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Building Ethics and Project Management into Engineering Technology Programs

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Abstract

Our Industry Advisory Board (IAB) strongly suggested that we include more managerial skills in the Engineering Technology curriculum. Revised ABET criteria now require such skills. Our programs were already so long that they adversely impact student retention. The dilemma was how to implement more so called *"soft skills"* without adding more hours to the curriculum. This paper reviews our approach to solving this problem.

Introduction

In 1999 and again in 2000, our Industry Advisory Board (IAB) strongly requested that we include more managerial skills in Engineering Technology Programs so as to graduate students who not only have excellent technical skills, but also possess so called *"soft skills."* This request was for BS Programs in Electrical, Computer & Telecommunications Engineering Technology. These programs were already 5-year cooperative programs and were chock full. We turned this request and problem into a great opportunity that not only satisfies the original goal, but also may be a major contributor toward fulfilling two other, perhaps more important goals.

- Include more managerial skills and graduate students with so called *"soft skills*
- Satisfy the new ABET requirements for Engineering Technology Programs
- Expand Program breadth, while, at the same time, provide succinct programs. Successful progress toward time to graduation is a key component of RIT's retention improvement programs. Lengthy programs may diminish the perception of progress.

Only the initial goal was originally undertaken. Like so many innovations, the other outcomes were incidental benefits that will ultimately improve our student's skills and the programs at least as much as the original goal.

Genesis of Change

Our Engineering Technology programs utilize Industry Advisory Boards as input to potential improvement of our curriculum and programs. At a minimum, these boards meet with faculty curriculum committees twice per year. Historically, individuals who serve on these IABs offer suggestions for introducing advanced technology, tools and tests into the curriculum. They also

suggest subjects that graduates no longer need to learn. It was with some surprise when in 2000, the Computer Engineering Technology IAB complimented us on our technical curriculum while strongly requesting that students become more knowledgeable with managerial skills such as Ethics and Project Management.

This was a dilemma for us since we already require 192-quarter credit hours in the CET Program and more for ET & TET. Several Ethics courses are taught within the Philosophy Department in the College of Liberal Arts. Business teaches a graduate MBA Ethics course as well. Several departments teach Project Management, each with an emphasis on applying those concepts to their own area of specialty. Students could take courses in these other departments and, some did take the very courses that cover this subject matter. However, most students did not participate in these subjects. Please note: This paper does not address the research and need for these so called "*soft skills"*. That issue has been thoroughly researched and presented in many venues. Rather, we are presenting one method of implementing "*soft skills"* into bursting ET programs. There were several possible solutions that were considered:

- Eliminate two electives and require two additional courses
- Add two course requirements to the already long list of requirements
- Ignore the problem and do nothing like we did in 1999.
- Consider substituting one existing, one-subject matter course with a course that addresses multiple disciplines.

Ultimately, we decided that it would be better to teach less Engineering Economics if we could create a course that would utilize time "stolen" from Engineering Economics to benefit the teaching of Ethics and Project Management. Other solutions that were considered seemed to offer many more drawbacks than pluses. Could some other course have been selected? Yes! Why was Engineering Economics chosen? Engineering Economics is an excellent course but was chosen because no Computer Engineering Technology students were going on for a PE exam and certification. There is none. Upon further review, no Telecommunications Engineering Technology and very, very few Electrical Engineering Technology students were addressing the PE certification. We also held the belief that from a real world environment, Engineering Economics knowledge and skills was no more nor less needed and important than Ethics and Project Management. The IAB also held this view. See Appendix A for a sample of the RIT CET Program.

Implementation Phase---Beta to Production & Course Specifics

After considerable review and study of three specific topics—Engineering Economics, Ethics and Project Management, the course **Management Topics for Engineers** was proposed and offered in a Beta format during 2001. It proved to be nearly impossible to cover all that was desired to be taught within the initial course boundaries. Originally only lecture periods were used within a traditional 10-week quarter. Subsequently, a 2-hour per week lab was added during the pilot offering later that year. The additional hours greatly helped and allowed all of the Project Management to be taught in a lab environment with PCs readily available for MS Project. Please see the following course summary and goals:

Course Summary:
This course provides future Engineers and Engineering Technologists with a sound foundation in Management Principles. It will encompass three main topics in one course (3-in-One) The selected major topics are: Engineering Economics, Ethics and Project Management with management principles covered as part of each topic. It is envisioned that the course will quickly lay a foundation in Project Management basics and utilize a contemporary PC based Project Management tool. This topic will primarily be covered in one two-hour lab each week. The first half of the "traditional" lecture series will introduce and develop a keen understanding of core Engineering Economics. The latter part of the "traditional" lecture series of the course will introduce and develop Business and Engineering Ethics.

