachers to work with your company over the summer to learn more about manufacturing.
- Call your public school administration, encourage career guidance, and offer your employees as mentors to students.
- Call a meeting of your staff and explore how your company could benefit from offering paid internships, co-op experiences, or apprenticeships for students at all levels of their educational path from high school through graduate school.

- Offer to sponsor incentives for local science or engineering fairs, or commit to starting one yourself.
- Schedule a day for your employees to bring their children and a friend to tour your plant.
- Call the public school superintendent and ask where the students go after graduating and what the percentage of students graduating from college is after six years. If (s)he doesn't know, find out why and discuss the value of vocational education with (him)her.
- Determine which manufacturing segment you are a part of, identify other companies in that same segment, and call your peers at several of these companies to begin a discussion on similarity of needs and how your companies could collaborate on things like creating a multi-employer training program.
- Ask your HR manager to create a chart showing the pathways that your new employees come from and how they advance. Consider if you are taking advantage of all of the available pathways and if you are doing enough to support the primary ones.
- Commit to sponsoring a middle school or high school team in a competition such as BotsIQ, BattleBots, Lego League, or one of the many such competitions available.
- Call your local schools and volunteer to help them establish or enhance 2+2+2 programs, programs that articulate training for college credit, and programs with delivery models that provide the flexibility required by adult workers.
- Contact your local economic development agency, your local industrial resource centers, and/or your local workforce development agency to see if you can sponsor or join a group of employers to influence regional, state, and national policy makers and local educational institutions.
- Conduct a search (online and amongst your colleagues) for industry-recognized credentials that would be applicable to your workforce. Encourage the use of credentials for recruitment and promotion.
- Review your company's policies for training, tuition reimbursement, and educational time off to see if they are development friendly.
- Review who amongst your workforce is taking advantage of training and whether they are being given the opportunity to apply it immediately on the job.
- Review your hiring requirements to see if you are asking for things that aren't important because they are easier to measure—like knowledge of a specific piece of equipment or software.
- Inquire about the means your company is using to assess skills and whether certifications or formal assessments are being used.

Actions for Educators

- Call the local workforce agency to obtain data on the types of manufacturing in the area and the needs of manufacturers.
- Start calling the executives of some of the larger manufacturers in the area to explore opportunities for plant tours, internships, scholarships, summer employment for students and teachers, acceptance and use of industry credentials, and developing

recruiting partnership with local career centers and community colleges.

- Encourage all staff members to become familiar with the facts related to four-year college and career education as presented in this book and the resulting impact on careers.
- Assess how many of your instructors have recent manufacturing experience and seek ways of exposing them to local manufacturing plants.
- Call local manufacturing executives and request their participation in curriculum development activities or ask your economic development, industrial resource, or workforce agency to assemble such a group for you.
- Establish institutional goals for workforce preparedness as well as for academic achievement.
- Establish goals that make it clear that lowest common-denominator solutions are never acceptable, even when funding is elusive.
- Ask yourself if your classroom and extracurricular STEM programs are reaching all of the student body and not just advanced placement students.
- Convene a task force to explore flexible scheduling alternatives and the use of e-learning.
- Call local school administrators to explore collaborative arrangements to reduce the infrastructure (lab) requirements for each individual school while providing maximum hands-on exposure for students.
- Call the manufacturers, association or workforce agency and request opportunities for administrators, counselors, and teachers to visit advanced manufacturing facilities.
- Assess if your manufacturing programs are aligned to the type of manufacturing done in your area. Explore which schools are serving which types of manufacturing and form a network with different schools teaching different specialties.
- Review the membership of all of your industrial advisory boards. Do they contain a mixture of disciplines (HR, Maintenance, Engineering) and responsibility levels (plant managers, discipline managers, practitioners)? Do they adequately represent the types and importance of manufacturers in your area (as measured by economic output or employment), and are they representing your targeted manufacturing customers?
- Establish a career day where manufacturers are invited to address the student body.
- Initiate development of a plan for aligning the goals of adult education and conventional academic programs, with articulation of credit for training and skills mastered.
- Conduct a search of the available industry-recognized credentials appropriate for your programs and evaluate if you are taking full advantage of them.
- Evaluate if your postsecondary program provides for obtaining stackable job-readiness certifications along the way to a degree.
- Evaluate if your programs articulate credits with programs from schools above, below, and alongside yours.
- Convene a meeting to discuss how the school can advance career guidance around manufacturing.
- Begin planning to inform and encourage parents and students to seriously consider attending a Career and Technology Center (CTC) or a community college that offers the type of technical training that manufacturers are looking for in today's environment. Discuss the realities of college completion and underemployment of many college graduates.

- As in industry, plan for both customer (industry) and consumer (student) satisfaction, putting their needs ahead of all others. React quickly to changing needs.

