

Design Thinking: Additive Manufacturing Summer Institute: Year 2 Interim Evaluation Report

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June 2019



This material is based upon work supported by the National Science Foundation under grant number 1700455. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

Executive Summary

Columbus State Community College, in collaboration with the PAST Foundation, community, and industry partners, will develop a career pathway in Additive Manufacturing. The Design Thinking: Additive Manufacturing Summer Institute (AMSI) will simultaneously train high school teachers and students in additive manufacturing using industry-based problems. This project addresses the need for technicians in the manufacturing sector. By 2026, 3.5 million U.S. jobs will be needed in advanced manufacturing, and 2 million are expected to go unfilled. This predicted gap will be particularly problematic in Ohio, where 16.9 percent of the economy is in manufacturing. Many of these positions will be in the area of additive manufacturing, which is one of the rapidly expanding areas in modern manufacturing.

The findings in this report are based on the limited data that had been collected from students and teachers who participated in the Year 1 AMSI program as well survey data collected from outreach events that were developed and implemented during Year 2.

In this second year, the project team has modified the AMSI program, which will run again in June of 2019. The curriculum and team activities will have a greater emphasis on careers in manufacturing and how Columbus State programs can prepare students for those careers. The AMSI project team also developed and delivered two events (Manufacturing Day and Manufacturing Night) that were effective in raising awareness. These efforts have been effective in increasing awareness and interest among students. Even stronger evidence of the effectiveness of the program, however, comes from the number of students in the AMSI program itself who plan to either continue taking relevant courses in high school and the number who plan to take courses at the college level.

The project appears to be on track and moving forward as expected. The AMSI program was effective in terms of preparing teachers to incorporate the learning modules into their own programs and motivating students to learn more about additive manufacturing. It is recommended that the project team take advantage of the opportunity to determine the extent to which the new program changes are impacting the desired attitudes and behaviors and what modifications might strengthen the AMSI program in 2020. The project team should also consider options for remaining in contact with student participants to determine how many pursue continued education and evaluation careers in modern manufacturing. It is also recommended that the project team find some way to ensure that schools at least have the core software and equipment needed. One option to consider is the submission of a request for supplemental funding. Another option would be to seek out industry partners who might be willing to donate equipment.

Table of Contents

Executive Summary	2
Background.....	4
Purpose and Design of the Evaluation.....	4
Findings.....	5
Evaluation Question 1: How effectively is the project being planned and implemented? What aspects of planning and implementation have gone well, and what challenges have been experienced? How have challenges been addressed?	5
AMSI 2018 – High School Teacher Professional Development.....	5
AMSI 2018 High School Student Summer Institute	6
Planning for AMSI 2019	6
Evaluation Question 2: How are teachers and students reacting to the program in terms of perceived effectiveness? For teachers, how satisfied are they with the support and resources that are being provided to help them develop and incorporate problem-based additive manufacturing modules into their classroom?	6
Teacher pre- and post-survey responses for AMSI	7
Student pre- and post-survey responses for AMSI	8
Evaluation Question 3: Is the program improving teachers’ and students’ knowledge and skills?	9
Evaluation Question 4a: Is the program increasing student interest in advanced and additive manufacturing careers?	10
AMSI Program	11
Manufacturing Day	11
Manufacturing Night.....	15
Evaluation Question 4b: Is the program increasing the number of students enrolling in CCP courses and/or one of Columbus State’s course?	18
Recommendations.....	18
AMSI program development.....	18
Ensuring teachers and students have the needed resources at their schools.....	18
Appendix A – AMSI Logic Model.....	20
Appendix B – Manufacturing Day Survey	21
Appendix C – Manufacturing Night Survey.....	22

Background

Columbus State Community College (Columbus State), in collaboration with the PAST Foundation, community, and industry partners is developing a career pathway in Additive Manufacturing. The Design Thinking: Additive Manufacturing Summer Institute (AMSI) that simultaneously trains high school teachers and students in additive manufacturing using industry-based problems as the basis for learning. The PAST Foundation is a major project sub-recipient that was founded in 2000 to make ongoing scientific research across a broad spectrum of professions accessible to the public. It has extensive experience with informal and formal secondary STEM educational programs.

This project addresses the need for technicians in the manufacturing sector. By 2026, 3.5 million U.S. jobs will be needed in advanced manufacturing, and 2 million are expected to go unfilled. This predicted gap will be particularly problematic in Ohio, where 16.9 percent of the economy is in manufacturing. Many of these positions will be in the area of additive manufacturing, which is one of the rapidly expanding areas in modern manufacturing.

There are three project objectives:

Objective 1: Develop and implement an Additive Manufacturing Institute Model to provide high school students with the opportunity to explore the variety of careers associated with advanced manufacturing leading to earning industry-recognized certifications.

Objective 2: Develop and implement an interactive High School Faculty Professional Development Initiative in additive manufacturing that prepares teachers to design relevant and rigorous curricula.

Objective 3: Develop a model education pathway that integrates the Additive Manufacturing Summer Institute with Columbus State's manufacturing courses.

Purpose and Design of the Evaluation

The Rucks Group, LLC was contracted to work with the AMSI project team in July of 2018 at the start of the project's second year and just shortly after the initial run of the AMSI program. The Rucks Group worked with the project team to articulate an evaluation plan guided by the following six (6) evaluation questions:

1. How effectively is the project being planned and implemented? What aspects of planning and implementation have gone well, and what challenges have been experienced? How have challenges been addressed?
2. How are teachers and students reacting to the program in terms of perceived effectiveness? For teachers, how satisfied are they with the support and resources that are being provided to help them develop and incorporate problem-based additive manufacturing modules into their classroom?
3. Is the program improving teachers' and students' knowledge and skills?
4. Is the program increasing:

- a. Is the program increasing student interest in advanced and additive manufacturing careers?
 - b. The number of students enrolling in College Credit Plus (CCP) courses and/or one of Columbus State's?
 - c. The number of students ready to enter 3rd and 4th year Learning Labs high school programs that provide early college opportunities?
 - d. Number of students obtaining SME Additive Manufacturing Fundamental certifications.
 - e. The number of students finding positions in additive manufacturing.
5. Are teachers incorporating the problem-based additive manufacturing modules into their curriculum? What is going well? What are the challenges?

