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ABET Assessment Program for a Bachelor of Science in Engineering Technology Degree – Strategies and Best Practices

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Background

In this full paper, we present strategies for a comprehensive and innovative assessment program and continuous improvement process developed by one of the newest engineering technology programs in the United States. The program was developed from the ground up to build a strong philosophy of assessment in preparation for accreditation. In developing the new program, one of the requirements was to implement an assessment plan involving faculty and staff from all regional campuses and establish a strong assessment culture. The curriculum was developed rigorously based on the needs of the industry to build the manufacturing workforce. An effective ABET assessment process will help build a curriculum that meets the standards necessary to prepare graduates to enter industrial manufacturing fields in the global workforce. A curriculum development and assessment committee (CDAC) was formed in the first year the program was launched. The assessment plan includes direct and indirect assessment measures for student outcome attainments. It targets not only program-level outcome attainment but also course-level outcomes. Continuous improvement involves evaluation of the collection of CDAC reports which are prepared by the ABET Assessment Committee members every semester to guide faculty and course coordinators. The committee prepared a plan for measuring student learning outcomes and implementing a robust framework utilizing the university's learning management system (LMS). The data and results collected from this learning management tool will help decide curriculum revisions and continuous improvement. Methods developed as part of our assessment plan are widely applicable to the programs offered at the regional campuses and are included in the paper. Two papers have been presented in the previous years that introduced the framework developed for this program; this is the third paper in the sequence. With this paper, the authors hope to share the implementation of the assessment process and assessment results from all three years of the program. The authors also hope to share the best practices for the assessment of learning outcomes in capstone courses.

Introduction

The choice of an academic institution or a program has lifelong implications due to which there is an increased demand for education and awareness of academic quality and accreditation credentials to make informed decisions [1]. Access to programmatic information has led the accreditation agencies to focus on specific program-level criteria instead of the institutional level and aim to instill more confidence in the standing of these programs. Academic institutions strive hard to gain accreditation to ensure graduates have met the educational requirements necessary to enter relevant professions and build confidence in their stakeholders. Most post-secondary degree-granting institutions look up to the Accreditation Board for Engineering and Technology (ABET) as an agency for guidance on meeting the quality standards of the profession for which that program prepares graduates. Established in 1932, the agency has accredited about 4,564 programs at 895 colleges and universities in 40 countries [2]. ABET has a well-defined comprehensive requirement for prospective programs but does not require a specific approach for measuring the attainment of learning outcomes. Establishing a new program that fulfills ABET requirements is a major undertaking not only for the administration but also for the faculty and staff. There is a huge responsibility to develop the curriculum and assessment tools to meet programmatic and institutional outcomes. In this paper, we will share the experience of establishing an assessment process for ABET accreditation of an engineering technology program offered at the regional campuses of a large midwestern institution. The guidelines and accreditation standards for the bachelor-level program are obtained from the Engineering Technology Accreditation Commission (ETAC) of ABET.

A recent demand and supply shock caused by the pandemic has revolutionized the way the manufacturing industry operates due to the inflationary pressure on the global economy including semiconductor shortages. This has resulted in several manufacturing firms relocating [3]. Industrial automation and robotics are in high demand since they help facilitate accurate, safe, cost-effective, and reliable control processes that support community development. According to the U.S. Bureau of Labor Statistics, employment rates have been improving since the pandemic, especially in the manufacturing field. In addition, recent hourly and annual earnings are shown to also increase for occupations commonly found in manufacturing [4]. There has been a great concern about finding enough highly skilled workers to staff manufacturing facilities. These facilities have already struggled with the “skills gap” around the state due to low unemployment rates and flourishing logistics and automobile manufacturing industries. With advancements in industrial automation, robotics, and cyber security, there is an increased demand for highly trained and skilled workers in the state. The shortage of qualified candidates to serve the needs of the local manufacturing industry is due to insufficient engineering technology programs in the area. Because of the dire need for skilled workers in the state, this institution has invested in developing a manufacturing engineering technology program. One of the unique characteristics of this program is the partnerships with neighboring community and technical colleges to share resources and align curriculum and manufacturing facilities to integrate academic study with practical work experience. All regional campuses of this institution are co-located with the area technical schools which provides an interesting infrastructure to offer an undergraduate engineering technology program.

With this paper, the authors aim to a) continue communicating the implementation of an effective assessment program for ABET ETAC accreditation; b) share the results of the assessment from the first three years of the program b) share the best practices with peers planning to offer a new degree program and preparing for initial accreditation.

This paper is organized in the following order: I. Engineering Technology Program, II. Curriculum and Coursework, III. Defining Program Objectives and Student Outcomes, IV. Program Constituents and Governance, V. Assessment and Evaluation Process, VI. Strategies and Best Practices. The paper concludes with acknowledgments and a summary and recommendations for future work.

I. Engineering Technology Program

As mentioned earlier, there has been an increased demand for skilled workers to fill manufacturing jobs in the state. Regional focus groups were established to study current and future engineering technology skills needed to serve the manufacturers. A steering committee was formed in 2019 to brainstorm ideas to develop a four-year engineering technology degree program with a focus on management and leadership skills [5]. The educational objectives, learning outcomes, and proficiencies were developed as per the ABET accreditation guidelines. In the interest of the institutional mission to serve the community, it was proposed to offer the program in the areas of higher manufacturing needs and hence the regional campuses were chosen to offer this program. Faculty members, administrative staff, industry advisors and students collaborated on several fronts to develop a unique program. University resources such as the Manufacturing Institute, Course Design Institute, Office of Technology and Digital Innovation and Center for Design and Manufacturing Excellence, and Teaching and Learning Resource Center were utilized to develop the curriculum for this new program. Students and parents were excited about the four-year degree program being offered at the regional campuses. Since the cost of tuition, living and other expenses is low on regional campuses, students tend to stay for the entire degree program. This is the first technical degree program being offered at the regional campuses. Manufacturers emphasized the importance of essential skills that graduates should have such as critical thinking, problem-solving, adaptability, communication, and soft skills.

Since general mathematics and science courses were already being offered in the College of Arts and Sciences, engineering students could begin taking those courses as part of the engineering technology major. Curriculum development began in Summer 2019 and every summer new courses were being developed. Courses were all developed by Autumn 2023, but it was warranted that there will be revisions based on assessment data and recommendations from faculty. The goal was to develop all the core engineering technology courses during the summer to allow time for faculty/developers to focus and obtain industry feedback. Once the courses were developed, they were reviewed and approved by curriculum committees at all regional campuses, the College of Engineering, and the Office of Academic Affairs. The program was launched in Autumn 2020 during the pandemic, due to which the initial enrollment was not as expected for a new program, hence the low number of students in the graduating class.

