AC 2008-290: APPLIED ENGINEERING TECHNOLOGY PROGRAM'S CURRICULUM

Vladimir Genis, Drexel University

Dr. Vladimir Genis, Associate Professor and Program Director of Applied Engineering Technology in the Goodwin College, Drexel University, taught and developed graduate and undergraduate courses in physics, electronics, nondestructive testing, biomedical engineering, and acoustics. His research interests include ultrasound wave propagation and scattering, ultrasound imaging, nondestructive testing, electronic instrumentation, piezoelectric transducers, and engineering education. He serves as a member of the Drexel's Faculty Senate.

Gerry Marekova, Drexel University

Gerry Marekova is the Program Manager for Applied Engineering Technology in the Goodwin College of Professional Studies at Drexel University. She has a Bachelor of Science Degree in Business Administration with major in Marketing and is currently pursuing her Master Degree in Higher Education Administration at Drexel University. Her responsibilities include scheduling classes, maintaining partnership programs with community colleges and high schools, and mentoring current and prospective students. She has a strong interest in curriculum and program development.

Applied Engineering Technology Program's Curriculum

Abstract

Drexel University is the leading institution of higher education in the Delaware Valley and Greater Philadelphia region that offers a Bachelor of Science (B.S.) degree in Applied Engineering Technology (AET). The AET program was initiated as a response to job- and education-related issues expressed by government, academic institutions and industries across the nation. Since fall of 2002, Drexel has been offering its AET major in collaboration with the Delaware County Community College (DCCC) under a dual model, in which the students can pursue both associate in applied science (A.A.S.) and B.S. degrees concurrently at DCCC facilities. In fall 2004, the AET major became available to the students at Drexel wishing to pursue the B.S. degree on a full- or part-time basis. Starting in the fall of 2006, the AET major became available as a degree completion to New Jersey residents due to a new partnership between Drexel University and Burlington County College (BCC) with both full- and part-time enrollment options.

The AET program's content provides an integrated educational experience directed toward developing the ability to apply the fundamental knowledge gained in the Drexel's Goodwin College to the solution of practical problems in the engineering technology fields. The program's curriculum, which is comprised of Electrical, Mechanical, and Industrial concentrations, places emphasis on the application of theory rather than on derivations and proofs. The majority of courses are fully integrated with training and laboratory experience and extensive use of software and industrial case studies.

Introduction

The Applied Engineering Technology (AET) program's co-op-based curriculum offered by the Goodwin College at Drexel University is described in this work. The AET program is based on a cyclic model of the relationship between knowledge production and improvement of practice in undergraduate education and clearly distinguishes itself from traditional engineering programs in the following ways:

- It forms the bridge between the engineer/scientist and the technical and/or production workforce.
- The curriculum places emphasis on the application of theory rather than on derivations and proofs.
- The majority of courses are fully integrated with training and laboratory experience, extensive use of software and industrial case studies.
- Faculty members with extensive industrial and academic experience support the program.

The goals of Drexel's Applied Engineering Technology program are:

- To become a national model for the delivery of high-quality, affordable, technically-oriented education by focusing on student-centered learning and the integration of hands-on laboratory and industry-based experiences.

- To create a flexible curriculum that is responsive to the workplace and which incorporates advances and the best practices in science and technology.
- To increase the number of traditionally underrepresented students (low-income, ethnic and racial minorities, persons with disabilities, and women) in AET program.
- To provide students with a strong foundation of engineering practices and stimulate students' interest by using a problem-solving approach in state-of-the-art laboratories.
- To provide students with leadership, management, and communication skills, as well as an understanding of professional ethics, which will serve as a foundation for future development and success in their careers.

To achieve these goals and improve the learning, Goodwin College is in the process of expanding and upgrading its educational facilities. The developed educational laboratories serve as training centers for undergraduate AET students as well as for the workforce of companies, such as Boeing, Lockheed Martin, and PECO Energy, with whom Drexel has a rich history of educational and research partnership. After careful consideration and discussions with the largest employers in the Atlantic region, and based on our research, educational, and engineering experience, we came to the conclusion that the creation of the hands-on approach to teaching and learning would significantly benefit our students and working engineering personnel. Engineering education is changing with its focus shifting from the traditional theory-based curriculum to more team-based learning, problem solving with open-ended solutions, additional hands-on projects, and team-oriented communications.[1] Furthermore, many manufacturing jobs in the tri-state area (PA, NJ, and DE) have been lost to outsourcing, creating a growing need for engineering technologists who can competently maintain and service existing equipment and provide support to the designers and engineers. Addressing the needs for skilled engineering workers is a required competitive and survival strategy for most manufacturers. [2]