The findings in this report are based on the limited data that was collected from students and teachers who participated in the Year 1 AMSI program as well survey data collected from outreach events that were developed and implemented during Year 2. These sets of data provide some evidence pertaining to evaluation questions 1 through 4b. The Rucks Group is developing an evaluation tool for the Year 2 AMSI program and other methods and tools for data collection in Year 3 to obtain richer and more targeted information to answer these evaluation questions as well as evaluation question 4c, 4d, 4e and 5 which will be addressed in subsequent reports.

Findings

Evaluation Question 1: How effectively is the project being planned and implemented? What aspects of planning and implementation have gone well, and what challenges have been experienced? How have challenges been addressed?

AMSI 2018 – High School Teacher Professional Development

The development and implementation of the 2018 AMSI involved close collaboration between the Columbus State project team members and a member from the PAST Foundation. The design of the AMSI teacher professional development component was based on the PAST Foundation's P3 (Problems, Projects, and Products) framework for leveraging Transdisciplinary Problem-Based Learning. The P3 approach encourages instructors to develop courses that create cross-disciplinary units to solve real-world problems through activities that ultimately result in shareable products.

Three central Ohio high school teachers participated in this immersive 8-week program that ran from May 7, 2018, to June 29, 2018. The first four weeks were completed through an on-line course, which provided instructors with an overview of the instructional strategies associated with Transdisciplinary Problem-Based Learning (TPBL). The course included a combination of on-line content, podcasts, and virtual synchronous discussions. The high school teachers then participated in a four-week AMSI program as they modeled the P3 approach with the help of facilitators from the PAST Foundation. After the program, teachers were expected to develop a plan to incorporate additive manufacturing concepts into their classroom curriculum.

AMSI 2018 High School Student Summer Institute

The 2018 AMSI for incoming 10th to 12th grade students ran from June 4, 2018, to June 29, 2018, at the PAST Foundation. Sixteen students participated in the program where they learned and utilized additive manufacturing concepts through team-based activities to identify, design, and then prototype an assistive device. Students had the opportunity to tour central Ohio manufacturing employers to learn about additive manufacturing-related career opportunities and the demand for such jobs in the area.

Planning for AMSI 2019

The Year 2 AMSI teacher professional development program is scheduled for May 6, 2019, to May 24, 2019, and the combined teacher and student portion of the institute is scheduled for June 3, 2019, to June 28, 2019. The curriculum and team activities in the Year 2 program will have a greater emphasis on careers in manufacturing and how Columbus State programs can prepare students for those careers.

Michael Kunselman, an engineering technology teacher at Gahanna-Lincoln High School, joined the project to create a manufacturing foundations curriculum that will be utilized in the upcoming institute. He has a bachelor's degree in Technology Education, and certifications in Project Lead the Way curriculum and Yaskawa programming. He currently teaches high school courses in 3D design, digital fabrication, and electrical, civil, and mechanical engineering. He was identified as the ideal candidate to develop the curriculum due to his expertise in building STEM educational programs for high school students. Before developing the curriculum, he completed the P3 program to ensure greater consistency and integration with the PAST team. Mr. Kunselman will also act as a mentor for the teachers in the program, allowing them to learn from his expertise and further enhance their professional development.

Updated student and teacher flyers were developed to promote the 2019 AMSI program. The recruitment strategy for the second year of AMSI incorporated a social media campaign on Twitter to reach more prospective students and their parents. Official standardized program branding was also developed and has been incorporated into all outreach and promotional materials. A new registration website has been created, which will allow students and parents to easily research and register for the engineering technology summer program that best fits their career goals and interests.

The various engineering technology summer programs at Columbus State have been aligned to enhance student recruitment for engineering technology degrees. As a result, students in AMSI will now spend two days at the Advanced Automation Summer Experience at Columbus State. This provides them with the opportunity to explore the campus and to participate in hands-on learning labs and tours in manufacturing. AMSI students will also have a chance to test for the SolidWorks Certified Additive Manufacturing Associate (CSWA) certification at the end of the camp.

Evaluation Question 2: How are teachers and students reacting to the program in terms of perceived effectiveness? For teachers, how satisfied are they with the support and resources that are being provided to help them develop and incorporate problem-based additive manufacturing modules into their classroom?

The three teachers and the sixteen students completed surveys before and after the AMSI event that had been developed by the PAST Foundation. The teacher surveys included questions related to teachers' prior experience, comfort levels, and attitudes regarding the topics, teaching methods, and technology covered in AMSI; how helpful various aspects of the P3 Online Professional Development and AMSI were;

their intentions and plans for teaching the learning modules to their students; the availability of resources at their home institutions, and the challenges they anticipate.

The student survey asked questions regarding how students heard about AMSI; why they chose to enroll in the program; their prior experience, comfort levels, and attitudes regarding the topics, learning methods, and technology covered in AMSI; and future education and career plans particularly as they relate to Additive Manufacturing.

Results pertaining directly to the evaluation questions outlined previously will be presented in this section.

Teacher pre- and post-survey responses for AMSI

All three participating teachers completed the pre-and post-surveys for AMSI. Experience levels varied among them with one having 1-3 years, one having 4-10 years, and the other had more than ten years of experience. Although it could not be determined from the data which courses individual teachers taught, the content areas across all teachers included math, calculus, geometry, science, physics, engineering, robotics, digital technology (e.g., CAD, coding), and industrial arts (e.g., 3D printing) which included students across grade levels from 9th to 12th.

In terms of the perceived effectiveness of the P3 Online Professional Development portion, all three found the weekly virtual sessions (i.e., Q & A with program leads) and the Fusion 360 tutorial to be helpful. Two teachers also found the Google and Virtual Teamwork to be helpful and all three teachers found the collaboration with other AMSI teachers during the P3 Online Professional Development to be helpful in building the experience needed to facilitate teamwork with AMSI students.

Regarding the AMSI event itself, teachers were asked if they were comfortable with the AMSI approach of Immersive Professional Development (i.e., concurrent work with students while continuing PD for Additive Manufacturing). Two said they were "very comfortable" while the other said "comfortable." As was the case with the Professional Development portion, all three teachers found the collaboration with other AMSI teachers to be helpful in building the experience needed to facilitate teamwork with AMSI students.