A *unique* facet of this program is that is it only offered at regional campuses. Unlike other engineering technology programs across the country, the central campus does not offer the program. The reason for this arrangement is the demand to satisfy the workforce needs of the industries in the local areas surrounding the regional campuses. Another factor in this process is the lack of space and infrastructure to support this program at the central campus. Although it is offered at the regional campuses, the program is offered in the College of Engineering and receives resources and support as any other engineering program within the college. The program was launched in Autumn 2020 at three campuses and the fourth campus came on board in Autumn 2023. Even though the fourth campus started offering the curriculum three years later, the curriculum will be the same as offered at other three campuses.

II. Curriculum and Coursework

After discussions with the steering committee and stakeholders, it was obvious that the curriculum developed should not only address the needs of the manufacturing industry but also meet the ABET standards of high-quality education that prepares our graduates for the professional practice of engineering. Since it is the Engineering Technology (ET) degree with a manufacturing concentration, the focus of the curriculum is the foundational knowledge, skills and abilities (KSA) in manufacturing and mechanical processes, electrical and electronics, programming, industrial automation, robotics, operational excellence and leadership and safety and security.

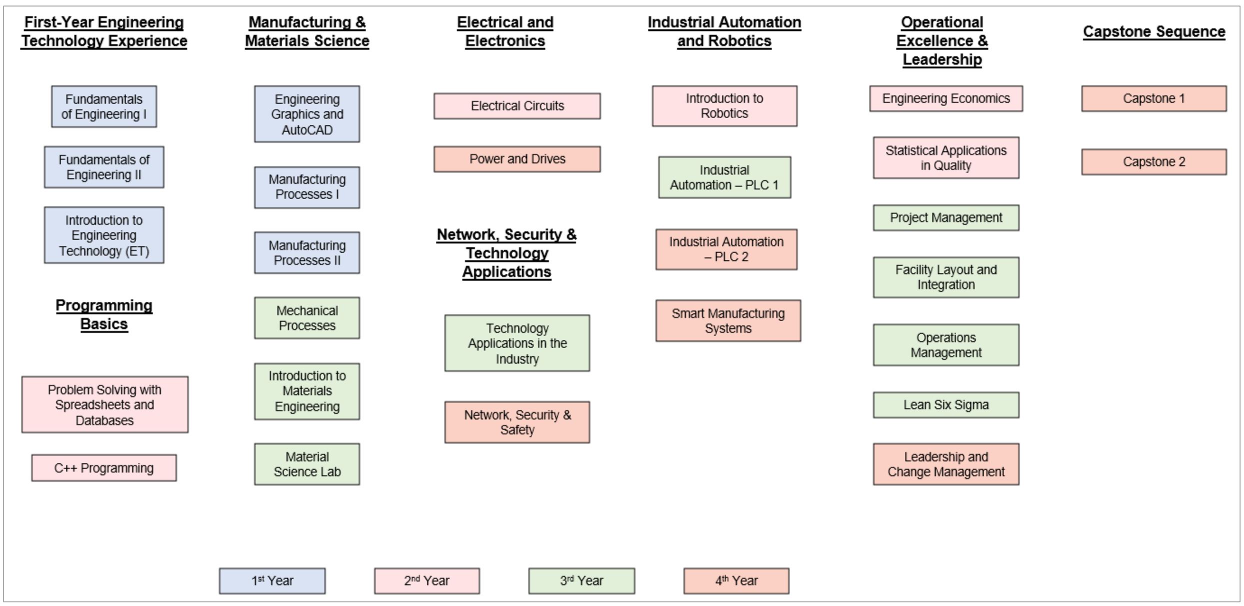

Figure 1: ***<u>Curriculum for the Engineering Technology Program</u>***

Students are required to complete 121 credits of undergraduate coursework including a one-year capstone in their final year. The curriculum involves several experiences of hands-on and project-based learning. A sample of the four-year coursework is shown in Figure 1. All the students are required to take courses in each of these pillars: *First-Year Engineering Technology Experience, Programming Basics*, *Manufacturing and Material Sciences, Electrical and Electronics, Industrial Automation and Robotics, Network Security and Technology Applications, Operational Excellence and Leadership and Capstone Sequence.* In addition to these courses, students take Chemistry, Physics I and II, and Calculus I and II offered through the College of Arts and Sciences. Since the previous publication of authors on the same program, the curriculum has been adjusted to accommodate all the regional campus's needs. Since it is one program offered at multiple locations, there is significantly more collaboration, resources and support needed to ensure consistency in course offerings. Most of the core courses are taken in the second and third years of the program. Technical core courses include Introduction to Electrical Circuits, Industrial Automation using Programmable Logic Controllers (PLCs), Mechanical Processes, Manufacturing Processes, Robotics, Network Security and Safety. The Project Management courses include Operations and Change Management, Facility Layout and Integration, Lean/Six

Sigma including Black Belt training and these courses are offered to provide students with an administrative and managerial skill set.

Several courses in this curriculum are lab-intensive reinforcing the application of KSAs attained in the lecture component of the courses. Students transferring from community colleges and technical schools have to submit a transfer request which will be reviewed by the CDAC committee and credits assigned to continue to the next level. Collaboration with the area technical schools helps the campuses attract talent and set up pathways for advanced careers in the manufacturing field.

All four regional campuses share the resources by co-listing some of the courses that could be offered in a remote setting. Faculty courseloads, course materials, software licenses, laboratory equipment and facilities are shared among the campuses to ensure the sustainability of the program. Faculty collaborates on course revisions; preparation of class schedules and owns the assessment of learning outcomes. This is one of the main facets of the ABET accreditation to ensure complete faculty involvement in setting up assessment tools, evaluating the results and providing feedback and recommendations for continuous improvement.