Students' recruitment

Drexel University is located in West Philadelphia and is surrounded by a large number of public schools where the majority of students are women, minorities, and underrepresented groups (WMUGS). Moreover, the AET dual program has been launched in collaboration with area community colleges and technical schools where women and minorities are present in significant proportions. Historically, Drexel has succeeded in developing the procedures necessary for attracting these underrepresented groups to its programs, despite its relatively higher tuition fees when compared to the state universities. One of the major problems in attracting underrepresented groups of students is the lack of information about existing programs available to students while they are still in high school. To help resolve this problem, Drexel University initiated a partnership program with the Philadelphia School District three years ago. Under this program, high school students engaged in the pre-engineering curriculum can take Drexel's three-credit courses and collect up to 18 credits toward a B.S. degree if the earned grades are A, B, or C. The following laboratory / project-based courses have been taught to the students who participated in this program within the AET major:

1. Introduction to Applied Engineering Technology.
2. Graphical Communications.
3. Introduction to Electric Circuits.

During the past three years, the AET faculty and administration have been developing articulation agreements with local high schools and have taught pre-engineering courses to high-school students from the Philadelphia School District. Course syllabi include experiments and procedures that encourage the students' interest in furthering their study in the AET field. For example, during the Introduction to Applied Engineering Technology course, groups of students (three students per group) build a motorized car. The students then evaluate the gear ratio to design the car so that it can achieve the maximum speed and can carry the maximum weight. After completion of the project, groups of students participate in a competition (Figure 1), with the winning group receiving a prize.

Figure 1. Design of the motorized car (left).
A group of students participates in the competition (right).

The project was featured on the website of the SAE foundation, which donated the car kits to Drexel's AET program (www.sae.org/foundation/awim/newsletter/200510.pdf). It inspired pre-engineering program students to join the AET program after graduation from high school. The AET faculty and the program manager have visited local high schools, including Haddon Township High School, Clearview Regional High School, Middle Bucks Institute of Technology, and Eastern Center for Arts and Technology to actively promote the AET program with an emphasis on recruiting female and ethnic minority students.

Throughout each year, the AET faculty and program manager have hosted Drexel's Shadow Days, numerous information sessions, and open houses. During Shadow Days, high school science teachers and students were introduced to the AET laboratories and participated in hands-on, real-time laboratory experiments (Figure 2).

Figure 2. Students and teachers from the local high schools during the Shadow Day.

AET faculty members participate in the Delaware Valley Science Fair as judges in the areas of physics and engineering. Students from regional high schools presented projects that were developed without constant supervision of their teachers. A significant number of students were comprised of women, minorities and underrepresented groups. During the competition, local companies, universities, and community colleges presented advertisement materials to attract students to their educational programs. In the past three years, Goodwin College has participated in this event by distributing AET fact sheets to students interested in pursuing their careers in applied engineering technology. These efforts will continue in the future.

AET program's curriculum

The higher education is rapidly evolving to reflect the industry needs.[3] The global marketplace is becoming more competitive, resulting in advanced approaches to higher education in engineering and engineering technology, specifically in educating students using quantitative and qualitative measures.[4] The need for a technologically literate and dynamic workforce dictates the requirements for a flexible curriculum, which provides students with knowledge and experience in extremely competitive environment, creates critical thinking skills, and promotes real-time decision makers.[5,6]

The objective of AET program curriculum is to combine the solid foundation in mathematics, physics, and chemistry with fundamental knowledge of the course materials and real-world technological practices. The majority of the courses have laboratory/project components using Goodwin's state-of-the-art laboratories. As has already been mentioned, the AET program comprises of Electrical, Mechanical, and Industrial concentrations. First three years are common for all concentrations, which allow all AET students gain a fundamental knowledge in engineering technology disciplines, work in teams, effectively communicate, and operate in the real-world technological and business environment.[7] In addition, students have time to develop skills in a particular concentration and motivate themselves in making the right choice for their careers. Such curriculum provides opportunities for self-directed learning activities that promote critical thinking skills and motivation for asking for help.

