

CUYAHOGA COMMUNITY COLLEGE
TRADE ADJUSTMENT ASSISTANCE COMMUNITY COLLEGE CAREER
TRAINING GRANT

Final Report
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Executive Summary

TAACCCT Program/Intervention Description and Activities

This report describes the activities that occurred during the implementation of the Cuyahoga Community College (Tri-C) TAACCCT grant funded by the United States Department of Labor (USDOL). The report is intended to document the activities of the college relative to the content of the scope of work and to offer reflections on the success of the grant in achieving its goals.

The project received \$2.5 million to improve workforce opportunities for Greater Cleveland residents in the additive manufacturing sector and strengthen the regional manufacturing sector by supporting the workforce needs of businesses. The period of performance spanned October 1, 2012 through March 31, 2016.

Tri-C proposed a variety of strategies to help develop a technical additive manufacturing workforce in their grant application. The vision was to make the program accessible and useful to a variety of workers including lower-skilled or inexperienced individuals, and higher-skilled or longer-tenured individuals. It was envisioned that professional engineers would also utilize the program to enhance their knowledge of the additive field. Three principal strategies and their respective models were described in the grant proposal.

Strategy 1 involved streamlining advanced manufacturing programs and creating stacked credentials to improve completion and meet employer needs. To carry out this strategy, Tri-C proposed to incorporate the following models:

- Model 1.1: Actively engage employers in curriculum development and program enhancement efforts.
- Model 1.2: Streamline and enhance programs using evidence-based approaches.

Strategy 2 involved transforming developmental education to accelerate student advancement. To carry out this strategy, Tri-C proposed to incorporate the following models:

- Model 2.1: Redesign assessment and placement processes.
- Model 2.2: Eliminate developmental math and reading/writing courses for targeted programs.

Strategy 3 involved utilizing new technology-enabled systems for career coaching and academic advising. To carry out this strategy, Tri-C proposed to incorporate the following models:

- Model 3.1: Upgrade and enhance technologies.
- Model 3.2: Minimize student drift.
- Model 3.3: Award of Prior Learning Credit for students in targeted programs.
- Model 3.4: Enhance connections to the job market.

Evaluation Design Summary

Implementation Analysis Design

The implementation evaluation has two goals: (1) to assess fidelity to the intent, and (2) to identify factors affecting outcomes. Implementation evaluation activities involve communicating with local project staff and instructors, project leadership, students, and/or employers and include: (1) interviews, (2) focus groups, (3) surveys, and (4) on-site visits. Assessment of progress measures or benchmarks required in the original grant proposal or established by Project leadership are embedded in the activities.

Implementation Analysis Research Questions

Broadly, the implementation evaluation seeks to capture the following:

- What is being implemented, and how is it theorized to drive impacts?
- Has implementation occurred on time and as intended?
- Is there fidelity among to the stated objectives in the grant? When variation exists, is it effective and consistent with project outcomes?
- What contributions did each of the partners (employers, workforce system, other training providers and educators, philanthropic organizations, and others) make in terms of: 1) program design, 2) curriculum development, 3) recruitment, 4) training, 5) placement, 6) program management, 7) leveraging of resources, and 8) commitment to program sustainability. What factors contributed to partners' involvement or lack of involvement in the program? Which contributions from partners were most critical to the success of the grant program? Which contributions from partners had less of an impact?

Impact Study Design

The primary goals of the Impact Evaluation are to determine the impacts of grant activities on participant employment-related outcomes, including participant earnings, job attainment and retention, and program-related outcomes, including program completion and credit hour attainment. Attempts were made to establish a reasonable parallel comparison group for the college.

Impact Analysis Research Questions

The impact research questions are based on the DOL reporting requirements for the annual performance report. For each question listed, we are comparing grant participants in the grant-affected programs of study to comparison group individuals:

1. How many unique participants/comparisons have been served?
2. How many individuals have completed a grant/comparison program of study?
 - a. Of those, how many are incumbent workers?
3. How many individuals are still retained in their program of study (or other grant-funded program)?
4. How many individuals are retained in other education programs?
5. How many credit hours have been completed?
 - a. How many students have completed credit hours?
6. How many credentials have been earned by participants/ comparisons?
 - a. How many students have earned certificates (<1 year)?
 - b. How many students have earned certificates (>1 year)?
 - c. How many students have earned degrees?
7. How many students are pursuing further education after program of study completion?
8. How many participants/comparisons are employed after program of study completion?
9. How many participants/ comparisons are retained in employment for three quarters after program of study completion?
10. What are the earnings of participants/ comparisons relative to before enrollment?
 - a. How many of those employed at enrollment received a wage increase post-enrollment?

Design Methodology

The study design was intended to be quasi-experimental, although challenges faced by Tri-C implementing the project hindered the capacity to do an extensive quasi-experimental analysis. A random-assignment research design was impractical because Tri-C is an open-access community college with limited resources to serve students in targeted programs. Randomly assigning those students to different systems of programs and services would have been resource-intensive and hindered the success of the program.

CNC Machining and Composites Manufacturing was chosen as the comparison group because similarities of short-term program length, number of students involved in the program, and demographics, such as gender, race, and ethnicity.

Data Used and Its Reliability

Data comes from different sources:

- College Student Information System:
 - on an ongoing basis, college submits data on their students, including information such as completions
 - Once per student, college submits data on their students that does not change over time, such as gender, race, and date of birth
- State wage agency: at the end of the grant period, the state wage agency (Ohio Department of Job and Family Services) is contacted to obtain wage data on students, starting with the quarter of enrollment

We consider the data to be reliable. College data is part of the ongoing business of an institution of higher learning, and given the relatively simple nature of the college data required, we believe this data is also reliable. Lastly, we have no reason to believe there are systematic inaccuracies in state wage data.

Outcomes and Impacts Measured

The outcomes measured are those that allow us to answer the research questions above (completion, credit hours, further education, and employment). The impact is the difference between the treatment group (grant participants) and the control group (comparison group individuals) after adjustment to make the groups as comparable as possible.

Implementation Findings

Theme 1: Start-up and administrative challenges led to an evolving project vision and delays in implementation.

- One important factor contributing to the start-up and administrative challenges of grant implementation is the late development of the proposal. Tri-C had not applied to the request for proposals for TAACCCT Round 2 funding, but was contacted as grants were awarded to develop a project in an under-represented region. Because of the condensed timeline, Tri-c developed a proposal with less stakeholder engagement than would have been possible given a standard timeline for proposal development. Administrative delays in gaining USDOL approval on the statement of work and budget after the proposal was submitted further delayed project implementation. The visionary for the project left the institution shortly after grant award.
- Project staff were not hired until the scope of work approval was received. The late onboarding of project staff caused further delays in project implementation.
- Administrative challenges which spurred further implementation delays:
 - a. The financial approval process for the new additive manufacturing program took more than one year to complete.
 - b. The lengthy budget approval process delayed equipment purchases.

Theme 2: business engagement, especially in an emerging industry, is challenging.

Keeping a finger on the pulse of workforce needs in an emerging industry such as additive manufacturing takes significant time and energy. To keep training programs in line with industry needs, training providers must be in constant communications with local businesses to keep programs and equipment in-line with evolving standards.

- While many local manufacturing businesses have expressed interest in utilizing new additive manufacturing technology, few have integrated it into their core business.

Additive is used most for companies that need to create a product immediately, or those who want to create complex, low-volume geometries.