III. Defining Program Objectives and Student Outcomes

Accreditation agencies require all programs to assess student performance in order to attain and maintain accreditation status. However, there are no strict guidelines as to how the programs assess performance. Accreditation may be defined as a process for evaluating whether or not an educational institution or program meets specified standards of educational quality based on professional judgment [6]. The assessment process required to meet the guidelines for Criterion 3 and 4 forms the basis for the accreditation outcomes. If the assessment plan is effective and considers feedback from all the constituents, there is a higher chance that the program will be accredited. On the other hand, if there are concerns about the assessment plan, and evaluation of assessment data then the accreditation would be at risk. It is essential to demonstrate objectives and outcomes of the program are being measured and accomplished. ABET requires the program's educational objectives to be aligned and consistent with the mission of the institution and periodically reviewed to ensure they remain consistent. The program educational objectives must be communicated with the constituents and mapped to the curricula and learning outcomes to improve awareness.

- Objective 1: *Systems Thinking and Problem Solving*: The successful student will be able to effectively solve problems by applying the appropriate engineering technologies, tools, and techniques within systems of equipment, controls, and people.
- Objective 2: *Professional Skills/Communication*: The successful student will be able to demonstrate, appreciate, and master interpersonal communication skills in the modern workplace.
- Objective 3: *Business Management*: The successful student will be able to understand business terminology, analyze the value of alternatives, and communicate their business, societal and global impacts effectively.
- Objective 4: *Continuous Improvement*: The successful student will be able to optimize processes and systems with respect to quality, timeliness, and continuous improvement.

The authors published these program educational objectives in the previous papers [7-8]. Four program educational objectives (PEOs) were developed in 2019 before the complete development of the curriculum. However, they have been reviewed by the faculty and industry advisory council to ensure consistency with the current and future demands of the industrial market for our graduates.

The most influential characteristic of a successful program is the quality of assessment. Programs with Continuous, Consistent and Complete (C3) assessment processes are rewarded with accreditation and become exemplars for the community. Since the majority of the work involved in Self-Study reports is Criterion 3 and Criterion 4, there is a huge responsibility on the assessment teams/committees overseeing these processes. Student Learning Outcomes (SLOs) are broadly defined by ABET and documentation of periodic review and revision is expected for continuous improvement. For baccalaureate degree programs, there are five (5) SLOs defined under the general criteria and five (5) under the program criteria for manufacturing engineering technology or similar programs as seen in Table 1. Usually, courses within the program have course goals and outcomes already defined when the content was developed. Tracing them back to the program outcomes and proving that they have been met through assessment will help close the loop.

SLO 1	An ability to apply knowledge, techniques, skills and modern tools of mathematics, science, engineering, and technology to solve broadly-defined engineering problems appropriate to the discipline;
SLO 2	An ability to design systems, components, or processes meeting specified needs for broadly-defined engineering problems appropriate to the discipline;
SLO 3	An ability to apply written, oral, and graphical communication in broadly-defined technical and non-technical environments; and an ability to identify and use appropriate technical literature;
SLO 4	An ability to conduct standard tests, measurements, and experiments and to analyze and interpret the results to improve processes; and
SLO 5	An ability to function effectively as a member as well as a leader on technical teams.
SLO SME_a	Knowledge, skills and abilities in materials and manufacturing processes;
SLO SME_b	Knowledge, skills and abilities in product design process, tooling, and assembly;
SLO SME_c	Knowledge, skills and abilities in manufacturing systems, automation, and operations;
SLO SME_d	Knowledge, skills and abilities in statistics, quality and continuous improvement, and industrial organization and management;
SLO SME_e	Knowledge, skills and abilities in capstone or integrating experience that develops and illustrates student competencies in applying both technical and non-technical skills in successfully solving manufacturing problems.

***Table 1:** ABET Student Learning Outcomes*

Program-specific criteria apply to engineering technology degree programs with a concentration or a modifier in their titles. Our degree is focused on manufacturing engineering and industrial systems. Leadership skills will be necessary for manufacturing competitiveness and to enter careers in the manufacturing process. SME (the Society of Manufacturing Engineers) is dedicated to the advancement of manufacturing and leads the industrial ecosystem by elevating manufacturers, academia and the communities in which they operate [9]. According to SME, Manufacturing holds the key to economic growth and prosperity. The purpose of SME is to advance manufacturing to drive competitiveness, resiliency, and national security. Hence, the Society of Manufacturing Engineers (SME) program criteria have been adopted for instruction and assessment of learning outcomes. For this study, the ABET student outcomes from the general criteria are numbered and the program criteria are labeled as SME_*letter* with a *letter* representing a through e SME outcomes. Performance indicators are defined for each learning outcome which are measurable and help identify the level of attainment. These performance indicators are mapped to introductory, intermediate and advanced courses.

A portion of this mapping completed for this program is shown in Table 2. Since the degree has a manufacturing concentration, the goal is to provide graduates with technical, management and leadership skills in system design, operations and maintenance. Therefore, we rely on the Society of Manufacturing Engineers (SME) to offer guidance on program criteria.

Engineering Technology Courses	**ABET SLOs**									
	1	2	3	4	5	SME_a	SME_b	SME_c	SME_d	SME_e
Manufacturing Processes I and II		x		x		x	x			
Intro. to Engineering Technology Topics			x					x		
Engineering Graphics			x					x		
Electric Circuits	x		x	x						
Intro. to Robotics	x	x						x		
Problem-Solving - Spreadsheets & Databases	x									
Material Science with Applications			x	x		x	x			
Project Management	x	x	x		X				x	
Statistics with Applications in Quality	x			x					x	
Mechanical Processes				x		X	x	x		
Industrial Automation PLC 1 and 2	x	x	x	x	X			x		
Power and Drives	x		x		X	x		x	x	
Facility Layout Integration	x	x	x			x	x	x		
Leader/Change Management			x		X				x	
Lean/Six Sigma	x	x	x		X				x	x
Capstone 1	x	x	x			x				x
Smart Manufacturing Systems	x	x	x	x	X	x	x		x	x
Technology Applications in Industry	x	x			X	x		x	x	
Capstone 2			x	X	X	x	x	x	x	x

Table 2: <u>Mapping Courses to ABET Student Learning Outcomes</u>

Student learning outcomes are assessed in homework, quizzes, lab assignments, project reports and presentations, team evaluations, and exam questions. Faculty from all four regional campuses meet regularly to map outcomes and plan for assessment using planning guides. The assessment team has compiled a planning guide to help train the faculty on the ABET verbiage and map the learning outcomes to the appropriate assignments in the course. A course coordinator is assigned for each course and is responsible for ensuring consistency of the content and its delivery and supporting the faculty. The course coordinator meets with the ABET team every semester the course is offered to review the mappings, complete the planning guide and collect feedback from the instructors.