The industry-oriented laboratory- and project-based AET program curriculum is described below in detail. The program curriculum consists of 187.5 quarter credits and was developed to provide students with both an understanding of the fundamental principles of engineering technology and the practical experience in real-world industrial applications according to the ABET guidelines and requirements.[8] Curricula for Electrical (Table 1), Mechanical (Table 2), and Industrial (Table 3) concentrations of the AET program are presented below.

The distinguishing feature of the AET program is the core set courses, consisting of 62 quarter credits, which are common for all three concentrations. These courses provide students with knowledge and experience in engineering technology and management. Staring the junior year, students take required courses and technical electives specific to their concentrations. Most of the laboratory- and project-based core courses encourage students to apply their knowledge and experience in solving real-world engineering problems and develop skills in making professional presentations and writing technical reports. Experience gained by students during laboratory sessions is applied in their senior design projects and during their co-op cycles. The purpose of the core courses is not to develop new techniques, but to expose students to existing techniques by introducing them to the equipment and methods used in real-world industrial applications. The outcomes of this approach to teaching and learning will lead to the improvement in the education process, since industry is becoming increasingly reliant on the effective application of the advanced technology and the demand on the engineering technologists is increasing. Several project- and laboratory-based courses that provide students with a unique industrial experience are absent in most universities and community colleges in tri-state area.[9] Among them are EET 203 (Nondestructive Evaluation of Materials), EET 319 (Programmable Logic Controllers), MET 205 (Robotics and Mechatronics), and MHT 225 (Measurements Lab) (Figure 3).

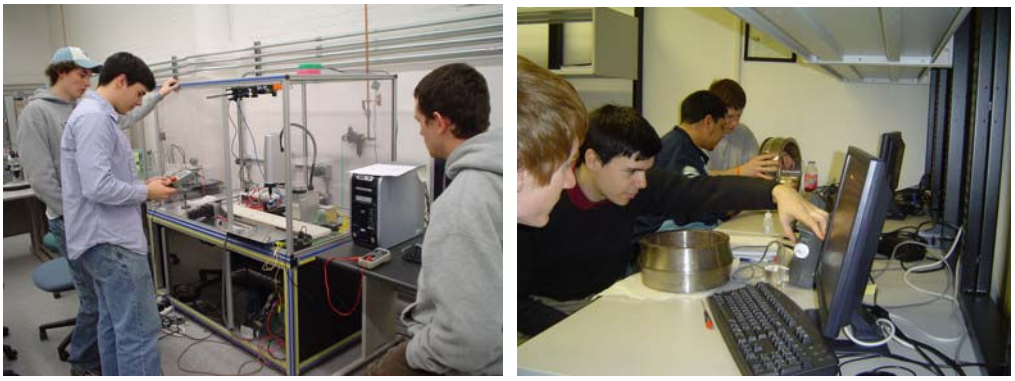

Figure 3. AET students carry out laboratory experiments
During EET 203 and MET 205 classes

Table 1

Drexel University - Goodwin College of Professional Studies

BS Applied Engineering Technology

Electrical Engineering Technology

Total Credits 187.5

Humanities & Social Sciences		**34**	**cr**
( ) ENGL 101	Expository WR	3	cr
( ) ENGL 102	Persuassive WR	3	cr
( ) ENGL 103	Analytical WR	3	cr
( ) COM 230	Principles of Speech	3	cr
( ) COM 111	Principles of Communication	3	cr
( ) ECON 201	Microeconomics	4	cr
( ) PHIL 315	Engineering Ethics	3	cr
( ) HIST 285	Technology in Historical Perspective	3	cr
Liberal Studies Electives			
( )		3	cr
( )		3	cr
( )		3	cr
Basic Sciences		**14.5**	**cr**
( ) CHEM 111	Chemistry I	4	cr
( ) CHEM 113	Chemistry Lab I	1.5	cr
( ) PHYS 152	Physics for Life Science I	4.5	cr
( ) PHYS 154	Physics for Life Science II	4.5	cr
Mathematics		**15**	**cr**
( ) MATH 110	Precalculus	3	cr
( ) MATH 121	Calculus I	4	cr
( ) MATH 122	Calculus II	4	cr
( ) STAT 201	Statistics I	4	cr
Misc		**8**	**cr**
( ) UNIV 101	University Seminar	2	cr
( ) EET 101	Introduction to AET	3	cr
( ) CS 161	Intro to Computing	3	cr
Free Electives		**13**	**cr**
	187.5		

