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Innovative Curriculum: Collaboration Between Technician Education and Workforce Development

Christine Michelle Delahanty (Area Coordinator of Science and Engineering)

Vladimir Genis (Department Head, Engineering Technology)

Susan Herring

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Abstract

Bucks County Community College (Bucks) is aware of the growing and urgent need for workforce ready technicians to fill numerous industry positions. Our NSF ATE grant #1902075 entitled, "Increasing the Number of Workforce Ready Engineering Technicians in Southeastern PA" is a collaboration between Bucks credit and non-credit sides of the college, and Drexel University as our four-year partner. This grant focuses on workforce readiness of engineering technicians to prepare them for the workforce of the future. We are accomplishing this by including our Center for Workforce Development (CWD) certifications as additional pathways into our occupational engineering technology (ET) major, enhancing manufacturing experiences within the major, and embedding soft skills training and career exploration throughout our ET program. We have restructured our ET major to make it more cross-curricular to accommodate diverse industry needs, and to require a greater business aspect. Within this restructuring, we have created courses in different modalities in response to the COVID-19 pandemic. We are committed to increasing awareness of STEM education to underrepresented groups through K-12 STEM-related outreach initiatives, and are in the process of establishing a plan to recruit such groups into our technician education programs. In addition to the services already in place at Bucks, development of our recruitment plan includes professional development sessions of faculty and staff, discussion sessions at national conferences, Professional Learning Communities, special convenings of students, and outreach initiatives to school districts with a higher percentage of underrepresented groups. We expect that fulfillment of the goals of this grant will increase the number of engineering technicians in our region, and become a blueprint for community colleges nationwide.

Introduction

Bucks County Community College (Bucks) is committed to serving the community and the nation by addressing the growing and urgent need for skilled and capable employees [1]. Our NSF ATE grant #1902075 entitled, "Increasing the Number of Workforce Ready Engineering Technicians in Southeastern PA" is a collaboration between the Bucks credit and non-credit workforce development sides of the college, and with Drexel University [2] as our four-year partner. This grant focuses on workforce readiness of engineering technicians to prepare them for the workforce of the future. We have accomplished this by completing three grant goals. Our first goal is to collaborate with our Industry Advisory Board (IAB), our Center for Workforce Development (CWD), and our Business and Innovation Department (BID) to enhance our engineering technology major [3], [4]. The primary focus of this goal is to increase the number of pathways for students who have completed industry-related certification programs, enhancing our engineering design course to include a greater manufacturing experience (Goal #2), and embedding soft skills training and career exploration throughout our occupational engineering technology (ET) program. Bucks is aware of the limitations of our technical workforce due to lower percentages of workers in industry technician jobs, particularly those in underrepresented groups [5]. Within Goal #3 of our grant, we are developing strategies to recruit students from underrepresented groups into our ET program through a formalized plan that complements our already successful recruitment initiatives at Bucks. We expect that our

enhanced ET program will lead students to success in technician education, while preparing them for the evolving needs of industry.

Enhancement of our Engineering Technology Major

The first goal of our grant is: ***Collaborate with IAB, CWD, and BID, to implement an innovative, collaborative model for connecting Technician Education to CWD, and to entrepreneurial opportunities.*** Our ET major has been restructured to better accommodate the growing need for a diverse, capable workforce (See Figure 1). The ET major is now more cross-curricular within the technical electives, requires a business focused writing course, and an introduction to entrepreneurship. Cross curricular technical electives include mechanical, electrical, chemical, biotechnology, biology, nanotechnology (through Penn State University), computer, environmental, and brewery concentrations. Table 1 highlights notable changes to the curricula. ENGR112, Engineering Design, was recently added to our general education curriculum as an Arts/Humanities elective, which allowed for an additional elective course. Enhancement to ENGR112 is discussed within grant goal #2.

Old Engineering Technology Major (2012)	
Degree Course Requirements:	*Credits*
Cultural Perspectives	3
ENGR112 Engineering Graphics	3
CHEM121 Chemistry I	4
COMM110 Effective Speaking	3
ECON111 Macroeconomics	3
COMP110 English Composition I	3
CISC115 Computer Science I	4
MATH115 Elementary Statistics	3
MATH125 Pre-Calculus	4
PHYS106 Physics A	4
PHYS107 Physics B	4
ENGT222 Applied Statics	3
ENGT240 Applied Circuit Analysis	4
INTG285 Integration of Knowledge	3
Personal Health	2
Old Technical Electives	13- 14
Total	63-64

Revised Engineering Technology Major (2022)	
Degree Course Requirements:	*Credits*
COLL101 College Success Seminar	1
ENGR112 Engineering Design	4
CHEM121 Chemistry I	4
COMM110 Effective Speaking	3
ECON111 Macroeconomics	3
MGMT135 Business Communication	3
Computer Science Elective	3 - 4
MATH115 Elementary Statistics	3
MATH125 Pre-Calculus	4
PHYS106 Physics A	4
PHYS107 Physics B	4
ENGT222 Applied Statics	3
ENGT240 Applied Circuit Analysis	4
MGMT155 Intro. To Entrepreneurship	3
Revised Technical Electives	15
Total	61-62

Figure 1. Comparison of old and new ET majors.