- Tri-C is in an excellent position to be a leader in AM workforce as it emerges in Northeast Ohio. Tri-C has made important business connections in the region during program development, and organizes and hosts a conference attended by more than 100 industry representatives. The businesses that attended were anticipating the rise in use of AM in production. Tri-C excited businesses about AM and being on the frontier of the use of the tool. However, most businesses that want to use additive cannot. It is not yet widely used and requires a large investment of resources.

Theme 3: It is difficult to balance the needs of current students in a program evolving to meet the needs of a future workforce.

- It is difficult to create a new program, especially in an emerging industry. Contextualizing curricula and finding knowledgeable professors can be challenging.
- This quickly growing and changing field has spurred the beginning of various academic programs dedicated to AM. The challenge is that leaders must balance the needs of current students and the current AM job market with the broader vision of the program. –
- The certificate that Tri-C has developed through the grant allows graduates to search for technician level jobs, which are yet to appear on the market in Northeast Ohio (see figure 2). However, per interviews with AM employers, this certificate created valuable soft skills that they found widely employable. Moving forward, it will be important for Tri-C to continue to embed versatile skills into its AM credentials so that its graduate may find work that is not directly related to AM production.

Participant Impacts and Outcomes

The impact research questions are based on the DOL reporting requirements for the annual performance report. Given the limitations, in data availability, some questions were answerable to a greater or lesser extent. Here are direct answers to the questions posed in the evaluation plan. Further analysis is included in the Impact Evaluation section later in the report.

1. How many unique participants/comparisons have been served?

In total, 204 individuals were served by the grant.

2. How many individuals have completed a grant/comparison program of study?
 - a. Of those, how many are incumbent workers?

Over the course of the grant, 13 participants completed a grant-affected program of study (5 of whom were incumbent workers). The completion rate for participants was higher than the completion rate for comparison individuals (6% vs. 4%).

3. How many individuals are still retained in their program of study (or other grant-funded program)?

191 participants were still continuing with their grant-affected program of study at the completion of the grant.

4. How many individuals are retained in other education programs?

None of the participants were retained in other education programs.

5. How many credit hours have been completed?
 - a. How many students have completed credit hours?

In total, nearly 3000 credit hours were completed by study participants (2951), spread across 131 participants who completed credit hours.

6. How many credentials have been earned by participants/ comparisons?
 - a. How many students have earned certificates (<1 year)?

- b. How many students have earned certificates (>1 year)?
- c. How many students have earned degrees?

Participants earned 24 certificates or degrees over the course of the grant. 13 students earned short-term certificates, none of the students earned long-term certificates, and 3 earned degrees.

7. How many students are pursuing further education after program of study completion? Of those who completed a grant-affected program of study, 4 continued on to further education after completion.

8. How many participants/comparisons are employed after program of study completion? Of those who were non-incumbent workers at the time of entering, 4 participants who completed a grant-affected program gained employment in the semester after completion.

- 9. How many participants/ comparisons are retained in employment for three quarters after program of study completion?

Of those 4 employed, 1 was retained in employment through quarters two and three after completion. If longer follow-up was possible, we would expect more to be retained through three quarters.

- 10. What are the earnings of participants/ comparisons relative to before enrollment?
 - a. How many of those employed at enrollment received a wage increase post-enrollment?

Of those who were employed at study intake, 65 earned a wage increase in their employment.

Evaluation Challenges

The two primary challenges in this evaluation were: 1. a shifting participant definition, which introduces methodological challenges, and 2. limited labor market opportunities for AM production workers, which limits data on AM careers. Participants were originally defined narrowly around enrollment in the targeted programs. As discussed in detail, the project was slow to launch and very few participants were enrolled through the first 2.5 years of the project. During the project's last year, the definition of participants was expanded to include a broader set of individuals taking grant-affected courses even if the individuals were enrolled in other programs. This created a challenge related to the construction of the comparison group, as originally conceived, and assigning "dosage" of the grant intervention as individuals varied in the degree of grant participation. Finally, we learned that the AM labor market is small, although with growth potential. AM skills tend to be embedded in within many occupations, including non-manufacturing occupations, which made assessment of successful application of skills in the job market difficult.

Conclusions

As the Tri-C developed its AM program, it faced challenges assembling a community of partners in the nascent AM field. As will be discussed later, the college has served as a principal organizer among businesses and other industry stakeholders as a result of this grant. A big issue was that there was no pre-existing sector partnership among users of AM technologies. Tri-C did groundbreaking and original work in Northeast Ohio assembling businesses and other partners. Unfortunately, it was slow at times as the project lacked a manager for a significant portion of the early grant stages. Tri-C is among the first community colleges in the country to launch an AM program. A challenge that came with the nascence of the field was that the college struggled to find subject matter expertise in the early stages of the grant. As Tri-C got further into the project they learned the program structure they had assembled was not ideally aligned with the emerging needs in the field. The college adapted to each challenge along the way.

Introduction

In 2009, the American Recovery and Reinvestment Act amended the Trade Act of 1974 to authorize the Trade Adjustment Assistance Community College and Career Training (TAACCCT) Grant Program. On March 30, 2010, President Barack Obama signed the Health Care and Education Reconciliation Act, which included \$2 billion over four years to fund the TAACCCT program.

TAACCCT provides community colleges and other eligible institutions of higher education with funds to expand and improve their ability to deliver education and career training programs that can be completed in two years or less, are suited for workers who are eligible for training under the TAA for Workers program, and prepare program participants for employment in high-wage, high-skill occupations. Through these multi-year grants, the Department of Labor is helping to ensure that our nation's institutions of higher education are helping adults succeed in acquiring the skills, degrees, and credentials needed for high-wage, high-skill employment while also meeting the needs of employers for skilled workers. The Department is implementing the TAACCCT program in partnership with the Department of Education.

Project Description

This report describes the activities that occurred during the implementation of the Cuyahoga Community College (Tri-C) TAACCCT grant funded by the United States Department of Labor (USDOL). The report is intended to document the activities of the college relative to the content of the scope of work, and to offer reflections on the success of the grant in achieving its goals.

The project received \$2.5 million to improve workforce opportunities for Greater-Cleveland residents in the additive manufacturing sector and strengthen the regional manufacturing sector by supporting the workforce needs of businesses. The period of performance spans October 1, 2012 through March 31, 2016.

This report covers the implementation period of the project. The document contains a background section, project overview, record of planning, an interim implementation report, and an impact evaluation report that may help interpret outcomes of the grant.

Background

Citing 8,868 workers certified as TAA-eligible in the five years preceding the grant application, Tri-C was funded by the USDOL Trade Adjustment Assistance Community College Career Training (TAACCCT) program to train workers in high-demand skilled technical occupations in the evolving manufacturing industry. The project specifically focuses on emerging additive manufacturing technologies and processes. At the time of the application, Tri-C believed additive manufacturing was a future source of employment growth in its home region, Northeast Ohio. Several dozen companies had expressed individualized interest in introducing additive manufacturing technologies and processes or had implemented it in a limited fashion; but the technology was described as emerging and not a large source of employment. Labor market data projecting demand for trained additive manufacturing workers was not systematically available.

This project's storyline is that of a community college seeking to take a leadership role in anchoring a community of partners interested in adopting or expanding uses of additive manufacturing technologies. An enthusiastic core of businesses, industry groups, and university partners joined the effort. The goal was to promote additive manufacturing technologies and processes throughout the Northeast Ohio manufacturing community. The TAACCCT grant

funded Tri-C to develop a technical workforce aiding in the adoption of additive manufacturing.

What is Additive Manufacturing?