Applied Engineeing Technology Core		**62**	**cr**
( ) EET 201	Circuit Analysis I	4	cr
( ) EET 202	Circuit Analysis II	4	cr
( ) EET 203	NDE of Material	4	cr
( ) EET 204	Intro to Nanotechnology	3	cr
( ) EET 205	Digital Electronics	4	cr
( ) EET 319	Programmable Logic controllers	4	cr
( ) EET 311	Modeling of Engineering Systems	4	cr
( ) EET 401	Microcontrollers	3	cr
( ) MET 100	Graphical Communication	3	cr
( ) MET 101	Manufacturing Materials	4	cr
( ) MET 204	Quality Control	3	cr
( ) MET 205	Robotics & Mechatronics	3	cr
( ) MET 209	Fluid Power	3	cr
( ) MET 213	Applied Mechanics	4	cr
( ) MHT 205	Thermodynamics I	3	cr
( ) MHT 226	Measurement Lab	3	cr
( ) INDE 240	Technology Economics	3	cr
( ) INDE 370	Industrial Project Management	3	cr
EET Concentration Requienments		**26**	**cr**
( ) EET 206	Analog Electronics I	4	cr
( ) EET 313	Signals and Systems I	4	cr
( ) EET 317	Analog Electronics II	4	cr
( ) EET 322	Energy Conversion	4	cr
( ) EET 323	Electrical Systems Design	3	cr
( ) EET 324	Power Electronics	4	cr
( ) EET 325	Microprocessors	3	cr
EET Technical Electives		**6**	**cr**
	Any not required course from EET, MET, INDE		
	See advisor for specific courses		
Capstone Course		**9**	**cr**
( ) MET 421	Project Design I	3	cr
( ) MET 422	Project Design II	3	cr
( ) MET 423	Project design III	3	cr

Table 2

Drexel University - Goodwin College of Professional Studies
BS Applied Engineering Technology
Mechanical Engineering Technology
Total Credits: 187.5

Humanities & Social Sciences			**34**	**cr**		**Applied Engineering Technology Core**			**62**	**cr**
( )	ENGL 101	Expository WR	3	cr	( )	EET 201	Circuit Analysis I		4	cr
( )	ENGL 102	Persuassive WR	3	cr	( )	EET 202	Circuit Analysis II		4	cr
( )	ENGL 103	Analytical WR	3	cr	( )	EET 203	NDE of Material		4	cr
( )	COM 230	Principles of Speech	3	cr	( )	EET 204	Intro to Nanotechnology		3	cr
( )	COM 111	Principles of Communication	3	cr	( )	EET 205	Digital Electronics		4	cr
( )	ECON 201	Microeconomics	4	cr	( )	EET 319	Programmable Logic controllers		4	cr
( )	PHIL 315	Engineering Ethics	3	cr	( )	EET 311	Modeling of Engineering Systems		4	cr
( )	HIST 285	Historical Perspectives in Tech	3	cr	( )	EET 401	Microcontrollers		3	cr
					( )	MET 100	Graphical Communication		3	cr
Liberal Studies Electives					( )	MET 101	Manufacturing Materials		4	cr
( )			3	cr	( )	MET 204	Quality Control		3	cr
( )			3	cr	( )	MET 205	Robotics & Mechatronics		3	cr
( )			3	cr	( )	MET 209	Fluid Power		3	cr
					( )	MET 213	Applied Mechanics		4	cr
Basic Sciences			**14.5**	**cr**	( )	MHT 205	Thermodynamics I		3	cr
( )	CHEM 111	Chemistry I	4	cr	( )	MHT 226	Measurement Lab		3	cr
( )	CHEM 113	Chemistry Lab I	1.5	cr	( )	INDE 240	Technology Economics		3	cr
( )	PHYS 152	Physics for Life Sciences I	4.5	cr	( )	INDE 370	Industrial Project Management		3	cr
( )	PHYS 154	Physics for Life Sciences II	4.5	cr						
					MET Concentration Requirements				**25**	**cr**
Mathematics			**15**	**cr**	( )	MET 316	CNC		3	cr
( )	MATH 110	Precalculus	3	cr	( )	MHT 206	Thermodynamics II		3	cr
( )	MATH 121	Calculus I	4	cr	( )	MHT 222	Applied Dynamics		3	cr
( )	MATH 122	Calculus II	4	cr	( )	MHT 301	Fluid Mechanics I		3	cr
( )	STAT 201	Statistics I	4	cr	( )	MHT 314	Thermo & Heat Transfer Lab		3	cr
					( )	MHT 401	Mechanical Design I		4	cr
Misc			**8**	**cr**	( )	MET 407	Manufacturing Processes		3	cr
( )	UNIV 101	University Seminar	2	cr	( )	MET 408	Manufacturing info Management		3	cr
( )	EET 102	Introduction to AET	3	cr						
( )	CS 161	Intro to Computing	3	cr	**MET Technical Electives**				**6**	**cr**
							Any not required course from EET, MET, INDE			
Free Electives			**14**	**cr**			See advisor for specific courses			
		187.5								
					Capstone Courses				**9**	**cr**
					( )	MET 421	Project Design I		3	cr
					( )	MET 422	Project Design II		3	cr
					( )	MET 423	Project Design III		3	cr