Bucks is a well-known leader in online education, and as part of the enhancement to the ET major, created courses in many modalities in response to the COVID-19 pandemic [6] - [8]. These modalities included remote (synchronous), online (asynchronous), and various forms of

hybrid courses including online/face to face, online/remote, and remote face to face, to assure that students had the options they needed to safely continue their education [6]. We developed numerous strategies to assure student engagement and success through this difficult time. Students in our credit and workforce development programs have benefitted from many options for course and program delivery, and from college-wide engagement and programs designed to increase retention and focus on student success [9] – [12]. We created a pathway from workforce development to our credit sector by establishing an articulation agreement for Center for Workforce Development (CWD) Industrial Maintenance and Metalwork Training certifications. These valuable certifications are now accepted into our ET program for 12 college credits each through our Prior Learning Assessment (PLA) option [13]. Students can also apply for Prior Learning Assessment (PLA) credits for experience such as other workforce certifications, work experience, or military training. Our CWD has incorporated the PLA option into their marketing and outreach materials, finding this information helpful in generating interest for the Metalwork and Industrial Maintenance programs among in-school and out-of-school youth and their parents. This outreach strategy reaches youth who are hands-on learners and not yet ready or confident enough to immediately pursue a college degree. These programs act as a springboard to skilled employment and optimally making the transition to credit studies. CWD is also planning to use virtual reality tools to reinforce skills learned in the lab, and as career exploration activities to build awareness and recruit more students to technician programs.

Table 1. *Notable Enhancements to the ET Major Based on Industry Needs*

Old ET Major	Revised ET Major
• 63-64 Credits Total	• 61-62 Credits Total
• ENGR112 was 3 credits	• ENGR112 is 4 credits with manufacturing
• Arts/Humanities Gen Ed Elective	• ENGR112 counts as Arts/Humanities
• CISC115 was required	• Comp Sci. Elective
• English composition	• Business writing course
• Social Science/Diversity elective	• ECON111 is required
• Personal Health was required	• Personal Health was eliminated
• INTG285 was required as part of Gen Ed	• INTG was eliminated from Gen Ed
• 13-14 Specific Technical Electives	• MGMT155 Entrepreneurship is required
	• 15 Cross Curricular Technical Electives
	• General Elective Added

We found that many students do not know what engineering technology (ET) is, or how to distinguish it from the engineering major. In addition, students do not understand ET as a valuable industry-related major, or as a career path that is highly valued and greatly needed in industry [14] – [17]. We provide a visual comparison of both the engineering and engineering technology majors as part of the advising guide we are developing so that students better understand the differences and similarities from the perspective of curriculum. Figure 2 shows that the engineering major is much more mathematically rigorous than the ET major. Table 2 summarizes the notable comparisons between the two majors. These comparisons show the level of flexibility of the ET major with more technical elective courses and fewer required math courses. The ET major requires an algebra-based curriculum, instead of calculus-based curriculum of the engineering major. Our statistics show that students who seek to change their

major from engineering will typically choose the business major over ET. One possibly for this is that they are not as aware of ET as a lucrative option within the engineering profession. We plan to develop more effective marketing initiatives to promote ET as a lucrative and valued major that is in demand locally and nationally. We want to highlight that the "Degree is Engineering Technology, the Career is Engineering." ET is in the career category of engineering and will allow students to earn the hands-on credentials they need for industry with a combination of manufacturing training and business experiences. Our IAB members have hired our ET students as both interns and employees and we will continue to strengthen these partnerships.

ENGINEERING (AS 1028 Transfer)	
Degree Course Requirements:	*Credits*
COLL101 Introduction to College	1
ENGR112 Engineering Design	4
CHEM121 Chemistry I	4
COMM110 Effective Speaking	3
COMP110 English Composition I	3
CISC119 Comp Sci for Engineers	4
Social Science/Diversity	3
COMP111 or COMP114	3
MATH140 Calculus I	4
MATH141 Calculus II	4
MATH242 Calculus III	4
MATH250 Differential Equations	3
PHYS121 Physics I	4
PHYS122 Physics II	4
ENGR222 Statics	3
ENGR223 Dynamics	3
ENGR224 Strength of Materials	3
ENGR240 Circuit Analysis	4
Engineering Elective	3-5
Total	64-66