All three teachers also said that it was "very helpful" to observe Design Challenge instructional practices modeled by the AMSI instructors in preparing for work with their students in the fall of 2018. Teachers were asked to select other aspects of the instructional design for AMSI that they found helpful in preparing them to work with students. All three teachers selected the following:

- Learning about Additive Manufacturing side-by-side with AMSI students
- On-site collaboration with other AMSI teachers

Two of the teachers also selected the following as being helpful:

- Experience gained in working with AMSI student teams
- On-site PD sessions (two afternoons/week during AMSI)
- BASECAMP communication to support online PD
- Fusion 360 tutorial

As mentioned previously, one of the primary goals of AMSI is for teachers to incorporate the modules learned and used at AMSI into their curriculum. All three teachers said that they planned to implement multiple Additive Manufacturing modules with their students in fall 2018. On the post-survey, all three

teachers said that they planned to work independently on the modules over the summer which was a shift from the pre-survey on which two said they would be developing the modules in the fall as part of on-going professional development and only one teacher indicated plans to develop the modules independently.

The teachers did anticipate challenges in implementing Additive Manufacturing modules. The following were selected as likely challenges by two of the teachers.

- My modules will not be fully developed and ready for implementation in the fall
- Time constraints to fully implement my modules in the classroom
- Integrating Additive Manufacturing modules with core curriculum
- Effectively guiding student teamwork

The lack of needed resources for implementing Additive Manufacturing could also be a barrier for teachers. All three teachers said that they had enough access to computers and access to community partners who could support student projects. Two of the three also have access to CAD design software and other materials and supplies. Only one teacher, however, indicated having access to a 3D printer and none of the teachers have access to a 3D scanner, a CNC machine, a Welder, a Fab Lab, or a Maker Space.

Teachers reacted positively to the instructional design and content of the P3 Online Professional Development and AMSI programs. Most importantly, teachers felt that the programs effectively prepared them to incorporate the modules into their own teaching and, after the AMSI program, all three teachers indicated that they would be able to work on the plans independently over the summer whereas only one of the teachers had felt that way before AMSI. Despite the readiness and willingness to incorporate the Additive Manufacturing modules, two of the teachers did indicate that there are some potential challenges with regards to time, trying to fit the content into the core curriculum, and the ability to guide student teamwork. Also, two of the teachers said that they don't have access to a 3D printer, and none have access to other equipment that might be critical for effectively teaching these modules. Unfortunately, the data captured from the teacher and student surveys do not provide sufficient detail to determine the extent to which these barriers are a problem and no information about potential measures that might be taken to address the issues.

Student pre- and post-survey responses for AMSI

Thirteen of the 16 students completed the pre-survey and post-survey for the AMSI event. In terms of the grade distribution of the students, four would be entering the 12th grade in the fall of 2018, seven would be entering the 11th grade, and two selected "other." When asked how they had heard about the AMSI program, six had learned about it from their teacher, four from a parent, and three received word from their counselor.

Many students endorsed positive statements that described their experiences with working in teams when completing their AMSI projects.

Statement	Number of students
I really enjoyed working with my teammates	10
I think I was able to complete my work tasks to contribute to our team’s progress on our project	9
I think I was able to work well with my teammates	7
I think others on the team didn’t get their work done, making it hard for my team to complete our project	3
I didn’t enjoy working on a team	2

Table 1. Frequency responses to items included under the question, “What do you think about your teamwork experience in completing your AMSI project?” (N=13)

Most of the students had positive reactions to the use of Design Thinking to develop and build their AMSI projects.

Statement	Number of students
Our team was able to explore and evaluate different ideas leading to a final design and build plan that the team thought was the best solution for the problem.	11
I was able to contribute to the team’s Brainstorm about the project design and build strategy.	10
Our team conducted research and used new information to help improve our project design and build strategy.	9
Our team was able to modify our original design during the process of building our project.	9

Table 2. Frequency responses to items included under the question, “What do you think about using Design Thinking to develop and build your AMSI project?” (N=13)

Evaluation Question 3: Is the program improving teachers’ and students’ knowledge and skills?

The post-survey for teachers did not include any direct questions to assess improvement in their knowledge and skills. They were, however, asked if they felt they needed additional training in working with various resources to support the implementation of the Additive Manufacturing student learning modules. None of the three teachers indicated a need for additional training on computers, CAD design software, 3D scanners, or Maker Space. One of the teachers did express the need for additional training on 3D printers, CNC, Welder, and Fab Lab.

Most of the teachers seem to have the knowledge and skills needed to teach the AMSI modules but, at least one needed additional training on some of the critical software and hardware. It will be important to ensure that teachers have the opportunity to close any knowledge and skills gaps that might prevent them from effectively teaching the modules.

Students' skills and abilities were positively impacted by their experiences at AMSI. On the post-survey, students were asked to describe their level of ability to work with 3D scanners, 3D printers, Laser cutters, and CAD design software either in school or on their own. Students left AMSI with well-developed skills in using the core software and hardware, including CAD design software, 3D printers, and 3D scanners (See Figure 1). Most students, however, appear to need more training and guidance on laser cutters, but this is a more advanced aspect of additive manufacturing that will presumably be learned as students advance in their education.

Most students left AMSI with a good understanding of how to use CAD design software and 3D printers but still need help with 3D scanners and laser cutters.