Table 3

Drexel University - Goodwin College of Professional Studies

BS Applied Engineering Technology

Industrial Engineering Technology

Total Credits: 187.5

Humanities & Social Sciences		**34**	**cr**
( )ENGL 101	Expository WR	3	cr
( )ENGL 102	Persuassive WR	3	cr
( )ENGL 103	Analytical WR	3	cr
( )COM 230	Principles of Speech	3	cr
( )COM 111	Principles of Communication	3	cr
( )ECON 201	Microeconomics	4	cr
( )PHIL 315	Engineering Ethics	3	cr
( )HIST 285	Historical Perspectives in Tech	3	cr
Liberal Studies Electives			
( )		3	cr
( )		3	cr
( )		3	cr
Basic Sciences		**14.5**	**cr**
( )CHEM 111	Chemistry I	4	cr
( )CHEM 113	Chemistry Lab I	1.5	cr
( )PHYS 152	Physics for Life Sciences I	4.5	cr
( )PHYS 154	Physics for Life Sciences II	4.5	cr
Mathematics		**15**	**cr**
( )MATH 110	Precalculus	3	cr
( )MATH 121	Calculus I	4	cr
( )MATH 122	Calculus II	4	cr
( )STAT 201	Statistics I	4	cr
Misc		**8**	**cr**
( )UNIV 101	University Seminar	2	cr
( )EET 102	Introduction to AET	3	cr
( )CS 161	Intro to Computing	3	cr
Free Electives		**7**	**cr**
		187.5	

Applied Engineering Technology Core		**62**	**cr**
( )EET 201	Circuit Analysis I	4	cr
( )EET 202	Circuit Analysis II	4	cr
( )EET 203	NDE of Material	4	cr
( )EET 204	Intro to Nanotechnology	3	cr
( )EET 205	Digital Electronics	4	cr
( )EET 319	Programmable Logic Controllers	4	cr
( )EET 311	Modeling of Engineering Systems	4	cr
( )EET 401	Microcontrollers	3	cr
( )MET 100	Graphical Communication	3	cr
( )MET 101	Manufacturing Materials	4	cr
( )MET 204	Quality Control	3	cr
( )MET 205	Robotics & Mechatronics	3	cr
( )MET 209	Fluid Power	3	cr
( )MET 213	Applied Mechanics	4	cr
( )MHT 205	Thermodynamics I	3	cr
( )MHT 226	Measurement Lab	3	cr
( )INDE 240	Technology Economics	3	cr
( )INDE 370	Industrial Project Management	3	cr
IET Concentration Requirements		**31**	**cr**
( )ECON 202	Economics II	4	cr
( )ACCT 115	Financial Acct Foundation	4	cr
( )FIN 301	Introduction to Finance	4	cr
( )INDE 300	Quality Management	3	cr
( )INDE 350	Industrial Engr. Simulation	3	cr
( )INDE 363	Operations Research for Engr I	3	cr
( )INDE 365	Systems Analysis Methods I	3	cr
( )INDE 366	Systems Analysis Methods II	3	cr
( )INDE 375	Quality Improvement by Experimental Design	4	cr
IET Technical Electives		**7**	**cr**
	Any not required course from EET, MET, INDE, OPM, MKGT		
	See advisor for specific courses		
Capstone Courses		**9**	**cr**
( ) MET 421	Project Design I	3	cr
( ) MET 422	Project Design II	3	cr
( ) MET 423	Project Design III	3	cr