ENGINEERING TECH (AAS 2193 Occupational)	
Degree Course Requirements:	*Credits*
COLL101 Introduction to College	1
ENGR112 Engineering Design	4
CHEM121 Chemistry I	4
COMM110 Effective Speaking	3
MGMT135 Business Communication	3
Computer Science Elective	3 - 4
ECON111 Macroeconomics	3
MGMT155 Intro. To Entrepreneurship	3
MATH115 Elementary Statistics	3
MATH125 Pre-Calculus	4
PHYS106 Physics A	4
PHYS107 Physics B	4
ENGT222 Applied Statics	3
ENGT240 Applied Circuit Analysis	4
Technical Electives	15
General Elective	3
Total	61 – 62

Figure 2. Comparison of engineering and ET majors in our advising guide.

Graduates of our ET program have gone on to become leaders in industry, and have earned higher level degrees including BS and MS degrees. Some are currently employed in the following industry positions: control engineer, applications engineer, field technician, senior design engineer, test lead, and production manager. Through presentations we are developing as part of our outreach initiatives, we are working to enlighten students to the lucrative careers they can have in ET, and how these positions are crucial for sustainability in the engineering field. We

are also in the process of establishing a revised articulation agreement with our higher education partner, Drexel University, so that students in the ET major can transfer to Drexel to earn a BS degree in ET [18]. Drexel's ET program offers concentrations in computer, electrical, healthcare, industrial, mechanical and manufacturing, and robotics and automation. Table 3 compares enrollment and graduation rates for engineering and ET. Graduation rates for the engineering major showed no trend and averaged 5.3%. Graduation rates for the ET major have grown consistently since it was first offered in 2012 and was 20% in 2020-2021. Although there were no ET graduates in 2020-2021, this could have been due to complications students faced during the pandemic. We will continue to monitor enrollment and graduation rates in both majors. The percentage of students in the ET major as compared to the engineering major has grown since it was first offered in 2012. In addition, students in the ET major are successful in their required ET courses where 95% of them earn a C or better.

Table 2. *Notable Comparisons Between Engineering and ET Curricula*

Engineering	Engineering Technology
• 64-66 Credits Total	• 61-62 Credits Total
• Two composition courses	• Business writing course
• Social Science/Diversity elective	• ECON111 is required
• High level math courses	• Business and tech. math courses
• Calculus-based physics	• Algebra-based physics
• Required Sophomore level engineering courses	• Applied Statics and Circuits
• One Technical Elective	• 15 Technical Electives
	• One General Elective

Table 3. *Comparison of Engineering and ET Enrollment and Graduation Rates (2012-2021)*

AAS 2193: Engineering Technology (Occupational) (Last Audit 2017*)									
	ATE Grant #1902075						ATE Grant #1103891		
	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Enrollment	7	13	16	23	26	35	32	34	25
# Graduates	N/A	N/A	1	2	2	5	6	0	5
Graduation Rate	N/A	N/A	6.3	8.6	7.7	14.3	18.8	0	20
% of Engr Major	1.8	3.5	4.5	6.6	7.5	10.6	11.4	10.9	10.4

(C or Better: > 95% of ET students succeed in required courses)

AS 1028: Engineering (Transfer) (Last Audit 2021*)									
	ATE Grant #1902075						ATE Grant #1103891		
	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Enrollment	396	369	355	348	345	329	281	312	241
# Graduates	17	21	18	21	12	19	12	19	14
Graduation Rate	4.3	5.7	5.1	6.0	3.5	5.8	4.3	6.1	5.8

Table 4 highlights demographic comparisons of the two majors. Table 4 shows the notable statistics displayed in red in Tables 3 and 4. In the ET major, there was an increase in the

percentage of students reporting an Asian cultural background, and in the engineering major there was an increase in the percentage of students indicating a Hispanic cultural background. The percentage increase of women students was notable in the engineering major but not in the ET major. Table 5 also includes 2021 demographical statistics for the percentage of veterans and first generation students enrolled in the ET major. Statistics on first generation students include both no college and some college without a degree.

