Public Policy Associates Incorporated

Retooling America

Increasing capacity and capability to train skilled workers in precision machining technology

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Prepared by Public Policy Associates, Inc. for
Danville Community College

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Table of Contents

Executive Summary

TAACCCT Program Description and Activities

With a Trade Adjustment Assistance Community College and Career Training (TAACCCT) Round Four grant from the U.S. Department of Labor, Danville Community College (DCC) built on its legacy Diploma program in Precision Machining Technology (PMT) and added an Associate of Applied Science (AAS) degree in Integrated Machining Technology (IMT) to the talent pipeline vitally important to advanced manufacturing employers in the region. The competency-based AAS IMT program includes a unique capstone Computer Numerical Control (CNC) Work Flow Cell experience that requires students to apply the advanced manufacturing and work cell team soft skills they learn in the program to an actual shop floor experience within a supervised community college facility. Graduates exit the program not only ready to work but ready to generate revenue for their employers.

DCC envisioned that the *Retooling America* program would be the linchpin in its plans to expand and sustain its capacity and capability to meet the growing need for advanced manufacturing technicians, and catalyze economic development in the region in the process. Dual-enrollment high school programs and connected community college programs help expand and sustain the PMT/IMT talent pipeline. The pipeline also includes an on-ramp for incumbent workers to be trained in specific skill sets, an on-ramp to entry-level jobs through training provided by a leveraged partner, training for secondary school Career and Technical Education teachers in state-of-the-art advanced manufacturing machinery and tools, and the early addition of a Dimensional Inspection (Metrology) curriculum in response to employer encouragement.

Evaluation Design Summary/Overview

To understand the effects of the *Retooling America* program, DCC contracted with Public Policy Associates, Inc. (PPA) to conduct an independent third-party evaluation. Together, PPA and DCC designed an evaluation that included both an implementation study to monitor fidelity to the program model and offer information for continuous improvement, and an outcomes study to provide insight into how program components contributed to improved student education and employment outcomes. Guided by a set of research questions, the evaluation had four objectives:

1. To assess the degree to which the *Retooling America* program increases student retention and completion.
2. To assess the degree to which the *Retooling America* program accelerates time to attainment of industry-recognized credentials.
3. To assess the degree to which *Retooling America* contributes to improved student education and employment outcomes.
4. To understand the various factors that mediate the outcomes achieved by program participants.

Key Implementation Findings

The goals of the *Retooling America* program were ambitious and went beyond creating a new credential and introducing a new wrinkle in work-based learning. The DCC project team and its partners aimed for nothing short of revival of the manufacturing economy in Southside Virginia and demonstration of a comprehensive, talent-pipeline-building model for career and technical education. Though the program has not achieved the primary outcomes performance targets stated in its grant application to the U.S. Department of Labor, the results of its efforts under the TAACCCT grant to create a sustainable precision machining talent pipeline that stimulates economic development in the region are impressive.

- The **competency-based IMT program, along with its uniquely innovative work-flow-cell component**, provides students with an exceptional learning experience that prepares them to be immediately productive in employment following graduation. Survey data indicate that students feel confident in their ability to apply the knowledge and skills they learn through the program. Likewise, employers are very satisfied with the preparation that students receive through the program.
- **The deep, active involvement of employers is key** to the program's effectiveness. Employer needs, including developments in technology and work practices, define the IMT curriculum. Employer contributions of equipment, tools, production materials, and staff time enabled DCC to provide students with a robust learning experience. That employers also bring in production, design, or tooling problems for students to work on is a testament to the trust they have in the instructors and staff, and the confidence they have in the education students receive, which further solidifies their ongoing involvement and support.

- The **responsiveness of DCC and *Retooling America* leadership and staff** and their collective focus on meeting the talent needs of advanced manufacturing companies is the key factor in building relationships that result in deep, active, and ongoing employer involvement with the program.
- The **dedication and shared vision of partners, such as the Institute for Advanced Learning and Research**, local and state economic developers, career and technical education providers, and local government amplify the role played by DCC and *Retooling America* leaders and staff. Their collaboration has contributed to growth of the program and advancement of the Retooling model, as well as attraction of new advanced manufacturing businesses to the region.
- The **success of the *Retooling America* program is generating additional support within as well as outside the region**. Funds are being sought to replicate and/or adapt the model in other regions across Virginia and the South and in other industry sectors. The Governor of Arkansas spent a day visiting DCC and the IALR to explore how the model might be adapted in Arkansas, leading to passage of a millage to create a new Career and Technical Education Center in Ft. Smith.
- The **Institute for Advanced Learning and Research (IALR) recently announced creation of an Advanced Manufacturing division** that will continue to work closely to produce a work-ready talent pipeline of skilled machinists. It also intends to capitalize on the success and national attention of the DCC-IALR advanced manufacturing partnership in playing a leading role in responding to the next generation of developments in manufacturing. Additional companies are moving into the region and investments from the Danville Regional Foundation and the State of Virginia will add considerably more space for industry rapid launch and manufacturing optimization.
- **The pipeline is expanding into middle schools**, engaging students from the sixth grade upward, and providing an exciting option especially for students on the margin in traditional academic settings.

Participant Impact and Outcomes

DCC made substantial progress toward its goal of increasing the capacity of its precision machining talent pipeline to increase the number of individuals enrolled in programs developed and improved with TAACCCT grant funds. It added more dual-enrollment high school and community college feeder programs to the pipeline, launched the Dimensional Inspection (Metrology) program early, and trained an increasing number of secondary

school Career and Technical Education teachers. In addition to increasing the supply of skilled precision machining workers it also played a major role in increasing the demand for same. Since the program began, three companies have established or are in the process of establishing new manufacturing facilities in the DCC region, with 130 new jobs anticipated at full start-up, due to the precision machining talent pipeline developed at DCC.

While DCC fell short of its participant goals for the *Retooling America* initiative, several factors may have contributed to this situation: low unemployment levels; the lure of high-wage employment for PMT graduates; inability to count as participants incumbent workers in short-term programs for which no industry-recognized credential was available; and delays in completing the advanced manufacturing training facility earmarked for veterans.

None of the confirmatory hypotheses were supported. Small sample size and limitations on availability of data were the two confounding factors that most likely affected the statistical analysis. However, available data does suggest very promising longer-term outcomes:

- The relationship between students' perceptions of their work-skills and competencies and employers' assessments of their job-readiness was not statistically significant. However, student and employer perceptions of job readiness were closely aligned. Anecdotal evidence also indicated that employers were very satisfied with the preparation IMT students received. Many students in the IMT program had multiple job offers to choose from upon graduation.
- The data provided by DCC to determine if students in the Integrated Machining Technology program are more likely to achieve higher-level employment positions (e.g., supervisory) upon graduation than PMT students upon graduation was not quantifiable. Visual review of the job titles depicted little difference for both groups upon graduation.
- Available wage data indicates that starting wages for PMT and IMT graduates average $21.23 and $23.67 per hour, respectively, and go up from there one year and two years after graduation. While only preliminary evidence is available for wages one year and two years after graduation, it appears that wages for IMT graduates rise more quickly and higher than for PMT graduates, as *Retooling America* program planners expected. The confirmatory hypothesis, that IMT students are more likely to achieve higher wages upon employment than PMT students after completing two years on the job is not supported.

Key Lessons Learned

- Extensive and long-standing employer involvement in DCC's advanced manufacturing programs has been integral to the design, implementation, and further growth of *Retooling America*.
- Being responsive to employer needs is the key factor for eliciting and sustaining deep employer involvement.
- Employers continue to play a significant role in the PMT, IMT, and Dimensional Inspection programs by contributing tools, equipment, materials, projects, and staff time, as well as working with faculty and staff to refine the curricula to meet changing industry needs and requirements.
- Creating a deep and sustainable PMT/IMT talent pipeline that turns out skilled, work-ready machinists annually is a critical factor for attracting new advanced manufacturing employers to the region.
- The capstone Computer Numerical Control (CNC) Work Flow Cell experience that IMT students receive is highly regarded and greatly appreciated by advance manufacturing employers in the region—a testament to the efficacy of work-based learning.
- Preliminary evidence indicates that adding a third year to a student's precision machining education pays off for employers, who claim that new hires' productivity and revenue-generating capability is much higher than for PMT graduates, as well as for the students who see their wages rise higher and faster than for PMT graduates.

Implications for the Field

Community colleges or institutions seeking to create a CNC machining flow cell program for students or create or enhance an advanced manufacturing career pathway can benefit from the lessons learned during the course of the *Retooling America* program.

The program's design is unique in postsecondary education in that it provides students with an opportunity to apply the advanced manufacturing and work flow cell team soft skills they learn in the program to an actual shop floor experience within a supervised community college facility.

Robust employer engagement is really the key to success. This is primarily relationship driven, as a healthy partnership between the community college and employer partners requires active listening, negotiation, and responsiveness on the part of the community

college. Investing in time up front to lay the groundwork and build those relationships is time well spent.

Community colleges can play a pivotal role in rebuilding or transforming an economy when there is shared understanding among stakeholders as to the goals and approaches to meet those goals. The *Retooling America* experience has shown that it is possible to bring together higher education, K-12 education, economic development, community, and employer partners to work effectively toward a shared vision of regional economic growth.

If you train students in the skills that employers say they want and need, students will gain employment when they complete their studies.

Future success builds on past success. The success of DCC's legacy precision machining program provided a solid foundation on which to build the extraordinary capabilities that are generated through the *Retooling America* program.

