



An Interdisciplinary Strategy for Improving Enrollments in ET Programs

Dr. Austin B. Asgill, Southern Polytechnic State University

Dr Austin B. Asgill received his B.Eng.(hons) (E.E.) degree from Fourah Bay College, University of Sierra Leone, his M.Sc. (E.E.) degree from the University of Aston in Birmingham and his Ph.D. in Electrical Engineering from the University of South Florida. He is currently a Professor of Electrical and Computer Engineering Technology at Southern Polytechnic State University (SPSU). Prior to joining the faculty at SPSU, he was an Associate Professor of Electronic Engineering Technology at Florida A&M University (FAMU), where he served as Program Area Coordinator and Interim Division Director. With over 23 years of teaching experience in Electrical/Electronic Engineering and Engineering Technology, he currently teaches in the areas of networking, communication systems, biomedical instrumentation, digital signal processing, and analog and digital electronics. He has worked in industry in the areas of telephony, networking, switching and transmission systems, and RF and MMIC circuits and system design. Dr. Asgill also has an MBA in Entrepreneurial Management from Florida State University. He is a member of the IEEE, the ASEE and is a licensed professional engineer (P.E.) in the state of Florida.

Dr. Craig A Chin, Southern Polytechnic State University

Craig A. Chin received his Ph.D. in electrical engineering from Florida International University in 2006. He is currently an Assistant Professor in the electrical and computer engineering technology at Southern Polytechnic State University. His research interests include biomedical signal processing, pattern recognition, and active learning techniques applied to engineering education.

Dr. Florian Misoc P.E., Southern Polytechnic State University

Dr. Florian Misoc is an associate professor of Electrical and Computer Engineering Technology. He joined Southern Polytechnic State University in August, 2011. Dr. Misoc earned his Ph.D. in Electrical Engineering from Kansas State University. He also holds a Master's of Science Degree in Engineering Technology from Pittsburg State University, and a Bachelor's Degree in Physics from the University of Bucharest, Romania. Dr. Florian Misoc is a registered Professional Engineer in the state of Arkansas. His research focus is in the areas of renewable energy (generation, transmission and distribution), power electronics, and vehicular systems.

Dr. Simin Nasser, Southern Polytechnic State University

Dr. Simin Nasser is an associate professor in the department of Mechanical Engineering Technology at Southern Polytechnic State University. She obtained her Ph.D. in Mechanical Engineering from Sydney University, Australia, where she worked as a senior research associate. She has published eighteen papers, mainly in peer-reviewed journals (such as J. of Non-Newtonian Fluid Mechanics), and her research areas include Rheology & viscoelasticity, polymer processing (experimental analysis and constitutive modeling), biomechanical engineering, CFD, and micromachinery. She has work experience related to manufacturing and design and currently teaches a variety of undergraduate courses in her field such as engineering mechanics and manufacturing courses.

Dr. Adimathara P. Preethy, Southern Polytechnic State University

Prof. Scott J. Tippens, Southern Polytechnic State University

Prof. Randall A. Emert, Southern Polytechnic State University

Eight plus years industry experience with engineering design, sheet metal fabrication, machining, and project management. Ten years of academic experience teaching engineering graphics, machining, and welding. Current interest in medical applications of rapid prototyping and speeding the product development cycle with 3D scanning and additive manufacturing.

Dr. Ali Khazaei, MET Department at SPSU



Dr. Ali Khazaei is an Assistant Professor in Mechanical Engineering Technology Department at Southern Polytechnic State University. He has more than seventeen years teaching experience as a full time faculty and long industrial experience as a design engineer. His teaching includes different courses in three fields ("Solids", "Fluid" and "Heat") at the undergraduate and graduate levels. He published 12 articles which were presented in ASME conferences. His areas of research interests are: Renewable Energy Methods and Green Technology, Heat /Energy systems with focus on nonlinearities, MEMS systems with focus on MEMS thermal behavior, and Kinematics and mathematical modeling with applications such as autonomous vehicles.