Additive Manufacturing (AM) describes technologies that build 3D objects by adding layer-upon-layer of material, whether the material is plastic, metal, concrete, or biological. Common to AM technologies is the use of a computer, 3D modeling software (Computer Aided Design), machine equipment, and layering materials. Once a CAD sketch is produced, the AM equipment reads in data from the CAD file and lays down or adds successive layers of liquid, powder, sheet material or other, in a layer-upon-layer fashion to fabricate a 3D object. The term AM encompasses many technologies including subsets like 3D Printing, Rapid Prototyping (RP), Direct Digital Manufacturing (DDM), layered manufacturing and additive fabrication.

Additive manufacturing enables companies to produce items to a detailed specification, immediately. Materials and equipment are relatively expensive, so in Northeast Ohio, it is primarily used as a tool for developing prototypes, rather than as a means for mass production. The belief is that, as the cost comes down, the technology has the potential to help companies shorten supply chains, reduce material costs, eliminate shipping costs, or reduce lead times because materials will be manufactured on-site and without producing the waste associated with subtractive manufacturing. Affordable 3D printers have helped make the technology more accessible to students, researchers, tinkerers, and entrepreneurs. Tri-C reports that designers and manufacturing engineers are extending their capabilities as additive manufacturing accommodates increasingly complex, geometric shapes and features. The development of high-performance polymers and metal-based systems offer possibilities for companies utilizing a wider range of materials.

Project Description

Tri-C proposed a variety of strategies to help develop a technical additive manufacturing workforce in their grant application. The vision was to make the program accessible and useful to a variety of workers including lower-skilled or inexperienced individuals, and higher-skilled or longer-tenured individuals. It was envisioned that professional engineers would also utilize the program to enhance their knowledge of the additive field. The three principal strategies, and their respective models are listed below as they were described in the grant proposal:

Strategy 1: Streamline advanced manufacturing programs and create stacked credentials to improve completion and meet employer needs.

The project proposed to develop five new Certificates of Achievement and one new One-Year Certificate and retool an Associate Degree program. The completion of all five CA's will earn the student a One-Year Certificate. The proposed are listed below.

Certificates of Achievement	One-Year Certificate	Associate Degree
(1) Product Innovation and New Product Development Process, (2) Computer-Aided Design, (3) Rapid Prototyping/ Additive Manufacturing (4) Product Transition from Design to Manufacturing, (5) Product Launch to Customers	Engineering and Manufacturing Product Development (completers receive nationally recognized IC3 industry credential)	Engineering Technology – Manufacturing Engineering (completers receive nationally recognized IC3 industry credential)

To carry out this strategy, Tri-C proposed to incorporate the following models:

- **Model 1.1: Actively engage employers in curriculum development and program enhancement efforts.** Tri-C's highly-active manufacturing Industry Advisory Council will be engaged to help construct new curricula, retool existing curricula, and contribute to program enhancement efforts. Additionally, the college will seek to create new internship opportunities for students in the manufacturing engineering program.
- **Model 1.2: Streamline and enhance programs using evidence-based approaches.** Within these credential programs, Tri-C will adopt Complete College America recommendations for cohorts and learning communities, block scheduling, and hybrid learning.

Strategy 2: Transform developmental education to accelerate student advancement.

To carry out this strategy, Tri-C proposed to incorporate the following models:

- **Model 2.1: Redesign assessment and placement processes.** Tri-C will adopt an assessment preparation/retake process for the targeted programs to ensure that students' developmental course placements are appropriate—not driven by other factors such as lack of computerized test-taking skills, test anxiety, or rustiness on assessment topics.
- **Model 2.2: Eliminate developmental math and reading/writing courses for targeted programs.** Tri-C will embed contextualized basic math and reading/writing skills within the targeted programs. For students who are unprepared for the embedded content, Tri-C will establish technology-enhanced accelerated bridge program, which will replace traditional pre-requisite developmental education courses. These bridge programs students will only be required to master content required for targeted programs. These programs will align with Tri-C's work as a member of Anne Arundel's Round 1 TAACCCT consortium, which established a contextualized and accelerated bridge strategy for developmental education in STEM programs.

Strategy 3: Utilize new technology-enabled systems for career coaching and academic advising.

To carry out this strategy, Tri-C proposed to incorporate the following models:

- **Model 3.1: Upgrade and enhance technologies.** For students in targeted programs, Tri-C will pilot upgraded technologies for assessing student interest/aptitude, initial and ongoing career coaching, occupational program mapping and completion plans, regular degree or progress audits, and early alert systems for struggling students. Using extensive technical assistance and professional development, Tri-C will integrate technologies to enhance advising and career coaching systems at the college. This strategy will leverage products that are being piloted as part of Anne Arundel TAACCCT consortium STEM initiative. Currently, two advisory/student management technologies are being piloted. This grant will enable piloting the products among a broader set of students and will further support selection and institutionalization of a preferred technologies.
- **Model 3.2: Minimize student drift.** Using new technologies, Tri-C will require individualized career coaching and course/program advising for all manufacturing engineering students from entry to completion.
- **Model 3.3: Award of Prior Learning Credit for students in targeted programs.** Tri-C has seven methods for awarding prior learning credits. (College Level Examination Program (CLEP), DANTES, Military Training Credit, Standardized Training and Certification Programs (ACE), Credit by exam (CBE), By-Pass Credit, and Tech Prep Credit.) As part of the coaching strategy under this grant, program participants will be counseled and encouraged on the possibilities for earning credit for prior learning. Manufacturing engineering program directors will re-evaluate prior learning credit opportunities for students in targeted programs to ensure opportunities are maximized. Additionally, the Ohio Board of Regents is currently assessing

prior learning credit policies statewide. Tri-C will participate in this re-assessment and comply with policy adjustments that emerge from the state.

- **Model 3.4: Enhance connections to the job market** through enhanced partnerships with local One-Stops. Tri-C will develop career services partnerships with local One-Stops to leverage online information and services for TAA-eligible students including recruitment opportunities, job aptitude and interest tools, inventory of past experience, local and regional job forecasts, local and regional salary/benefit information, job postings, resume development, and placement assistance.

Evaluation Research Design and Methodologies

There are two parts to the evaluation: (1) an implementation evaluation that captures the details of project implementation and the extent to which the college implemented according to the original blueprint of the project; and (2) an impact evaluation that captures the impacts of grant activities on participant earnings, job attainment, employment intensity, wages, and likelihood of working in a job that offers benefits (e.g., health insurance) along with program retention and completion using a comparison approach. There are constraints in the feasibility of doing comparison-based analyses for prior learning assessment, basic skills bridges, and credit-bearing work experience participants. Thus, the impacts of many individual elements of the grant are not disentangled in the Impact Evaluation.

Implementation Analysis Design

The implementation evaluation has two goals: (1) to assess fidelity to the intent, and (2) to identify factors affecting outcomes. Implementation evaluation activities involve communicating with local project staff and instructors, students, and/or employers and include: (1) interviews, (2) focus groups, (3) surveys, and (4) on-site visits. Assessment of progress measures or benchmarks required in the original grant proposal or established by project leadership are embedded in the activities.

Implementation Analysis Research Questions

Broadly, the implementation evaluation seeks to capture the following:

- What is being implemented, and how is it theorized to drive impacts?
- Has implementation occurred on time and as intended?
- Is there fidelity among to the stated grant objectives? When variation exists, is it effective and consistent with project outcomes?
- What contributions did each of the partners (employers, workforce system, other training providers and educators, philanthropic organizations, and others) make in terms of: 1) program design, 2) curriculum development, 3) recruitment, 4) training, 5) placement, 6) program management, 7) leveraging of resources, and 8) commitment to program sustainability. What factors contributed to partners' involvement or lack of involvement in the program? Which contributions from partners were most critical to the success of the grant program? Which contributions from partners had less of an impact?