Table 4. *Comparison of Engineering and ET Demographical Statistics (2015-2021)*

AAS 2193 Engineering Technology Major												
Race/Ethnicity	2015-16	%	2016-17	%	2017-18	%	2018-19	%	2019-20	%	2020-21	%
African American	0	0	1	4	0	0	1	3	2	6	1	4
Asian	0	0	0	0	0	0	1	3	3	9	2	8
Hispanic/Latino	3	13	4	15	3	9	4	13	3	9	2	8
Unknown/Other	9	39	9	35	5	14	3	9	3	9	3	12
White	11	48	12	46	27	77	23	72	23	68	17	68
Total	23	100	26	100	35	100	32	100	34	100	25	100
Female	1	4	3	12	2	6	2	6	2	6	2	8
Male	22	96	23	88	33	94	30	94	32	94	23	92

AS 1028 Engineering Major												
Race/Ethnicity	2015-16	%	2016-17	%	2017-18	%	2018-19	%	2019-20	%	2020-21	%
African American	5	1	12	3	15	5	9	3	5	2	7	3
Asian	22	6	22	6	24	7	24	9	30	10	16	7
Hispanic/Latino	18	5	20	6	22	7	28	10	28	9	24	10
Unknown/Other	82	24	76	22	53	16	34	12	29	9	22	9
White	221	64	215	62	215	65	186	66	220	71	172	71
Total	348	100	345	100	329	100	281	100	312	100	241	100
Female	35	10	45	13	39	12	39	14	46	15	41	17
Male	313	90	300	87	290	88	242	86	266	85	200	83

Table 5. *Notable Comparisons between Engineering and ET Statistics in Tables 2 and 3*

Engineering	Engineering Technology
• Downward Enrollment Trend (Dropped 31%)	• Upward Enrollment Trend (10.5% of Engineering Major)
• Graduation rates averaged 5.3% over the 6-year period (no trend)	• Graduation rates increased from 8.6% in 2016 to 20% in 2021
• Percentage of women increased steadily from 10% to 17%	• Percentage of women varied between 5% and 12%
• Percentage of Hispanic students increased from 5% to 10%	• Percentage of Asian students increased from 0% to 8 -9%
• Percentage of students reporting cultural identity increased by 14%	• Percentage of students reporting cultural identity increased by 26%
	• 2021: 12% Veterans, 24% First Gen No College, 80% Some College

We are also continuing to collaborate with our CWD within the establishment of their future robotics and automation (R&A) and welding certifications. These certification programs are expected to be developed and implemented upon the completion of their new Center for Advanced Technologies (CAT) [20]. We are developing pathways for both of these certifications

into our ET program. We will develop a credit pathway for the CWD R&A certification into our ET major and also into our computer related majors that include computer science, networking, information science, cybersecurity, and a future concentration in artificial intelligence. We plan to develop modules on the credit side that can be offered throughout many different courses, and also as part of CWD education. Within the CWD welding certification, we are investigating pathways into our credit programs through a non-destructive evaluation (NDE) credit concentration. Our IAB has reported an interest and need in these additional pathways, and we are confident that they will contribute to the sustainability of our technology education programs and of the college.

We now offer our College Success Seminar (COLL101) as a cohort of first semester engineering and ET majors that highlights career exploration and business skills specific to students who have entered these programs. We are working with our CWD to utilize their best practices for workforce readiness. Our CWD has a prominent Industry Advisory Board (IAB) that offers company tours, both in person and virtual. These tours are now included in our COLL101 cohort course where students are required to choose a company to tour, and to reflect on their experience. As part of this assignment, they are to discuss their area of interest and if the company they toured would be interesting to them as a place of employment . In collaboration with our CWD, we are also investigating the possibility of job shadowing within our COLL101 course to provide a richer career exploration experience, but this has been delayed due to complications created by the pandemic [21], [22]. We expect that the cohort of engineering and ET students in COLL101 together will help to increase retention in these programs.

Enhancement of Our Engineering Design Experience

Our second grant goal is: ***Collaborate with CWD, IAB, and educational partners to (1) develop a for-credit manufacturing processes course, and (2) Investigate the development of a Fab Lab for use throughout college-wide curricula.*** We have improved our engineering design course by designating a portion of instructional minutes to hands-on training on our additive and subtractive manufacturing equipment, where students will create solid models of their CAD designs. We have developed a manufacturing course that will require our introductory engineering design course as a prerequisite. Our IAB will review this course to assure that it is compatible with industry needs, and that it will enhance workforce readiness. This course will also be reviewed by our higher education partners for transferability into their engineering and engineering technology programs. Enrollment has been an issue at Bucks for courses that are not cross curricular. Assuring transferability into both engineering and engineering technology programs will make this manufacturing course more cross curricular at Bucks and more appealing to transfer institutions.

As part of curriculum development for these two courses, focusing on manufacturing, we are developing instructional videos that focus on specialized techniques and strategies for effective manufacturing. Some strategies for effective manufacturing were developed from our support of the Personal Protective Equipment (PPE) effort during the pandemic where we manufactured over 3000 face shields utilizing techniques to increase volume, reduce time, and lower cost [23]. We have presented these techniques at national conferences and in our engineering design classes. In addition to articulation with our higher education partners, we will

continue to develop articulation with area high schools to accept related manufacturing courses and certifications for college credit in our ET major as part of dual enrollment programs [24]. We also plan to use the instructional videos for community outreach to these school districts.