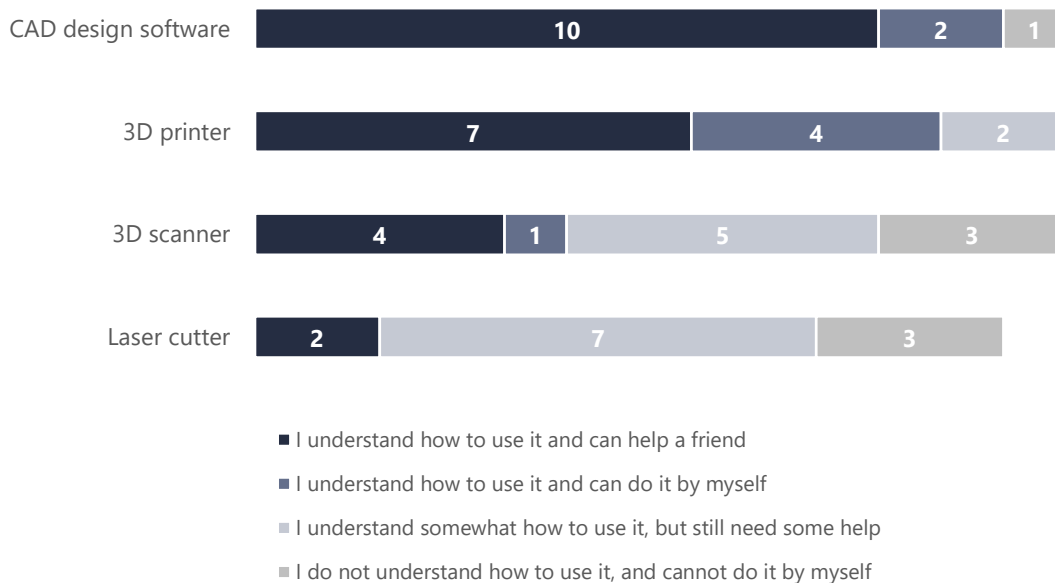


Figure 1. Responses to the question, "How would you describe your ability to work with any of the following, either in school or on your own?" (N=13)

Evaluation Question 4a: Is the program increasing student interest in advanced and additive manufacturing careers?

Data collected from students after the AMSI event included several questions to determine if they planned to continue taking steps to build the knowledge and skills required in additive manufacturing which might include taking additional courses at their high schools or – if applicable – enroll in any Additive Manufacturing courses at Columbus State or any other college in the fall of 2018.

In addition to the AMSI program itself, the project team also developed and delivered outreach activities in Year 2 of the project including Manufacturing Day and Manufacturing Night that provided opportunities for students and educators to learn about the growing fields in modern manufacturing including additive manufacturing. Students completed surveys after those events to assess changes in levels of awareness regarding various facts related to advanced manufacturing, changes in levels of interest in these fields, the related educational opportunities that would be of most interest, and perceptions regarding the effectiveness of the event.

Survey results from the AMSI program, Manufacturing Day event, and Manufacturing Night event that pertain to awareness of – and interest in – additive manufacturing are presented below.

AMSI Program

Ten of the 16 students planned to take courses in fall 2018 at their high school to continue to build their skills in Additive Manufacturing. Courses included robotics, engineering, computer science, digital technology, and 3D printing. Three said that they planned to enroll in an Additive Manufacturing course at Columbus State in fall 2018, and one said they planned to enroll in the course at a different school. Seven of the students who participated in the 2018 AMSI program are enrolled in the College Credit Plus program (CCP). Six of these entered the AMSI program already enrolled in CCP, but one student successfully applied and was granted admission to the CCP program cohort that began on January 14, 2019.

The number of students indicating that they planned to apply for an internship with a local community business in the next school year increased from two to four although the data available did not include a description of the types of positions being sought.

Looking further into the future, ten students also said that they plan to seek out information from teachers, CCP counselors, and Columbus State advisors about education courses or other programs to continue to build their skills in Additive Manufacturing.

Manufacturing Day

Columbus State marked the occasion of National Manufacturing Day on October 5, 2018, with a series of concurrent half-day events at Central Ohio regional high schools which provided an opportunity for students and educators to learn about the growing fields of Logistics Engineering Technology, Additive Manufacturing, and Modern Manufacturing.

Staff members from Columbus State facilitated the half-day event at each school which included a brief presentation covering the various advanced manufacturing fields and Columbus State's related educational opportunities followed by a tour at one of Columbus State's industry partners. The facility tours allowed participants to engage in hands-on experiences, talk to industry professionals, and learn about opportunities in advanced manufacturing. The events were held at the following high schools and corresponding industry partner facilities:

High School	Paired industry partner
Canal Winchester	Amazon
Canal Winchester	Nifco
Northland	Pharmacore
West	Advanced CNC

Table 3. Participating high schools and industry partners for Manufacturing Day.

At the end of the event, student participants were asked to complete a brief paper/pencil survey designed to assess changes in levels of awareness regarding various facts related to advanced manufacturing, changes in levels of interest in these fields, the related educational opportunities that would be of most interest, and perceptions regarding the effectiveness of the half-day event (See Appendix B for copy of the full survey).

The student surveys were administered and completed by 31 students from Canal Winchester High School who toured the Nifco facility and 21 students from Northland High School who toured the Pharmacore facility. Unfortunately, the survey was not administered to students from Canal Winchester High School who toured the Amazon facility or the West High School students who toured Advanced CNC. Four teachers responded to the educator’s follow-up survey.

Students’ levels of awareness increased for every fact related to the manufacturing/engineering fields covered at the event.

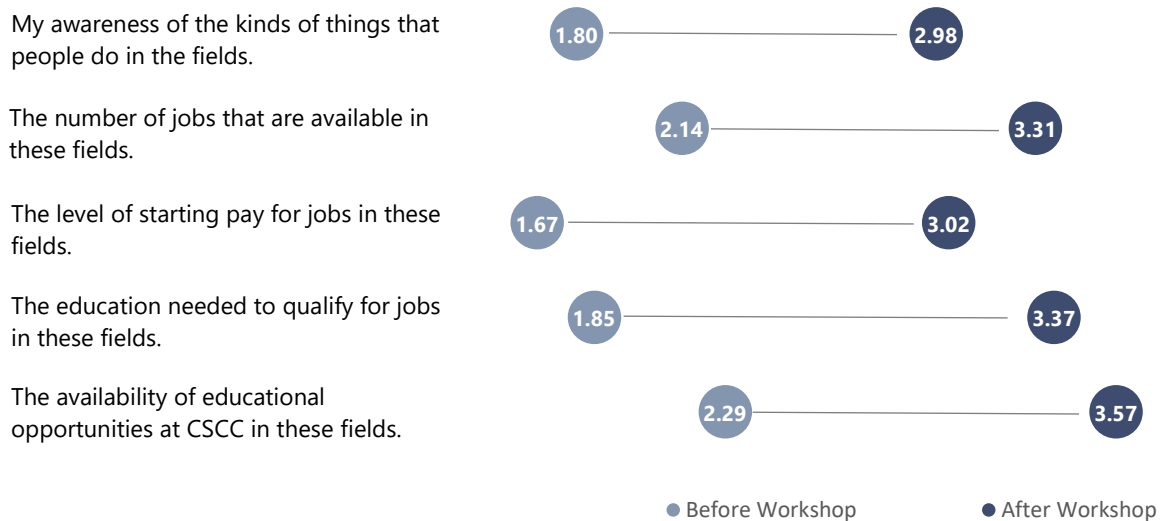


Figure 2. Mean participant responses to the question, “For each of the fields covered at today’s event please indicate how you would have rated your level of awareness on each item BEFORE the event and how you rate it AFTER the event.” The response scale was from 1 to 4 with 1=Not aware at all, 2=Only slightly aware, 3=Somewhat aware, 4=Fully aware. (N=48)