IV. Program Constituents and Governance

Before the arrival of the inaugural class of students in Autumn 2020, the steering committee and the assessment team have been identifying educational objectives, and constituencies of the program and brainstorming on the assessment methods and tools [10]. As part of a state-funded academic institution, the program will have many stakeholders or constituents. The following constituents have been identified for our program:

- Industry and Employers of Program Graduates – Graduates should be able to make significant contributions to the success of their employers. The Industry Advisory Council (IAC) has been established as an external constituency with representatives from all the manufacturing facilities within the geographic areas of regional campuses. The members of the IAC are leaders in their respective fields.
- Alumni - Our graduates must be prepared with the knowledge and skills for successful engineering technology careers or advanced studies.
- Current Undergraduate Students - Our program must provide an environment that fosters the success and accomplishment of our current students. We have student representation in CDAC and other committees within the program.
- Faculty - Faculty play a critical role in identifying the needs of students and building mechanisms to help students flourish in their courses. The faculty collaborate on a different level since they belong to different campuses, they all come together as a team to bridge the gap due to geographical constraints and ensure the program accomplishes its goals.
- Administrative Staff – The academic director works with the deans of each regional campus to ensure all operations are running smoothly. They help organize curriculum, manage alignment of faculty, enrollment, advising, and career services and support student success.

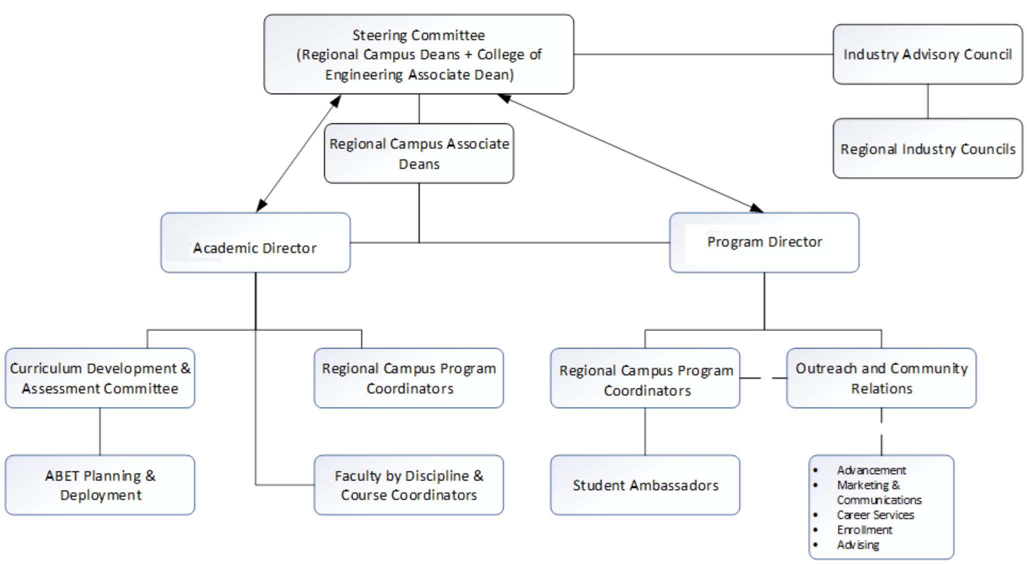

Figure 2: Program Governance

The program governance was established recently to ensure the program runs smoothly across all regional campuses. A portion of the governance chart adopted by our program is shown in Figure 2 above. Since the program is offered at four regional campuses, the above governance chart helps everyone navigate through the process and continue executing their respective tasks. It also becomes necessary to document the responsibilities of each role to ensure accuracy and avoid any conflict. A short explanation of the roles and responsibilities is provided in Table 3 below.

Lead Role	Responsibility
Regional Campus Deans	Serve on the Steering Committee, liaison to University's Academic Affairs Committee, lead and support faculty assignments and schedules, support advancement/development opportunities and conduct faculty hiring
Program Academic Directors	Organize curriculum and ensure consistency of program across all regional campuses, manage alignment of faculty, enrollment, advising, career services, etc., support student success and collaborations with industry and supervise regional campus leads
Regional Campus Faculty Leads and Course Coordinators	Coordinate courses to ensure consistency across campuses and programs, manage class schedules and maintain lab inventory
ABET Planning & Deployment Team	Manage ABET accreditation process, oversee the planning, deployment, data collection and evaluation of assessment results
Advisors	Advise students and work with the admissions office
Curriculum Development & Assessment Committee (CDAC)	Review and approve course development and revisions, review and approve credit transfer requests, ABET oversight and planning
Career Services	Coordinate internships and oversee industry collaborations
Enrollment	Student recruitment
Marketing & Communications	Support program messaging, promotional prints, social media and other communication channels, website development and interview students and compile testimonials
Outreach & Community Engagement	Coordination of advancement efforts, marketing & communications to local schools, career services, enrollment, retention and other advising functions
Student Ambassadors	Outreach, "Hometown ambassadors" to K-12 schools and technical schools

Table 3: Responsibilities of the Lead Program Roles

V. Assessment and Evaluation Plan

The Engineering Technology program has employed the best practices from several peer institutions and ABET programs to develop an assessment and evaluation plan that serves our constituents in an effective way [11]. The goal of this assessment and evaluation plan is to ensure that the engineering faculty is capable of creating, maintaining, and monitoring the performance of students related to the SLOs. As mentioned earlier, faculty involvement is an essential facet of the assessment and evaluation process.

Assessment Team

In the previous papers, the formation of the assessment team was discussed including the required training. The Assessment team is the foundation for our assessment and evaluation processes and is the faculty team with prior ABET accreditation experience. The team was trained on Institutional

Data Policy (IDP) to ensure data security and protection of the university's institutional data. The team also completed Canvas Affiliate training to be able to import outcomes into courses. Additional training modules include the Family Educational Rights and Privacy Act (FERPA) and CyberSecurity training.

After the Curriculum Development and Assessment Committee (CDAC) was formed, the ABET accreditation and assessment responsibilities were integrated within this governing body along with curriculum revisions, credit transfers and other businesses. The major tasks of the assessment team are:

- Initiating the course coordinator and faculty meetings at the start of the semester;
- Planning, scheduling and conducting assessment-focused faculty training, especially for new instructors;
- Updating assessment and evaluation plan as needed;
- Administering faculty and student surveys;
- Documenting feedback and recommendations to report out to CDAC committee;
- Preparing Readiness Review documents and Self-Study report.