Bucks is aware of the importance of hands-on industry related experiences for students that will lead to valuable skills necessary for success in industry professions [16], [18], [25] – [29]. Within the second part of our second grant goal, we are investigating the feasibility of developing a Fab Lab on campus. This Fab Lab is intended to be a consolidated space for students to utilize our manufacturing equipment, initially in our engineering design courses, and then for wider use throughout the campus community. Currently, the equipment used in our engineering and engineering technology programs is housed in five different locations at the Newtown campus. We are investigating a more appropriate space for our equipment where students will be able to have a combined classroom and laboratory experience in consolidated manufacturing bay area. We are investigating options at our Newtown, PA campus in the Science Center, and at the CAT at the Lower Bucks campus.

To further address the urgent need to workforce ready industry technicians, we are collaborating with Dow Chemical in Bristol, PA to offer an Applied Associate in Science (AAS) in Advanced Technology (AT) degree at Bucks [30]. This AT curriculum depicted in Figure 3, is designed specifically for industry technicians who seek to earn national apprenticeship certifications, where an Associate degree is required for such a certification. Figure 4 displays a pathways diagram for students that we developed under the guidance of Dow Chemical. This is the pathway that Dow employees will take to complete coursework in process control technology, and earn an AAS degree in AT. Because we do not currently have Process Control Technology (PCT) course options at Bucks, students will travel to our local partner community college, Delaware County Community College (DELCO) and take PCT courses there at in county prices [31].

Course	Credits	Course	Credits
COLL101	1	MATH120	4
College Success Seminar		College Algebra	
CHEM101		MGMT135	3
Chemistry A		Business Communications	
OR		PHYS106	4
CHEM121	4	Physics A	
Chemistry I		PHYS107	4
COMM110	3	Physics B	
Effective Speaking		Computer Science Elective	3-4
Social Science/Diversity	3	Math Elective	3-4
ENGR112	4	General Elective	3
Engineering Design		Technical Electives	22
			61 – 63

Figure 3. Curriculum for Advanced Technology major.

Plan to Recruit Underrepresented Groups into Technician Education Programs

The third goal of our grant is: ***Strategize and develop a program to recruit underrepresented groups and veterans into Technician Education programs, and involve students in industry-related community outreach to recruit such groups***. Women and

minorities continue to comprise a much lower percentage of STEM jobs, including STW technician positions, and these percentages have changed only minimally in the ten year period [5]. According to *The State of U.S. Science and Engineering 2022, Science and Engineering Indicators (National Science Board)*, women comprise 46% of the general population, 33% of STEM workers, and only 26% of Skilled Technical Workers (STW), or skilled workers without a bachelor's degree [5]. The percentage of women STW has remained the same as in 2010 [5]. Although the percentages of STW of other minority groups has remained consistent with percentages in the working population, the numbers of STW in underrepresented groups is still low. At Bucks we understand the importance of diversity and inclusion at our college and in our programs [5], [32] – [35].