Specific questions pertaining to each grant strategy are posed, as follows:

Strategy 1:

- Did Tri-C actively engage employers in curriculum development and program enhancement efforts? How did that impact the implementation of the project?
- How well did Tri-C integrate internship opportunities into their additive manufacturing program?
- Did Tri-C use evidence-based approaches to streamline and enhance programs?

Strategy 2:

- Did Tri-C redesign assessment and placement processes to ensure correct placement of students?
- Were developmental math and reading/writing courses eliminated and embedded into targeted programs?

Strategy 3:

- Did Tri-C upgrade and enhance technologies? Were these technologies piloted to enhance advising and career coaching systems?
- Was student drift minimized via individualized career coaching?

- Were program participants counseled on their opportunities for earning credit for prior learning?
- Did Tri-C leverage connections to the job market through enhanced partnerships with local One-Stops?

Impact Study Design

The primary goals of the Impact Evaluation are to determine the impacts of grant activities on participant employment-related outcomes, including participant earnings, job attainment and retention, and program-related outcomes, including program completion and credit hour attainment.

Impact Analysis Research Questions

The impact research questions are based on the DOL reporting requirements for the annual performance report. For each question listed, we are comparing grant participants in the grant-affected programs of study to comparison group individuals:

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Design Methodology

The study design is quasi-experimental. A random-assignment research design was impractical because Tri-C is an open-access community college with limited resources to serve students in targeted programs. Randomly assigning those students to different systems of programs and services would have been resource-intensive and hindered the success of the program. CNC Machining and Composites Manufacturing was chosen as the comparison group because similarities of short-term program length, number of students involved in the program, and demographics, such as gender, race, and ethnicity.

Data Used and Its Reliability

Data comes from many different sources:

- College Student Information System:
 - o on an ongoing basis, college submits data on their students, including information such as completions
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- State wage agency: at the end of the grant period, the state wage agency (Ohio Department of Job and Family Services) is contacted to obtain wage data on students, starting with the quarter of enrollment

We consider the data to be reliable. College data is part of the ongoing business of an institution of higher learning, and given the relatively simple nature of the college data required, we believe this data is also reliable. Lastly, we have no reason to believe there are systematic inaccuracies in state wage data.

Outcomes and Impacts Measured

The outcomes measured are those that allow us to answer the research questions above (completion, credit hours, further education, and employment). The impact is the difference between the treatment group (grant participants) and the control group (comparison group individuals) after adjustment to make the groups as comparable as possible.

Implementation Evaluation Report

This section of the report details New Growth's findings for the implementation in five sections:

- (1) Implementation inquiries to-date
- (2) Emerging themes in the implementation evaluation
- (3) Grant strategies implementation, fidelity to model, and factors affecting outcomes
- (4) Student pipeline analysis
- (5) Implementation evaluation limitations and topics of future inquiry

Implementation Inquiries to-Date

The implementation evaluation seeks to assess fidelity to the intent of the grant, and identify factors affecting the grant outcomes. The findings detailed in this section are based several rounds of interviews with Project Coordinators and grant staff, a student focus group, business partner interviews, and a workforce needs survey of local businesses. Details of implementation evaluation inquiries conducted to-date are below:

Spring 2013	- Interview with Project Coordinator
Spring 2014	- Interview with Project Coordinator
Spring 2015	- Interviews with Project Coordinator and grant staff - Instructor interview
Spring 2016	- Interviews with Project Coordinator and grant staff - Student focus group - Instructor interview - Business partner interviews
Summer 2016	- Closeout questionnaire with grant staff
Summer 2016	- Greater Clever additive manufacturing workforce analysis

Emerging Themes in the Implementation Evaluation

Several themes have begun to emerge in the implementation evaluation. These themes affect each strategy differently, but impact many of the grant activities.

Theme 1: Start-up and administrative challenges led to an evolving project vision and delays in implementation.

One important factor contributing to the start-up and administrative challenges of grant implementation is the late development of the proposal. Tri-C had not applied to the request for proposals for TAACCCT II funding, but was contacted as grants were awarded to develop a project in an under-represented region. Because of the condensed timeline, Tri-c developed a proposal with less stakeholder engagement than would have been possible given a standard timeline for proposal development. Administrative delays in gaining USDOL approval on the statement of work and budget after the proposal was submitted further delayed project implementation. The visionary for the project left the institution shortly after grant award. Project staff were not hired until the scope of work approval was received. The late onboarding of project staff caused further delays in project implementation. These individuals and their approximate start times are listed below:

- Alethea Ganaway, Career Coordinator was hired in August of 2013
- George Aslanidis, Program Manager was hired in May of 2013
- Craig McAtee, Program Director was hired in September of 2013
- Phyllis Kolodny, Project Coordinator began working part-time in August of 2013, and became full-time on the grant in December of 2013.
- Instructors were hired for the Spring semester of 2015

In addition to these hiring delays, the college experienced several administrative challenges which spurred further implementation delays. The financial approval process for the new additive manufacturing program took more than one year to complete. In order to gain approval, new courses were identified, curriculum was developed and a faculty advisor was selected. New courses were then approved by the Associate Dean of Engineering, the curriculum development department, and the Tri-C board. The Executive Director of Enrollment and Financial Aid submitted for Financial Aid approval from Ohio, which was approved in September of 2014.

These delays and startup challenges contributed to challenges among project staff determining their role in the labor market. AM is a new and emerging field with limited job demand, which will be discussed later. As such, the vision for the project has evolved throughout the grant period under new leadership and in response to the demands of the local additive manufacturing industry.

As the program was developing, it faced challenges assembling a community of partners in the nascent AM field. As will be discussed later, the college has served as a principal organizer among businesses and other industry stakeholders as a result of this grant. A big issue was that there was no pre-existing sector partnership among users of AM technologies. Tri-C did original work in Northeast Ohio assembling businesses and other partners. Unfortunately, it was slow at times as the program lacked a leader for a significant portion of the early grant stages. Tri-C is among the first community colleges to launch an AM program. The college lacked subject matter expertise in the early stages of the grant. As they got further into the project they learned the program structure they had assembled was not ideally aligned with the emerging needs in the field.

All of the above noted administrative challenges have led to an evolution in the project vision which is further described in the '*Implementation of Grant Strategies, fidelity to model, and factors affecting outcomes*' section below.

Theme 2: business engagement, especially in an emerging industry, is challenging.

Keeping a finger on the pulse of workforce needs in an emerging industry such as additive manufacturing takes significant time and energy. Though it is still emerging, Additive manufacturing, which includes the use of 3D printers, is expected to be the "third industrial revolution" due to the potential for rapid advancement of the industry⁴. This pending revolution means that Additive Manufacturing is emerging, growing, and diversifying quickly and it can be difficult for businesses and educational training providers keep up. To keep training programs in line with industry needs, training providers must be in constant communications with local businesses to keep programs and equipment in-line with evolving standards.

While many local manufacturing businesses have expressed interest in utilizing new additive manufacturing technology, few have integrated it into their core business. Additive is used most for companies that need to create a product immediately, or those who want to create complex, low-volume geometries.