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Austin B. Asgill, Craig A. Chin, Ali Khazaei, Florian Misoc
Simin Nasser, Adimathara Preethy, Scott Tippens, Randall Emert
Southern Polytechnic State University

Abstract

The recent trend of declining enrollments in many Engineering Technology (ET) programs across the US has prompted universities offering BS degree programs in ET disciplines to seek strategies to maintain their identity, viability, and continued relevance in the face of competition from Engineering programs, and the prevailing poor economic conditions. Strategies adopted by some institutions have included the "if you can't beat them, join them" option of switching their programs entirely from ET to Engineering, renaming their programs to differentiate them from similarly named Engineering programs, seeking innovative ways to develop pipelines for students to enter their programs via articulation agreements with two-year institutions, or developing highly innovative and specialized new curricula that seek to differentiate the ET programs from Engineering programs. This latter strategy was considered to be the better option by the faculty of the Electrical and Computer Engineering Technology (ECET) department at Southern Polytechnic State University (SPSU). In 2006, the ECET department at SPSU sought to take advantage of the rapid growth in the biomedical Engineering area to develop an innovative option in Biomedical Engineering Technology (BMET) under its existing Electrical Engineering Technology (EET) program^[1-3]. While there has been a lot of interest in this BMET option, the anticipated growth in enrollment has been slow to materialize due to the fact that the option was not a separate degree program. Students have had difficulty in accepting the fact that the actual degree obtained will be the BSEET degree with an option in BMET. As a result the ECET faculty have revisited the option and is working in conjunction with their Mechanical Engineering Technology (MET) colleagues to develop a novel full-blown BMET degree program that incorporates aspects of device design and manufacturing into the curriculum. This program is being developed in conjunction with another program in Renewable Energy Engineering Technology (REET) that is also a joint effort between ECET and MET faculty. These two new highly innovative "boutique" ET degree programs are expected to capture the growing interest in Biomedical Engineering and Renewable Energy Systems. This paper discusses the development of these two new curricula and the anticipated challenges in offering these programs and recruiting students into these new interdisciplinary majors.

I. Introduction

Southern Polytechnic State University (SPSU) is a STEM focused urban institution located in Marietta, Georgia with a student population of approximately 5,400 students. Since its inception, the university offered a number of Engineering Technology (ET) programs in Civil (CET),

Computer (CpET), Electrical (EET), Industrial (IET), Mechanical (MET), and Telecommunications (TCET) Engineering Technology. These ET programs have consistently been ranked amongst some of the top-rated programs in the country, and all six are ABET^[4] accredited.

Unfortunately, as has been the case for many ET programs across the country in recent years, SPSU has struggled to maintain the identity, viability, and continued relevance of its ET programs in the face of competition from Engineering programs. In addition to the flagship Engineering programs offered by Georgia Institute of Technology, SPSU itself began offering specialized Engineering programs in 2008 starting with Construction Engineering (spring), Systems Engineering (fall), and Mechatronics Engineering (fall). In the spring semester of 2010, SPSU began offering traditional Engineering programs in Civil, Electrical, and Mechanical Engineering in an evening format. This brought the Engineering competition in-house and resulted in student attrition, particularly in the similarly named ET programs. In addition, two other state universities have been approved by the Georgia Board of Regents (BOR) to begin offering Engineering programs starting in 2012, further increasing competition within the state.

In order for its ET programs to survive, the university had to seek innovative ways to preserve and maintain the identity, viability, and continued relevance of its ET programs in light of these new in-house engineering programs and the competition from within and outside of the state as well. One option that has been deemed to be the most viable option by faculty in the Electrical and Computer Engineering Technology (ECET) and Mechanical Engineering Technology (MET) departments at SPSU, is to develop highly innovative and specialized new interdisciplinary curricula that seek to differentiate the ET programs from Engineering programs. Two such programs that are currently being developed are a BS degree in Biomedical Engineering Technology (BMET), and a BS degree in Renewable Energy Engineering Technology (REET). In addition, the MET department is creating options in Manufacturing and Graphics Design under its MET degree. This paper provides details on the current state of the development of the BMET and REET curricula, and the anticipated challenges in offering these programs and recruiting students into these new interdisciplinary majors.

II. Motivation and Background

Since the fall semester of 2006, the ECET department has offered a Biomedical Engineering Technology option under its EET degree program. The main motivation for developing this option came from solicitations from incoming and transfer students who were interested in getting a degree in the Biomedical Engineering area, as well as from an approach made to the ECET department by a local two-year Technical college which offers an A.S. degree in Biomedical Engineering Technology^[1, 2]. While there has been a lot of interest in this BMET option, the anticipated growth in enrollment has been slow to materialize due to the fact that the option was not a separate degree program. Students have had difficulty in accepting the fact that the actual degree obtained will be the BSEET degree with an option in BMET. As a result the ECET faculty have revisited the option and are working in conjunction with their MET colleagues to develop a novel full-blown BMET degree program that incorporates aspects of device design and manufacturing into the curriculum.

