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Engineering Technology Programs at the Crossroads: Curriculum Revisions to Meet Emerging Needs

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Abstract

Northern Kentucky University (NKU) has had TAC of ABET Accreditation since 1997 for BS degree programs in Manufacturing Engineering Technology, and Electronics Engineering Technology. Closely associated with these, we have Mechanical and Manufacturing Engineering Technology (MMET) and Electronics Engineering Technology (EET) programs under review for ABET accreditation. All programs lead to the Bachelor of Science in Engineering Technology.

This paper reports on the work in progress; our response to simultaneous changes in program requirements. Recent changes in the Engineering Technology (ET) educational environment provide us with a rare opportunity to enhance both programs for students, faculty, schools, and industry. We discuss program enhancements in five areas:

- adaptation of the outcome-based ABET criteria to our ET programs
- increasing number of cross-disciplinary courses in the two programs
- engaging undergraduates in research activities dealing with emerging technologies
- adopting an application-based approach to teaching materials and processes
- collaboration with community colleges in better preparing our future students

Introduction

Today, engineering Technology educators must teach academic fields which encompass a greater range and depth of technology than ever before. Engineering Technology graduates, on the other hand, are expected to combine detailed understanding of a subspecialty with the flexibility to adapt to globalization [1, 2] , new technologies[3], interdisciplinary challenges [4] and a changing marketplace [5] .

The Engineer Technologist must be able to see beyond technical issues to the social implications of technology, adapt to the rapid changes in world markets and new technologies, resolve interdisciplinary challenges, and combine a depth of knowledge with the depth of understanding required for real-world engineering. In recent years, as these demands have increased, engineering technology education has shifted with the continued expansion of technology to

become more integrated and more flexible. This paper discusses initiatives undertaken at NKU to align the Engineering Technology Program to meet the new demands.

Without doubt, the transition from old methods to the new paradigm of outcome based assessment will not be easy. Many Engineering Technology Programs are faced with financial pressures, while the resources to make the changes rest mostly with those who oppose the change in the first place. This "just cut costs and leave the program alone" attitude, along with no "one-size-fits-all" transition paradigm, represents the challenge to change. Still, a number of engineering technology programs have made significant changes and have developed innovative approaches in their undergraduate programs.[2]

Northern Kentucky University (NKU) is in the Greater Cincinnati Region, with the NKU main campus just south of Cincinnati. Undergraduate enrollment is over 14,000. The ET programs (EET and MMET) have about sixty full time majors each, about half non-traditional students. Since 2005 both programs are now part of Department of Physics and Geology, along with a pre-engineering program.

This is a report of changes in the engineering technology program to meet the needs of the Greater Cincinnati, and Northern Kentucky Regions for high-quality graduates. The combination of practical and theoretical education leads to graduates with agile technical skills throughout a wide range of applications, prepared for technical and managerial responsibilities."

History of NKU and Accrediting Board of Engineering and Technologies

In 1994 NKU Engineering Technology programs petitioned for TAC of ABET to review our EET and MET (Mechanical Engineering Technology) program for accreditation. ABET evaluation of our programs meant that we prepared by documenting specifics about our program, e.g.: types of tests and exercises used in courses, examples of work done by students with a range of abilities and grades, education and background of instructors in each course.

In the accreditation process, each program was to demonstrate that we were preparing the students for employment as engineering technologists, and to validate that by assessment tools such as student and employer surveys. ABET asked us to prescribe the "means to the end," according to TAC of ABET criteria [6], and then check the end goal through assessment tools such as surveys of graduates and their employers.

We went through the process, met this criteria, and received the ABET accreditation for our MET and EET programs in 1996.

Engineering Technology Program Course Grouping

As we prepare for our upcoming ABET accreditation for the EET and MMET program, several factors enter in with grouping of courses (core, support, option) making up the two programs.

1. The EET program was changed to CEET (Computer and Electronics Engineering Technology). We had a choice to seek accreditation as computer ET, electronics ET, or

both. Since the EET program is accredited already it is easier to show program history, and changes within the EET program, to return to that original EET program.