Introduction

Overview of the Retooling America Program

Danville Community College's (DCC) *Retooling America* program, funded through a Trade Adjustment Assistance Community College and Career Training (TAACCCT) Round Four grant from the U.S. Department of Labor (USDOL), has contributed to advancement of a larger strategy to attract advanced manufacturing businesses to Southside Virginia. The *Retooling America* program is significantly increasing the region's capacity and capability to train skilled workers in precision machining technology (PMT). This initiative was developed in response to several factors: high unemployment caused by a severe decline in employment levels in the textile, wood products, and tobacco industries; encouragement from advanced manufacturing employers that wished to grow their businesses in the region; and opportunities and challenges identified in a study commissioned by the Commonwealth Center for Advanced Manufacturing and Virginia's Tobacco Indemnification & Community Revitalization Commission, conducted by the Boston Consulting Group (BCG).[1]

> *"The vision of Retooling America was retooling our schools, retooling our students, retooling the community with workers who had skills that makes our region extremely competitive on a global stage with new investment. So we sat down with these manufacturers for hours and days to determine what those skills need to be."*
>
> – DCC's Director of Advanced Manufacturing

In addition to forecasting that over 6,000 new and replacement advanced manufacturing jobs would need to be filled in the region over the next few years, the BCG report provided guidance to DCC as well as the employer and economic development members of its precision machining advisory committee to:

- Understand the potential skill gaps that could impair the growth of the advanced manufacturing industry cluster.

[1] The Boston Consulting Group, *Developing an Advanced Manufacturing Workforce for Virginia's Tobacco Region: Key Findings and Recommendations* (Boston, MA: The Boston Consulting Group, January 2013).

- Identify the required curricula and equipment needed to close those gaps.
- Create an implementation plan to guide the region's efforts in providing the workforce needed to realize the vision.

Program Overview

In recent years, Southern Virginia has been significantly impacted by foreign trade, resulting in the loss of many jobs. From 2002 to 2010, the city of Danville (population 42,444[2]) alone saw over 3,000 workers certified as Trade Act-eligible[3] with 178 TAA-certified workers residing in DCC's service region,[4] comprised of Pittsylvania and Halifax counties (combined population 98,000[5]) at the time the program began. An additional 3,446 Trade Act-eligible workers resided within an hour's drive from the college at this time.

The manufacturing environment in the region has also undergone recent changes. Many of the jobs lost in the region required only a high school education or less in industries such as tobacco products, textile and apparel, and wood products manufacturing.[6] Currently, it is much more difficult to obtain a job earning family-supporting wages in the DCC service region with a high school diploma (or less) and little or no experience than it was with previous generations. Rapid changes in manufacturing technology and in the mix of manufacturing employers in the region, combined with an increase in the skills required for employment in advanced-manufacturing occupations, all contribute to an increased need for college-level education and training. Employers also frequently require that these skills be documented with credentials or degrees granted by community colleges or other institutions of higher education.

DCC also had to contend with the fact that retaining community college students in a program of study is difficult, even under the best of conditions. Low retention and completion rates are a major source of concern for community college administrators and

[2] U. S. Census Bureau, "State and County Quick Facts," accessed April 28, 2015, http://quickfacts.census.gov/qfd/states/51/51590.html.

[3] "U.S. Department of Labor Employment & Training Administration searchable database," http://www.doleta.gov/tradeact/taa/taa_search_form.cfm.

[4] Danville Community College, *Retooling America: Retooling its Workforce, Retooling its Education Programs* (Washington D.C.: U.S. Department of Labor Employment and Training Administration).

[5] "State and County Quick Facts."

[6] Danville Community College, *Retooling America*.

policymakers nationwide.[7] For adult students, such as TAA-eligible workers, work and family needs and the demands of an academic environment provide additional challenges and distractions that make retention and completion more difficult. Additionally, people with low education attainment levels such as those found in the DCC service area (22.8%, 22.1%, and 23.9% of the population having less than a high school diploma in the city of Danville and Pittsylvania and Halifax counties, respectively)[8] often require remediation before becoming fully engaged in coursework leading to the credential they desire, further complicating efforts to increase retention and completion. Contextualizing the General Education Development (GED) and other remediation curricula—such as is done with the PluggedIn Virginia (PIVA) model, a contributing partner to DCC—to integrate with industry-specific technical training has an evidence base to support its effectiveness. The report *Background and Supporting Evidence for Adult Education for Work* released in 2009 by The National Center on Education and the Economy, the Workforce Development Strategies Group, highlights the need to develop and implement career pathways systems of learning for low-skilled adults through work-oriented adult education programs, rather than relying on academically focused developmental education classes.[9]

Retooling America increased capacity and enhanced DCC's training capabilities by adding to its legacy precision machining technology program and creating another step to a career pathway for students and another segment in the talent pipeline vitally important to employers. With grant funds, DCC created an associate of applied science (AAS) degree in Integrated Machining Technology (IMT) that culminates in a Capstone Work Flow Cell experience. This provided students with the option of adding a third year of advanced training and education in integrated machining technology to their precision machining technology experience at DCC. The program's design is unique in postsecondary education in that it provides students with an opportunity to apply the advanced manufacturing and work cell team soft skills they learn in the program to an actual shop floor experience within a supervised community college facility.

Successful completion of the two-year diploma program in Precision Machining Technology from DCC, or its equivalent elsewhere, is required for enrollment in the IMT program. To

[7] Jennifer Gonzalez, "Multiyear Study of Community-College Practices Asks: What Helps Students Graduate?" *The Chronicle of Higher Education* (February 2, 2012), accessed June 17, 2013, http://chronicle.com/article/Community-College-Study-Asks-/130606/.

[8] Danville Community College, *Retooling America*.

[9] Forrest Chisman, *Background and Supporting Evidence for Adult Education for Work*, (National Center on Education and the Economy,2009), http://www.jff.org/sites/default/files/AEW_Background.PDF.

earn the AAS IMT degree, students are required to complete additional general education courses. However, if they choose not to complete the general education courses, they will still earn a Career Studies Certificate in Computer Numerical Control (CNC) Flow Cell Machining.

DCC's precision machining program offers opportunities for incumbent workers as well. They can enroll in training courses that lead to accumulation of stackable industry credentials. They can earn a Career Studies Certificate in CNC Flow Cell Machining and/or participate in the Capstone experience. They can also take selected modules to meet their own needs for professional development and/or their employer needs for higher-skilled workers.

Critical Components

DCC designed the *Retooling America* project to meet the education and career-training needs of workers who were eligible for training under the Trade Adjustment Assistance Act for Workers Program (TAA), veterans, and other adults. The innovations incorporated into the *Retooling America* design included:

1. Accelerated student progress
    a. Implemented flexible scheduling to engage and retain students.
    b. Created stackable industry-recognized credential and career pathways.
    c. Added higher-level credentialing opportunities.
    d. Provided career pathway beyond National Career Readiness credential.
    e. Expanded technology-enhanced learning opportunities.
    f. Incorporated competency-based learning options.
2. Enhanced student assessment
    a. Incorporated experiential and other prior learning assessments.
3. Enhanced wraparound student support services
    a. Added a career-coaching component to provide academic and career coaching, program recruitment and college transition services, and referral services.

These features were intended to increase student retention and completion, as well as accelerate the time needed to attain industry-recognized credentials. This was anticipated

to speed the return of laid-off workers to employment in jobs with family-supporting wages and address industry needs for skilled workers.

DCC not only values employer input, but seeks it out and modifies curriculum and practices accordingly in response to the needs they identify. It is a reciprocal arrangement. Employer needs and input were instrumental in establishing the IMT program and curriculum. Moreover, their contributions of precision machining equipment, tools, and materials; of real-world production projects and problems they bring for students to work on; and the staff time they make available to work with students enhances and enriches the student experience.

> *"Our company had a need and the program addressed it. I am supportive [of the program] because I am going to have another need."*
>
> – Representative of BWX Technologies

A career coach was hired to provide further support to *Retooling* students by offering dedicated services to improve retention and completion. According to a national evaluation conducted for the USDOL Employment and Training Administration (ETA), most TAA-affected workers possess a high school diploma or GED, have been out of school for over two decades, and require remedial education before taking technical college courses. Most are married with family responsibilities, have financial concerns, and are largely unfamiliar with the resources available to help them return to employment in jobs with family-supporting wages.[10] Moreover, work and family concerns may limit the social, emotional, and academic peer support (for both traditional and non-traditional students) that can contribute to increased student retention.[11]

Summary of Evidence Base Supporting the Project's Innovations

Considerable evidence is available to support the strategies implemented in the *Retooling America* program to achieve the overarching goals of TAACCCT-funded programs:

[10] Sarah Dolfin and Jillian Berk, *National Evaluation of the Trade Adjustment Assistance Program: Characteristics of Workers Eligible Under the 2002 TAA Program and Their Early Program Experiences* (Washington D.C.: U.S. Department of Labor Employment and Training Administration, April 2010), http://preview.tinyurl.com/3lokxht.

[11] Linda Wild and Larry Ebbers, "Rethinking Student Retention in Community Colleges," *Community College Journal of Research and Practice* 26 (2002), 503-519.

1. Better prepare TAA-eligible workers and other adults for high-wage, high-skill employment in growth industry sectors by increasing their attainment of degrees, certificates, diplomas, and other industry-recognized credentials that match the skills needed by employers.
2. Introduce or replicate innovative and effective methods for designing and delivering instruction that addresses specific industry needs and leads to improved learning, completion, and other outcomes for TAA-eligible workers and other adults.
3. Demonstrate improved employment outcomes for TAACCCT participants.

DCC implemented three key program components to support the steps necessary to build and sustain the advanced manufacturing talent pipeline essential for economic development in that industry sector and support TAACCCT goals. The college leveraged its partnership with Goodwill Industries of South Central Virginia to prepare individuals through contextualized instruction to access the on-ramp to entry-level employment and an opportunity to progress along the career pathway in advanced manufacturing. A career coach was hired to recruit individuals to take advantage of the opportunities available in DCC's precision machining programs and to also connect students with supports they might need to aid their retention and program completion.

DCC also instituted a work-flow cell into its Integrated Machining Technology curriculum to provide a work-based learning experience for its students under the direct supervision of its highly skilled and experienced instructors. In addition, the college was motivated by its desire to build on its legacy precision machining technology programs to spearhead creation of a sustainable talent pipeline that would support and catalyze economic development in the region. A brief review of the evidence supporting these components follows.