Data Management System

Assessment data and its evaluation are necessary components of any accreditation. Whether it is a direct assessment or an indirect one, the results help the program close the loop for continuous improvement. And, due to the institutional data policies reinforced at higher education institutions, there is a requirement to store the data on university-managed systems. Student education records are private data for the university and must be stored on the university-managed cloud storage system.

At this institution, a Microsoft Office application named OneDrive is used for file hosting, storage and sharing. Shared folders are created to store not only student artifacts and assessment results but also accreditation-related supporting documents. Information about the program development, course offerings, schedules, faculty CVs, syllabi, assessment results, etc. resides on the cloud. With four regional campuses, it is necessary to carefully organize the data relevant to each campus. Since it is the first engineering technology program at the university, the program will be seeking an initial accreditation which might require a readiness review. Therefore, an effective strategy is to follow the Self-Study template for ETAC to organize the content for each campus. According to the readiness review document, folders are created and organized systematically. Instructors are only given access to a shared folder where student artifacts and assessment results are to be stored.

Mapping Student Learning Outcomes to Courses

Effective assessment process, periodic review of student learning outcomes and educational objectives and proper documentation are requirements of programs requesting initial accreditation. For the past several years, direct and indirect assessments of student outcomes and program objectives have become the assessment standards for engineering and engineering technology programs. Direct assessment involves mapping student learning outcomes to tests, homework problems, projects, and other assessments in the course and collection of student submissions. It also requires analysis and interpretation of results to provide recommendations for changes to the courses. To perform the direct assessment, the team began scheduling meetings with the faculty to map out student learning outcomes. Since third- and fourth-year courses were recently developed, the course developers were required to incorporate ABET student learning outcomes in the syllabi and map those out to assessments in the course.

Prior work on ABET accreditation and assessment of student learning outcomes describes performance criteria, vectors, and indicators to be the guidelines for measuring student performance [11, 12]. For this program, the assessment team developed performance indicators that are measurable and used to assess competencies. These were discussed in the previously published papers. Table 3 provides a snapshot of the performance indicators used for two student learning outcomes (SLO4 and SLO_SME_c). The rationale assess student learning outcomes in the first semester was to ensure students' progress is monitored from the first year as it is a new program. The assessment team decided not to assess mathematics and physics courses since those were not regulated by the College of Engineering and monitoring assessment was tedious. Therefore, only first-year engineering and engineering technology courses were considered for the assessment of student learning outcomes. Another unique characteristic of this program is that all engineering and engineering technology students take common introductory courses such as Fundamentals of Engineering I and II. This allows students to transfer in/out of the program conveniently without losing any credits. Therefore, it is necessary to identify and segregate engineering technology students for assessment purposes. So, the assessment team identified engineering technology students from the enrollment data and shared that information with the faculty to perform assessments for only those students.

ABET SLOs	Performance Indicator (PI)	Course
SLO4 - An ability to conduct standard tests, measurements, and experiments and to analyze and interpret the results to improve processes	SLO4_a: Read and follow the design experiment procedure. (Knowledge)	ENGR 1181, ET 1500, ET 2300, ET 2500, ET 3100, ET 4300
	SLO4_b: Collect measurement data on appropriate variables. (Application)	ENGR 1181, ET 1500, ET 2300, ET 2500, ET 3100, ET 4300
	SLO4_c: Analyzes and compares the experimental data and results to the theoretical models. (Analysis)	ET 2300, ET 2500, ET 3100, ET 4300
	SLO4_d: Explain the observed difference between the model and experiment and offer basic explanations. (Evaluation)	ET 2300, ET 2500, ET 3100, STATS 3440, ET 4300
	SLO4_e: Draw conclusions by interpreting results and provide recommendations to improve processes. (Conclusion)	ET 2300, ET 2500, ET 3100, ET 4300
SLO_SME_c – Knowledge, skills, and abilities in manufacturing systems, automation, and operation	SLO_SME_c1: Applies knowledge, skills, and abilities in manufacturing systems	ET 1600, ET 2100, ET 3600, ET 3900, ET 4200
	SLO_SME_c2: Applies knowledge, skills, and abilities in automation	ET 2100, ET 3600, ET 3900, ET 4200
	SLO_SME_c3: Applies knowledge, skills, and abilities to describe the operations of a manufacturing process	ET 3600, ET 3900, ET 4300

Table 4: ***Performance Indicators for SLO 4 and SLO_SME_c***

Table 4. shows that the performance indicators were mapped to at least three courses in the program to obtain statistically significant results for the attainment of the outcome. This was done intentionally to address the lack of data for assessment in the first couple of years and to monitor student progress. In case of course cancellation, data from another course could be assessed to measure the competence of the outcome or an indicator. Also, this mapping will be revised based on faculty feedback after the initial offering of the courses. In addition to laying down the measurable indicators, faculty can utilize the description of these indicators within the rubrics set up in the LMS.

Assessment Tool and Rubrics

Most of the courses offered at all the regional campuses utilize the learning management system (LMS) to deliver the course content. *Canvas* is used as a Learning Management System for the assessment of performance indicators and eventually the student learning outcomes. Curriculum development experts have offered support to the faculty developing engineering technology courses and setting up the framework in Canvas. In addition to creating assignments, quizzes and exams in the system, rubrics are also developed to streamline the process of outcomes assessment.