Currently, several entities in northeast Ohio use Additive manufacturing, including:

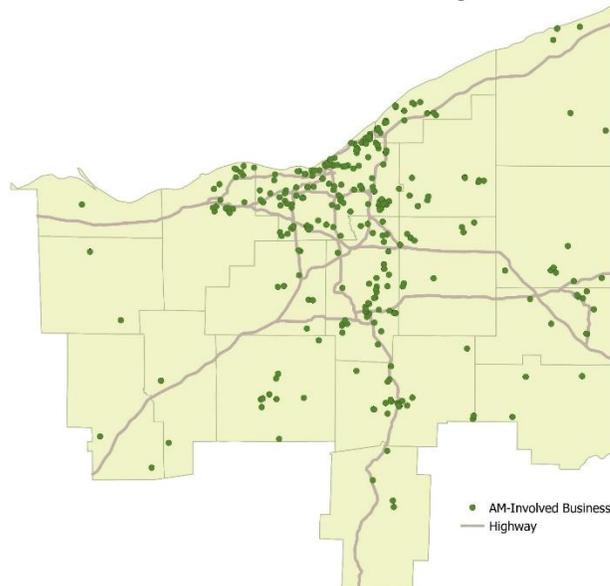
- Manufacturing companies:
- Research companies and think tanks: America Makes in Youngstown, Ohio is a national accelerator for AM and 3D Printing. It is the nation's leading and collaborative partner in AM and 3DP technology research, discovery, creation, and innovation. They have a large number of public and private member organizations that work together to

innovate and accelerate AM and 3DP by fostering collaboration and facilitating the development of technologies. In Avon Lake, Ohio there is an organization called

- Niche prototypers:
- Rp+M. It is a solutions company that has experience developing technology in the AM space. They build products for their clients built to suit their needs, from concept to production. Think[box], Case Western Reserve University's center for innovation and entrepreneurship, emphasizes cross-discipline and cross-institution collaboration endeavors. This center provides the resources and educational environment that foster collaboration, invention, and value creation. The Manufacturing Advocacy & Growth Network (MAGNET) serves to support, educate, and champion manufacturing, with the goal of transforming NEO's economy into a powerful global player. MAGNET is a voice for manufacturers in the region and offers business assistance services to support the growth of technology-oriented companies.

More businesses in the area are involved in AM even if they do not utilize it for production:

Figure 1: Locations of Additive Manufacturing-Related Businesses in Northeast Ohio



Source: US Census Bureau TIGER Line Shapefiles; National Establishment Time Series (NETS), 2013

Note: List of businesses were compiled using stakeholder interviews, previously compiled lists from TeamNEO and Tri-C, and Google searches.

Tri-C is in an excellent position to be a leader in AM workforce as it emerges in Northeast Ohio. Tri-C has made important business connections in the region during program development, and organizes and hosts a conference attended by more than 100 industry representatives. The businesses that attended were anticipating the rise in use of AM in production. Tri-C excited businesses about AM and being on the frontier of the use of the tool. However, most businesses that want to use additive cannot. It is not yet widely used and requires a large investment of resources.

Additive manufacturing faces various obstacles to expansion. AM lacks formal regulations and sufficient research to improve cost-saving measures⁴. High material and capital costs impede rapid advancement and widespread usage of additive technologies⁴. This results in a bias towards conventional manufacturing, with AM seen as a tool for prototyping and small batch manufacturing rather than large-scale production⁴. Additionally, there are difficulties in

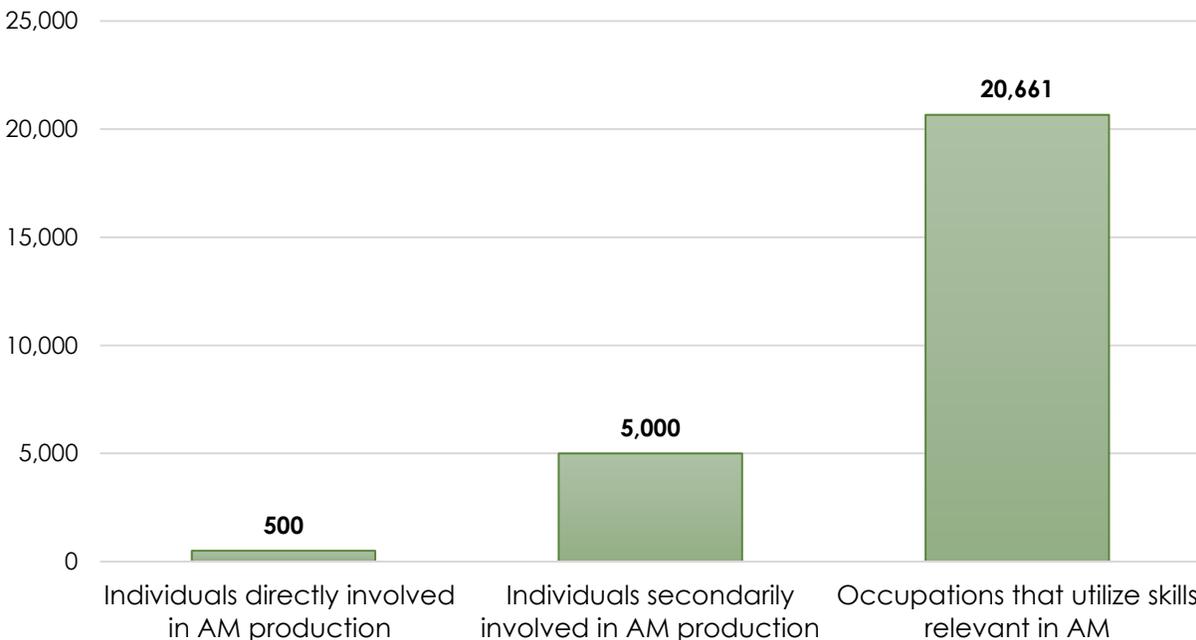
contextualizing educational programs to train potential workers in the additive field. Because it is an emerging industry, it can be challenging to find experienced and knowledgeable professors. Additive is rapidly progressing, making it difficult for academia to be on the cutting edge of the field. Because AM is considered a tool in many industries, educational programs are often not long enough to go into extensive depth on all the ways it can be applied.

Theme 3: It is difficult to balance the needs of current students in a program evolving to meet the needs of a future workforce.

It is difficult to create a new program, especially in an emerging industry. Contextualizing curricula and finding knowledgeable professors can be challenging.

This quickly growing and changing field has spurred the beginning of various academic programs dedicated to AM. The challenge is that leaders must balance the needs of current students and the current AM job market with the broader vision of the program. The certificate that Tri-C has developed through the grant allows graduates to search for technician level jobs, which are yet to appear on the market in Northeast Ohio (see figure 2). However, per interviews with AM employers, this certificate created valuable soft skills that they found widely employable. Moving forward, it will be important for Tri-C to continue to embed versatile skills into its AM credentials so that its graduate may find work that is not directly related to AM production (see figure 2).

Figure 2: AM Job Market by Involvement Level, Northeast Ohio



Source: NETS; EMSI; Stakeholder Interviews

This TAACCCCT grant is a part of a larger initiative in the region to build a skilled workforce which will promote the attraction of additive manufacturing businesses or the expansion of current businesses into the AM field. While it is important to keep the bigger vision in mind, the program must also be mindful of current talent and jobseeker needs. Northeast Ohio industry leaders hope and expect additive manufacturing business to take off in the region. As opportunities present themselves, Tri-C will be well-positioned to lead discussions on workforce needs in AM in the region.

Implementation of Grant Strategies, fidelity to model, and factors affecting outcomes

Strategy 1: Streamline advanced manufacturing programs and create stacked credentials to improve completion and meet employer needs.