Contextualized Education/Instruction

The term "contextualized education or instruction" refers to a set of teaching, learning, and assessment practices that are aimed directly at developing the skills and knowledge adults need to deal with specific situations or perform specific tasks and that they have identified as important and meaningful to themselves in their present situations. The concept is intended to have broad applications to help adults more effectively perform in all three primary life roles such as within the family, at work, and in the community.[12] Appropriately,

[12] Peggy McGuire and Duren Thompson, "FAQ: What is 'Contextualized Instruction?'" EFF Teachers' Instructional Practices & Strategies: Supporting Adult, ttps://efftips.wordpress.com/2012/05/29/faqwhat-is-contextualized-instruction/.

the USDOL encourages application of contextualized instruction to help adult workers to successfully complete basic skills remediation needed to enter on-ramps to career pathways leading to high-skill, high-wage jobs. For many, the basic skills, such as math, needed to succeed in postsecondary training become rusty if not used often. Often, the desire for a good job supplies the meaning and level of importance in which contextualized instruction can be most effective.

DCC leveraged its partnership with Goodwill Industries of South Central Virginia to prepare TAA and other workers to take a first step along the career pathway leading to high-skill, high-paying jobs in advanced manufacturing. Goodwill's approach drew lessons from the PIVA initiative, an I-BEST type career pathways program that provides motivated adult learners with a contextualized GED curriculum integrated with industry-specific technical training as a means to develop essential workplace skills for entry-level jobs in targeted industries. The I-BEST model integrates the teaching of basic skills and technical content in order to accelerate a student's transition into and through a college-level occupational field of study.[13] The goals of the PIVA initiative align with those of the *Retooling America* initiative:

- Align regional partnerships, sector-based programs, and state systems around a career-pathways model.
- Bring industry-driven career pathways to scale throughout the state.
- Provide new career-ladder footholds to low-wage workers with limited skills.[14]

[13] John Wachen et al., "Contextualized College Transition Strategies for Adult Basic Skills Students: Learning," *Washington State's IBEST Program Model*, (December 2012): 2; and Virginia Commonwealth University. "PluggedInVA," http://www.pluggedinva.com/.

[14] "Rise Partnership," accessed August 26, 2013, http://risepartnership.org/about.

Goodwill provided contextualized adult basic education and GED preparation opportunities to individuals to prepare them for training and entry-level employment as a manufacturing technician and progress along a career path that could ultimately lead to enrollment in *Retooling America* courses.

Career Coach to Support Retention and Completion

Retooling America was also designed to enhance student support services through the hiring of a career coach. The coach provided academic and career coaching as well as transition and referral services to support and increase student persistence and achievement outcomes. Research from the Community College of Denver showed that students who received comprehensive counseling and academic support services had a withdrawal rate of 7.8 percent compared to the overall campus rate of 12.4 percent.[15] Additionally, in a paper published by the American Association for Higher Education, the authors reported that a student's contact with a significant person within an institution of higher education is a crucial factor in her/his decision to remain enrolled in college.[16]

> Cellular manufacturing is a process in which production work stations and equipment are arranged in a small-scale, clearly-defined production unit within a larger factory (a cell), that supports a smooth flow of materials and components through the production process with minimal transport or delay. This unit has complete responsibility for producing a family of like parts or a product. All necessary machines and manpower are contained within this cell, thus giving it a degree of operational autonomy.

[15] Thomas R. Bailey and Mariana Alfonso, "*Paths to Persistence: An Analysis of Research on Program Effectiveness at Community Colleges*" (Indianapolis, IN: Lumina Foundation for Education, New Agenda Series, January 2005), 16.

[16] Arthur W. Chickering and Zelda F. Gamson, "Seven Principles for Good Practice in Undergraduate Education," *AAHE Bulletin* 39, no. 7, 3-7.

The Work Flow Cell Teaching Model

The central feature of the *Retooling America* program was the development of a cellular manufacturing[17] workplace-like setting within the community college that integrates, in its Integrated Machining Technology program, precision machining with real-work operations and production demands to better prepare students for high-skill, high-paying jobs upon graduation. DCC's work flow cell (cellular manufacturing) laboratory concept drew upon the practices used in the education and training of apprentices, that typically combines on-the-job training with classroom experiences, to prepare students with the hard and soft skills desired by advanced manufacturers in the region. Apprenticeships have been shown to be effective in preparing individuals for higher-skill, higher-paying jobs.[18] In the IMT work flow cell, DCC creates a simulated real-work, shop-floor environment that provides students with an opportunity to demonstrate competence in self-management, problem-solving, working in teams, and other soft skills that are desired by advanced manufacturing employers.[19]

Additionally, research on work-based learning and cooperative capstone experiences suggests that these approaches help improve scoring on student assessments, allow employers to participate in developing their future workforce, better prepare students for work, and have a tendency to increase the starting pay for new graduates entering the workforce.[20] Work-based learning also provides students the opportunity to develop social competencies relevant to work, practice soft skills and teamwork, and develop competencies specific to an industry or industry sector.[21]

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[17] U.S. Environmental Protection Agency, "Lean Manufacturing and Environment: Lean Thinking and Methods," http://www.epa.gov/lean/environment/methods/cellular.htm and R. Anthony Inman, "Cellular Manufacturing," Reference for Business: Encyclopedia for Business (2nd Edition), http://www.referenceforbusiness.com/management/Bun-Comp/Cellular-Manufacturing.html.

[18] Debbie Reed et al., *An Effectiveness Assessment and Cost Benefit Analysis of Registered Apprenticeship in 10 States* (Washington, DC: Mathematica Policy Research, July 25, 2012), http://wdr.doleta.gov/research/FullText_Documents/ETAOP_2012_10.pdf.

[19] Inman, "Cellular Manufacturing."

[20] Elizabeth D. Richard, Richard Walter, and Edgar Yoder, "The Effect of Capstone Cooperative Education Experiences, and Related Factors, On Career and Technical Education Secondary Student Summative Assessment Scores," *Career and Technical Education Research*, no. 1 (2013): 19-37.

[21] Anne Mari-Hall, Daniela Ulicna, and Claire Duchemin, *Work-Based Learning: Benefits and Obstacles – A Literature Review for Policy Makers and Social Partners in EFT Partner Countries* (Turin, Italy: European Training Foundation, 2013).

Community Colleges and Economic Development

Development of the *Retooling America* project was influenced by a report from the Boston Consulting Group that indicated a need for workers in the Southside Virginia region with advanced manufacturing skills and the potential to attract new businesses by creating a deep-rooted talent pipeline. While not a goal explicitly stated in the application for TAACCCT grant funds, it was part of DCC's strategy from the onset of the *Retooling* initiative to play a key role in attracting new advanced manufacturing businesses to the region. The *Retooling* project has been instrumental in building a comprehensive talent pipeline that includes a middle school career-awareness component, dual-enrollment programs with high schools in the region, collaboration with another community college to provide the first year of the two-year PMT diploma program, and the Certificate and Associates degree programs in computer numerical control machining. The existence of the talent pipeline has significantly contributed to attraction of new advanced manufacturing businesses to the region.

DCC's experience is consistent with and adds to the moderate evidence that points to community colleges' involvement in economic development as a natural complement to their mission of expanding education and employment opportunities for students. One study stated that the level, breadth, and sophistication of a college's commitment to meeting local workforce needs correlates with its degree of community engagement, as reflected in partnership and connections.[22] Another offered that community colleges "represent a ready-made structure within which to place responsibilities for activities that support existing businesses and attract new ones."[23] Yet another indicated that through years of experience working within a community college system, the development of partnerships and collaborations holds the key to success in growing economic and workforce development opportunities[24]. DCC's experience with the *Retooling* initiative adds important details to the body of literature by illustrating, through its experience, the process by which a community college comes to actually driving economic development through

[22] John Dyer, "Economic Diversification: How Community Colleges Prepare the Workforce," presentation made to the International Economic Development Council and the American Association of Community Colleges, November 2017.

[23] Diane Hershberg, "The Role of the Community College in Economic and Workforce Development" ERIC Digest: ERIC Clearinghouse for Junior Colleges (Los Angeles, CA: ERIC, December 1991), https://www.ericdigests.org/1992-5/economic.htm.

[24] Dennis L McElhoe, "The Impact of Industry and Community College Collaborations on Economic and Workforce Development," SEEN: Southeast Education Network, November 23, 2014 http://www.seenmagazine.us/Articles/Article-Detail/ArticleId/4394/The-Impact-of-Industry-and-Community-College-Collaborations-On-Economic-and-Workforce-Development.

creation of a multi-layered talent pipeline—a perspective that is only minimally present in the literature.

The Role of a Community College in Creating a Talent Pipeline

An efficient and effective talent pipeline requires a continuous and consistent supply of talent that is, at the least, sufficient to meet employer hiring needs. When hiring needs increase, due to industry expansion or business attraction, the effectiveness of the talent pipeline becomes even more paramount. High school dual-enrollment programs are a valuable component of a talent pipeline that incorporates postsecondary education completion. High school dual-enrollment programs in precision machining technology, established or in the process of being established, in the region enable students to complete the first year of the two-year PMT diploma program by the time they graduate and ensure a continuous supply of students for the precision machining programs and skilled workers for employers. Dual-enrollment programs also serve the purpose of improving student outcomes. In one study, dual enrollment was shown to have a positive effect on persistence, retention, and completion, in large part because of the momentum toward college completion students built up while in high school.[25] A review of other studies indicated that dual enrollment increases success in college and positively correlates with high school students enrolling in college, earning higher grade point averages (GPAs), and attaining more college credits.[26] Yet another study reported similar findings—that students that participated in dual-enrollment programs in high school had higher GPAs than students that did not participate.[27]

The level of evidence pertaining to the various supports included in the *Retooling America* program design is moderate to strong. However, the work flow cell laboratory concept is new and untested as a teaching/learning innovation, though the innovation is reported as

[25] Xeuli Wang, Hsun-yu Chan, L. Allen Phelps, and Janet I. Washbon, "Fuel for Success: Academic Momentum as a Mediator Between Dual Enrollment and Educational Outcomes of Two-Year Technical College Students," *Community College Review* 43, no. 2 (March 11, 2015): 165-90, https://doi.org/10.1177/0091552115569846.