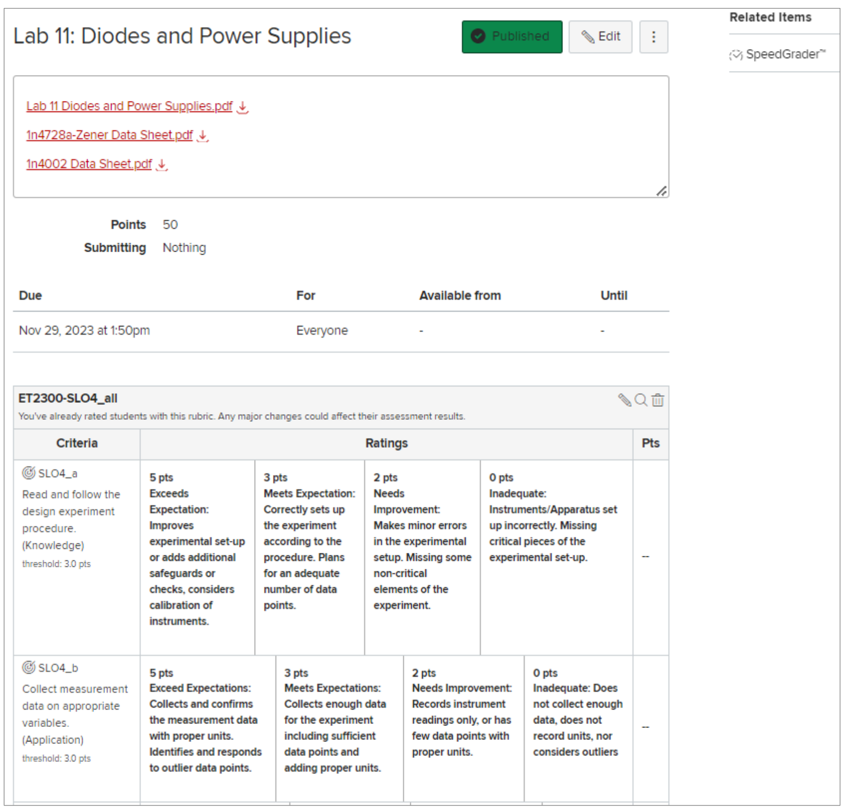

***Figure 3:** <u>Canvas LMS – Instructor view of the Performance Indicators SLO4_a and SLO4_b</u>*

Rubrics were developed using a standard 5-point Likert scale with 5: Consistently exceeds expectations, 4: Exceeds expectations, 3: Meets expectations, 2: Needs Improvement, and 1: Inadequate. Since the rubrics for performance indicators were developed outside of Canvas, the scales were consolidated into four main categories: 5-4: Exceed Expectations, 3: Meets

Expectations, 2-1: Needs Improvement, and 0: Inadequate. Figure 3 above shows the instructor's view of the rubric within the Canvas LMS for the performance indicator (SLO4_a and SLO4_b). An instructor's view of another performance indicator is shown in Figure 4 below. This is for SLO_SME_c outcomes.

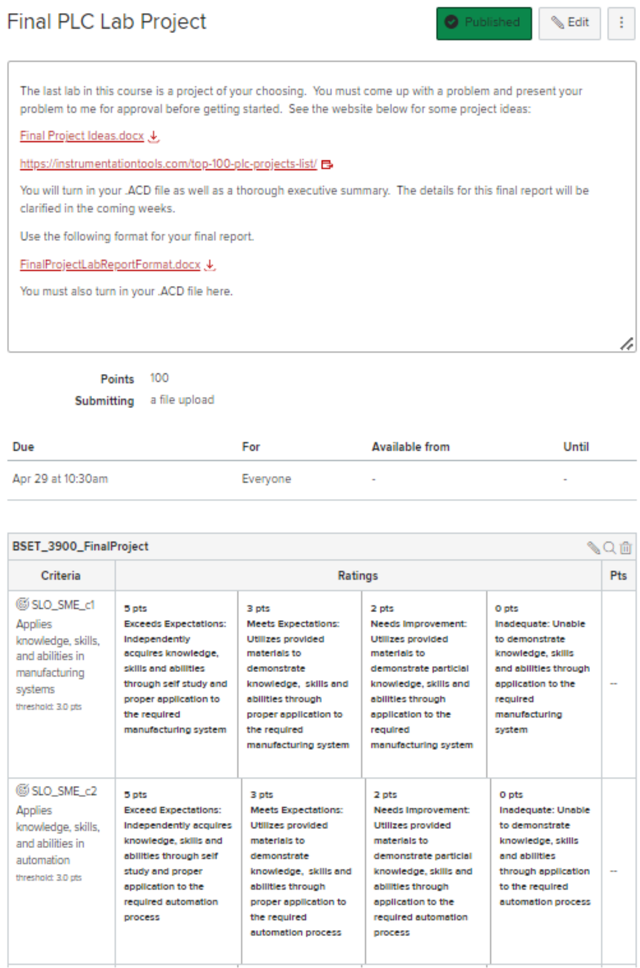

Figure 4: ***Canvas LMS – Instructor view of the Performance Indicators SLO_SME_c1 and SLO_SME_c2***

Assessment Cycle

Instructors teaching the courses at each regional campus are responsible for conducting assessments of SLOs. This is to ensure the assessment results are based on the instructor's observations of the students and their performance in class. The assessment process must be periodic to allow continuous improvement and must be owned by the instructors. This program utilizes two assessment cycles: Cycle A - odd academic fiscal years (2021, 2023, etc.) and Cycle B – even academic fiscal years (2020, 2022, etc.). Any outcomes not being attained in a specific cycle will be assessed in the following cycle. To ensure continuous improvement, the feedback from instructors and student evaluations is incorporated into future course offerings. These changes will be documented in the Self-Study report and the planning guides are updated accordingly. The course coordinators are responsible for ensuring all instructors are approving the recommendations to the ABET team and eventually to the CDAC committee.

Assessment Results and Discussion

Continuous improvement is a necessary concept in higher education as it defines the framework for assessment and evaluation, which is required by accrediting agencies. The main idea driving the continuous improvement process is to know whether the program can demonstrate if the degree has prepared students for the careers that they intend to pursue. The assessment results of SLOs can provide support to identify strengths and weaknesses of the program and its operational processes. Assessment processes that focus on the continuous improvement of the program produce results that can be systematically used by faculty and administration in meaningful ways.

Programs often struggle with deciding what data to collect and ensuring the data is measurable. In addition, our assessment process should show how results are applied to further improve our program. Documentation is critical in assessment especially for program evaluators and program chairs at the time of site visit. As part of the outcomes assessment, instructors are trained on the Learning Mastery Gradebook and Rubrics features of the Canvas LMS. During the semester, instructors conduct the assessment of student learning outcomes and download the learning mastery results from Canvas after the semester ends. Any recommendations for improvement, either from the course instructor or from the assessment team are documented.

Results from Autumn 2023 assessments for one of the SLO is shown in Figure 5 below. As evident from the figure, the performance indicators are mapped to more than one course and the actual percentages are calculated to report the overall percentage of the attainment of the outcome. Since the assignment could be scheduled in different weeks of the semester, the title of the assignment might vary from campus to campus. Therefore, it is critical to identify the title of the assignment in addition to recording the results. This is also to ensure appropriate assignments are downloaded from Canvas for the documentation of student artifacts.