In addition to the BMET option, the ECET department had also begun offering special topics courses in the Renewable (Alternate) Energy Engineering Technology area since 2008 to coincide with the establishment of the Alternate Energy Innovation Center (AIEC), and to take advantage of the tremendous interest in this important area of work. These courses would support a proposed concentration area in Power and Energy Systems within the EET curriculum. The first such course was a survey course, ECET 4550 - Alternate Energy. Since that time, other special topics courses in Solar Photovoltaic Systems, Wind Energy Systems, Distributed Energy Systems, and Fuel Cell Technology have been offered. Due to the great amount of student interest in these courses and in consultation with industry partners, MET faculty, and our Industrial Advisory Board (IAB) members, it was decided that this provided the faculty with an opportunity to develop another innovative degree program in Renewable Energy Engineering Technology (REET).

These two new highly innovative "boutique" ET degree programs are expected to capture the growing interest in Biomedical Engineering and Renewable Energy Systems. In developing these new ET programs, a key factor was to have programs that would match the unique capabilities and strengths of Engineering Technology students. In general, these types of students respond well to course content that is practically oriented and less abstract. As a result, both curricula are being developed as project-based curricula that offer plenty of hands-on and experiential learning opportunities.

III. Curriculum Development

The establishment of the Alternate Energy Innovation Center (AIEC) on the SPSU campus provided an opportunity for ET faculty to integrate their applied research work into their teaching. A number of ECET and MET faculty have been engaged in projects through the AEIC. In the initial stages, the center focused on research into Solar Energy Systems and is equipped with roof-mounted solar panels with solar tracking equipment. The scope of work has recently been expanded to include the study of Wind Energy Systems, Fuel Cell Technology, Power Electronics and Applications, Energy Conversion, Smart Grid Technology, Distributed Energy Systems, and Alternate Energy Vehicle Systems. Some of these projects have contributed to the development of project-based special topics courses that have greatly enhanced the course offerings in ET.

Task force committees that include faculty from both the ECET and MET departments have been working to develop the curricula for the new BMET and REET programs. One of the charges to both committees was to ensure that the curriculum developed took advantage of the strengths of both ECET and MET faculty and make use of existing courses to the extent that this was possible without compromising the target focus of these programs. Additionally, in keeping with the goal of eventual accreditation of both programs by ABET, it was decided that the total number of credit hours for these programs should not exceed a maximum of 130 credit hours as set by the Georgia Board of Regents (BOR).

The proposed curriculum (technical courses) for the BSBMET degree is shown in Table 1.

Table 1. Technical courses in the proposed BSBMET degree program.

COURSE NAME	SEMESTER NUMBER	WEEKLY LECTURE HRS	WEEKLY LAB HRS	CREDIT HOURS
Orientation	1	1	0	1
Design Fundamentals	1	1	3	2
Circuits I	2	3	3	4
Digital I	2	3	3	4
Health Care Systems	3	3	0	3
Circuits II	3	3	3	4
Electronics I	3	3	3	4
Engineering Mechanics Statics	4	3	0	3
Digital II	4	3	3	4
Electronics II	4	3	3	4
Biomechanics	5	3	3	4
Biomaterials	5	3	0	3
C++, JAVA and HTML	5	2	3	3
BMET Elective	6	3	3	4
Embedded PCs	6	3	3	4
BMET Elective	6	3	3	4
Biomedical Instrumentation	7	3	3	4
Medical Device Design	7	3	0	3
Free Technical Elective	7	3	3	4
BMET Elective	8	3	3	4
BMET Capstone Project/Internship	8	3	3	4

Weekly lecture hours, laboratory hours, and total credit hours are also provided. Laboratory exercises will be conducted for 12 out of the 16 weeks in each semester. The program will be structured within the 130 credit-hour limit set by the Georgia Board of Regents (BOR). The proposed curriculum will have Sixty (60) hours of Mathematics, Science, English, and Social Science core courses along with Seventy (70) hours of Technical courses. Of the 70 Technical credits, Thirty Four (34) will constitute a core of ECET courses; Twenty Nine (29) hours will be BMET specific courses. The rest will be Engineering Mechanics (3 credits) and a Free Technical Elective (3/4 credits). The free elective can be any 3xxx or 4xxx level course from ECET, MET, IT, CS or other related discipline.