[26] Drew Allen, and Mina Dadgar, "Does Dual Enrollment Increase Students" Success in College? Evidence from a Quasi-Experimental Analysis of Dual Enrollment in New York City," *New Directions for Higher Education* 2012, no. 158 (June 19, 2012), https://doi.org/10.1002/he.20010.

[27] Brian P An, "The Influence of Dual Enrollment on Academic Performance and College Readiness; Difference by Socioeconomic Status," *Research in Higher Education* 54, no. 4 (June 2013): 407-32, https://doi.org/10.1007/s11162-012-9278-z.

possessing strong evidence of promise.[28] Consequently, the evaluation examines the evidence of the degree to which this innovation contributes to improved student outcomes.

Finally, the findings will contribute to the research literature evidence regarding the ability of the program to deliver positive outcomes for program participants and the factors deemed influential in accounting for differences in outcomes.

[28] Danville Community College, *Retooling America*.

Overview of the Evaluation

Goals of the Evaluation

Public Policy Associates, Inc. is the third-party evaluator selected to evaluate the *Retooling America* Trade Adjustment Assistance Community College and Career Training (TAACCCT)-funded project. The evaluation over the grant-funded period focused on the following four goals:

1. To assess the degree to which the *Retooling America* program increases student retention and completion.
2. To assess the degree to which the *Retooling America* program accelerates time to attainment of industry-recognized credentials.
3. To assess the degree to which *Retooling America* contributes to improved student education and employment outcomes.
4. To understand the various factors that mediate the outcomes achieved by program participants.

Implementation Study Design

The evaluation used quantitative and qualitative data to achieve these research goals. The methods included employer phone interviews and a survey; review of administrative documents and extant data; five site visits at regular intervals throughout the grant period to conduct interviews, focus groups, and roundtables with key stakeholders, such as project faculty, staff, students, and members of the advisory committee; and online student surveys and focus groups.

The evaluation consisted of both an implementation study and an outcomes study. These two facets are deeply related. The implementation study—which was conducted during the first three years of the grant period—provided data for evaluating outcomes and also offer data for continuous improvement, program sustainability, and replication or adaptation elsewhere.

- The implementation study assessed fidelity to the *Retooling* program design and implementation plan. Additionally, the implementation study collected data on participants' utilization of and satisfaction with the project's innovations; these data

were used to assess the degree to which program innovations contributed to differences in student outcomes between the participant and comparison cohorts.

- The outcomes evaluation assessed the degree to which program components contribute to improved student education and employment outcomes. That study compared outcomes achieved by students enrolled in the grant-funded Integrated Machining Technology (IMT) program with a comparison group comprised of graduates of the Danville Community College (DCC) Precision Machining Technology (PMT) diploma program who did not enroll in the capstone IMT Associate of Applied Science (AAS) program.

Over the course of the evaluation, the PPA team maintained close communication with the *Retooling America* project team to track the development and implementation of each aspect of the project plan, to ensure smooth data-collection processes, and to share interim evaluation findings that informed adjustments to and the ongoing improvement of the *Retooling* program.

Implementation Study Research Questions

The following questions informed and guided the data collection and analysis activities used in the Implementation Study.

1. What roles did employers play in the development and implementation of the program?
    a. Which employer contributions are perceived to be the most critical to the success of the grant program?
    b. How engaged were the employers in monitoring implementation, and what factors affected their degree of engagement?
2. Are program activities implemented with fidelity to the plan and timeline?
    a. What are the challenges encountered?
    b. Where variation occurred, did it help or hinder program implementation?
3. How were the choices made in designing *Retooling America*?
    a. What factors were considered? Who was involved?
    b. How were curricula selected and enhanced?
4. What was the process for incorporating technology enhancements into the IMT courses?
    a. What was the experience in training faculty to use these?

    b. How easy was it for faculty to integrate these into their courses?

5. What role did assessments play in helping students make informed decisions about program enrollment, course selection, and their career paths?
6. What value did students and other stakeholders place on flexible learning, stackable and latticed credentials, technology-enhanced learning, assessments, soft-skills training, wraparound services, and career coaching?
7. What were considered the advantages and disadvantages of these program features?
8. To what extent is the veterans employee-in-training program utilized?
9. To what extent are students satisfied with the program features?
    a. What can be done to improve the quality of the services?
    b. To what extent and in what ways do TAA grantees, veterans, female students, and members of minority groups perceive the value of the program or its features differently?
10. To what extent are employers satisfied with the employment readiness of students or completers of enhanced programs?
    a. To what extent are students and alumni satisfied with the preparation for employment they received with technology-enhanced learning components?

Conceptual Framework/Logic Model: How this Guided the Implementation Analysis

The logic model constitutes the framework within which the evaluation was constructed. The evaluation documents the degree to which the inputs are utilized and the activities implemented, as well as tests the relationships posited in the logic model.

The logic model (in the appendix volume) shows the components of the *Retooling America* program, providing a shorthand view of the connections between the resources that were planned to be utilized, the activities that were planned to take place, and the anticipated results. The inputs (first column) describe the assets and prior experience that were foundational for the success of the program. The remainder of the table describes the logical flow of the *Retooling* program in terms of the activities, the direct outputs that result from the activities, the short- and medium-term outcomes, and the expected long-term outcomes.

The links between the content in one column and that of the next column are understood as a continuum of the attribution of effect. That is, the most direct linkages are from column

one (inputs) to column two (activities), and from column two to column three (outputs); moving from left to right across the diagram, the linkages become less direct, i.e., the ability to attribute causality declines. For example, many factors other than *Retooling* program components could have influenced the employment changes shown in the impacts column at the far right of the logic model. Therefore, it would be difficult to attribute these changes to *Retooling* alone. Nonetheless, the evaluation sheds light on how the planned and unanticipated program innovations affect program implementation, student learning, and student employment outcomes.

The logic model is organized to track outputs and outcomes at the individual level of change. Nonetheless, there are anticipated changes that will occur at the systems level, and while these are of interest in understanding the program implementation, they are not a focal point in the model. Systems-level factors are noted as inputs, activities, and outputs, though their purpose is to support and permit improvements in the services received by individuals. A copy of the Logic Model is included in Appendix A.

Implementation Data and Methods

To carry out the implementation study, the evaluation team utilized a number of data-collection methods to obtain information needed to address the research questions: site visits, key informant interviews on site as well as by telephone, regular/monthly conference calls with the client, student surveys and focus groups, employer roundtables and interviews, and reviews of DCC administrative records.

Data collection focused on the degree to which activities proposed in the application for TAACCCT grant funds, and included in the logic model, were completed and how barriers and challenges to activity completion were resolved. The implementation study also focused on activities pertaining to expansion of the talent pipeline and DCC's role in regional economic development that were not included in the

Data Collection

5 site visits

25 interviews

3 focus groups

3 participant surveys

4 employer interviews

1 employer and key stakeholder roundtable

1 employer survey

TAACCCT grant application but which were at the heart of DCC's long-range development plans.

A list of implementation study variables and data sources is included in Appendix B.

How Capacity-Building Was Measured

One of the overarching purposes of the TAACCCT grant program was to increase the capacity of grantee institutions for providing education and training programs for in-demand occupations. The DCC *Retooling America* program laid out several activities and goals intended to build DCC's capacity for delivering advanced manufacturing training that meets the needs of local employers, increasing student retention and completion, and decreasing the amount of time needed to attain industry-recognized credentials. **Table 1** below shows the program's planned capacity-building activities and the indicators used in the implementation evaluation to measure progress.

Table 1. Capacity-Building Activities and Indicators

Activity	Indicator
Explore articulation agreements with four-year institutions	Articulation agreements created
Develop competency-based models to engage incumbent workers and veterans	Competency-based models created
Assess students for remedial needs, prior learning, and competencies	Student assessments conducted
Develop career coaching model and identify student supports	Coaching model created and supports identified
Hire career coach	Career coach hired
Hire precision machining technology technician and program analyst	Program instructors hired
Install and beta-test new equipment	New equipment ready for students to use
Create industry-recognized career pathway	Career pathway developed
Develop work flow cell curriculum	Curriculum created and approved

Table 1. Capacity-Building Activities and Indicators

Activity	Indicator
Engage software developer to create web-based content	Web-based instructional content created
Develop and improve partnerships with manufacturing employers	New partnerships created; Employers provide input on curriculum
Create open entry/exit modules	Modules are created

In addition to the indicators of capacity-building listed in the table above, the outcomes evaluation included several metrics related to the effectiveness of capacityobuilding efforts. These included:

1. Number of training programs created
2. Student enrollment
3. Persistence in program of study
4. Program completion
5. Credentials earned

Outcomes Study Design

Research Questions

The following research questions guided and informed the outcomes analysis.

1. Are students in the grant-funded IMT program of study more likely to have improved enrollment status (retained, transferred; not dropped) as compared to those in the comparison group?
2. To what extent do students in the grant-funded programs have more positive employment outcomes than students in the comparison group?
3. To what degree to do students who receive wraparound services experience more positive outcomes (retained; transfer; earn associates degree; earn a greater number

of credits; employed) as compared to students who received fewer or no wraparound services?

Methodology

To better understand the effect of the *Retooling America* courses over-and-above the status quo training, the outcomes of the Capstone students were compared to the outcomes of the diploma-only students in a non-experimental study. The groups were neither randomized nor were any variables being manipulated to infer causal relationships. The AAS Capstone experience in IMT is a brand new program that builds on the student experience acquired through the PMT Diploma program; enrollment is limited to only those individuals that have completed that program at DCC or at another community college that provides a consistent student experience. Consequently, there was no group of students that engages in the same or similar program of study without the program enhancements—either concurrently or prior to the *Retooling America* launch—from whom a comparison group could be drawn for a quasi-experimental design outcomes study. This does not, however, mean that this research approach is not valuable.

First, a correlational study was conducted to examine the statistical relationship between an index of student work-skills competency and an index of employer job-readiness assessment for Capstone students only. Both indices were constructed and validated for the purpose of this study. It is expected that student work-skill competency gained from the Capstone program will be strongly correlated with the employer's assessment of their job readiness.