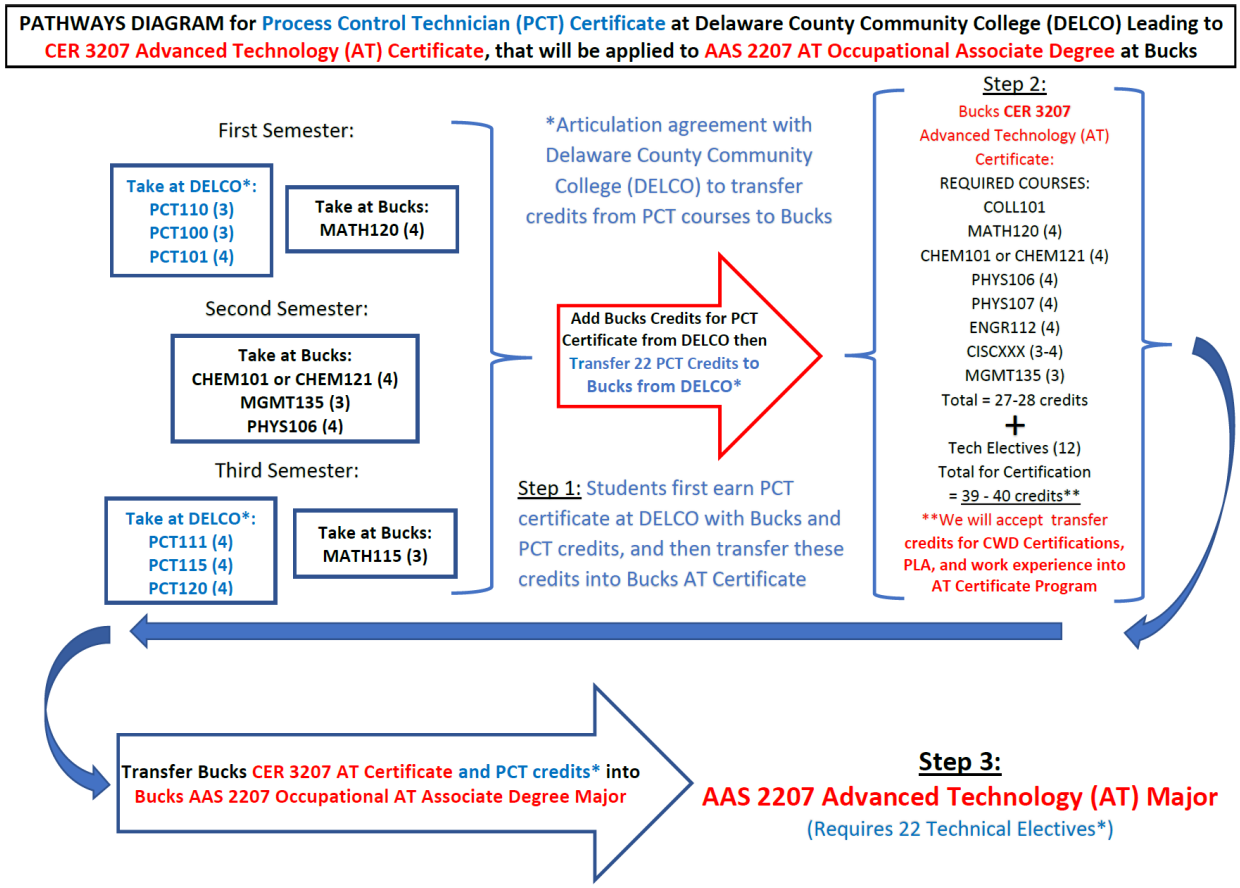

Figure 4. Pathway to AAS AT degree for Dow Chemical Process Control employees.

We are committed to increasing awareness of STEM education to underrepresented groups through K-12 STEM-related outreach initiatives, and are in the process of establishing a plan to recruit such groups into technician education programs. In addition to the services already in place at Bucks, development of our recruitment plan includes professional development sessions of faculty and staff, discussion sessions at national conferences, Professional Learning Communities, special convenings of students, and outreach initiatives to school districts with a higher percentage of underrepresented groups. Programs at Bucks already in place include a Summer Bridge Program that was piloted in the summer of 2020 with an enrollment of 20 rising freshmen, a counselor's breakfast to enlighten key high school personnel

of the opportunities for students at Bucks, and campus tours for high school students with a higher percentage of underrepresented groups [36]. These tours of both our Newtown and Lower Bucks campuses were very successful, where we had over 100 students attend each event, and rising high school students were introduced to our different career oriented majors through presentations and displays. Bucks is currently collaborating with several local high schools to continue offering these field trips. Bucks faculty and administration have also visited local high schools to highlight our technician education programs. We plan to continue and extend this outreach.

In Fall 2021, we piloted the use of Virtual Reality technology as a recruitment tool for our Workforce programs. Virtual Reality products provide job training and career exploration simulations designed with industry to showcase in-demand, well-paying jobs. Utilizing immersive experience training methods help trainees build confidence in their knowledge, skills, and abilities. One hundred and thirty high school juniors and seniors were given the opportunity to experience skills training through VR. A pre-session survey asked, on a scale of 1 to 10 "How familiar are you with the topics you are about to explore?" Students indicated that, on average, they were moderately familiar (average of 5) with manufacturing opportunities. After experiencing the virtual reality training simulation, they were asked "How much more informed do you feel about the careers you explored?" The average after the simulation, was a 7.5 indicating an uptick in knowledge about manufacturing careers. This technology is useful in providing underrepresented groups with exposure to these careers in a non-traditional, innovative way. We intend to use VR to recruit in K-12 and our ISY program.

Outcomes of our Professional Development sessions and Professional Learning Communities indicated that there were overlapping concerns and suggestions that laid the foundation for some first steps that were discussed to develop this plan. Some of the highlighted discussion concerns and topics from the multiple sessions we held for faculty and staff are:

1. Communication is the key!! (Establish effective marketing strategies)
2. Reach out to alumni to highlight their great experiences
    a. Recruitment and retention go hand in hand. **(Recruitment is not effective unless there is a plan to retain students as well)**
3. Define what exactly a technician is, and who are those in underrepresented groups? This will help to establish recruiting strategies.
4. Enlighten students to exciting majors and careers that they might not know about.
5. Extend recruitment initiatives to more than high schools. Include clubs, churches, sports teams, social groups etc. Contact townships to learn how the community can help.
6. Educate students and parents on the application and financial aid process