There are five grant models within Strategy 1. Of the five, two activities (activity 2 and activity 3) have been completed as described, two activities (activity 1 and activity 4) have been partially or mostly complete as described, and one activity (activity 5) is no longer being pursued.

	This activity has been completed as described
	This activity is partially or mostly complete as described
	This activity is behind schedule or failing due to unexpected circumstances
	Not applicable/ other

Strategy 1	
Activity 1: actively engage employers in curriculum development and program enhancement efforts	Advisory council meetings have been held annually that highlight industry involvement in this project. Tri-C has surveyed employers to better comprehend and serve their workforce needs. The industry's participation has evolved over the three-year grant to an increasingly active role in the program. Additional engagement for curriculum improvements and industry needs will be essential in the continually evolving field of Additive Manufacturing.
Activity 2: engage the Advisory Council to construct new curricula, retool existing curricula, and contribute to program enhancement efforts	Tri-C has held meetings with advisory council members to discuss current and future curricula to improve the program and ensure that the technology taught is relevant. Industry engagement is rising and is of increasing importance as the Additive Manufacturing field evolves rapidly.
Activity 3: create internship opportunities for students in the additive manufacturing program, is still progressing.	Since Fall 2015, nine students have qualified for internships. Of the nine, seven have been placed in internships and four received full-time positions. Additional engagement with businesses to increase the availability and placement of interns will be important for the success of the program and the continually evolving field of Additive Manufacturing.
Activity 4: streamline and enhance programs using evidence-based approaches, is progressing, but faces barriers.	Tri-C has worked with their educational advisory council and utilized additional research to enhance the program with evidence-based approaches. This Activity still has not removed some barriers to entry that create challenges for new or incumbent worker students.

<p>Activity 5: adopt College America's recommendations for cohorts and learning communities, block scheduling, and hybrid learning, is partially complete.</p>	<p>After the first semester, it was determined that the schedule should follow the standard academic schedule and cohorts would be organized by semesters. Tri-C views cohorts as ideal in most training and education programs, but finds it very challenging to implement when the majority of community college students have various competing demands in their lives, including working and caretaking. Instructors have incorporated hybrid learning in three of the courses and three courses are offered completely online.</p>
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Strategy 2: Transform developmental education to accelerate student advancement.

There are five activities within Strategy 2. Of the four, one activity (activity 1) is partially or mostly complete as described, and four activities (activity 2, activity 3, activity 4, and activity 5) are no longer being pursued.

<p>Strategy 2</p>	
<p>Activity 1: redesign the assessment preparation/retake process adopted for the targeted programs to ensure that students' developmental course placements are appropriate—not driven by other factors such as lack of computerized test-taking skills, test anxiety, or rustiness on assessment topics.</p>	<p>The college has assessment tests in place that are required for students in addition to providing review sessions in math and English for new students. Online tools were purchased to support these services but lag in use and being developed fully. The goal is to implement the EMSI Tools within the next semester.</p>
<p>Activity 2: eliminate developmental math and reading/writing courses for targeted programs.</p>	<p>Activity 2 is no longer being pursued. Only two students beginning the program needed developmental math. Because of the low need, it was determined that the students would utilize the development classes established by the college. Ohio State requirements have been updated over the past year, making this goal more difficult to achieve. Math needs to be integrated instead of standing alone for workforce development courses, programs and degrees.</p>
<p>Activity 3: embed contextualized basic math and reading/writing skills within the target programs.</p>	<p>Activity 3 is no longer being pursued due to assessment scores of students. In addition, Ohio state requirements have been updated over the last year, making the math goal further away from being completed than when the grant began. Math must be integrated and not stand alone for workforce courses, programs and degrees. Some reading and math programs have been integrated.</p>

<p>Activity 4: establish a technology-enhanced accelerated bridge program to replace the traditional pre-requisite developmental education courses. The status of this activity is not complete.</p>	<p>Activity 4 is no longer being pursued. This is due in part to the low need of students, approximately 1%, that need developmental classes. Online tools were purchased but lag being used and developed to help the College's students improve in key areas.</p>
<p>Activity 5: align Tri-C's work as a member of Anne Arundel's Round 1 TAACCCT consortium which established a contextualized and accelerated bridge strategy for developmental education in STEM programs, is not complete.</p>	<p>Activity 5 is no longer being pursued due to low need from students given their assessment scores. To help students improve in key areas, the college purchased online tools but they currently lag being implemented.</p>

Strategy 3: Utilize new technology-enabled systems for career coaching and academic advising.

There are eleven activities within Strategy 3. Of the eleven, six activities (activity 3, activity 5, activity 6, and activity 7, activity 8, and activity 10) are complete as described and five activities (activity 1, activity 2, activity 4, activity 9, and activity 11) are partially or mostly complete as described.

<p>Strategy 3</p>	
<p>Activity 1: upgrade and enhance technologies.</p>	<p>The Project Team and Tooling U have developed the Intro to Additive Manufacturing course. Additional courses were mapped from Amatrol and Tooling U online curriculum to integrate into the hybrid learning delivery, with some classes being offered online. Online tools were purchased but still lag being used and developed to maximize their potential for students.</p>
<p>Activity 2: upgrade pilot technologies for assessing student interest and aptitude, initial and ongoing career coaching occupational program mapping and completion plans, regular degree or progress audits, and early alert systems for struggling students.</p>	<p>The online tools purchased are not currently being used to their full potential, however, the goal is to implement the EMSI Tools soon.</p>
<p>Activity 3: integrate technologies to enhance advising and career coaching systems at the college.</p>	<p>Online tools that have been purchased are not being used to their full potential currently, but the goal is to implement them fully soon. The goal of purchasing the EMSI Career Assessment Tool is for students to access data on current jobs, complete career assessments and use the resume builder. All students have access to this tool and it is a marketing tool for students to match specific jobs with certificates or degrees from Tri-C. Individual Career Plan assessments for students is being developed.</p>
<p>Activity 4: pilot products among a broader set</p>	<p>The online tools have been purchased for this</p>

of students to further support selection and institutionalization of preferred technologies.	activity lag being used and implemented fully.
Activity 5: minimize student drift.	The college cited difficulties with this activity because of the barriers many community college students face. It can be difficult to coach and motivate the grant participants because of their competing life demands, such as work, family, and transportation.
Activity 6: require individualized career coaching and course/program advising for all manufacturing engineering students from entry to completion.	Students were required to meet with the Career Coach or to speak with the Coach throughout the semester, in addition to attending workshops. Students met with the Career Coach each semester prior to registering for classes. The Coach and her staff have kept records and have coached and nurtured incoming, current, and completing students. The goal is to implement purchased online tools into this process as soon as possible.
Activity 7: award prior learning credit for students in targeted programs.	Students were given credit for prior learning experience at other educational institutions as well as work experience. This is an area that Tri-C is working diligently on, as every case must be understood and documented individually. Standards and systems to streamline this process are a high priority and continue to be improved.
Activity 8: encourage and counsel grant participants on the possibilities for earning credit for prior learning and have manufacturing engineering program directors re-evaluate prior learning credit opportunities for students in targeted programs to ensure that opportunities are maximized.	The status of this activity is mostly complete. Students meet with the Career Coach individually before enrolling in the program. During this initial meeting, the Coach reviews with the students their prior learning and work experience to determine eligibility for receiving prior learning credit. The dean gave final approval for prior learning experience. Standards and systems to streamline this process continue to be improved.
Activity 9: participate in the re-assessment of prior learning credit policies statewide with the Ohio Board of Regents and comply with policy adjustments that emerge from the state.	This is an area that Tri-C is working on, as each individual case is different. Tri-C is making it a high priority to streamline this process.
Activity 10: enhance connections to the job market.	The 3D team hosted an annual advisory committee meeting. Additionally, Tri-C held a conference to bring together employers throughout Northeast Ohio to network and discuss additive manufacturing growth. Tri-C and the AM/Engineering program continue its outreach, industry engagement, advisory committees, and formal internships, co-ops