Second, a comparison of employment-related outcomes between the Capstone students and the diploma-only students was conducted based on the outcomes of employment level and increase in wages. The analysis used Mann–Whitney U tests of means.

Data Sources

The specific variables needed to conduct the outcomes analyses, and the sources for these, are shown in Table 2.

Table 2. Variables and Data Sources			
	Data Sources		
Variables	Employer and Key Informant Interviews*	Student Surveys and Focus Groups	DCC Administrative Records
Veteran status			X
TAA-eligible			X
Age, gender, race, and ethnicity			X
Prior level of education attainment and grade-point average	X		X
Employer, start date/quarter, position	X		X
Employment level and salary at time of enrollment	X		X
Wage record data			X*
Program of study			X
Date (semester) of enrollment			X
Utilization of career coaching; number of meetings	X	X	
Satisfaction with career coaching services		X	X
Number of courses completed, number of credits completed			X
Number of credentials attained			X
Semester-to-semester retention			X
Time to credential/degree			X

As a policy, DCC does not require students to provide their social security identifiers when they enroll. Consequently, it was not possible to collect employment and wage record data from the Virginia Employment Commission. However, as a practice instructors in the PMT and IMT programs annually collect and enter employment and wage data in administrative records maintained by staff in those programs. The outcomes analyses were structured to correspond with the research questions.

Data Used and Reliability

Employment and wage data was collected annually from graduates of the PMT and IMT programs at the time of or shortly following graduation and for several years afterward. Because the data was self-reported by graduates the reliability of the data cannot be empirically confirmed. However, DCC staff and instructors maintain ongoing close contact with employers, which allows them to verify if wage rates reported by graduates is consistent with employer practices.

Measured Outcomes

The key measures of success for the *Retooling America* program are the outcomes that individuals achieve through their participation in the program. Those outcomes are shown below in Table 3.

Table 3. Primary Outcomes[29]

Outcome Measures	Outcome Targets	Data Sources
Total unique participants served	520	DCC records
Total participants completing TAACCCT-funded program	416	DCC records
Total participants retained in their program of study or other TAACCCT-funded program	99	DCC records
Total participants completing credit hours	493	DCC records
Total participants earning credentials	935*	DCC records
Total participants enrolled in further education after TAACCCT program of study completion	22	DCC records
Total participants employed after TAACCCT-funded program of study completion	481	DCC records
Total participants retained in employment after program of study completion	432	DCC records
Total participants employed at enrollment who received a wage increase post-enrollment	10	DCC records

* Refers to number of credentials earned.

[29] Ibid.

Implementation Findings

How the TAACCCT Grant Helped Build Institutional Capacity

Funds from the Trade Adjustment Assistance Community College and Career Training (TAACCCT) grant helped Danville Community College (DCC) to purchase key equipment needed to outfit the work flow cell. TAACCCT funds were also used to make adjustments to the Precision Machining Technology (PMT) curriculum and create and obtain accreditation for the Associate of Applied Science degree Integrated Machining Technology (IMT) curriculum.

TAACCCT grant funds provided by the U.S. Department of Labor (USDOL) reinforced the confidence in the *Retooling America* program and its approach that key employers, school districts, and economic development partners had already been developing. Consequently, other donations of advanced manufacturing machinery, tools, production materials, and employer time followed as did other investments.

From the outset, the Institute for Advanced Learning and Research (IALR) was an integral partner, working with DCC to write the grant for TAACCCT funds that DCC submitted to the U.S. Department of Labor. With the TAACCCT grant award, the IALR made space to create the Gene Haas Center[30] that houses the classroom and lab that contains the work flow cell for the IMT program.

Other public investments were leveraged to increase DCC's institutional capacity such as creating additional dual-enrollment programs in regional high schools in which juniors and seniors can complete the first year of the two-year diploma program by the time they graduate. The City of Danville invested $1.6 million to create a dual-enrollment program at Danville Public Schools' George Washington High School. When combined with the previously existing dual-enrollment program at the Pittsylvania Career and Technical Center, DCC helped to create a sustainable supply of students to progress along the PMT/IMT talent pipeline. An additional program, created through a memorandum of

[30] The Gene Haas Foundation is a major contributor to the *Retooling America* program. The foundation made a $1-million investment, and was awarded naming rights to the building located at the IALR, to aid in the sustainability of the program.

understanding negotiated with Patrick Henry Community College to offer the first year of the diploma program on its campus, further expanded capacity of the PMT/IMT program.

In the fall 2015 semester DCC also launched a 28-credit Dimensional (Metrology) Inspection (DI) Certificate program with a cohort of 14 students. This certificate was not an original project goal, but was added in response to industry advisory committee input, which recognized that the equipment, and some of the coursework, needed for the *Retooling America* program was also needed for the DI program. Employers also pointed out that what students would learn through the DI curriculum mirrored what was likely to occur on the shop floor of a real work flow cell. Consequently, students would have an opportunity to see how dimensional metrology is integrated with the precision machining processes in an advanced manufacturing environment.

DCC has been able to build on the success made possible through the TAACCCT grant and leverage other funds to create additional precision machining capacity and capability since the close of the grant-funded activity period. The Danville Regional Foundation is making a significant investment to add 13,000 square feet of space to the Charles R. Hawkins Building at the Institute for Advanced Learning and Research (IALR) to increase its industry rapid-launch capability. The State of Virginia is providing funds to build a 51,000-square-foot building to also be used for rapid-launch capability as well as to help new businesses and existing companies to optimize their processes so that they can remain globally competitive. Three additional businesses are in the process of moving start-up operations into existing rapid-launch space in the IALR while their factories are being built. DCC and the IALR are in late stage negotiations with additional companies considering location in the Danville region. Starting average salaries for these firms are anticipated to be in the $55,000 – $65,000 a year range.

These investments and developments have contributed significantly to DCC's institutional capacity in precision machining technology. To date, DCC has received over $30 million in public and private investment in support of and to expand the program for the entire pipeline that includes DCC, the IALR, and participating high school and middle school program components.

Key Steps Taken to Create and Run the Program

Identifying and Responding to Employer/Industry Needs

A key development leading to DCC's application for TAACCCT grant funds occurred when a major employer in the region announced plans to expand its Virginia manufacturing operations. When considering expansion possibilities, the company's primary concern was ensuring that it could get a skilled workforce for its advanced manufacturing facilities. To that end, it encouraged creation of a pipeline of workers skilled in applying the relevant technology, at the scale required, to meet its immediate and anticipated long-term workforce needs. A study conducted by the Boston Consulting Group (BCG) reinforced what DCC, employers, economic developers and others had already estimated to be of critical importance: for advanced manufacturing to thrive and new businesses to be attracted, the region needed to increase its capacity and capability to build and sustain an advanced manufacturing workforce pipeline, especially in medium-skilled occupations, such as traditional and computer numerical control (CNC) machinists, welders, and industrial maintenance mechanics. This ultimately led to conversations with instructors in the legacy machining program at DCC who were hearing of this need from other regional manufacturers as well.

Creating a Vision and Building Capacity

DCC recognized that building and sustaining an advanced manufacturing talent pipeline presented a significant and challenging opportunity for the college and the region. Enhancing and expanding the college's ability to provide high-quality education and training in precision machining could not only lead to local residents obtaining good-paying jobs; it could also help to draw businesses to the region attracted by the college's programs. Moreover, the BCG report made it clear that additional investments and partnerships would be needed to create and sustain an advanced manufacturing pipeline. Long term, the number of students in DCC's two-year PMT diploma program would not be sufficient to entice new businesses to the region. More students would be needed in the pipeline and, with that, increased education and training capacity—i.e., facilities and equipment investments.

> *"I can tell you the number one reason for coming to Danville is the Capstone and DCC program."*
>
> – Employer moving into the region

Since the release of the BCG report in 2013, an informal working group led by DCC's director of advanced manufacturing strategized ways to expand training facilities and equipment, increase student and parent interest in advanced manufacturing as a career, and generate ongoing support and involvement from employers. Over a period of months, multiple one-on-one and small-group conversations, college-related and civic functions, community sporting events, and other social engagements became opportunities for discussing the possibilities with local public and private-sector officials, whose support was needed. Those who supported the initiative were recruited to help inform others and garner support so that additional elements of the pipeline could be put in place.

Leadership of the IALR worked closely with DCC's director of advanced manufacturing to reach out to employers, economic developers, educators, and local officials to generate enthusiasm and build support. The local economic developer recognized the value that expanding the precision machining talent pipeline would add to business-attraction efforts and became a strong proponent.

Generating Student Interest

Building capacity also required attracting more students to the PMT/IMT programs. As part of its efforts to attract students, DCC worked to change the often unfavorable perceptions that students and their parents had of advanced manufacturing as a potential career choice. To generate better understanding of advanced manufacturing, DCC invited K-12 students and their families to tour the training facilities and see what an advanced manufacturing environment is like. DCC held day-long "Concept to Creation" workshops where students experienced the process of taking a product from design to manufacture. In addition, DCC is spearheading efforts to introduce middle school students to advanced manufacturing opportunities by investing in manufacturing labs in middle schools so that 6th graders will understand what is involved in advanced manufacturing and what the opportunities are in the region.

> *"It is not an obligation [to support the program] because we are not forced to do it. This program creates desire!"*
>
> – Employer in DCC's service area

Engaging with Employers

DCC's director of advanced manufacturing acknowledged that manufacturers have been the key ingredient to developing the *Retooling America* program and designing its curricula. Moreover, that is by design. DCC took the approach to ask employers what skills they needed program graduates to be able to apply

and genuinely considered how best to respond. This resulted in creating the third-year IMT curriculum, including the highly innovative work flow cell component, and changing parts of the PMT curriculum. All is reviewed regularly, both formally and informally, with members of an advisory committee of employers to ascertain if the changes made keep up with new developments in their respective industries. Employers indicated that they provide assistance freely as the relationship they have with DCC's advanced manufacturing programs is reciprocal. DCC's instructors and students are quick to respond when employers need help with a design or production problem they are experiencing.