2. For the MMET program, we propose to add mechanical engineering technology, so that the new accreditation will be for the combined Mechanical and Manufacturing Engineering Technology.
3. In the university, CEET is currently split into EET (electronics ET) and CET (computer ET), but this division was engineering versus programmer and not embedded computer versus general computer. The core courses in computer hardware, part of EET, are:
   - IET345 Digital Electronics (lecture and lab with logic design and analysis)
   - IET348 Electronic CAD (system, connectivity for digital systems and sub-systems)
   - IET367 Microprocessors (instruction sets, assembler programming, interfacing)
   - IET448 Network Hardware (concepts, data, transmission media, routers, interfaces)
   - IET467 Advanced Microprocessors (architectures, multitasking, virtual memory)
4. These courses went with CET as part of Computer Science; this separation could cause ABET to question the EET use of computers. The content of these computer hardware core courses needs to be under close EET program control.
5. We propose moving all computer hardware courses into EET, and expand the use of the electronics minor. The electronics minor consists of seven courses.
   - Four course core of DC, AC, electronics, and digital circuits courses
   - Three course options of any other upper level engineering technology courses.
     - This electronics minor is available to give any major a computer hardware emphasis
   - For CS majors, the former CET minor goes to an electronics technology (ET) minor.
   - For EET majors, a computer science minor, or more MMET courses are available
6. There are shared courses within EET with old prefix ATS (applied technical science). These courses, with new prefix, including new EGT318):
   - EGT261 Engineering Materials (structures, properties, failure modes, selection, testing)
   - EGT300 Statics and Strength of Materials (rigid body, stress, strain, moments, loading)
   - EGT318 Introduction to Nanotechnology (nanoscale materials, structures and devices)
   - EGT340 Applied Dynamics (dynamic forces, work, kinetics, impulse, momentum)
   - EGT361 Fluid Power (basic concepts of fluid mechanics, applications, design)
   - EGT450 Thermodynamics, Heat Transfer (first and second laws of thermodynamics, properties of liquids and gases, heat power, heat transfer, cooling and heating cycles)
7. Because of the benefits to both MMET and EET students, we will keep MMET and EET together as closely allied branches of engineering technology. With more shared classes, this allows for less under-enrolled classes and more class offerings. Students in both EET and MMET programs can choose courses in the two lists of courses, and in the Computer Science courses.

ABET Outcome-based Evaluation, Enrollment, Reduction of Credit Hours

As we prepare for renewal of our ABET accreditation, factors of outcome-based program evaluation, recruitment and retention in both programs, and reduction of credit hours in the programs became important. Several factors work together.

1. The program objectives for both EET and MMET were developed and refined. ABET guidelines, and the general studies objectives for all Bachelor of Science NKU programs, were the two measurement tools.
2. Objectives/outcomes for each course were developed in a matrix of specific program objectives. This was difficult but very worthwhile,
3. We need more project management skills, networking skills, cross-discipline skills, and integrated simulation and analysis, even though the number of courses is being reduced.
4. By rearranging course content, dropping some courses, adding or modifying others, the course objectives are streamlined while providing new focus and program content.
5. The problem remains on how to monitor courses, test objectives, and cycle needed changes back into the courses as needed, all without increasing faculty workload. One plan is to spread the outcome evaluation so that one course per semester per faculty member is being fully outcome evaluated, and then modified. Rotating the course evaluations would allow for all courses to be periodically evaluated and modified.
6. A positive result is that focusing on our core course objectives as determined from the matrix-driven program objectives allows us to reduce number of courses, increase flexibility, and still increase meaningful marketable ET skills of our graduates.

Cross-Discipline Courses, Undergraduate Research

The present day engineering technology student is being educated for a wider spectrum of skills, from research to sales, and training to planning. Increasingly, the engineering technologist is asked to contribute in many cross-discipline skills: computer to mechanical design to circuit analysis. Several modifications in both EET and MMET programs address these needs

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1. There is available a more flexible list of technology options, with electronics, computers, and mechanical courses. This adds to the increased number of mechanical courses in the electronics program, and vice versa, to insure that the choices are there for the student to tailor a program for their individual situation.
2. Cross-discipline courses between EET and MMET help to insure that there will be in every engineering technology graduate a basic knowledge of other technical disciplines. For example, EET and MMET students both take a required EGT261 Engineering Materials course, and a EGT161 DC circuit analysis course. Additional cross-discipline courses are optional for both programs.
3. Each program has built into several courses an increased use of design cycle, projects, and integrative assignments. While many courses can be used for growing projects into cross-course, cross-discipline undergraduate research, four courses, available to EET and MMET students are noteworthy for expanding technical horizons:
    - EGT417 Senior Design in Technology (capstone, project, course in last semesters)
    - EGT261 Engineering Materials (wide range, processes, application and design based)
    - EGT310 Project Management and Problem Solving, (basics of MS Project, and problem solving taught as methods and cross discipline principles)
    - EGT318 Introduction to Nanotechnology (electronics, mechanics, structures, power)

Application Based Approach to Teaching Materials and Processes

In response to the need for a more useful material selection course, a new approach has been successfully adopted in the EGT 261 Engineering Materials course.