The capstone course is envisioned as either a capstone project in an area of Biomedical Engineering Technology or as a supervised industrial Internship during which the student will gain a broad experience of some area(s) of Biomedical Engineering Technology. Students will be required to write a report of their Internship experiences, and will also be provided with a grade based on feedback from their industrial supervisor.

The proposed BMET electives will allow students to gain knowledge in such areas of Biomedical Engineering Technology as:

- Bioinformatics and Telemedicine
- Medical Imaging
- Biometrics
- Tissue Engineering
- Biomedical Nanotechnology
- Health Care Safety
- Health System Administration
- Virtual Biomedical Instrumentation

Students may also wish to expand their knowledge in related topics such as:

- Communications Network and the Internet
- Network Programming and Interfacing

The proposed curriculum for the BSREET degree (technical courses) is as shown in Table 2. The program will be structured within 128 credit-hours. Sixty (60) hours of Mathematics, Science, English, and Social Science core courses along with Sixty Eight (68) hours of Technical courses. Of the 68 Technical credits, Twenty Six (26) will be REET specific courses.

Unlike the BMET proposal, the REET program proposal is novel and uncharted territory as far as ABET is concerned. As such, it was deemed necessary to develop program specific Digital Systems and Electronics courses for the degree rather than try to utilize existing Digital and Electronics courses within the ECET curricula. This will enable the curriculum to meet the BOR mandated credit hour limitations while offering a substantial interdisciplinary curriculum to satisfy the goals of the program.

Table 2. Technical courses in the proposed BSREET degree program.

COURSE NAME	SEMESTER NUMBER	WEEKLY LECTURE HRS	WEEKLY LAB HRS	CREDIT HOURS
Energy Fundamentals	1	1	0	1
Circuits I	2	3	3	4
Digital Systems	3	3	3	4
Circuits II	3	3	3	4
Energy Conversion Systems	4	3	3	4
Electronics	4	3	3	4
Engineering Mechanics Statics	4	3	0	3
Power Systems Analysis	5	3	3	4
Thermodynamics I	5	3	0	3
Engineering Mechanics Dynamics	5	3	0	3
Power Transmission and Distribution	6	2	3	3
Fluid Mechanics	6	3	3	4

Energy Storage	6	2	3	3
Senior Design Proposal	7	1	0	1
Power Electronics	7	3	3	4
Control Systems	7	3	3	4
REET Elective	7	3	3	4
Senior Design Project	8	2	3	3
REET Elective	8	3	3	4
REET Elective	8	3	3	4

The proposed REET electives will allow students to gain knowledge in such areas of Renewable Energy Engineering Technology as:

- Solar Photovoltaic Systems
- Wind Energy Systems
- Solar Heating Systems
- Fuel Cell Technology
- Geothermal Energy Systems
- Ocean Energy Systems
- Smart Grid Technology
- Distributed Energy Systems
- Energy Management and Analysis
- Hybrid Energy Systems

IV. Current Status

A Biomedical Engineering Technology Industrial Advisory Board (IAB) has been established consisting of educators as well as industry experts who are currently engaged in the Biomedical Engineering field. The BMET IAB members have provided valuable additional input on the proposed curriculum. They have provided support for the proposed interdisciplinary curriculum and offered suggestions for some of the course material.

A similar IAB is in the process of being constituted for the Renewable Energy Engineering Technology degree program. The faculty involved in the design of the program has utilized their knowledge, expertise and industrial contacts through their work in the AEIC to develop the proposed curriculum (see Figure 1). A number of project-based special topics courses in the Renewable Energy area have been developed and offered in both the ECET and MET departments over the past several semesters. Table 3 provides the enrollment numbers in some of the special topics courses that have been offered to this point. It is clear from the enrollments that there is significant interest in the Renewable Energy area. In addition to these courses, faculty who teach the digital sequence of courses in the ECET department have utilized them as conduits for related projects such as the development of embedded control systems for the solar panel arrays in the AEIC, solar cooking systems, solar powered lawn mowing units, etc. A video demonstrating some of these projects can be found here:

<http://www.wsbvtv.com/videos/news/students-show-off-engineering-concepts/vFWGW/>.