During the senior year of the study, all AET students get a capstone experience through the Senior Design Project sequence (MET 421, MET 422, and MET 423). This is a three-term, nine-credit course, in which students participate in a real-world engineering technology project. Students select a topic in consultation with their advisor according to the AET program's guidelines and design and develop the working prototype. The Senior Design Sequence is a capstone experience, which provides students with the opportunity to apply their knowledge and skills gained in the previous years of coursework. It is the most important challenge of the senior year. This three-term sequence stimulates students' interest in engineering technology and requires precise planning of each milestone. In addition, it demonstrates students' technical competence and ability to work in teams and communicate orally and in writing on the progress and results of the project. During the fall term, students form a team, select their project and advisor, and submit the pre-proposal, which must be approved by the team's advisor and the AET program's Senior Design Committee. Emphasis is placed on the problem and its solution, not on the technologies that are used by the team. During the winter term, students revise their design report and begin implementation of the project. By the end of this term, students demonstrate the functionality of the prototype and make necessary modifications according to their advisor's recommendations. At the end of the term, the team makes a 20-minute presentation outlining their progress to the advisor and Senior Design Committee representatives. During the spring term, the team completes the project, conducts the final tests of the functionality of the developed prototype, and prepares the final report and presentation. During the third week of May, the project is presented to the Senior Design Committee.

Summary

The Applied Engineering Technology program's curriculum is described in this document. The curriculum combines the solid foundation in mathematics, physics, and chemistry with fundamental knowledge of the course materials and real-world technological practices. AET is a co-op based, five-year program, which includes three distinct concentrations: Electrical, Mechanical, and Industrial Engineering Technology. The curriculum consists of 187.5 quarter credits, 62 of which are core courses. These courses are required courses for all three concentrations. Most of the program's courses are laboratory-and project-based. They provide AET students with unique knowledge and experience in engineering technology and management that is applied in their senior design projects and during their co-op cycles. Students are exposed to the laboratory procedures similar to those that are used in real-world industrial applications. During the laboratory sessions, projects, and case studies, AET students gain a fundamental knowledge in engineering technology disciplines, work in teams, effectively communicate, and operate in the real-world technological and business environment. The Senior Design Project is a capstone experience, which provides students the opportunity to apply their knowledge and skills gained in the previous years of coursework.

Bibliography

1. Clough , W. The future of engineering education. 2007. Retrieved from http://gtalumni.org/news/magazine/win00/future.html.

2. Hoff, A., Barger, M., Gilbert, R., Riggs, R. Workforce development: a critical interaction between high technology industries and academia. Univ. of South Florida, Tampa, FL. 2001. Retrieved from http://ieeexplore.ieee.org/iel5/7603/20743/00960289.pdf?tp=&isnumber=&arnumber=960289
3. Anderson-Rowland, M. R., Blaisdell, S., Fletcher, S., Fussell, P., Jordan, C., McCartney, M.A., White, M. A comprehensive programmatic approach to recruitment and retention in the college of engineering and applied sciences. Proceedings of Frontiers in Education Conference, Vol. 12A, pp. 706-713, 1999.
4. NCES. Number of U.S. colleges and universities and degrees awarded. Digest of Education Statistics. 2005. Retrieved from http://www.infoplease.com/ipa/A0908742.html
5. Lynn, L., & Salzman, H. The Real Global Technology Challenge. Change 39(4), 8-13, 2007.
6. Gordon, E. Skill wars: Winning the battle for productivity and profits. Boston: Butterworth-Heinemann. 2000. Retrieved from http//www.netlibrary.com.
7. Linda Vanasupa, Blair London, Katherine Chen, and Richard Savage. Curricula to educate the 2020 MSE engineering professional: Simple but powerful changes in the way that MSE is taught. Proceedings of the ASEE Conference, pp. 1-11, 2006.
8. Engineering Accreditation Commission, Criteria for Accrediting Engineering Programs. Baltimore, MD: ABET, Inc., 2005.
9. V. Genis, W. Rosen, R. Chiou, W. Danley, J. Milbrandt, G. Marekova, S. Racz, T. Kitchener, and B. LaVay. Laboratory- and Project-Based Courses in the Engineering Technology Curriculum. Proceedings of the Mid-Atlantic ASEE Annual Conference, pp. 1-12, 2007.