Students' levels of interest increased for each of the fields covered at the event.

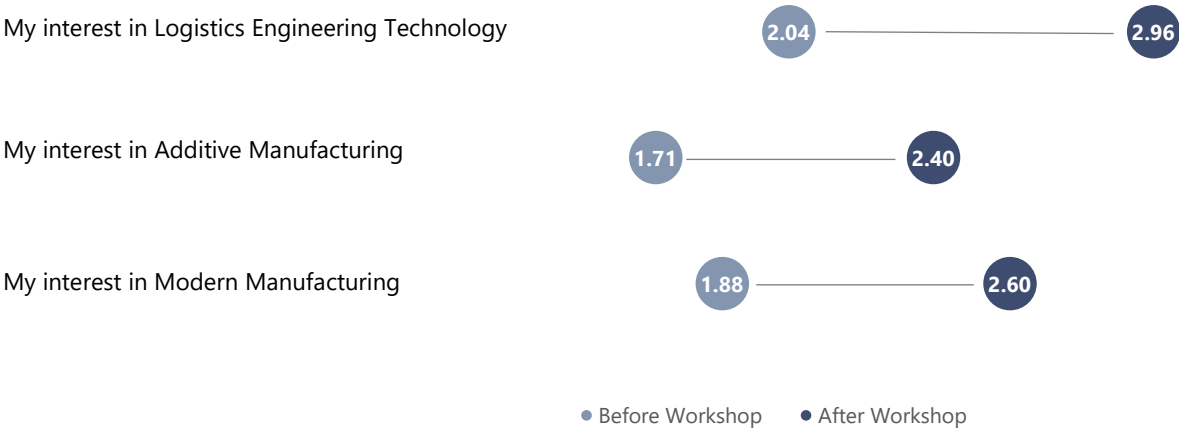


Figure 3. Mean participant responses to the question, "Please indicate how you would have rated your level of interest in each field BEFORE the event and how you rate it AFTER the event." The response scale was from 1 to 4 with 1=No interest at all, 2=Only slight interest, 3=Moderate interest, 4=High interest. (N=47)

Most of the student respondents would enroll in the Modern Manufacturing Work Study program if they had to choose one of the educational programs covered at the event.

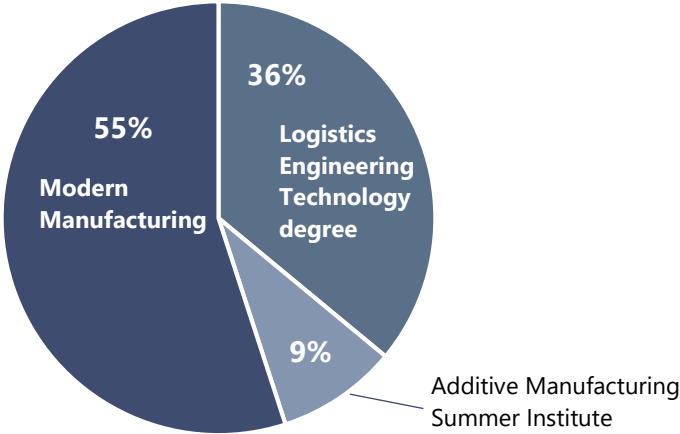


Figure 4. Participant responses to the question, "If I had to choose, in which of these programs would you be MOST likely to enroll?"

The facility tour and the Columbus Sate presentation were rated as being either “Very effective” or “Extremely effective” by more than 70% of the students.

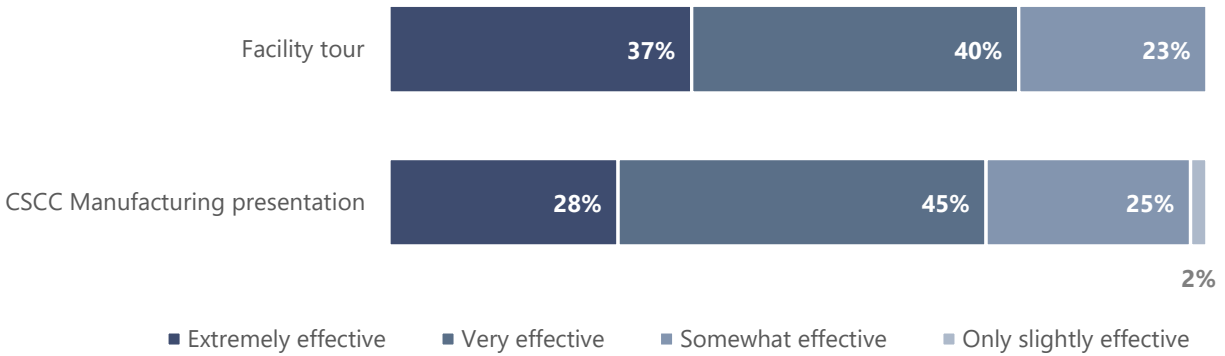


Figure 5. Participant responses to the question, “Overall, how would you rate the effectiveness of each aspect of the day?” (N=45)

Approximately a week after the event, the participating educators from each of the high schools were asked to complete a brief web-based survey designed to assess their own perceptions regarding the effectiveness of the event.

Educators viewed the event as effectively meeting its objectives.