Actions for Government Officials

- Schedule a workshop to facilitate engagement between those in manufacturing and education with emphasis on the importance of addressing skills training in terms of economic development.
- Initiate a study to determine the primary manufacturing sectors in your area, and evaluate them in terms of both economic output and employment. Use the results to guide priorities for development activities and to establish appropriate groupings of industry partnerships.
- Initiate a gap analysis between manufacturing needs and educational capabilities.
- Initiate regional leadership of educational priorities so that funding may be allocated in a way to create a limited number of high-quality programs that will guarantee success through partnership.
- Call grant providers and legislators and encourage support for skill-based programs through funding for labs and equipment. There is more than enough good curriculum available that should be shared, not developed again. Industry will pay for quality training.
- Initiate activities for regional market research and public relations to determine real needs and explain real benefits to students and parents.
- Call a regional meeting of school guidance counselors to explain the needs of the region and present the case for career and four-year education. Show that career education and community college are both pathways to a university degree, but at significantly lower cost and with emergency exit ramps along the way. We cannot delude ourselves into believing that everyone has the need, ability, or desire to move directly from high school to university.
- Schedule yourself to attend a school board meeting to explain the need for trained technicians in local manufacturing operations and the need for increasing career and technical education programs.
- Schedule yourself with your state education secretary and the legislative education committee chairs, making the same case as above.
- Schedule a trip for local educators to attend a major manufacturing trade fair to get a compressed glimpse of advanced manufacturing.
- Schedule a visit to a region that has successfully addressed some portion of the workforce development issue to exchange best practices.
- Call educators and encourage them to send their staff members to see what other schools have accomplished.
- Challenge conventional thinking regarding calculation of college credits for skill-based training. Act as a neutral arbiter to ensure quality and consistency of degree programs.

- Encourage industry partnerships and individual manufacturers to expect more of the public education system, rather than finding work-arounds to it. Industry can lead.
- Consider establishing a high-level strategic advisory board to work with all schools in a region and to complement the tactical advisory boards that each may have.

Appendix

The following are links selected by the editor that provide additional information on the topics covered in this Playbook. Additional links will be found in the various chapters of the Playbook.

Federal Reports on Manufacturing Skills

Capturing Competitive Advantage in Advanced Manufacturing

http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_amp_steering_committee_report_final_july_17_2012.pdf

State Reports on Manufacturing Skills

Three reports and several other documents on advanced manufacturing careers in PA

http://www.paworkforce.state.pa.us/portal/server.pt/community/l_i_advisory_council_on_advanced_manufacturing/18909

Report of the PA Governor's Manufacturing Advisory Council

http://teampa.com/wp-content/uploads/2012/09/GMAC_FinalReportRecommendations_Revised.pdf

Texas technology forecast on Mechatronics

http://forecasting.tstc.edu/wp-content/uploads/2010/12/Mechatronics-TSTC_Forecast-2007.pdf

Industry Reports on Manufacturing Facts about Manufacturing

<http://www.themanufacturinginstitute.org/Research/Facts-About-Manufacturing/Facts.aspx>

Middle Skill Jobs

America's Forgotten Middle-Skill Jobs

http://www.nationalskillscoalition.org/assets/reports-/americasforgottenmiddleskilljobs_2007-11.pdf

The Forgotten Middle-Skill Jobs reports from many states may be found here

<http://www.nationalskillscoalition.org/states/state-coalitions/>

Pathways to Prosperity Project Report

http://www.gse.harvard.edu/news_events/features/2011/Pathways_to_Prosperty_Feb2011.pdf

Reports on Higher Education

Five Trends to Watch in Higher Education

https://www.bcgperspectives.com/Images/Five_Trends_Higher_Education_Apr_2014_tcm80-157815.pdf

Manufacturing Competency Models

U.S. DoL's Competency Model Clearinghouse

<https://www.careeronestop.org/COMPETENCYMODEL/>

Advanced Manufacturing Competency Model

<https://www.careeronestop.org/COMPETENCYMODEL/competency-models/advanced-manufacturing.aspx>

PMMI Mechatronics Competency Model for Hybrid Manufacturing

<https://www.careeronestop.org/COMPETENCYMODEL/competency-models/mechatronics.aspx>

Manufacturing Skills Certifications

The Manufacturing Institute's Skills Certification Program

<http://www.themanufacturinginstitute.org/Skills-Certification/Certifications/NAM-Endorsed-Certifications.aspx>

PMMI's Mechatronics Certification Program for Hybrid Manufacturers

<http://www.pmmi.org/Education/content.cfm?ItemNumber=1010>

National Institute of Metalworking Skills for Discrete Manufacturers

<https://www.nims-skills.org/web/nims/3>

Schools with Industry Recognized Programs

NAM's M-List

<http://www.themanufacturinginstitute.org/Skills-Certification/M-List/M-List.aspx>

Videos

Reading Area Community College Manufacturing Mechatronics

https://www.youtube.com/watch?v=zj10V0XUgXo-*

<http://vimeo.com/67277269>



MANUFACTURING WORKFORCE DEVELOPMENT PLAYBOOK

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Our thanks to these organizations for their sponsorship of the Playbook. A portion of net proceeds will go to the David A. Harvey Memorial Scholarship to help fund workforce development efforts.



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“Modern manufacturing is creating wealth for nations, changing practices from mass production to mass customization. A well educated workforce is essential for its growth and remains critical for driving opportunities in a global economy.”

- Dr. Nader Imani CEO, Festo Didactic Inc.

We empower people to succeed.

Festo Didactic is the world-leading provider of equipment and solutions for technical education.

We design and implement learning centres and laboratories, educational equipment and programs that train people to perform in highly dynamic and complex environments. Our product and service portfolio offers customers holistic education solutions for all areas of technology in factory and process automation, such as pneumatics, hydraulics, electronics, electrical engineering, manufacturing technology, process control engineering, mechatronics, CNC technology, HVAC as well as telecommunication. And it meshes the technical learning content with knowledge and training courses from other specialist areas, such as process optimization, management and communication.

Our Goal and Perspective:

Markets across the world are subject to constant change. Companies that operate in these markets compete with each other to drive products and technologies and conquer new markets. What's more, production is carried out in many regions with very different requirements and increasingly complex processes. At the same time, however, they must supply their products all over the world in the same high quality. To do this, they urgently require skilled people who are qualified in the latest technologies and who can quickly and efficiently support a company's production process.