	and apprenticeship programs with growing success.
Activity 11: develop career services partnerships with local One-Stops to leverage online information and services for TAA-eligible students including recruitment opportunities, job aptitude and interest tools, inventory of past experience, local and regional job forecasts, local and regional salary/benefit information, job postings, resume development, and placement assistance.	Members of the 3D team have presented to and hosted local One-Stops representatives to discuss the additive manufacturing program, along with setting up recruitment tables at local One-Stops and participating in Veteran's events. The College and this AM/Engineering program continue its outreach, industry engagement, advisory committees, and formal internships, co-ops, and apprenticeship programs with growing success. Several WCED departments work together for career fairs, recruitment, industry engagement, and veterans' assistance, which has been successful.

Student Pipeline Analysis

This section of the report seeks to document how grant participants are recruited, assessed, trained, supported, and ultimately move into employment or pursuit of higher education.

- **Recruitment:** As stated in the grant, the goal of the project is to enroll 200 participants during the grant period of performance. Due to the delays in the early implementation stage of the project, project leadership has requested a no-cost extension from the DOL. If granted, Tri-C will continue enrolling participants through March 31st, 2016. A brief summary of participant sources and recruitment strategies used for each are included in Figure 3 below:

Table 1: Recruitment Strategies and Goals

Participant Type	Recruitment strategies	Spring 2015	Summer 2015	Fall 2015	Spring 2016	Summer 2016	TOTAL
For-credit program-level participants	Print media (flyers, newspaper advertisements), radio advertisements	19	7	22	20	10	78
Course-level participants (creative arts/ other)	Word of mouth (staff and faculty referral), flyers	0	0	10	10	5	25
Course-level participants (engineering)	Word of mouth (staff and faculty referral), flyers	6	6	20	15	5	52
Non-credit participants	Employer engagement	0	0	15	15	15	45
	TOTAL	25	13	67	60	35	200

- **Assessment:** All students take the Compass test upon admission to Tri-C. Testing into Math 950 and English 990 is a prerequisite for the all for-credit program-level participants. For-credit program-level participants who do not meet this requirement are referred to developmental education courses before continuing with the program. Tri-C is currently undergoing an institution-wide change in assessment procedures, and will be using Accuplacer for

assessments as soon as Spring of 2015.

- **Remediation:** For-credit program-level participants who do not meet prerequisites for the AM program take developmental education to prepare for their AM coursework. While the development of an embedded contextualized STEM bridge program is a model cited in strategy 2, its development has not yet been pursued due to lack of need. To date, only two for-credit program-level participants have not tested into Math 950 or English 990, and those students have been placed in traditional developmental education courses.
- **Hands-on work-based learning:** The curriculum endeavors to create as many hands-on opportunities as possible. Instructors are encouraged to incorporate work-based learning into their classrooms. Internships are a required component of the for-credit program – each student in the for-credit program completes 120 contact hours to receive their one credit-hour internship course credit.
- **Student Support Services:** Students are referred to Tri-C's existing student support services on an as-needed basis. Key student support services offered by the institution include:
 - o Public transportation assistance
 - o Financial aid advising
 - o Tutoring services
 - o Study skills workshops
 - o Assistance in transferring to four-year institutions
- **Career services:** Connection to work is a major emphasis of the project. For-credit program-level participants are in regular communication with the Career Coach throughout the AM program to prepare them for quick placement in successful careers. The Career Coach works individually with each participant to create and review resumes, and craft a portfolio for potential future employers. In addition, Blackboard is utilized to provide career-readiness resources and soft-skills coaching modules to students. Several soft-skills blackboard modules which were developed under the Anne Arundel TAACCCT project have been leveraged for the project.

Implementation Evaluation Limitations

The findings presented in this report are based on interviews and surveys of college staff and document review. While all interviews were conducted in good faith and information which was apparently inconsistent was cross referenced to documentation, interviews and surveys are nonetheless given by individuals with differing opinions and depths of knowledge.

In addition, the Additive Manufacturing program continues to evolve. While this is true of many other TAACCCT projects, it is particularly evident in this program due to the emerging nature of the additive manufacturing industry and the startup challenges in the early implementation of the project. The constant evolution has presented challenges to the implementation evaluation.

Impact Evaluation Report

The starting point of the impact evaluation is the impact research questions, which are based on the DOL reporting requirements for the annual performance report. Given the limitations in data availability, some questions were answerable to a greater or lesser extent.

Overall, the participant completion rate and credit hour completion out-performed the comparison group. Employment outcomes were not subject to comparison analyses due to a paucity of completers and incumbent workers.

Here are direct answers to the questions posed in the evaluation plan. Of note, due to gaps in data, especially employment data, many of the outcome numbers are lower than might be expected. Indeed, with complete data, it is expected that many of these counts would be higher.

1. How many unique participants/comparisons have been served?

In total, 204 individuals were served by the grant.

2. How many individuals have completed a grant/comparison program of study?
 - a. Of those, how many are incumbent workers?

Over the course of the grant, 13 participants completed a grant-affected program of study (5 of whom were incumbent workers). The completion rate for participants was higher than the completion rate for comparison individuals (6% vs. 4%).

3. How many individuals are still retained in their program of study (or other grant-funded program)?

191 participants were still continuing with their grant-affected program of study at the completion of the grant.

4. How many individuals are retained in other education programs?

None of the participants were retained in other education programs.

5. How many credit hours have been completed?

- a. How many students have completed credit hours?

In total, nearly 3000 credit hours were completed by study participants (2951), spread across 131 participants who completed credit hours.

6. How many credentials have been earned by participants/ comparisons?

- a. How many students have earned certificates (<1 year)?
 - b. How many students have earned certificates (>1 year)?
 - c. How many students have earned degrees?

Participants earned 24 certificates or degrees over the course of the grant. 13 students earned short-term certificates, none of the students earned long-term certificates, and 3 earned degrees.

7. How many students are pursuing further education after program of study completion?

Of those who completed a grant-affected program of study, 4 continued on to further education after completion.

8. How many participants/comparisons are employed after program of study completion?

Of those who were non-incumbent workers at the time of entering, 4 participants who completed a grant-affected program gained employment in the semester after completion.

9. How many participants/ comparisons are retained in employment for three quarters after program of study completion?

Of those 4 employed, 1 was retained in employment through quarters two and three after completion. If longer follow-up was possible, we would expect more to be retained through three quarters.

10. What are the earnings of participants/ comparisons relative to before enrollment?

- a. How many of those employed at enrollment received a wage increase post-enrollment?

Of those who were employed at study intake, 65 earned a wage increase in their employment.

College Results

The following analyses give data for all demographics and outcomes that are available. Because the most data is available for answering the research question about completion rates and credit hours completed, those are the questions where the analysis goes the deepest. In addition to raw data, a statistical analysis of completion rates and credit hours completed and an estimate of the program effect on them is calculated. Detailed descriptions of each outcome can be found in the Outcomes/Impact Study Design portion of this report.