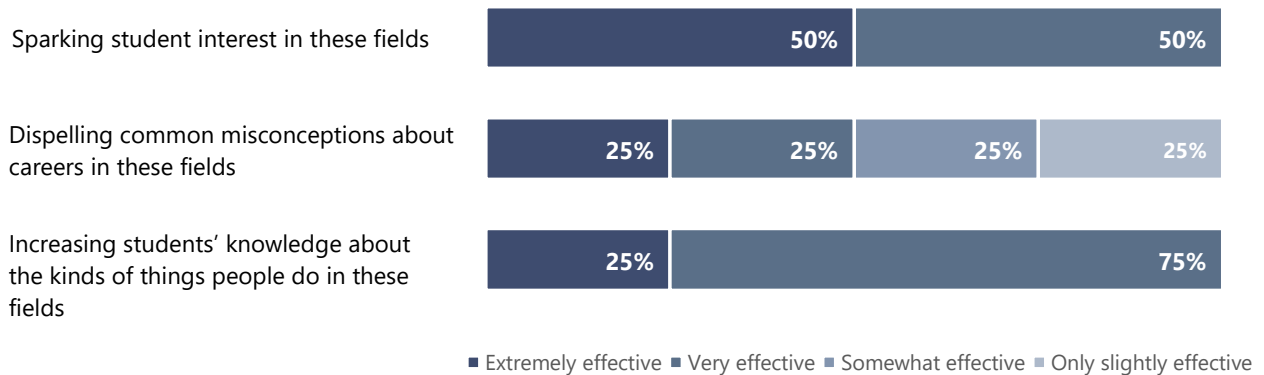


Figure 6. Participant responses to the question, “In your view, how effective was the program regarding each of the following?” (N=5)

Manufacturing Night

Columbus State also hosted a Manufacturing Night event on February 12, 2019. The event provided an opportunity for current Columbus State students, prospective students, parents, and educators to meet Columbus State staff, engineering faculty members and industry representatives to learn about career opportunities in the field of advanced manufacturing and the related educational and training options available through Columbus State's Associate of Science in Engineering Technology degree.

The evening event included brief presentations covering the various advanced manufacturing fields and Columbus State's related educational opportunities followed by a tour at one of Columbus State's industry partners

At the end of the event, attendees were asked to complete a brief paper/pencil survey designed to assess changes in levels of awareness regarding various facts related to advanced manufacturing and perceptions regarding the effectiveness of the half-day event. A question was also included for current and prospective students to assess any changes in levels of interest regarding Logistics Engineering Technology, Modern Manufacturing, and enrolling a Work Study program at Columbus State. A copy of the survey is provided in Appendix C. The surveys were completed by 28 of the 200 (14 percent) of the attendees.

Most of the Manufacturing Night attendees were prospective and current students

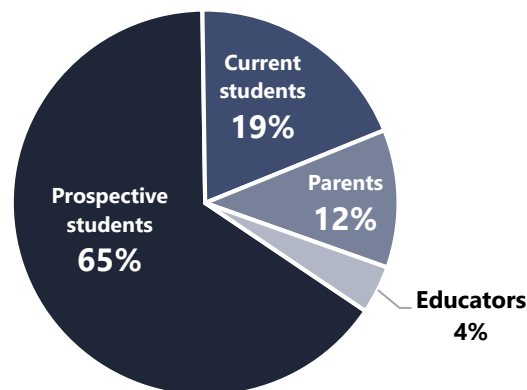


Figure 7. Distribution of respondents by role. (N=26)

Respondents' levels of awareness increased for every fact related to the manufacturing/engineering fields covered at the event

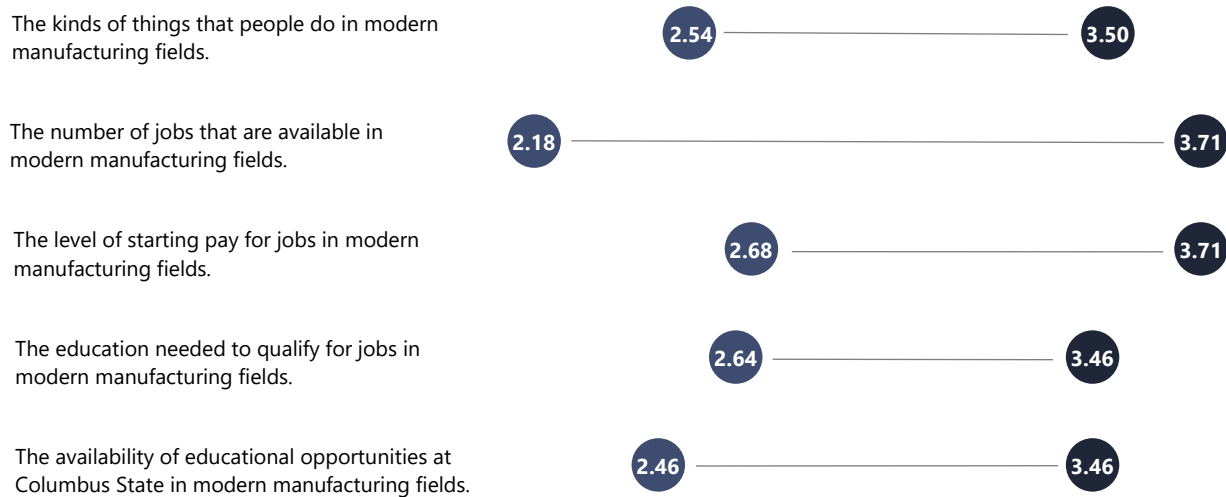


Figure 8. Mean participant responses to the question, "Indicate how you would have rated your level of awareness on each item BEFORE tonight's event and how you rate it now AFTER tonight's event." The response scale was from 1 to 4 with 1=Not aware at all, 2=Only slightly aware, 3=Somewhat aware, 4=Fully aware. (N=28)



The MOST surprising things attendees learned at Manufacturing Night.

The availability of jobs in these fields (6)

- All different job opportunities.
- How many jobs are out there.
- The amount of jobs available.
- The fact that there are more jobs in manufacturing than there are workers.
- What is actually done in manufacturing.
- The range of positions.

The level of pay for jobs in these fields (4)

- \$84K pay
- Manufacture makes 2.8 billion dollars[sic] in America.
- Starting pay
- The entry level pay.