Festo Didactic educational solutions directly evolve from technologies and innovations in automation and engineering. They place students in real-life situations and enable them to gain practical experience with high-tech industrial components and current systems. The product design focuses on excellence in usability and practice orientation: All functional components stand out from their complex industrial surroundings. They are easy to use and easy to remember. Their specific functions, positions and connections within the learning system intuitively show how technologies really work.

All learning environments are offered in conjunction with technical, organizational and people-oriented training programs – in 40 languages worldwide – and are associated with services like planning and operating complex learning centers, and with consultancy services for industrial companies.

Fields:

- MechatronicsFactory and process automation
- Electricity and electronics
- Fluid power
- HVAC
- Industrial maintenance
- Instrumentation and process control
- Electronic engineering
- Energy efficiency and mobility
- Renewable energy

Products:

- Training programs
- Laboratory equipment
- Learning factories
- Mobile/E-Learning solutions
- Vocational and further training
- Operation of Learning Centers
- Competence development
- Consulting

Clients:

- Governments and government institutions
- Urban administrations
- Public and private educational institutions
- Industrial companies

As an outsourcing partner to industrial companies and organizations, Festo Didactic offers solutions that are standardized and scalable worldwide, based on qualification requirement analyses, and tailored to a company's needs or specific job profiles. From initial training and specialist, production-related advanced training to the development of training programs and even turnkey learning centers, companies are able to purchase solution packages from Festo Didactic at their international production site and receive services in line with the latest education standards and technology.

The range of consulting services offered by Festo Didactic is developed in partnership with the technology factories in the Festo Group and include the strategic development of skills at industrial companies, lean management and process optimization, as well as the integrated planning of factory areas. When it comes to planning and optimizing processes, crucial factors are developing target value streams, deducing fields of activity and qualifying employees in a targeted manner. Particular attention is paid to corporate culture-related barriers to change, as every technical and logistical change process requires the individual and well-coordinated involvement of the employees.

Festo Didactic is a part of the Festo Group.

Festo is a leading world-wide supplier of automation technology and equipment and solution provider for industrial and technical education. As a globally-oriented and independent family company with its headquarters in Esslingen, Germany, it has become the performance leader in its industry over the last 50 years, thanks to its innovations and problem-solving competence in all aspects of pneumatics as well as its unique range of technical training and education programs.

Today, the company provides pneumatic and electric drive technology for over 300,000 customers in 200 industries world-wide both for factory and process automation as well as cutting-edge training solutions. The Festo Group achieved sales revenues € 2,45 billion in its fiscal year 2014 and with 17,800 employees is represented world-wide in 250 locations.

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Morrison Container Handling Solutions

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Morrison Container Handling Solutions is the industry leader in the innovative design and manufacture of timing screws, change parts, custom container handling products, assemblies, and machines for the packaging industry. The company has a well-established record of success in solving the most complex container handling problems, always with Morrison's support-built-in culture.

Morrison was founded more than 40 years ago when President Nick Wilson saw an opportunity to advance technical expertise and creative problem solving in the packaging container handling industry. Over time, the company has become the most well-known and respected name in its field. One secret? A commitment to innovative education and learning, both for current employees and for students who might one day become employees.

Morrison believes that with an industry-wide focus on and support for education and workforce development initiatives, the future of U.S. manufacturing will be bright, competitive and thriving. The packaging sector is complex, with one individual position often requiring various types of engineering skills, technological savvy, and management experience. It is only by providing students and employees this unique mix of skills required to succeed that leading companies in the packaging space can hope to excel as well.

Morrison is participating in this Workforce Development Playbook as a Benefactor because the company is passionate about rallying others to support education initiatives to contribute to the success of U.S. manufacturing. What follows are specific programs Morrison has supported. They could very well be a blueprint for other like-minded companies to support education and workforce development initiatives in their professional networks and communities. This support is crucial to maintaining and building the strength of manufacturing in the U.S.

Focused Post-secondary Education

The cornerstone of Morrison's efforts toward education and workforce development is its partnership with Purdue University Calumet in Indiana. As with hundreds of other packaging machinery companies, Morrison needs engineers with a combination of skills not typically taught at the college level. It is common to find electrical engineers and mechanical engineers, but incredibly rare to find a student or graduate well versed in both fields. Typically companies had to train electrical engineers to be mechanical, or mechanical engineers to be electrical; Morrison sought a solution to the problem.

In 2007, President Nick Wilson developed an ongoing partnership with Purdue Calumet that would in only one short year result in the formation of the Mechatronics Engineering Technology Bachelor's degree program. It took only one trip to PMMI's PACK EXPO for the University's Technology Dean and other educators to be convinced that the program could be a success. And it is a success, both from the university's perspective and from Morrison's. The University can offer prospective students a completely unique engineering program not found at other institutions, and specifically geared toward the needs of today's manufacturers. Students in the program have a sure-fire career path to pursue, and they're given opportunities to make contacts throughout the course of their education that will help facilitate job placement upon graduation. Morrison has ensured itself a stable of qualified engineers, equipped almost immediately upon graduation to design and implement the innovative packaging machinery solutions for which the company is well known.

Interns, Interns, Interns

Long before Morrison's partnership with Purdue Calumet was underway, Morrison already had a long-standing internship program at the company. In fact, 42 years ago, Morrison's first employee – Steve Smit – was a student. Steve was part of a diversified education program – one that helps prepare students for careers by integrating classroom instruction with real-world work experience. Smart and responsible, he worked hard, and the fact that he had sought out such a program made it clear that he was serious about the work. Morrison's President Nick Wilson quickly realized how beneficial working with these types of programs could be, both for his company and for the students. Incidentally, Steve still works at Morrison today, and his tenure is truly a testament to how successful this type of partnership can be.