The first two columns in the table below list the programs that the college included in the project along with certificates, degrees, or awards that students could potentially earn. Grant participants were individuals enrolled in these programs. The third column lists the program from which comparison group members were drawn.

Table 2: Grant-Affected and Comparison Programs

Program	Certificate	Comparison
3D Digital Design and Manufacturing Technology	<ul style="list-style-type: none"> - Digital Design & Product Innovation Short-Term Certificate - Digital Manufacturing & Product Launch Short-Term Certificate - 3D Digital Design and Manufacturing Technology Certificate of Proficiency - Manufacturing Industrial Engineering Technology AAS 	CNC Machining and Composites Manufacturing

The table below shows the number of students enrolled in grant-affected programs for each year of the grant.

Table 3: Enrollment over Time

	Year 1	Year 2	Year 3	Year 4
Total Number of Individuals	0	0	139	65

The table below provides details on the total number of individuals included in the analysis along with demographic characteristics. Additionally, data on outcomes is listed including program completions, credentials earned, credit hours completed, employed after program completion, job retention three quarters after completion, incumbent worker completion, and incumbent worker wage increases. Data is presented in terms of counts and rates where it makes sense.

Table 4: Demographics and Outcomes

Variable	Participant Group	Participant Group N	Comparison Group	Comparison Group N
Total Number of Individuals	204	204	171	171
Demographics				
Age	30.2 ± 11.8	203	25.7 ± 10.0	73
Female	28 (14%)	203	31 (18%)	171
White	108 (62%)	173	105 (68%)	155
Black	47 (27%)	173	37 (24%)	155
Other/More than One Race	18 (10%)	173	13 (8%)	155
Hispanic/Latino	15 (7%)	203	9 (5%)	171
Full-Time	NA	NA	NA	NA

Variable	Participant Group	Participant Group N	Comparison Group	Comparison Group N
Part-Time	NA	NA	NA	NA
Incumbent Worker	83 (41%)	204	102 (60%)	171
Eligible Veteran	13 (6%)	203	8 (5%)	171
Disabled	NA	NA	NA	NA
Pell Eligible	80 (39%)	203	58 (34%)	171
TAA Eligible	NA	NA	NA	NA
Outcomes				
Program Completers	13 (9%)	139	7 (4%)	171
Credentials Earned	24	139	7	171
Students Earning Certificates (<=1 year)	13 (9%)	139	7 (4%)	171
Students Earning Certificates (>1 year)	0 (0%)	139	0 (0%)	171
Students Earning Degrees	3 (2%)	139	0 (0%)	171
Credit Hours Completed	2951	139	2173	171
Employed After Program of Study Completion	4 (31%)	13	1 (14%)	7
Retained in Employment 3 Quarters After Completion	1 (25%)	4	0 (0%)	1
Incumbent Worker Completer	5 (38%)	13	5 (71%)	7
Wage Increase Post-Enrollment	65 (78%)	83	83 (81%)	102
Further Education after Program of Study Completion	4 (31%)	13	NA	NA
Retained in Grant-Affected Program	191 (94%)	204	164 (96%)	171
Retained in Other Education Program	0 (0%)	204	0 (0%)	171

CNC Machining and Composites Manufacturing was chosen as the comparison group because similarities of short-term program length, number of students involved in the program, and demographics, such as gender, race, and ethnicity.

The table below offers details on the key outcome of program completion rates. Completion rates were calculated for individuals pursuing programs of similar duration over similar lengths of time.

Table 5: Completion Rate by Demographics

Variable	Completion Rate in Comparison Group	Completion Rate in Participant Group
Overall	4%	9%
Gender = Male	5%	7%
Gender = Female	0%	19%
Age < 24	1%	7%
Age >= 24	8%	10%
Non-White	8%	8%
White	2%	9%
Non-incumbent worker	3%	7%
Incumbent worker	5%	11%
Non-veteran	4%	9%
Veteran	12%	0%
Non-Pell grant eligible	2%	5%
Pell grant eligible	9%	13%

Estimation of Completion Rate Treatment Effect

The crude, unadjusted odds ratio (the odds of completion in the participant group relative to the odds in the comparison group) is 2.4 ($p=0.07$). A propensity score model (estimating the probability of being a member of the participant group) is fit using gender, age, race, incumbent, veteran, and Pell eligible. The propensity score adjusted odds ratio is 1.9 ($p=0.18$). The table below offers details on the key outcome of program credit hours completed. Credit hours were calculated for individuals pursuing programs of similar duration over similar lengths of time.

Table 6: Average Credit Hours by Demographics

Variable	Credit Hours in Comparison Group	Credit Hours in Participant Group
Overall	12.7	21.2
Gender = Male	12.7	21.2
Gender = Female	12.7	22.6
Age < 24	11.3	22.7
Age >= 24	14.5	20.4
Non-White	12.1	23.0
White	13.1	20.2
Non-incumbent worker	12.0	21.9
Incumbent worker	13.2	20.8
Non-veteran	12.6	20.8
Veteran	15.6	29.8
Non-Pell grant eligible	10.4	19.9
Pell grant eligible	17.1	23.4

Estimation of Credit Hour Treatment Effect

The crude, unadjusted treatment effect (the difference between the average credit hours in the participant group and the average credit hours in the comparison group) is 8.5 credit hours ($p<0.01$). A propensity score model (estimating the probability of being a member of the participant group) is fit using gender, age, race, incumbent, veteran, and Pell eligible. The propensity score adjusted treatment effect is 8.0 ($p<0.01$).

Challenges and Limitations

The two primary challenges in this evaluation were: 1. a shifting participant definition, which introduces methodological challenges, and 2. Limited labor market opportunities for AM production workers, which limits data on AM careers.

The definition of a grant participant shifted at the end of Year 3 when course-level participants were introduced. The original definition of participant only includes students who declared for, and enrolled in, the Additive Manufacturing program. Due to the broad application of certain courses, paired with low enrollment numbers, the definition was expanded to include any students who enrolled in Additive Manufacturing courses. This expansion of the participant definition created inconsistent "dosages" of grant intervention as individuals varied in the amount of grant participation received. As a result, the previously established comparison group fit was not ideal.

Additive Manufacturing is a relatively new industry. As a result, many businesses utilize additive technologies in a small capacity. For example, some companies only have one department within a larger organization utilizing additive technologies. This makes it difficult to identify if students are truly applying skills learned in their coursework within their job, or what percentage of their job involves additive skillsets.

Summary of Impact Evaluation Findings

The Tri-C implementation evaluation led to emergence of three key themes. These themes, established through interviews and focus groups, are also reflected in the data collected on participants.

Theme 1: Start-up and administrative challenges led to an evolving project vision and delays in implementation

Although the TAACCCT grant started in the Fall of 2012, the program did not start until the Spring of 2015, with 139 students starting in the Spring of 2015. This late start resulted in lower participants, completions, and employment outcomes for the duration of the grant.

Theme 2: business engagement, especially in an emerging industry, is challenging.

Tri-C has managed to connect with regional Additive Manufacturing stakeholders effectively through numerous forms of outreach, such as yearly conferences, advisory committees, and stakeholder luncheons. These seemed to benefit the participants, with state wage data reflecting employment of many completers with companies that regularly engaged with Tri-C.

Theme 3: It is difficult to balance the needs of current students in a program evolving to meet the needs of a future workforce.

Since Additive Manufacturing is an emerging industry, demand for additive technician jobs are low. As a response to this, Tri-C has enabled the credits earned from the short-term credentials to be stacked into a more broader-skilled AAS in Manufacturing Industrial Engineering Technology. Three of the 13 completers have chosen this option.