Some first steps to developing this plan that we have discussed at professional development sessions and at PLCs are:

1. Recruit from students we already have (*Recognize the difficulty in discussing a "lower level" major with students and highlight the benefits of entering such a career: Hold professional development sessions to discuss strategies for suggesting a different major)*
    a. In our first year college success seminars: Enlighten students to different majors and careers (What do people do in these careers?)
    b. Establish a guide to different majors and career paths through Advising

2. Talk with our own committees at Bucks such as Developmental Education, Advising, Advisory Counsel, Academic Affairs, Dev. Ed, Advising etc.
3. K-12 outreach: Start with high school and establish a Counselor Advisory Board
4. Participate in college fairs for the local high schools: What do we emphasize and how do we market at these events?
5. Continue with successful recruitment events at Bucks such as field trips for
6. For lower grades hold yearly assemblies sponsored by the College. Students will grow up knowing Bucks and what we offer!

Conclusion

Our grant team expects that fulfillment of the goals of this grant will help to address growing and urgent industry needs by better preparing students for the workforce, and increase the number of engineering technicians both in our region and nationally. We are disseminating successes and challenges of this project locally and at conferences nationwide through presentations, synergy sessions, Professional Learning Communities (PLC), professional development sessions, and workshops [6], [14], [16], [18], [21], [31]. We will continue to assess ET courses and conduct an audit of the enhanced ET major. Our research Department will monitor students who choose different pathways into the ET program, and enrollment, retention and graduation rates.

References

[1] Bucks County Community College. (2021). Retrieved from https://www.bucks.edu/

[2] Drexel University. (2021). Retrieved from https://drexel.edu/

[3] Engineering. Bucks County Community College. (2021). Retrieved from https://www.bucks.edu/catalog/majors/stem/engineering/

[4] Workforce Development. Bucks County Community College. (2021). Retrieved from https://www.bucks.edu/workforcedevelopment/

[5] Burke, A., Okrent A., & Hale, K. (2022). The State of U.S. Science and Engineering 2022. National Science Foundation (NSF). National Center for Engineering and Science Statistics (NCESS). Alexandria, VA. Retrieved from https://ncses.nsf.gov/pubs/nsb20221

[6] Delahanty, C., Herring, S., Timby, T.A., & Genis, V. (2021, July), *Education in a Remote World: Focus on Workforce Readiness.* Paper presented at 2021 ASEE Virtual Annual Conference Content Access, Virtual Conference. https://peer.asee.org/education-in-a-remote-world-focus-on-workforce-readiness

[7] Farrell, O., Brunton, J. A balancing act: a window into online student engagement experiences. Int J Educ Technol High Educ 17, 25 (2020). https://doi.org/10.1186/s41239-020-00199-x

[8] 2020 Best online community colleges in Pennsylvania. (2020). Retrieved from 2020 Best Online Community Colleges in Pennsylvania - OnlineU

[9] Academic Advising. Bucks County Community College. (2021). Retrieved from Academic Advising | Bucks County Community College

[10] Student Employment & Career Development. Bucks County Community College. (2021).Retrieved from Center for Student Employment + Career Development | Bucks County Community College

[11] Counseling Services. Bucks County Community College. (2021). Retrieved from Counseling Services | Services + Resources | Bucks County Community College

[12] Bucks +. (2021). Retrieved from Bucks+ | Bucks County Community College

[13] Prior Learning Assessment (PLA) (2022). Retrieved from https://www.bucks.edu/academics/pla/

[14] Delahanty, C, & Herring, S. (November, 2021). *Enhancing Workforce Readiness of Students in Technician Education Programs* [conference presentation]. NCPN Connect 2021. A Virtual conference. USA. https://www.ncpn.info/conf_2021_program.php

[15] Lennon, C. (2014). Lack of Skilled Workers Threatens Economic Growth. U.S. News and World Report. October 30, 2014. Retrieved from: https://www.usnews.com/news/stem-solutions/articles/2014/10/30/lack-of-skilled-workers-threatens-economic-growth-in-stem-fields

[16] Delahanty, C. M., Genis, V., Herring, S., Timby, T. A. (2020, June), *Enhancing Workforce Readiness of Engineering Technicians* Paper presented at 2020 ASEE Virtual Annual Conference Content Access, Virtual Online. https://peer.asee.org/34579

[17] Taraban, C. (2018). Building an Engineering Technology Workforce. Journal of Engineering Technology, 35(1), 30–38.