Morrison continues to seek out interns from a variety of schools and other programs. Most recently, the company has become involved with a program called MCIP (Manufacturing Careers Internship Program), funded jointly by multiple organizations, including the Department of Labor. The MCIP focuses on helping out-of-school youths between 18-21 interested in manufacturing find opportunities in the field. Morrison's role as a Manufacturing Ambassador gives the company the opportunity to teach interested applicants about manufacturing careers and the skills required to succeed in these roles. The first intern as part of the MCIP program completed his six-week internship at Morrison in April, and by all accounts he was a success.

Supporting programs like these is an easy choice for Morrison, since it helps encourage interest in manufacturing and packaging among young people who may not otherwise consider the field. It also allows Morrison to identify individuals who have the potential to make great employees.

Industry Involvement

One of the easiest ways for packaging industry professionals to become involved in education and workforce development is through active membership in PMMI, the Association for Packaging and Processing Technologies.

As Chairman of PMMI in 2011 and 2012 and a longtime member of the PMMI Education Committee, Morrison President Nick Wilson got a first-hand view of the variety of opportunities PMMI provides member companies to enhance their workforces.

- The PMMI Foundation provides tuition reimbursement to employees of PMMI member companies, reimbursing two job-related courses per year, up to \$500 per course
- The PMMI Certified Trainer Program is a train-the-trainer program giving companies strategies for successful in-house training across all skills levels – Morrison has nearly a dozen PMMI Certified Trainers
- The PMMI Mechatronics Certificate Program tests a workforce for technical skills and real-world problem-solving ability
- Involvement in the Education Committee and its initiatives gives member companies exposure to the myriad great programs PMMI sponsors to support education: scholarship administration, JumpStart, student tours, PACK solutions, and more

Additionally, Morrison employees support PMMI through active involvement in other PMMI committees.

Internal Workforce Development

Unfortunately, many companies suspend their efforts once they've landed the employee of their dreams. Morrison believes this is when some of the most important work begins. The company takes education seriously at all levels, and provides 100% tuition reimbursement for employees to further their education and skills. Additionally, Morrison takes advantage of the aforementioned certification and scholarship programs through PMMI and other programs, helping differentiate employees to the company's customers.

All of these initiatives that Morrison seeks out and supports serve two goals: one, a dynamic, innovative Morrison workforce, and two, the broad but critical goal of keeping manufacturing jobs in the U.S. The company believes it can help achieve this by bridging the gap between education and practical application, and supporting education and workforce initiatives wherever it can. It is one of the guiding forces for Morrison now and into the future.





Phoenix Contact

Phoenix Contact – Inspiring Innovations

Phoenix Contact has been setting trends in industrial technology for more than 90 years, beginning with the invention of the modular terminal block in the 1920s. While Phoenix Contact is still the world's leading supplier of terminal blocks, the company now offers more than 60,000 products for the industrial market. These products range from intelligent UPS devices and industrial PCs to a broad range of rugged networking solutions: wireless radios, Ethernet switches and advanced security devices. Most recently, Phoenix Contact launched a cloud-based remote VPN portal, enabling technician-to-machine communication. Today, engineers in manufacturing and critical infrastructure are looking to incorporate big data and real-time analytics into their machines and process. Phoenix Contact has the technology and expertise to help end users improve efficiency and reduce downtime as they move into "Industry 4.0" and the "Industrial Internet of Things."

People behind the Products

Phoenix Contact's innovations would not be possible without the talent and hard work of its employees (13,000 worldwide, including 675 in the U.S.). Phoenix Contact believes that one of its most valuable assets is its human capital. To constantly improve the products and services it creates, Phoenix Contact has made employee development and career growth a top priority by offering employees custom training plans that meet their individual personal and professional needs.

Mechatronics Apprenticeship

In August 2011, Phoenix Contact introduced its ambitious Mechatronics Apprenticeship program. Phoenix Contact selected the inaugural group of apprentices from existing manufacturing employees. Over a four-year period and 8,000 hours of on-the-job and classroom training, the apprentices learned the skills to support the technology within the manufacturing environment. The program includes:

- 250 hours on safety
- 50 hours on environmental protection
- 100 hours on documentation
- 400 hours on communication and collaboration
- 2,300 hours on preventive maintenance
- 4,500 hours on troubleshooting and repair
- 400 hours on design and building

Phoenix Contact has partnered with Harrisburg Area Community College so that Mechatronics Apprentices will simultaneously work toward an Associate in Applied Science Degree in Mechatronics during their in-house training at no cost to the apprentice. HACC's program is designed as a multidisciplinary program that incorporates theory and hands-on experience for students to gain the broad skill set necessary to maintain, repair and manage systems.

In May 2013, the Mechatronics Apprentice program became the first state-approved program of its kind. The Commonwealth of Pennsylvania's Apprenticeship and Training Council and the U.S. Department of Labor Office of Apprenticeship recognized Phoenix Contact as an official apprenticeship and training sponsor, making the program available to any company who desires to start its own Mechatronics program using Phoenix Contact's current program as a model.