Educational aspects (3)

- Full course load, with minimal break- also no technical classes at Delaware campus.
- The level of knowledge in the students about their field.
- The work study program and how much real work experience they get.

Table 4. Open responses to the question, "What did you learn during today's event that was MOST surprising to you?"

Students' levels of interest in LET and Modern Manufacturing increased as did their interest in enrolling in Columbus State for the works study program.

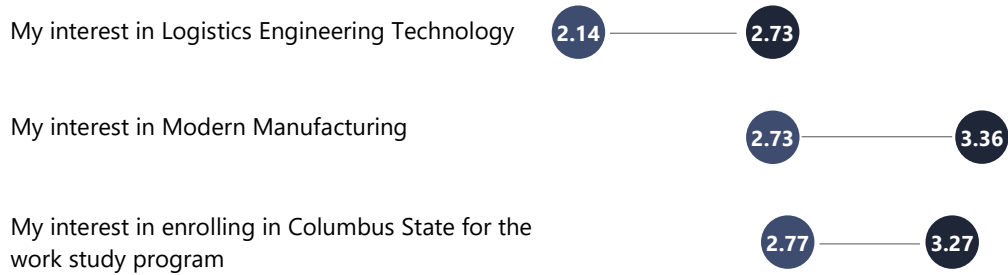


Figure 9. Mean participant responses to the question, "Please indicate how you would have rated your level of interest in each field BEFORE the event and how you rate it AFTER the event." The response scale was from 1 to 4 with 1=No interest at all, 2=Only slight interest, 3=Moderate interest, 4=High interest. (N=22)

Every aspect of Manufacturing Night was rated as "Extremely effective" or "Very effective" by most participants.

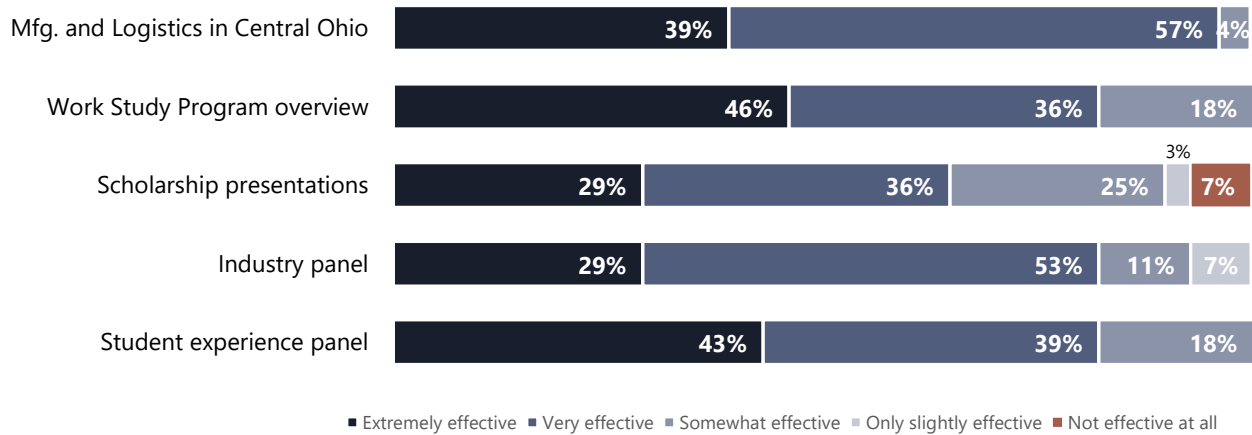


Figure 10. Response frequencies to, "How would you rate the effectiveness of each aspect of Manufacturing Night?" (N=28)

The outreach efforts to increase awareness and interest among students have been effective. Even stronger evidence of the effectiveness of the program, however, comes from the number of students in the AMSI program itself who plan to continue learning more about additive manufacturing by taking relevant courses in high school or at the college level.

Evaluation Question 4b: Is the program increasing the number of students enrolling in CCP courses and/or one of Columbus State's course?

Two students who were not enrolled in CCP classes prior to AMSI enrolled in CCP classes with Columbus State during the 2018-2019 school year. It is hoped that the greater emphasis on the benefits of pursuing a career in modern manufacturing planned for the 2019 AMSI program will increase the level of enrollment into CCP classes is expected to increase for students during the 2019-2020 school year.

Recommendations

The project appears to be on track and moving forward. Most of the teachers and students who participated in AMSI reported having positive experiences with the design and content of the program. Teachers left feeling prepared and motivated to incorporate the learning modules into their own programs. Students' skills and abilities were positively impacted, and most plan to learn more about additive manufacturing through courses or other programs. The Manufacturing Day and Manufacturing Night outreach efforts have effectively raised awareness of - and interest in - modern manufacturing fields and educational opportunities at Columbus State. The following recommendations are provided for the project team to consider as they prepare for the 2019 AMSI program and head into Year 3.

AMSI program development

The project team has made some modifications to the June 2019 program, including a more targeted focus on careers in modern manufacturing and how Columbus State programs can prepare students for those careers. This focus on careers and educational pathways should increase the numbers of students who express a strong interest in pursuing further educational training and a career in modern manufacturing. The project team should take advantage of the opportunity to determine the extent to which the new program changes are impacting the desired attitudes and behaviors and what modifications might strengthen the AMSI program in 2020. The project team should also consider options for remaining in contact with student participants to determine how many pursue continued education and evaluation careers in modern manufacturing. This type of longitudinal data gathering could also provide valuable information regarding the issues or factors that might divert students away from modern manufacturing as a career option.

Ensuring teachers and students have the needed resources at their schools

The teachers who have participated in AMSI seem dedicated to incorporating the modules into their curricula, and students are enthusiastic about learning more about - and doing more with - additive manufacturing. Information gathered from teachers and students after the AMSI program, however, indicates that some schools might not have the software and equipment needed. The inability of teachers to incorporate the modules into their courses would impede the achievement of longer-term outcomes. Consequently, it is recommended that the project team identify approaches to obtain at least the core software and equipment needed for schools. Funds would be needed to support this potentially expensive effort. One option that the project team should consider is the submission of a request for

supplemental funding. Another option would be to seek out industry partners who might be willing to donate equipment. Columbus State has built connections with many industry partners through other programs and could leverage those processes for this purpose. Succeeding in this effort to provide needed software and equipment to schools would have the added benefit of enhancing teacher recruitment efforts. Teachers would probably be more likely to enroll in the program if they knew that they could play a role in securing new resources for their school.