ABET Student Outcomes - General Criteria	Performance Indicators	Cycle B - FY2024 - AU2023	
		Assignment	Assessment Score
(4) an ability to conduct standard tests, measurements, and experiments and to analyze and interpret the results to improve processes	a) Read and follow the design experiment procedure. (Knowledge)	ET 2300 - Lab 9 - Power Supplies Lab Worksheet (All 3 Campuses) ET 3100 - Lab 2 Report (Campus 1, 2), Lab 3 Report (Campus3)	100.00 % 94.44 %
	b) Collect measurement data on appropriate variables. (Application)	ET 2300 - Lab 9 - Power Supplies Lab Worksheet (All 3 Campuses) ET 3100 - Lab 2 Report (Campus 1, 2), Lab 3 Report (Campus3)	100.00% 97.22 %
	c) Analyzes and compares the experimental data and results to the theoretical models. (Analysis)	ET 2300 - Lab 9 - Power Supplies Lab Worksheet (All 3 Campuses) ET 3100 - Lab 2 Report (Campus 1, 2), Lab 3 Report (Campus3)	91.67% 94.44 %
	d) Explain observed difference between model and experiment and offer basic explanations. (Evaluation)	ET 2300 - Lab 9 - Power Supplies Lab Worksheet (All 3 Campuses)	83.33%
	e) Draw conclusions by interpretting results and provide recommendations to improve processes. (Conclusion)	ET 2300 - Lab 9 - Power Supplies Lab Worksheet (All 3 Campuses)	100.00%

Figure 5: __Evaluation of SLO_4 based on assessment results__

Assessment results from each campus are gathered from the Learning Mastery Gradebook in Canvas LMS and average scores are obtained for all four campuses. Figure 6 shows the results obtained from each campus for Lab 9 of the ET 2300 course which assesses all the performance indicators of the same SLO_4 outcome as seen in Figure 5. In this case, the results meet the target of 75% attainment for each assignment. However, in case of lower assessment scores, instructors are required to document any issues or concerns with the assignment and or performance indicators. Based on the discussions with the course coordinators, the assignments are revised to clarify instructions or another assignment is mapped to the outcome. The assessment team meets with the course coordinators to finalize the recommendations to the CDAC committee for approval in the following cycle. This provides some guidance on the assessment process and history of the curriculum for the ABET Self-Study report.

ABET Student Outcomes - General Criteria	Performance Indicator (PI)	Course	Assignment	Percent Scores - Campus1	Percent Scores - Campus2	Percent Scores - Campus3	Percent Scores - Campus4	Percent Scores - AVERAGE	Instructor Feedback and Comments
SLO_4: An ability to conduct standard tests, measurements, and experiments and to analyze and interpret the results to improve processes	SLO4_a	ET 2300	Lab 10 - Power Supplies Worksheet	100.00%	100.00%	100.00%	100.00%	100.00%	
	SLO4_b			100.00%	100.00%	100.00%	100.00%	100.00%	
	SLO4_c			100.00%	100.00%	75.00%	91.68%	91.67%	
	SLO4_d			100.00%	100.00%	50.00%	83.32%	83.33%	
	SLO4_e			100.00%	100.00%	100.00%	100.00%	100.00%	

Figure 6: ***<u>Evaluation of SLO_4 assessment for all four regional campuses</u>***

A Qualtrics survey has been developed for indirect assessment and has been distributed among the instructors to complete at the end of the semester. Student evaluation of the course at the end of each semester is used as feedback on course delivery and instruction. Other feedback from course coordinators is compiled in the planning guides which helps gather more evidence-based evaluation and offer recommendations for improvement. Other information collected from the instructors includes curriculum worksheets with information about their classes such as course numbers, lecture/lab schedule, and delivery modes. They also upload the syllabus to the shared OneDrive folders.

VI. Strategies and Best Practices

Based on the results and feedback from the implementation of the assessment process, the authors believe that some of these strategies will help the new programs get ready for ABET accreditation. Although several changes are being implemented at the time the paper is compiled, it is our responsibility to share what we learned with the engineering technology community. Some of the best practices are discussed below:

- *Formation of ABET Assessment Team*: Training the team members on the assessment of student learning outcomes is critical for the assessment plan collecting reliable assessment data. The team members will benefit from attending the ABET annual symposium and learning from other programs and their experiences. Attending workshops and listening to other programs provide knowledge to develop measurable performance indicators for each learning outcome. Training on institutional data policy, LMS, and file storage systems must be mandated by the programs. Every institution uses licenses that allow for certain features of the tools. However, having rubrics feature in the LMS is the best approach for assessment. Faculty needs to be trained on rubrics within the LMS not only to streamline grading but also for assessment and feedback.

- *Documentation for Assessment using University-Managed Cloud Storage Systems*: Most of the higher education institutions utilize LMS and Cloud Storage System and grants storage spaces to students and employees. One of the strategies to store student artifacts is to utilize the university managed cloud storage due to the confidentiality of the information contained in those documents. Class rosters, student IDs, names, grades, faculty names are possibly included in the assessment records. Therefore, relying on a university managed system is an effective approach. During COVID-19, ABET had conducted online reviews of the programs and had to rely on their university-managed storage systems to access data, assessment and evaluation records. It has become a practice for program evaluators (PEVs) to request the materials from the program before the site visit to learn about the program and come prepared. This has enhanced the ability of all institutions to use these systems for assessment data. It is recommended that the programs utilize the Self-Study templates as a guide to organizing the folders on the cloud system. For instance, Criterion 2 requires documentation for program educational objectives (PEOs) and the review process. Therefore, the assessment team could organize this criterion based on the template as seen in Figure 7. Instructor feedback, evaluation of assessment data and other relevant information are also stored in sub-folders for Criterion 4 based on action items. Instructors must be granted access to the “Student Archive” folder so that they can upload artifacts from the LMS. It is recommended that institutions follow the same approach for easy access to the material.