Big-Picture Learning

Before implementing the Mechatronics Apprentice program, Phoenix Contact already had great success with two other apprenticeship programs: one for sales and marketing (started in 2006) and the other for IT (started in 2011). Phoenix Contact applied the lessons learned in these programs to give manufacturing employees the opportunity to grow their careers. All of these apprenticeship programs are designed to give participants a big-picture education about how the company operates. For example, in the Mechatronics program, the apprentice does not merely learn the ins and outs of the particular machine they operate. They get exposure to nearly every part of the business, so they have a better understanding of how Phoenix Contact operates as a whole, and how they have an impact on the company's business.

Real-World Experience for Interns

Phoenix Contact also hires dozens of interns every year. Interns are carefully screened and matched with the projects that best fit their skills. Supervisors mentor the internships during their time, and Phoenix Contact also schedules special “life skills” training programs for the interns.

Phoenix Contact interns are a true part of the team and receive hands-on career experience. For example, engineering interns get hands-on experience designing and developing new products. Under the guidance of an experienced engineer, these interns have a varied scope of work, including (in development) heat dissipation modeling of enclosure system, (in the lab) analyzing the performance of specific circuits and recommending enhancements or (in manufacturing) leading plant floor time studies. A marketing intern might analyze competitive data, create technical documentation for product use and develop training materials for outside sales and distributors. A successful internship can often lead to full-time employment.

Inspiring Engineers of Tomorrow

Fewer new college students are choosing engineering as a major. As a company whose success is built on the innovations of its engineers, Phoenix Contact is committed to showing middle school and high school students the endless possibilities of an engineering career.

- The Nanoline Contest challenges middle and high school students to design and build an automation project using Phoenix Contact’s Nanoline Controller, a flow chart-based programmable logic controller. The grand prize for the winning team is a trip to Germany’s Hanover Fair, the world’s largest industrial trade show. Since it began six years ago, the contest has grown significantly, both in the number of teams participating and in the complexity of the projects submitted.
- The xplore New Automation Award is an international automation competition for students in middle school through college. Students receive a budget to select the necessary Phoenix Contact products and software required to build their project. As in the Nanoline Contest, the winning teams present their project at Hanover Fair.
- During National Engineers Week, Phoenix Contact engineers teach science class for the week at a local middle school. The four-day curriculum includes both theory and hands-on learning. Both the engineer volunteers and the students have enjoyed this outreach activity for the past seven years.

Hands-on Training at a Location Near You

Phoenix Contact’s commitment to training extends beyond its own employees. The company offers a comprehensive schedule of hands-on classes for customers and distributors. Many classes are held at U.S. headquarters near Harrisburg, Pa., but to get closer to the customer, Phoenix Contact operates several Customer Technology Centers across the country – in Michigan, Texas and California.

Virtual Technology Center

The travel costs for training can be a serious investment for customers, especially in difficult economic times. Phoenix Contact helps customers reduce travel costs through the new Virtual Technology Center (VTC). The VTC supports real-time training from nearly anywhere. Available classes cover a wide range of cutting-edge technology and enable participants to take their application knowledge to the next level.





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A Well-Trained Workforce Equals a Strong Industry

As companies along the entire packaging and processing supply chain strive to find, train, and retain the top talent in our industry, PMMI provides programming and resources to enhance and grow your workforce. And in doing so, PMMI builds awareness of the packaging and processing industry across the United States and in many other countries. Many of our top-notch education and training offerings are available online—so, we make learning cost effective, convenient, and flexible.

Build a strong foundation

Our eLearning courses teach the basic skills necessary for your operation. Available 24/7, these courses provide a strong foundation for your operators, technicians, and maintenance staff—preparing them for anything that happens on the plant floor.

PMMI's Learning Management System allows you easy access to our online courses, the ability to track a student's progress, and print a certificate of completion. Our special group feature makes it easy for managers to track the progress of their staff.

eLearning courses include: Fundamentals of Risk Assessment; Introduction to Packaging Machinery; Basic Electrical Components; Basic Mechanical Components; Troubleshooting Packaging Machinery (available in English and Spanish)

Find talent

PMMI's job board, Pack Pro Jobs, is highly specialized for the packaging and processing

industry. Use it to post a job or find a job. It's that simple. And it links to other job boards featuring positions in manufacturing, like Indeed, Ladders, and SimplyHired.

Evaluate knowledge

PMMI's Mechatronics

Certificate Tests help assess your workforce for the core technical skills and real-world application needed in today's manufacturing environment. Our Mechatronics Tests are a great hiring tool: have potential employees take a Mechatronics test to make sure they have the right skills before you



hire them. Mechatronics Certificate Tests are great for current employees, too, giving them a solid advantage when competing for a promotion.

Mechatronics is recognized by the U.S. Department of Labor and endorsed by the National Association of Manufacturer's Skills Certification System.

These tests are based on industry-developed competencies and are taken online. The tests available are: Fluid Power 1; Industrial Electricity 1; Industrial Electricity 2; Mechanical Components 1; Programmable Logic Controllers (PLCs) 1

Train well

PMMI's Certified Trainer Workshop gives companies the strategies and tactics to train well across all employee skill levels. We currently have 85 machinery manufacturers and CPG companies that have PMMI Certified Trainers.

Certified Trainer, a leading train-the-trainer program, helps trainers maximize productivity, enhance safety, increase machinery efficiency, lower operating costs and reduce waste, and provide clear documentation.

PMMI also offers a Customized Workshop, which is designed specifically for your company. This in-plant workshop is an effective and practical way to train several team members.

Assess risk, comply with standards

Risk assessment is critical to meeting industry standards and keeping your customers' employees safe. PMMI's Risk Assessment Workshop gives you the necessary tools to find out what standards are essential and how to apply them at your facility.