Table 3. Enrollments in Special Topics REET Courses.

COURSE NAME	SEMESTER	ENROLLMENT
Alternate Energy	Fall 2009	21
Alternate Energy	Fall 2011	13
Solar Photovoltaic Systems	Fall 2011	5
Wind Energy Systems	Spring 2012	5
Fuel Cell Technology	Fall 2012	9
Applications of Power Electronics	Spring 2013	15

Students have also worked on a number of Biomedical Engineering Technology related projects for their Digital/Embedded Systems course projects (see Figure 2).

Some faculty members have been actively engaged in applied research in the REET and BMET areas, as well as investigating existing programs in the Power/Energy area with a view to assist with curriculum development ^[5 - 9].

Equipment for both programs is currently being acquired through the judicious use of funds from the ECET and MET departments. It is anticipated that equipment purchases will receive priority for funding within the current fiscal year. The ECET department has also received some offers from the BMET advisory board members for assistance with procuring equipment for the BMET program. It is expected that a constituted REET IAB will serve a similar role for that program.

V. Next Steps

The curricula for the BMET and REET degree programs have been approved by the general faculty, and a draft proposal is being prepared to be sent to the BOR for approval of these new programs. Once approval is received from the BOR, the new courses can then be offered as part of the BMET and REET programs. It is anticipated that the first such course offerings will begin by the spring semester, 2014.

In April 2011, the university signed a 2+2 articulation agreement with the Technical School System of Georgia (TCSG) to deliver the upper division of the curricula in EET, MET, and IET, to place-bound students around the state ^[10, 11]. It is expected that these agreements will be expanded in the future to include articulations into the new BMET and REET degree programs. The REET program in particular is also expected to attract students from other majors in engineering technology, engineering, and some of the science programs on campus. The faculty is already working on a marketing plan to target such students.

VI. Conclusion

The renewable energy industry promises to address many of the issues that are looming in the future for our state and our country. As our populations continue to grow, we will see a corresponding rise in energy demand. Current energy sources are limited by three fundamental factors: 1) Energy which comes from nonrenewable fossil fuel resources such as coal, oil, and gas are a finite resource. Oil and gas will be exhausted within the next few decades and coal will last longer but it will accelerate the second factor; 2) Environmental pollution caused by the burning of fossil fuels for transportation and energy production which generates a significant amount of pollution both in the form of air pollution and solid waste. Alternative forms of energy generation promise to reduce these emissions for future generations; 3) The era of abundant and cheap fossil fuels is fast coming to an end. With soaring prices, there is a new trend in the energy industry. Energy-using system designers are paying more attention to lifetime energy costs.

By preparing students to work in the renewable energy field, the REET program will be poised to be one of the forces driving this change. Educating experts and professionals who can solve the problems of utilizing a broad range of energy resources more efficiently and more effectively while being sensitive to the environmental and human costs often associated with energy generation is a fundamental need of the market. Statistics show that there is a growing trend in the "Renewable Energy Industry" which provides justification for the growing need for these kinds of professionals in this global industry, where sustainability and ethics are becoming as important as profit and growth^[12]. REET graduates will meet that need and the program will serve to attract businesses to the state that would otherwise establish operations in other states.

The field of Biomedical Engineering has experienced tremendous growth in recent years with a growth rate that has outpaced the growth in other traditional engineering disciplines such as Electrical Engineering (EE) and Mechanical Engineering (ME)^[1, 13]. Given this tremendous growth in the health care industry along with the subsequent increase in Biomedical Engineering and Biomedical Engineering Technology type programs, the proposed BMET program is a much needed, and timely, program. The life expectancy of the human population has been steadily increasing due to the advances in health care and technology. Preliminary surveys among ECET and MET students have indicated that there is enough interest within the student populations in these departments to justify the BS-BMET program. The proposed BMET program will offer a broad-based hands-on project-based experience that will make the graduates a valuable entity in the rapidly expanding Biomedical Engineering industry. It is anticipated that employment opportunities in the field will continue to grow with further advances in medical technology. This will fuel a continuing demand for graduates with BMET expertise.

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Figure 1. Students working on the AIEC Solar Array



Figure 2. Students demonstrating a helmet temperature sensor project