1. Both EET and MMET students take this course to have knowledge of materials, processes, finishes and fastening in the design process.
2. In this course, based on the textbook from Michael F. Ashby, the principles of design are taught from case studies (designs) to move from market need (design requirements) to product specification (complete manufacturing description).
3. Based on real-life databases for a wide variety of materials, the student is able to immediately apply the method to any design problem, going from concept through embodiment to detail.
4. This immediate usefulness in the workplace significantly helps to convince students and employers of the ET program quality.

Collaboration with Community Colleges for Better Trained Students

Throughout engineering technology education, boosting enrollments and increasing retention continue to be a top priority. There are several factors at work; while this is very much a work in progress, much remains to be done. At NKU we are working in these areas.

1. To provide students with some statistical knowledge. We offer an alternative way for ET students; students take Calculus 1 A and 1 B, they will take STA205 (Introduction to Statistical Methods) as an alternative choice to MAT221 Calculus 2 A.
2. Math skills in problem solving are low. We help to develop problem solving skills with increased design content in all the early ET courses, and particularly in EGT310 Problem Solving and Project Management
3. Course content of 2 year schools feeding to our programs are always reviewed. It is important to maximize reciprocity agreements by aligning courses. More flexible courses and web-enhanced, web-based, and evening courses are all ways to increase enrollments.
4. Some students with extensive work or military experience ask for specific 300 and 400 level course credit for 100, 200 level courses. We have re-introduced the Advanced-Placement Test, so that the student can accurately assess their knowledge in a particular course, and know that they can take the course if they fail to pass the Advanced Placement Test.
5. Faculty from institutions with Associates degree ET programs sit on our industrial advisor boards. This helps us make the decisions for the B.S. in EET or MMET to be both a broader and deeper degree than the A.S. degree. The advisory board, with academic and industrial members, helps us strike the best balance between education for the career and training for the job.
6. In MMET, certificate programs in partnership with selected industries have worked to induce students to complete skills for their job, and then go on to complete their bachelors degrees. In EET, the minor in electronics technology also works well for students to add an electronics technology minor to any major, for example, the major in computer science, business, radio/tv)

The MMET and EET programs at NKU work very well together. There is a strong confidence that the changes in process will improve the programs even more. Measuring the "outcomes" and then closing the loop to improve the programs is the key to this improvement process.

Summary and Conclusions:

The Engineering Technology programs (MMET and EET) at NKU are undergoing changes not only for the renewal of ABET accreditation but also to better prepare students for the challenges ahead in their careers. The changes helps better serve Northern Kentucky constituents. These include:

- Establishing objectives and outcomes for each individual course, and if possible individual sessions.
- Evaluation of the outcomes by not only grades, but also students surveys and employer surveys.
- Introduction of new courses that bring new emerging technologies such as nanotechnology.
- Removal of less relevant courses, combination of two or three courses in one, providing cross-disciplinary courses, offering minors, and offering undergraduate research.
- Emphasizing application base approach, alongside efforts to collaborate with community colleges to better prepare transfer students.

References

[1] S. J. Edington, M. B. Eljamal, and S. W. Pang, "Gaining International Competence: A Multi-Faceted Approach to International Engineering Education," presented at 2005 ASEE Annual Conference and Eposition, Portland, OR, 2005 .

[2] J. Yeargan and K. Hermaut, "Globalization of European Engineering Education: An American Observer's Perspective," presented at 2001 Frontiers in Engineering Education, 2001.

[3] R. Mott, G. Neff, M. Stratton, and D. Summer, "Future directions for mechanical, manufacturing, and industrial engineering technology programs," *Journal of Engineering Technology*, vol. 91, pp. 8-15, 2002.

[4] F. G. Splitt, "Challenge to change: On realizing the new paradigm for engineering education," *Journal of Engineering Education*, 2003.

[5] K. D. Hurst, "A New Paradigm for Engineering Education," presented at 25th Annual ASEE/IEEE Conf: Frontiers in Education '95, Atlanta, GA, 1995, http://fie.engrng.pitt.edu/fie95/2b3/2b32/2b32.htm

[6] "ABET Technology Accreditation Commission, Evaluation Criteria (http://www.abet.org/criteria.html)

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