Employers continue to contribute extensively to the program in a variety of ways by donating tooling, machinery, software, raw materials, and even staff time to review curricula and related program matters. Some employers have provided training to students, at no cost to them or the program, on use of equipment, tooling, or software. Employers have provided funds to apply toward scholarships for students. They participate in advisory committee meetings as well as provide insights and feedback informally on the curriculum, on tool and machinery acquisition, and other enhancements to the program. More recently, employers have been providing guidance to DCC on what might be needed to prepare students for what has come to be known as manufacturing (or, industry) 4.0, the next phase in the digitization of the manufacturing sector.[31]

Ensuring Internal Capability

Sufficient capacity is one of the necessary ingredients for building a successful and sustainable talent pipeline while robust capability is the other. The skills and effectiveness of the program's leaders, instructors, and staff, as well as their dedication, have contributed significantly to the program's successful student outcomes as well as to the role it plays in attracting new manufacturers to the region. DCC's director of advanced manufacturing, the IMT instructors, the program administration specialist, and the career coach are all highly skilled and experienced in the areas of their respective responsibilities, and are very dedicated to the success of their students and the program. All are passionate about the potential this program has to support a resurgent economic health and vitality in the region.

Creating a Curriculum with Deep Employer Input

[31] "Manufacturing's Next Act," Cornelius Baur and Dominik Wee, McKinsey & Company, June 2015, accessed September 1, 2017, http://www.mckinsey.com/business-functions/operations/our-insights/manufacturings-next-act.

The third-year IMT Capstone program was created in response to employers' desire for workers with actual experience integrating their precision machining skills within a shop-floor, work flow cell production environment. Employer hiring patterns suggest that the IMT program is addressing that need. The second cohort of IMT students completed their coursework in March 2017. All but one, who decided to continue his education, entered the workforce with starting salaries that averaged over $40,000 per year. Employers continued to recruit IMT students heavily with Cohort Two graduates all having multiple job offers by the time they graduated.

> *"These companies have spent hundreds of hours to develop this metrology program and this third-year program [the Capstone] to address the real needs for a really skilled, engaged worker who understands why manufacturing is important and why they have to engage in the operation."*
>
> – Advance manufacturing employer

The timetable for beginning the DI program was accelerated, also in response to employers' needs. A number of DCC employer partners indicated a strong desire for workers with DI skills, so that they did not have to take their best machinists off the job to perform that function. The second cohort of DI students also completed their coursework in spring 2017. All had job offers prior to completing the program and began employment with starting wages that averaged over $17.00 per hour. In addition, more employers are contacting DCC about the DI students when they become aware of the knowledge and skills that students develop while in the program.

Important Partnerships

DCC has cultivated very strong partnerships that have contributed to the development and success of the *Retooling America* program.

The Institute for Advanced Learning and Research: The IALR serves as a regional catalyst for economic transformation and has been a key partner from the point at which it became apparent that DCC could play a stronger role in regional economic development by expanding the pipeline of skilled precision machining graduates. DCC's precision machining programs are closely aligned with the IALR's core focus areas that include research providing a clear path to commercialization, advanced learning opportunities where education meets experience, and economic development through conferencing and a partnership with the Southern Virginia Regional Alliance. The IALR was instrumental in

developing the application to USDOL for TAACCCT grant funds, building support for the program with other partners, and housing the Gene Haas Center for Integrated Machining Technology.

Key employers and the employer advisory board: Employers have played a consistently strong role in developing, implementing, and continuously improving DCC's PMT and IMT programs. An employer's need was the initial catalyst that led to the Boston Consulting Group study that identified a critical need for skilled advanced manufacturing workers and the opportunity to strengthen regional economic development by addressing that need. Employers have contributed extensively to development of the IMT curriculum and its continuous improvement. A major donation from Haas Automation, Inc. and other employers provided key equipment for the work flow cell lab, production materials, scholarship funds, and their own staff time to help enrich the student experience.

Pittsylvania Career and Technical Center: The director of the Pittsylvania Career and Technical Center was an early supporter of the *Retooling America* concept and program and has played a key role throughout. She recognized early on the value that the opportunity to create an enhanced advanced manufacturing talent pipeline had for her students. Working with DCC, and aided by the Virginia Tobacco Commission and other grant funds, she facilitated the launch of the first dual-enrollment precision machining program that enabled high school juniors and seniors from her district to complete the first year of DCC's two-year diploma in PMT program by the time they graduate.

City of Danville: Recognizing the value that expanding the precision machining talent pipeline would add to business-attraction efforts, the City of Danville awarded a $1.6 million economic development grant to Danville Public Schools' George Washington High School, to be applied toward creation of a second dual-enrollment precision machining program. The program, which began in fall 2017, has the capacity to enroll 40 students overall per year, with 20 students in each of the junior and senior years.

Economic developers: Local economic developers, as well as the director of economic development for the Commonwealth Center for Advanced Manufacturing, played an instrumental role in building support for the *Retooling* program during its development stage. They continue to assist by generating interest in and support for the program and its graduates among employers and by attracting new advanced manufacturing employers to the region. Through August 2018, three new companies had established or were in the process of establishing operations in the region, with planned investments of over $23 million and an expected 131 new jobs created.

Assessing Fidelity to DCC's Original Design for the Program

Monitoring fidelity to the program design is a critical aspect of program implementation and plays an important role in both describing and understanding program effectiveness. As implemented, the *Retooling America* program did not demonstrate complete fidelity to the original program design. However, this is not uncommon for innovative programming that has yet to be tested in the field and it does not appear to have had a negative impact on the implementation or outcomes of the *Retooling America* program. Key program elements and their completion status are presented in Table 4 below.

Table 4. Fidelity to Original Program Design

Planned Model Elements	Completion Status	Comments
Utilize learning and tools from prior TAACCCT grantees	Researched and provided to project team members and utilized where applicable	Learning from prior TAACCCT grantees informed the design of the program and early conversations with other TAACCCT grantees helped to shape the instructional approach and career coach model.
Use prior learning assessment models	Completed.	Prior learning is assessed at an individual level; DCC tests students on NIMS levels I and !! competencies and accepts in place of certification.
Nurture partnerships with CBOs and other sources of students	In process	Not all of the partnerships outlined in the design came to fruition. DCC continues to develop and grow these and other relationships.

Table 4. Fidelity to Original Program Design

Planned Model Elements	Completion Status	Comments
Develop additional partnerships with local employers	Completed	New employers are locating in the region because of the talent pipeline of skilled workers developed by DCC
Develop articulation agreements with four-year institutions	In process	Discussions with four-year institutions have occurred and are ongoing, but have not yet yielded any articulation agreements.
Award credit for prior learning	Completed.	This is done on an individual basis
Students complete contextualized adult basic education and GED programs	Completed by partner organizations	Very few participants have been referred by partner organizations who were able to make the transition to advanced manufacturing training, though they are successfully completing entry-level training provided by partner organizations.
Students earn National Career Readiness Certification	Completed	DCC tests for NCRC certification but results not included in final report because it is not an industry recognized credential
Program serving veterans created	In process	The curriculum for the veterans program was completed, but construction of a new space to house the program has fallen

Table 4. Fidelity to Original Program Design

Planned Model Elements	Completion Status	Comments
		behind schedule.
Create Integrated Machining Technology curriculum	Completed	
Provide career coaching and supports for students	Completed	
Receive, install, and test new equipment	Completed	
Create an industry-recognized career pathway	Completed; the pathway is continuing to expand	The initial career pathway for machining technology was created, and efforts are ongoing to develop and add to that pathway.
Develop and embed entrepreneurship elements in the IMT program	An online component was completed and is available to interested students	There is no formal mechanism in place to propel students toward entrepreneurship, but there is support for individual students that express an interest in this area.
Receive employer input on curricula	Completed	
Create web-based content to support instruction	Completed	
Track student outcomes	Completed	
Evaluate progress on implementation and outcomes	Completed	
Utilize evaluation findings for continuous improvement	Completed	

Strengths and Weaknesses of the *Retooling America* Program

Many of the strengths of the *Retooling America* program have been recounted above. Nonetheless, it would be beneficial to draw attention to some of the program strengths that may be most useful for community college and workforce development professionals to understand when considering application or adaptation of the *Retooling* model in their own regions.

Strengths

Program leadership, staff, and instructors are highly responsive to employer input and needs. DCC's director of advanced manufacturing claimed that listening to employers and developing and improving the program based on what employers told them, and not what faculty tell them they need, is the secret to the program's effectiveness and success. It also helps to engender **deep and ongoing employer engagement**, that is provided in many ways including: donations of equipment, production materials, and tools; detailed vetting of curricula; staff involvement in classes and labs; involving students in addressing some of their product design and production needs; and working with DCC to build additional capacity and capability to meet existing and emerging industry needs.

> *"[The program was] above and beyond what I originally thought it would be."*
>
> – IMT student

DCC **built the** *Retooling America* **curriculum on the foundation of one of its legacy programs**, precision machining technology, in creating the *Retooling America* program. The program had enjoyed a strong reputation for many years and had a consistently strong record of placing program graduates, even during declining economies. **Highly skilled instructors were hired** that had the appropriate academic background as well as industry experience using much of the same equipment, engaging in many of the same experiences, and using the same processes that they would be teaching students. Moreover, these instructors teach, as well as practice, application of continuous improvement principles and tools, taking to heart comments and suggestions made by students. **DCC also cultivated and maintains very strong partnerships** with a range of individuals and organizations that are dedicated to optimizing outcomes for students, for advanced manufacturing employers, and for the region. **The capabilities of the entire *Retooling America* team have been**

and remain an enormous asset for this initiative. DCC, partners, and employers have been advancing a very aggressive agenda to implement and improve the program, play a leading role in economic development of the region, and prepare for the next big development in manufacturing—Industry 4.0. Managing all of that has been very challenging, yet the *Retooling* staff has done so very effectively. **IMT graduates are very satisfied** with the preparation they receive for employment**. Employers are also very satisfied with the preparations that students receive** through the IMT program. One employer commented that when his company hires PMT graduates, they expect that it may be as much as 12 months on the job before they can begin to make money from that person's work, but IMT graduates start making money for the company right away. **The career coach engaged in outreach to increase racial and gender diversity** in the PMT, IMT, and DI programs.