Risk assessment is required for compliance to the ANSI/PMMI B155.1-2011 standard and EU machinery directive 2006/42/EC. Therefore, PMMI has expanded the scope of the PMMI risk assessment training to include the important issues that generate the most questions from PMMI members.

Honor high achievers

The Packaging Hall of Fame is the packaging and processing industry’s highest honor and recognizes a lifetime of innovation and achievement. Awarded every other year, those chosen are leaders who have dedicated themselves to the industry through expanding knowledge and volunteer leadership, and have personally advanced the field of packaging. The next inductee(s) to the Packaging Hall of Fame is announced at PACK EXPO International this November.

OpX Leadership Network

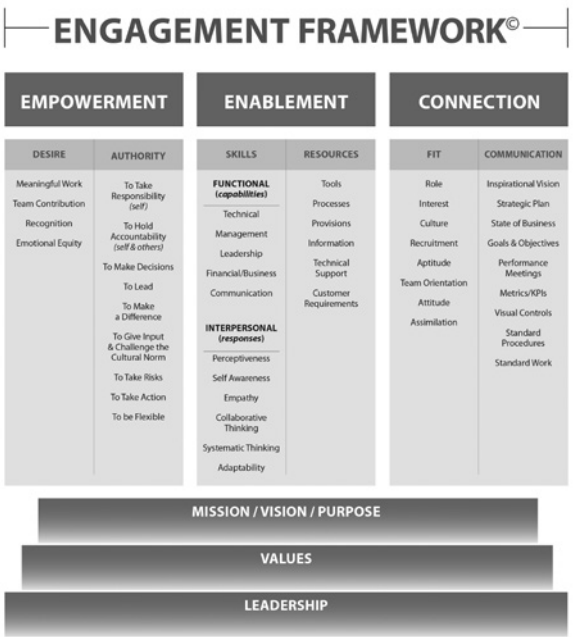


In addition to the strong training programs offered, PMMI convened the OpX Leadership Network (formerly AIOE) in 2011. CPG executives and suppliers join together to provide proven solutions to pressing operational challenges. The OpX Leadership Network has brought together industry professionals to develop best practices for Workforce Engagement, Operational Reliability, Total Cost of Ownership, Factory Acceptance Tests, Sustainability in Manufacturing, plus other areas. All solutions developed by OpX Leadership Network are available to all groups at no cost. More information is at www.opxleadershipnetwork.org.

Effective workforce engagement drives continued operations improvement. Chaired by Greg Flickinger, Snyder’s-Lance VP Manufacturing & Engineering, the Workforce Development Solutions Group completed a practical, proven workforce engagement model for production operations. This model (see Framework diagram) describes the three key principles of Engagement, the six primary attributes and their corresponding characteristics.

These are discussed in four workplace environments – traditional (top down); beginner; intermediate; and advanced –that span the workplace engagement continuum. A company moving toward fuller workforce engagement identifies their position based on the description of each attribute, then gains insight into moving to the next level of engagement. Leadership guidance is presented.

During development and at the rollout earlier in 2015, the model has continually received strong, positive feedback from other professional groups focused on workforce engagement. This feedback constantly reflects the real value of this engagement model focused on the manufacturing workforce. We welcome more involvement in this area. Contact Steve Schlegel



(sschlegel@opxleadershipnetwork.org) or Tom Egan (tegan@pmmi.org) to become involved. Visit www.opxleadershipnetwork.org regularly to capture new tools and how to effectively utilize them in your production operations.

Offer support

PMMI Scholarships provide over \$100,000 of financial support each year to students attending PMMI's Partner schools (there are currently 28).

Teach. Learn. Grow.

The **Amazing Packaging Race** is an annual fun and exciting event on the PACK EXPO show floor where teams of college students race against the clock and one another to complete challenging packaging tasks at exhibitor booths.

In its second year, PMMI hosts a week of interesting and fun plant tours for college students at machinery manufacturers and end users facilities. In 2013, the annual **"How It's Packaged" Student Tour** hit Greater Chicago; this year, the group heads to Greater Minneapolis.

JumpStart, a grass-roots initiative new in 2013, links equipment and supplier member companies and their customers with an avenue to connect with students in their local area. So far, JumpStart chapters have been established in Chicago, Milwaukee, and Minneapolis by PMMI member companies in those regions. Philadelphia and Tampa are forming later this year.

Also an annual event at PACK EXPO, **PACK Solutions Challenge** is a student contest that pits colleges and universities against one another in creating a packaging solution to a complex packaging problem. Experts from CPG companies select the winners. In 2013, Rutgers University took top prize and received college scholarships supported by sponsor B&R Automation; Purdue University Calumet was runner-up, and third place went to Clemson University.

Make the industry better, stronger

Marketing, sales, and operational executives of PMMI member companies attend our annual **MarketTrends Roundtable** to keep abreast of trends affecting the industry. Colleagues collaborate and learn during this interactive, two-day conference designed and for PMMI members only. Each roundtable features a new theme; this year's is Gaining the Edge.

Held annually, PMMI's **Need 2 Know** conference on safety, standards, and technology is open to PMMI members as well as end users of packaging and processing equipment. This 2-day event provides participants' important information needed to operate, maintain, design, and build packaging and processing machinery in today's marketplace.



Rockwell Automation

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Addressing Today's Business Challenges Through Workforce Development Planning

Today, most companies' goals include maximizing productivity, globalization, increasing innovation and improving sustainability practices. To achieve this, investments in advanced technologies and interconnected systems are being made, but are you investing in your most critical asset – your people?