[18] Delahanty C. (October, 2019). What Does Industry Really Need from Young Employees? [conference discussion session]. NSF ATE PI Conference, Washington, D.C., USA. https://www.aacc.nche.edu/wp- content/uploads/2019/10/ATE2019Program_Final.pdf

[19] Drexel University Engineering Technology Major (2022). Retrieved from http://catalog.drexel.edu/undergraduate/collegeofengineering/engineeringtechnology/

[20] Center for Advanced Technologies (2022). Bucks County Community College. Retrieved from https://www.bucks.edu/discover/foundation/donate/cat/

[21] English, N. (2018). Job shadowing as a mechanism for college and career readiness (Order No. 13819964). Available from ProQuest Dissertations & Theses Global. (2166880680). Retrieved from http://ezproxy2.library.drexel.edu/login?url=https://search-proquest-com.ezproxy2.library.drexel.edu/docview/2166880680?accountid=10559

[22] Frawley, T. A. (2009, 03). Job shadowing introduces the realities of manufacturing. Tech Directions, 68, 15-17. Retrieved from http://ezproxy2.library.drexel.edu/login?url=https://search-proquest-com.ezproxy2.library.drexel.edu/docview/218567870?accountid=10559

[23] Ayensu A., & Delahanty C. (2021, July 21-22). Manufacturing PPE During a Pandemic: A Call to Action [conference presentation]. High Impact Technology Exchange Conference, Waco, Texas, USA. https://www.highimpact-tec.org/hitec2021-on-demand-sessions.php

[24] Dual Enrollment (2022). Bucks County Community College. Retrieved from https://www.bucks.edu/catalog/info/admissions/dual/

[25] Jacsik, N. I., (2015, June). Sustainable undergraduate engineering 3-D printing lab. Paper presented at 2015 ASEE Annual Conference & Exposition, Seattle, Washington. doi:10.18260/p.12373.

[26] Platt, J. R., Thirty-Five Percent of Engineering Jobs Now Require 3-D Printing Skills: Learn what it takes to get in on the ground floor. (2015, April). The Institute. The IEEE New

Source. Retrieved from http://theinstitute.ieee.org/career-and-education/career-guidance/thirtyfive-percent-of-engineering-jobs-now-require-3d-printing-skills.

[27] Shin, M. (2016). A makerspace for all: Youth learning, identity, and design in a community-based makerspace (Order No. 10143759). Available from ProQuest Dissertations & Theses Global. (1811614961). Retrieved from http://ezproxy2.library.drexel.edu/login?url=https://search-proquest-com.ezproxy2.library.drexel.edu/docview/1811614961?accountid=10559.

[28] Blikstein, P. (2013). Digital Fabrication and "Making" in Education: The Democratization of Invention. In J. Walter-Herrmann & C. Büching (Eds.). FabLabs: Of Machines, Makers, and Inventors. Bielefeld: Transcript Publishers. Retrieved from https://tltl.stanford.edu/publications/papers-or-book-chapters/digital-fabrication-and-making-democratization-invention

[29] Galaleldin, M., Anis, H., Claude L., & Bouchard, F. (2016). The impact of makerspaces on engineering education. Paper presented at the Canadian Engineering Education Conference, Halifax NS. Retrieved from https://www.researchgate.net/publication/305227975_The_Impact_of-Makerspaces_on_Engineering_Education.

[30] Dow (2022). Retrieved from https://www.dow.com/en-us

[31] Process Control Technology Certificate of Proficiency (PCT) (2022). Delaware County Community College. Retrieved from https://catalog.dccc.edu/academic-programs/programs-study/process-control-technology-certificate-proficiency/

[32] Delahanty, C., Lopez, M., Pickering, C., & Timby, T. A., (October, 2021). Recruiting and Retaining Students in Technician Education [conference discussion session]. NSF Principal Investigator's Conference, A Virtual Event. https://www.atepiconference.com/wp-content/uploads/2021/10/2021_ATEConferenceProgram1021.pdf

[33] Delahanty, C., & Silverman, J. (2021, July), *Creative Self-Efficacy of Undergraduate Women Engineering Majors* Paper presented at 2021 ASEE Virtual Annual Conference Content Access, Virtual Conference. 10.18260/1-2—36877

[34] Delahanty, C. (2020). Creative Self-Efficacy of Undergraduate Women Engineering Majors: A Mixed Methods Study (p. xvi, 188 pages) [Drexel University]. https://doi.org/10.17918/00000005

[35] Kan, P. (2018). INCREASING THE RANKS OF WOMEN IN MANUFACTURING. Area Development Site and Facility Planning, 53(2), 60-62. Retrieved from http://ezproxy2.library.drexel.edu/login?url=https://search-proquest-com.ezproxy2.library.drexel.edu/docview/2095704759?accountid=10559

[36] Summer Bridge. (2022). Bucks County Cimmunity College. Retrieved from https://www.bucks.edu/academics/department/lang-lit/summer-bridge/#:~:text=The%20Summer%20Bridge%20Program%20at,succeed%20in%20a%20college%20environment.