Appendix A – AMSI Logic Model

Design Thinking: Advanced Manufacturing Institute Logic Model

Goal	Partners	Activities	Measurement	Outcomes
<p>To develop and pilot new programming that will lead to an increase in the supply of qualified technicians who have expertise in additive manufacturing.</p> <div style="border: 1px solid black; padding: 5px; margin-top: 10px; text-align: center;">Objectives</div> <ol style="list-style-type: none"> 1. To develop and implement an Additive Manufacturing Institute Model to provide high school students with the opportunity to explore the variety of careers associated with advanced manufacturing leading to earning industry recognized certifications. 2. To develop and implement an interactive High School Faculty Professional Development Initiative in additive manufacturing that prepares teachers to design relevant and rigorous curriculum. 3. To develop a model career pathway between the Additive Manufacturing Institute and Columbus State manufacturing courses. 	<ul style="list-style-type: none"> • Columbus State Community College • PAST Foundation • Ohio Manufacturing Institute of The Ohio State University • Edison Welding Institute • Applied Experience, LLC • Metro Early College High School • Tolles Career and Technical Center • Westerville City Schools • Local manufacturers 	<ul style="list-style-type: none"> • Design the summer institute program • Recruit high school students and teachers • Create laboratory at PAST Foundation • Create certified coordinators • Articulate with postsecondary opportunities • Host the summer institute for high school students • Host the summer institute for high school teachers • Evaluate program • Sustain program • Disseminate program 	<p><i>Student Achievement Benchmarks</i></p> <ul style="list-style-type: none"> • Pre- and post-assessments and change • Number of completers • Number earning certificates • Increased readiness to enter formal education • Number entering workforce • Number entering postsecondary education <p><i>Shared Delivery Benchmarks</i></p> <ul style="list-style-type: none"> • Manufacturing hub created • Shared laboratory facilities expanded • Corps of trained high school teachers increases • Reservoir of lesson modules increases 	<p><i>Short Term Outcomes</i></p> <ol style="list-style-type: none"> 1. Increased number of transitioning college students with STEM skills that are congruent with industry-based problems 2. Increased student interest in advanced and additive manufacturing careers 3. Increased number of students with additive manufacturing experience and certifications <p><i>Middle Range Outcomes</i></p> <ol style="list-style-type: none"> 1. Increased number of students ready to enter 3rd & 4th year Learning Labs high school programs that provide early college opportunities in Columbus State advanced manufacturing programs and industry internships Long Term Outcomes 2. Increased number of student enrollment in Columbus State advanced and additive manufacturing programs and certifications. 3. Increased number of student post placements in manufacturing workforce. 4. Overcomes employers defined challenge workforce obsolescence that slow modern manufacturing progress.

Appendix B – Manufacturing Day Survey

Responses are strictly anonymous; please do not provide your name.

For each of the fields covered at today's event (*Logistics Engineering Technology, Additive Manufacturing, Modern Manufacturing*) please indicate how you would have rated your level of awareness on each item **BEFORE** the event and how you rate it now **AFTER** the event.

Before today's event					After today's event			
Not aware at all	Only slightly aware	Somewhat aware	Fully aware	My awareness of...	Not aware at all	Only slightly aware	Somewhat aware	Fully aware
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	The kinds of things that people do in these fields.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	The number of jobs that are available in these fields.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	The level of starting pay for jobs in these fields.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	The education needed to qualify for jobs in these fields.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	The availability of educational opportunities at CSCC in these fields.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

What did you learn during today's event that was **MOST** surprising to you?

Please indicate how you would have rated your level of interest in each field **BEFORE** the event and how you rate it now **AFTER** the event.

Before today's event					After today's event			
No interest at all	Only slight interest	Moderate interest	High interest	My interest in...	No interest at all	Only slight interest	Moderate interest	High interest
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Logistics Engineering Technology	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Additive Manufacturing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Modern Manufacturing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

If you had to choose, in which of these programs would you be **MOST** likely to enroll?

Logistics Engineering Technology degree
 Additive Manufacturing Summer Institute
 Modern Manufacturing Study
 Work

Overall, how would you rate the effectiveness of each aspect of the day?

	Not effective at all	Only slightly effective	Somewhat effective	Very effective	Extremely effective
CSCC Manufacturing presentation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Facility tour	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Appendix C – Manufacturing Night Survey

Please mark the appropriate box.

Prospective student

Current student

Parent

Educator

Indicate how you would have rated your level of awareness on each item below BEFORE tonight's event and how your rate it now AFTER tonight's event.

BEFORE tonight's event				My awareness of...	AFTER tonight's event			
Not aware at all	Only slightly aware	Some-what aware	Fully aware		Not aware at all	Only slightly aware	Some-what aware	Fully aware
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	The kinds of things that people do in modern manufacturing fields.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	The number of jobs that are available in modern manufacturing fields.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	The level of starting pay for jobs in modern manufacturing fields.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	The education needed to qualify for jobs in modern manufacturing fields.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	The availability of educational opportunities at Columbus State in modern manufacturing fields.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

What did you learn during tonight's event that was MOST surprising to you?

How would you rate the effectiveness of each aspect of Manufacturing Night?

	Not effective at all	Only slightly effective	Somewhat effective	Very effective	Extremely effective
Welcome and overview	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Manufacturing and Logistics in Central Ohio	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Work Study Program overview	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Scholarship presentations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Industry panel	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Student experience panel	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

What are the 1 or 2 most impactful changes/improvements you would recommend?

(For current and prospective students only)

Please indicate how you would have rated your level of interest in each field BEFORE tonight's event and how you rate it now AFTER tonight's event.

BEFORE tonight's event				My interest in...	AFTER tonight's event			
No interest at all	Only slight interest	Moderate interest	High interest		No interest at all	Only slight interest	Moderate interest	High interest
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Logistics Engineering Technology	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Modern Manufacturing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Enrolling in Columbus State for the Work Study program	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>