The days of having specialists for each facet of your facility have passed and focus is now on finding employees with diverse skills to cover a wide range of functions. Finding new employees with the right skills to hire is becoming more difficult and the most skilled employees are nearing retirement age. This worldwide skills gap has contributed to increased plant downtime and decreased production. Because of this skills gap, preparing current and new employees for the realities of today's production environments has taken on a much greater importance.

The demands of your businesses are going up and the availability of skilled employees is going down. Do you have a plan to address these issues? As the world's largest company dedicated to industrial automation and information, Rockwell Automation can help. We firmly believe with a clear workforce development strategy in place, following our workforce development model, your business can solve the workforce challenges you face today. We offer a complete training portfolio, with global delivery in local languages.

Not Just a Catalog of Classes – A Holistic Approach to Training

Businesses often see employee talent as a cost rather than an investment; we're changing that perception. With dedicated plans and strategies, your business cannot only realize the benefits of a loyal and more productive workforce, but you will be able to measure it with

key metrics to show your return on investment.

Important questions to consider:

- Can you create a training strategy based on data rather than historical preferences or opinion?
- Do you know the workforce's current skill and knowledge levels prior to investing in training?
- Can you identify individuals who have the potential to be exemplary performers?
- Have you justified training expenditures that relate to improving productivity, generating a return on investment, or bringing the best results?

Assess: The First Step to Developing Your Workforce

Understanding the current skills across your workforce is the first step to truly verifying and executing your plan for workforce development. Your employees are individuals with varying levels of knowledge, so in order to fill gaps you need to properly assess and create a specific plan to train based on job tasks.

Training Advisor

Training Advisor helps you determine a tailored training path for your workforce to obtain the knowledge required to successfully improve on-the-job performance. This online tool helps you identify knowledge gaps hindering production performance and develop a training strategy that maximizes job performance and effectiveness.

- Verify knowledge levels of new hires and determine ways for closing any skill gaps
- Gauge workforce knowledge in areas such as controllers, networks, motion control, drives control, safety, visualization, process control and general industrial control
- Create a strategic training plan with a recommended list of specific courses to meet each employee's particular needs
- Prepare your workforce for new automation technology and develop a specific training plan

Integrated Performance Assessment

An integrated performance assessment is a comprehensive on-site analysis of employees' job skills and knowledge levels of automation and control equipment for specific jobs and tasks (maintenance, programming, etc.). It includes supporting information and recommendations to improve your employees' performance while remaining closely aligned to your company's business and training goals.

You may want to consider an Integrated Performance Assessment if you:

- Need to obtain a clear understanding of where you have workforce competency deficiencies
- Require a more comprehensive and hands-on solution for assessing your workforce needs
- Desire customization of knowledge assessments based on your specific equipment and job tasks

Train: Taking Action to Fill Your Workforce Knowledge Gaps

We provide a comprehensive selection of first class industrial automation and craft skills courses to meet your changing needs.

- **Open Enrollment:** Over 200 instructor-led courses can be conducted at a Rockwell Automation location. Courses are designed around the use of automation technologies and job function.
- **Private Classes:** Along with your traditional Open Enrollment courses, Private Classes give the ability for course delivery to be in your own facility. These classes include craft skills and mechanical concepts courses to develop core competencies, fundamentals, advanced fundamentals and equipment specific skills.
- **Virtual Classroom:** Just like our traditional open enrollment offering, only provided live online rather than in person. These classes offer location flexibility so employees can limit their time away from work without compromising the interactive experience.
- **Custom Courses:** We can help you develop a custom curriculum based on your automation environment. Your employees will be taught by a highly-skilled Rockwell Automation instructor, but the instructor will incorporate your automation equipment, software and system configuration for a custom experience.
- **E-Learning:** In addition to the instructor-led options that Rockwell Automation offers, computer-based e-learning solutions are available as well. Using e-learning, your employees receive the flexibility to avoid travel costs and time away from production.
- **Web-Based:** Ideal vehicle for delivering training to individuals anywhere in the world at any time and allows on-demand training stored in a server and accessed across a network via the Internet. This option allows you to customize the pacing and direction of the courses your employees experience.
- **iBooks:** Truly a self-paced, independent and immersive learning experience. Each iBook walks you through the fundamentals of automation from the convenience of an iPad. iBooks are available for download through the iTunes iBooks Store.

Apply & Measure:

Continuous Learning for Continuous Improvement

A pillar of our approach to workforce development is that even though a specific training activity may end, learning does not. After implementation of your training strategy, there

needs to be a level of engagement for your employees to continue their development and polish their newly learned skills. Subsequent measurement of the results of training engagements is also crucial.

Apply

Begin to see Results and Application of Knowledge from Learning Engagements

- **Workstations:** Training workstations are the ideal tool to reinforce and practice maintenance, troubleshooting and programming skills, train new employees on your technologies and ease the transition from one technology to another.
- **Job Aids:** Our award-winning job aids provide your employees with essential job task information, thereby minimizing errors that can occur at the most inopportune moments.
- **Troubleshooting App:** This app walks your employees through a variety of faults and issues that can arise in a production environment. Full of procedures, error code information, recommended actions and hardware/software diagrams, your employees can supplement their formal knowledge on their iPhone or iPad. Apps are available for download through the iTunes App Store.

Measure

Understand the Value of Your Workforce Development Investment

- **ROI Tool:** The ROI Forecasting tool includes common manufacturing metrics related to production, quality and service that are impacted by employee training.
- **Pre- and Post-Testing:** We can offer pre- and post-tests as standalone offerings after private classes are executed to see if your employees filled their knowledge.
- **Certificate Programs:** Certificate programs offer professional recognition and help your employees develop and apply technical skills and knowledge to your plant.