> *"I can tell you the number one reason for coming to Danville is the Capstone and DCC program."*
>
> – Employer moving into the region

Graduates of the PMT and IMT programs are much in demand by employers. Many graduate with several job offers to choose from. Starting wages are consistently strong and rise fairly quickly, especially for IMT graduates. **Three new manufacturers have moved into the region**, with more in discussions with local authorities. One employer engaged in small-scale production using space made available by DCC's partner institution, the Institute for Advanced Learning and Research, while its own factory was being built across the road from the Haas Center. That company has moved into its new location after its September 2018 ribbon-cutting. The three companies together bring planned investments of over $23 million and an expected 131 new jobs created for the region. **DCC continues to move its *Retooling America* agenda forward.** Plans are underway to apply the *Retooling* model to other industry sectors and to other regions of Virginia.

Weaknesses

DCC **has not yet achieved the racial and gender diversity** in enrollments that it hoped for with the IMT program. (See Appendix C for participant demographic data.) While those numbers have been improving somewhat, they are still below what is desired. DCC also envisioned that **programs preparing individuals for entry-level manufacturing employment have not yet contributed to PMT or IMT enrollments**. The grant application to USDOL for TAACCCT funds outlines a pathway for

that to occur. While still possible, those that enter manufacturing employment have yet to move further along the precision machining talent pipeline either due to the need for steady employment, less-than-required math skills, or other factors.

The IMT program has not achieved the enrollment numbers anticipated. Staff attribute this to the surging economy, low unemployment in the region, and the high demand for skilled precision machining employees. Many PMT graduates register for the IMT program but are drawn to employment before the third-year program begins. In spite of the additions to and increased capacity of the precision machining talent pipeline, **the *Retooling America* program is limited by space, staff, and operating funds**. New advanced manufacturing facilities being built in the region will create additional needs for highly skilled precision machining technologists that will create increased competition for graduates of the PMT, IMT, and DI programs. The ability to respond effectively to these needs will require additional investments.

Serving as both **a strength and a weakness is the very ambitious agenda** DCC and its partners laid out for the region, of which the TAACCCT-funded *Retooling America* program is only one part. It is a strength because it helped to unite the partners in working toward a common goal, and progress toward that goal is and has been very significant. Its weakness has been that the work of implementing that agenda has been carried out by a small staff that had to juggle competing demands on their limited amount of time.

Employer involvement is key to *Retooling America*'s success and growth

The degree and type of employer involvement in the *Retooling America* program did not come about on its own. It was carefully cultivated by DCC faculty and staff who listened intently to what employers said they needed and then developed programs to address those needs. The development of the Dimensional Inspection program, for example, was created in direct response to employer input. With that employer input, it was up and running quickly.

The support from industry has been invaluable to the *Retooling America* program. Advisory committee members provided feedback on curriculum and regularly offer suggestions for improvement. Employers contributed money for scholarships and tools, with one employer partner donating over $10,000 worth of measurement gauges. Others provided simulated parts for students to work on that were made of expensive metals.

Employers continue to play a vital role through loans and donations of precision machining equipment and through outreach to other businesses, as well as to prospective students. Some employers donate the time of some of their employees, such as when experts from a global leader in metal cutting tools came to DCC to provide a week's worth of hands-on training in advanced tooling operations to the AAS IMT students. Another employer contributed approximately $5,000 worth of labor hours supporting Retooling America during the first quarter of year two. The employer developed and produced replica parts for students to use as work guides. This enabled students to learn to build realistic parts in line with the specifications required by a leading industry partner so that when students entered jobs with that and other employers, they would already have experience with the specifications the employers required. That company also provided two company trainers to deliver six hours of Lean Manufacturing training to the IMT cohort. This work represented approximately 50 hours of that employer's staff time.

A number of employers have made generous donations to support the DCC programs. One created a $1,000,000 endowment of unrestricted funds for this program. Another donated six chip bins with a total value of approximately $15,000. Chip bins are used for collecting scrap metal in the Capstone flow cell lab. Still another donated approximately $9,500 worth of aluminum and stock metals. Students use these materials on projects in the lab.

Strengthen development of the pipeline of candidates for education and employment in the precision machining technology field. DCC, employers, and students all can play important roles in continuing to develop the pipeline of precision machining candidates. All are involved in recruiting students for the pipeline, including reaching into middle schools to meet with students and their parents and talking with classmates and peers who are considering career options. Many of the activities conducted by DCC, like facility tours, presentations, and the opportunity to engage in classroom/lab activities such as its Concept to Completion program are important—but perhaps not sufficient—components of a pipeline development strategy. DCC and its advisory committee might consider additional outreach and marketing strategies that include public displays on billboards, short videos showing precision machining work and workplaces, and job shadowing or internships to build familiarity about the opportunities and the rewards of precision machining.

Participant Impact and Outcomes

Participant Evaluation Group Eligibility

Capstone Students

All students who enroll in the Associate of Applied Science (AAS) degree program in Integrated Machining Technology (IMT) during the grant-funded program period will be eligible for inclusion in the participant group for the outcomes analysis. Matriculation in this program is limited to those who have earned a diploma in precision manufacturing technology (PMT) from Danville Community College (DCC), or from a comparable program from another community college in the Virginia Community College System. This latter group of individuals may be required to demonstrate knowledge and skill competence prior to enrollment in the AAS program.

Other Students Served by the Grant

- *Traditional students who enroll in the Diploma in PMT program at DCC in the fall semester 2015 or later*. Some new courses, developed with funds made available by the Trade Adjustment Assistance Community College and Career Training (TAACCCT) grant, are being added to the diploma program. Consequently when Diploma students take these courses they become TAACCCT participants. Students in this group are eligible to articulate into the AAS degree program and would be included in the participant group, if required competencies are demonstrated.
- *High school students eighteen years of age or older who are dual-enrolled in courses that are accepted for credit by their high school and that are also accepted for credit in the Diploma in PMT program*. These courses are taught by DCC-trained instructors. These students are simply a subset of the group mentioned above.
- *Students currently enrolled—that is, prior to fall 2015—in the PMT diploma program as well as diploma program graduates, if they take courses that are newly included in the Capstone program*. For diploma graduates, this may lead to attainment of additional credentials but not necessarily an AAS degree, though this is possible if they articulate into the AAS program.
- *Incumbent workers and veterans*. For these students, without a diploma in PMT, enrollment is only possible in the Computer Numerical Control (CNC) Flow Cell Machining Certificate program and then only if they can demonstrate the necessary competencies, such as through National Institute for Metalworking Skills (NIMS)

assessments, required to engage in the next level of learning. Unless one of these students enrolls in and completes the Diploma in PMT program (which is not expected) this type of involvement cannot lead to an AAS degree.

- *NCRC and Manufacturing Technician completers*. TAACCCT grant funds will not be used in these programs so these students are not included as participants unless they enroll in courses in the diploma program or the CNC Flow Cell Machining Certificate program supported by grant funds. While this is possible, and supported by DCC, it is expected to occur infrequently, if at all, during the time period funded by the grant due to the challenges faced by individuals who are beginning a journey along a career pathway at this point.

Retooling America Primary Outcomes

DCC fell short of its participant goals for the *Retooling America* initiative. Several factors may have contributed to this:

- Unemployment levels lower than when the application for TAACCCT funds was submitted. When unemployment is low, there is often a decline in community college enrollments.
- TAACCCT requires that incumbent workers can only be counted as participants if they receive an industry-recognized credential as a result of their participation. DCC hosted a number of incumbent workers in short-term programs for which no industry-recognized credential was available.
- The facility earmarked for enrollment by veterans was not completed during the grant-funded activity time period, so DCC was not able to engage in outreach and recruitment of veterans, who were anticipated to account for approximately 20% of enrollments.
- The lure of employment in a high-skill, high-wage job was strong for a number of PMT graduates. Many may have opted to go to work rather than enroll in the IMT program.

While the total number of participants served is lower than the number targeted, those served achieved outcomes at a rate comparable to that which was projected. Table 5, below indicates the outcome targets and actual outcomes.

Table 5. Primary Outcomes[32]

Outcome Measures	Outcome Targets	Actual
Total unique participants served	520	298
Total participants completing TAACCCT-funded program	416	168
Total participants retained in their program of study or other TAACCCT-funded program	99	95
Total participants completing credit hours	493	188
Total participants earning credentials	935*	763
Total participants enrolled in further education after TAACCCT program of study completion	22	5
Total participants employed after TAACCCT-funded program of study completion	481	112
Total participants retained in employment after program of study completion	432	52
Total participants employed at enrollment who received a wage increase post-enrollment	10	30

* Refers to number of credentials earned.

Participant Outcomes Analysis

Administrative data was managed in Microsoft Excel, survey data was managed in SPSS, and descriptive statistics were calculated using SPSS version 23. Quantitative analyses were conducted, when feasible, for data sources such as surveys, fidelity scales, and administrative information that could be subject to numeric summary. Descriptive techniques—such as frequency distribution, means, and cross-tabulation—were applied to

[32] The no-cost extension provided by USDOL to TAACCCT Round Four recipients created a situation in which outcomes for participants enrolled in Year Three but earned by March 31, 2018 in Year Four could be included in the primary outcomes analysis. At the time of submission of this report, the calculations for several primary outcomes had yet to be completed. A copy of this Final Report with updated Primary Outcomes data will be submitted upon receipt of updated numbers from DCC.

most numeric data. Statistical testing for significance was used when feasible and as appropriate in assessing the dependence between two variables (for example, Pearson product-moment correlation coefficient).

Confirmatory hypothesis 1: There is a statistically significant relationship between student work-skills competency and employer job-readiness assessment.

Table 6 displays a comparison of student perception of the skills they learned in the IMT program with employer perceptions of the degree to which students they hired from the program possess those skills. Student and employer perceptions are closely matched, with students rating their abilities slightly higher on some skills and employers rating student abilities slightly higher on others.