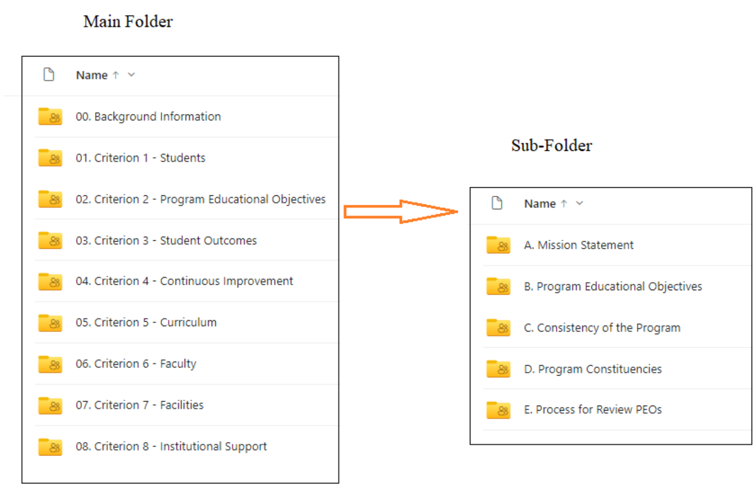

Figure 7: ***<u>Organization of folders on university-managed cloud storage system</u>***

- *Utilizing LMS as a tool for assessment:* It has become a practice to develop competencies/rubrics to assess learning outcomes using measurable performance indicators. The scales could vary from program to program but the consistency across all performance indicators and outcomes in critical. Utilizing the LMS for assessment will be an effective time-saving technique, especially for programs that use such systems for content delivery. The assessment team has created rubrics in Canvas for each course of the program. When a new course is offered, the faculty is provided with a shell to import the content and along with that they import the outcomes in their courses. Assessment team discusses the mappings with the faculty and imports the rubrics into the assignments to facilitate the instructors in completing their assessments. Another use of the LMS is to prepare assessment reports. Most LMS allows a report to be exported that shows the outcomes, performance indicators and assessment results. Once exported, these could be used for evaluation and discussion for continuous improvement.

- *Effective Communication with all Constituents*: Collaboration among administrative staff and faculty at all regional campuses is necessary for a successful and effective program. The accreditation process demands effective communication of the objectives and expectations of the program from all stakeholders. Accreditation of the program not only grants credibility to the programs but also acknowledges the efforts of the faculty and administration that strive for academic excellence. For programs offered at multiple locations, this is the most challenging part of the accreditation process. The administration plays a huge role in setting expectations and guidelines for each of the constituents. Instructors must be informed about the expectations and time commitment for the assessment of learning outcomes. For programs like these which are offered at different campuses, faculty interactions will result in an inclusive environment that fosters teamwork and growth. Building collaborations with industry partners and interacting with the industrial advisory council regularly allows faculty to explore new topics and create projects to incorporate into their courses.
- *Course Coordinators*: The need for creating an authoritative role for each course was necessary for this program since the faculty is spread across four regional campuses. Assigning a faculty member who is a subject matter expert and has an understanding of the assessment process to serve as a course coordinator became evident. New hires in the program need mentoring to adapt to the university policies and procedures. So, the course coordinator helps facilitate the training for the new hires. Course coordinators will also manage the content of the master shell in the LMS and grant access to those faculty members teaching the course. It helps streamline the content delivery, systematic grading and assessment of learning outcomes. They are also required to gather feedback and recommendations and forward those to the assessment team for continuous improvement. This is done in the form of planning guides and reports.
- *Building Partnerships with Industry and Academic Representatives*: Partnerships with industry and local businesses provide support to undergraduate and graduate programs. An advisory council must be established and members from local industries should be invited to provide feedback on how the program is doing. Their feedback will help shape the future of graduates who will be prepared to tackle current challenges in the industry. In this program, each campus pursues partnerships with local industries on several fronts (freshmen orientations, lunch and learn sessions, professional development workshops and industry seminars). Industry professionals are also invited to review the curriculum and offer feedback on content and laboratory exercises. The council is encouraged to support capstone courses by sponsoring projects and assisting with future internship or Co-op experiences. Students are invited to advisory council meetings to network with potential employers.
- *Professional Development and Equipment grants to help sustain programs*: Additional funding is a resource for programmatic improvements and professional development of faculty, staff and administration. Administrative staff have submitted several grants to federal and state agencies and have been successful in acquiring funds to support this

program. Faculty and administration can collaborate on several grants to request funds to help sustain the curriculum development and travel for faculty to attend conferences and workshops. Industrial advisory council will serve as a moderators to potential grants and assist in application process.

Summary and Future Work

In this paper, the authors presented a thorough assessment plan being implemented to prepare for the initial accreditation of the engineering technology program. The assessment plan was successfully used for the preparation of the initial accreditation request. This paper aims to guide new engineering technology programs in developing assessment processes for ABET ETAC accreditation. Although ABET provides updates every year about criteria for accreditation, there is no standard process prescribed for the attainment of student learning outcomes. Curriculum, instruction, personnel, facilities, and processes vary from program to program. The authors believe that this paper will help institutions offering programs at multiple campuses develop a robust process for program assessment. The Program Educational Objectives must be developed based on the mission and vision of the institution. Developing measurable performance indicators for each of the student learning outcomes will help align the coursework to ABET criteria. Indirect assessments such as course evaluations, faculty surveys and capstone surveys would help provide recommendations for continuous improvement.

In Autumn 2023, the assessment team prepared the instructors teaching Capstone courses for assessment of all the SLOs. At the end of Spring 2024, assessment results will be evaluated from two-semester Capstone courses along with the feedback and recommendations from instructors to close the loop on several outcomes. More data has to be collected to evaluate the efficacy of the program; however, improvements have been made over three years and the introductory and intermediate courses have been refined. The challenge is to sustain this assessment process over time since several new faculty are being hired at the regional campuses. Training new faculty and ensuring that they maintain the same level of interest in assessment is difficult. A comprehensive assessment program will contain both direct and indirect assessment methods to maximize the strength and validity of an approach.

The Industrial Advisory Council (IAC) is also playing a crucial role in curriculum revisions to incorporate industrial standards into the program. Capstone projects are being sponsored by the industry that needs the graduates from this program. The assessment team is part of IAC to help bridge the gap between industry professionals and faculty. IAC also reviewed the PEOs and the CDAC has approved the changes. With all these processes in place, the assessment team believes that a cohesive plan has been established for the ABET accreditation process. After attending the annual ABET symposium, the assessment team has begun compiling documents and preparing a Self-Study report for initial accreditation. The authors plan to continue sharing the best practices and lessons learned as this program progresses through the ABET accreditation process. The authors will strive to contribute to the community of ETAC programs offered at multiple campuses and help guide them through the process as they continue to overcome the challenges and build a successful assessment program.

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