Real Solutions

Rockwell Automation helps our customers become more productive and the world more sustainable. We can help increase the consistency, experience and competency of your employees to improve enterprise-wide productivity and profitability.

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MANUFACTURING WORKFORCE DEVELOPMENT PLAYBOOK

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Our thanks to these organizations for their sponsorship of the Playbook. A portion of net proceeds will go to the David A. Harvey Memorial Scholarship to help fund workforce development efforts.



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About Keith S. Campbell



Keith S. Campbell, creator and editor of this Playbook, has been a contributing editor to *Packaging World* and writer of OnTheEdgeBlog since retiring from The Hershey Company after a career of 28 years. While there, he worked on several projects with *Packaging World* that highlighted Hershey's use of advanced manufacturing technology. At retirement, Keith was Senior Director of Automation & Integration Engineering, from which position he led an engineering staff, led the corporation's manufacturing technology planning activity, and served as a member of the capital investment committee. Previous to that, he was a Director in Corporate Information Technology, serving as Relationship Manager for the manufacturing, engineering, R&D, and quality business units. He served the automation industry as Director of ISA's Food and Pharmaceutical Industries Division and was the founding director and later Executive Director of the OMAC Packaging Workgroup.

Earlier, Keith spent 13 years in various maintenance and engineering roles in the world's largest chocolate factory. In the early 70s he led an effort to develop maintenance strategies for transitioning from electro-mechanical automation through electronic automation and on to programmable automation. He installed PLCs in the mid 70s followed by microcomputers and factory networks. In the mid 80s he speculated on the potential for mechatronics (although no one had that word yet) and spearheaded the application of mechatronics for packaging in the late 80s and early 90s. He was chief systems architect for a Greenfield confectionery plant that employed DCS, PLC, and computer automation technologies to empower the workforce. With Keith's work at the leading edge of manufacturing automation, workforce development has always been an area in which he has been involved.

Keith currently operates Campbell Management Services, LLC, a firm providing guidance related to manufacturing technology planning, workforce development, and organizational development. His clients have included manufacturers, technology providers, machine builders, professional associations, schools, and workforce agencies. Keith has had the opportunity to see education and workforce development from many points of view as he visits, audits, and advises technical high schools, community colleges, and universities. He has worked with many of the contributors to this book. He works with national associations, regional Workforce Investment Boards, and economic development agencies, and he frequently speaks and writes on topics related to manufacturing workforce development. Since the release of the first edition of the Playbook, he has spoken about and conducted seminars on its content.

Keith holds a B.S. Cum Laude in Physics from Rensselaer Polytechnic Institute. His background in physics and systems engineering has contributed to his rejection of pursuing technology in silos. He is an outspoken advocate for mechatronics in manufacturing and for multidisciplinary industrial maintenance.

Keith lives near Hershey, PA, with his wife of 44 years. Fran has been active in community development, serving on the boards of two community housing projects, and was the chief fund-raiser and project manager of a project to build a new town square in their town. Before Keith founded his company, she recruited him and two other recently-retired engineers to oversee the construction. Keith and Fran have two grown children. Their son Troy attended high school at a regional career center where he had internships in a number of manufacturing shops before going on to the PA College of Technology, where he pursued a dual major in Automated Manufacturing and Machine Tool Technology. He is a certified farrier (blacksmith) and is employed as a machine tool service engineer with DMG Mori. Daughter Leanne Berget and her husband, Todd, are graduates of competing ivy-league schools, Cornell and Columbia, and are both involved in design and construction in the Annapolis/Washington D.C. area. Granddaughters Norah and Marin are great joys. Keith has benefitted significantly from the experiences of his extended family in understanding the needs, similarities, and differences of the manufacturing and construction industries, and wants to acknowledge the support and guidance of his family in the preparation of this Playbook.

In addition to his work and family interests, Keith restores antique automobiles and recently switched from sailing a Tartan 3400 sailboat to motoring in a Ranger R31 tugboat on the Chesapeake Bay. He judges youth engineering and science fairs and over the years has been involved with many church and scouting youth activities. He recently assisted in the creation of a local community development corporation to revive a depressed community and help its citizens find their way out of poverty. His work is motivated by the belief that a vibrant manufacturing sector is essential to the economic future of America, his children, and grandchildren. This Playbook evolved from a commitment to that belief.

You can follow Keith on his blog at www.OnTheEdgeBlog.com, on LinkedIn at www.linkedin.com/in/keithcmsllc, or you may reach him by e-mail at Campbell@Packworld.com.

There is no topic more important than the future of Manufacturing in the U.S., and this book nails how to strengthen it: By reframing both our educational approach to growing a high-productivity manufacturing workforce and by clearly communicating the desirability of manufacturing careers.

While many people assume that the U.S. long ago gave away all manufacturing to China – the truth is that it wasn't until about 2010 that the value add of goods manufactured in China equaled that of the U.S. The further truth is that we created that value here with just 10% of China's workforce. (Source: World Bank data shared at the 2012 MIT LGO Conference). High productivity trumps cheap labor every time. It is critical for the U.S. to revitalize technical education in high schools, vocational schools, and two- and four-year university degrees to build and maintain a high-productivity work force.

From the must read opening article by Fogarty thru strong supporting articles on virtually every facet of our technical education system as it pertains to building a high-productivity work force, this book is worth reading, and the format facilitates using it as a future reference.

James A. Keighley, PE, *Vice President of Engineering, Kraft Foods*

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