Table 6. Student and Employer Perceptions of New Skills

Scale of 1-7, with 7 being "strongly agree"	Students (N = 40)	Employers (N = 5)
Can apply proper toolpath strategies	6.4	6.2
Can utilize machine tool probes for initial setup and in process inspection	6.6	6.6
Can program, set up, and operate 5-axis milling machines and 3-axis lathes	6.3	6.7
Can use CAD/CAM software to model and produce CNC code for complex components	6.3	6.7*
Can program, set up, and operate a coordinate measuring machine	6.2	6.2
Can apply Lean and Sigma Six principles to improve efficiency and quality	6.4	6.0*
Can work as part of a high performance team (collaborate in a tight-knit group to produce superior results)	6.6	6.8
Can demonstrate good business ethics (such as honesty, trustworthiness, respect, excellence, and accountability)	6.8	6.2

Table 6. Student and Employer Perceptions of New Skills

Scale of 1-5, with 5 being "strongly agree"	Students (N = 40)	Employers (N = 5)
Have learned the right skills to get a job	4.7	5.0
Have earned the right credentials to get a job	4.8	5.0
Feel are prepared to enter the workforce	4.7	4.6

*2 of the 5 employer respondents did not think these tasks were relevant to their work processes; consequently the "N" for these two factors was 3.

Due to the employer sample size, it was not possible to conduct the correlational analysis that was stated in the Evaluation Design Report, as data was not available to match employer answers to those of each student hired. However, the 5 employers that responded to the survey collectively hired 13 IMT graduates, so their responses refer to their perceptions about the skills obtained from approximately a third of IMT graduates.

Analysis of Likert-scale data came down to Independent t-test and Independent Samples Mann-Whitney U Test. While both are typically unbiased with Likert data at many levels of sample size, in this case, the sample size of less than 6 for the employer data forced the use of Mann-Whitney U. No statistically significant differences were noticed on variables listed in Table 6. Further details on the test and *p* value (a mathematical procedure for determining whether a null hypothesis can be rejected) are provided in Appendix D. Additionally, the small size of the employer sample combined with the fact that there was little or no variance in their responses—i.e., employers largely agreed things were good—limited the ability to perform any additional meaningful statistical analysis.

Thus, the Mann-Whitney U test was unable to prove if there is a statistically significant relationship between student perceptions of their work-skills competency and employer assessment of their job-readiness. However, both students and employers tended to provide high scores on work-skills competency and employer job-readiness assessment.

Confirmatory hypothesis 2: Students in the Retooling America program are more likely to achieve higher-level employment positions (e.g., supervisory) upon employment following completion of Capstone AAS than Diploma-only students after completing one year on the job following completion of Diploma program.

Employment data provided by DCC was not quantifiable and visual review does not support this hypothesis. Students graduating from the IMT program begin employment with the job title "machinist" as do most of the graduates of the PMT program. Job titles for PMT graduates did not generally change one year after graduation unless the graduate changed employers. While job titles were not made available for PMT graduates one year after graduation, the job titles held by IMT graduates are the same as those held by PMT students when first employed.

IMT Graduates' Job Titles

- Machinist
- Machinist Level II

PMT Graduates' Job Titles

- Machinist
- CNC Machinist
- CNC Machinist II
- Machine Operator
- CNC Mill Operator
- CNC Operator II
- CNC Saw Operator
- Cold Form Operator
- Hutt Toolsetter Technician
- Lab Tech/Metrologist
- Manual Machinist
- Multi-Spindle Operator
- Tooling Technician
- Toolroom Technician
- Machining Technician
- Engineering Technician
- Operator II
- Shop Superintendent

Confirmatory hypothesis 3: Students in the *Retooling America* program are more likely to achieve higher wages upon employment following completion of Capstone AAS than Diploma-only students after completing two years on the job following completion of the Diploma program.

Three separate Mann-Whitney U analyses were performed to test Confirmatory hypothesis 3. Two additional exploratory hypotheses were tested to obtain a deeper understanding of the data. The three comparison groups and their test results are listed below in Table 7.

Table 7. Salary Comparison Analyses

Comparison Groups	Means Salary ($)	N
Confirmatory Hypothesis 3		
PMT Cohort 1, 2 years after graduation	$25.68	10
IMT All cohorts at graduation	$23.67	34
Exploratory Hypothesis 1		
PMT all cohorts at graduation	$21.23	61
IMT all cohorts at graduation	$23.67	34
Exploratory Hypothesis 2		
PMT Cohort 1&2, 1 year after graduation	$20.99	20
IMT Cohort 1&2, 1 year after graduation	$26.85	10

The test of Confirmatory hypothesis 3 comparison shows that although the mean salary of PMT Cohort 1, two years after graduation is higher ($25.68) compared to the mean salary of all IMT cohorts at graduation ($23.67), the difference is not statistically significant. Thus, the Confirmatory hypothesis 3 is not supported.

A second comparison was made between the mean salary of all PMT cohorts at graduation (mean salary $21.23) and all IMT cohorts at graduation (mean salary $23.67). No statistically significant differences were noticed between these two groups as well.

However, a statistically significant difference was noticed between the mean salary of PMT cohorts 1&2 one year after graduation (mean salary $20.99) and the mean salary of IMT

cohorts 1&2 one year after graduation (mean salary $26.85) ($U = 41$, $p = .00$). With the small sample size (below 20 in each comparison group) the effect size estimate may have been overstated (biased). To correct for this bias a slight adjustment to Cohen's d called Hedge's g was calculated to estimate the effect size of this comparison. The effect size of 1.17 (Large – Very Large) further attests to the statistically significant difference observed in this particular comparison.

The small sample size and incomplete data provided by DCC for all PMT and IMT graduates one and two years after graduation[33] limit the ability to offer empirical evidence about student outcomes. However, the data displayed in **Table 8** below does suggest that, for both PMT and IMT groups, on average, wages rise every year and rise higher more quickly for IMT graduates.

Table 8. Graduate Salary Comparison

Row Header	N	Mean Hourly Wage ($)	Standard Deviation
PMT Cohort 1 at graduation	13	$20.43	4.20
PMT Cohort 1, 1 year after graduation	15	$20.05	4.45
PMT Cohort 1, 2 years after graduation	10	$25.68	5.83
PMT Cohort 2 at graduation	24	$20.31	4.92
PMT Cohort 2, 1 year after graduation	5	$23.81	2.15
PMT Cohort 3 at graduation	24	$22.58	3.70
IMT Cohort 1 at graduation	11	$21.77	3.67
IMT Cohort 1, 1 year after graduation	7	$27.63	6.80
IMT Cohort 2 at graduation	13	$22.55	6.64
IMT Cohort 2, 1 year after graduation	3	$25.04	5.24
IMT Cohort 3 at graduation	10	$27.22	5.73

[33] Danville Community College does not require students to provide their social security numbers upon enrollment, making it impossible to engage in the customary practice of collecting wage record data from state sources.

Conclusions

Lessons Learned

The experience of Danville Community College (DCC) and its *Retooling America* program leaders, staff, and partners offer a number of lessons that may be useful for others that wish to apply or adapt the *Retooling* model in their own regions.

- Responding to employer needs helps to build a strong program, one in which students get good jobs and employers hire program graduates that begin making money for them when they start.
- New employers can be attracted to a region when deep and sustainable talent pipelines are built that provide them with graduates that have the skills they desire in new hires and that have the capability to take on increasingly responsible roles within their firms.
- Demand for workers with strong skill sets, for jobs that pay well, attracts more students.
- Small cohorts of students that receive intensive hands-on attention from instructors and employers help student retention and completion.
- Lessons DCC staff learned from implementation of the *Retooling America* program include:
  - Assess new Integrated Machining Technology (IMT) students at the beginning of the semester so that lesson plans and schedules can be adjusted based on their entering knowledge and skill levels.
  - During the interval between spring and fall semesters, a number of prospective IMT students accepted employment. DCC learned that beginning the next IMT cohort soon after students graduate from the Precision Machining Technology (PMT) program might help to increase IMT enrollments.
  - Schedule general education courses needed to complete the Associate of Applied Science degree earlier to increase the number of students graduating with that degree, which is assumed to increase their marketability.
- Data from this evaluation strongly suggests that students that spend a third year enrolled in the IMT program receive higher wages sooner than their counterparts that only complete the two-year program.

- Extensive and long-standing employer involvement in DCC's advanced manufacturing programs has been integral to the design, implementation, and further growth of *Retooling America*.
- Being responsive to employer needs is the key factor for eliciting and sustaining deep employer involvement.
- Employers continue to play a significant role in the PMT, IMT, and Dimensional Inspection programs by contributing tools, equipment, materials, projects, and staff time, as well as working with faculty and staff to refine the curricula to meet changing industry needs and requirements.
- Diversity of enrollments in the precision machining programs is slowly increasing due to efforts by the career coach and others.
- The number of participants in grant-funded programs is holding steady, for the most part, in spite of the low unemployment in the region. Overall, the number of grant-funded participants is below the number targeted as the number of incumbent workers anticipated to be trained is lower than expected.
- Students' need for career coaching while in training is greatly reduced when employers are deeply engaged and students frequently enter training with a job offer contingent on completion of the program.

Implications for the Field

Other community colleges or institutions seeking to create a Computer Numerical Control machining flow cell program for students or an advanced manufacturing career pathway can benefit from the lessons learned during the course of the *Retooling America* program. Robust employer engagement is really the key to success. This is primarily relationship-driven, as a healthy partnership between the community college and employer partners requires active listening, negotiation, and responsiveness on the part of the community college. Investing time up front to lay the groundwork and build those relationships is time well spent.

Community colleges can play a pivotal role in rebuilding or transforming an economy when there is shared understanding among stakeholders as to the goals and approaches to meet those goals. The *Retooling America* experience has shown that it is possible to bring together higher education, K-12 education, economic development, community, and employer partners to work effectively toward a shared vision of regional economic growth.

If you train students in the skills that employers say they want and need, students will gain employment when they complete their studies.

Future success builds on past success. The success of DCC's legacy precision machining program provided a solid foundation on which to build the extraordinary capabilities that are generated through the *Retooling America* program.