Course Objectives:
General
The objective of this course is to provide sufficient theoretical and practical information and exposure to Engineering Economics, Ethics and Project Management so as to enable a student to better understand how business and industry work. The student will become proficient with MS Project and be able to manage projects as well as be a proactive member of a project team. A sound introduction to economic decision-making will be introduced and students will be able to determine the economics of various Engineering projects and endeavors. Students will also gain a firm foundation in basic management principles, structures and goals and learn about the foundation of business, engineering and personal ethics. Students will be challenged to define their own personal ethics as well as invited to join a professional organization like the IEEE in an effort to gain professional recognition and understand a society's Professional Code of Ethics.

Specific Intended Learning Outcomes
At the end of the course the student will be able to:

- Demonstrate how to perform a basic economic analysis
- Demonstrate a knowledge of Ethics in: Business, Engineering and Personally
- Utilize MS Project as a management and tracking tool both as a Project Manager and as a Project Team Member
- Demonstrate knowledge of the concepts of Project Management

The 3-in-One approach is more difficult to teach than a single discipline course. Said another way, the course is challenging to teach but once mastered, it is fine, fun and very rewarding. The difficulty comes in the fact that each discipline is taught in its own best approach. It's interesting that in successful industry settings, these three disciplines often play off each other and mesh very well. Engineering Economics is taught in a traditional method and relies heavily on the latest edition of *Engineering Economy* by Blank & Tarquin. Readers are likely familiar with this traditional approach. Project Management covers the high level concepts. It then primarily focuses on tracking and control using MS Project. Examples of recent student MS Project "P" Final Exercises are: design and implement a robot that mimics what people say, mimics facial

expressions and does mathematical computations, create a new motherboard, develop a portable USB logic analyzer and develop a micro controller text display module.

Ethics was the more difficult discipline to develop and to teach. In order to best see how top Professors in that discipline teach this subject, I participated in an MBA Business Ethics Course. Additional reading and study led me to use the *Moral Issues in Business* by Shaw & Barry text. This introduces ethics subjects well, and then moves on to case studies. Current PE case studies are also used. Student's final Ethics track, Project "E" is a presentation of an ethical dilemma taken from personal, business or engineering situations. Students conclude with their recommended solution to the moral dilemma and must justify their solution to their peers--either through the use of basic moral principles &/or by asking: "Would I agree to be treated in the way that I am treating those involved?" This Project "E" helps students gain experience with the investigation and analysis of ethical problems and brought their study of Ethics to an applied practical conclusion. It also facilitated peer review of pertinent aspects of Ethics.

Recommendations, Summary and Conclusion

It is necessary for today's Engineering Technology graduate to possess certain so-called *"soft skills."* Yet, our ET Programs are already packed with priority technical and other requirements. It is possible to add soft skills like Project Management and Ethics to an ET Program without adding courses. Providing less Engineering Economics is one approach. For those disciplines or programs whose graduates do not soon go on for the PE exam, this is probably a very good method of culling out time and space to teach these skills. If many of your graduates do immediately go on for the PE exam, then this approach could be a detriment. Our approach worked for Electrical, Computer & Telecommunications Engineering Technology Programs.

How has this initiative helped with fulfilling ABET requirements and retention of students? ABET Criterion 2—Program Outcomes state:

"An engineering technology program must demonstrate that graduates have:

- "a." an appropriate mastery of knowledge, techniques, skills and modern tools of their disciplines,
- "i." an ability to understand professional, ethical and social responsibilities
- "j." a respect for diversity and a knowledge of contemporary professional, societal and global issues, and
- "k." a commitment to quality, timeliness and continuous improvement."

The course, Management Topics for Engineers allows us to specifically address each of the above outlined Criterion 2 Program Outcomes. Engineering Economics and Project Management are modern concepts with tools that are required in most ET fields. The ethics portion of the course very specifically targets professional, ethical and social responsibilities. Diversity and affirmative action are specifically addressed and thus far, students are required to

debate in written form, both sides of the affirmative action issue on their final exam using basic moral principles in their discussion. Quality, timeliness and continuous improvement are also easily addressed in this course. It would be nice to be able to build all of these outcomes into other more mainstream courses. We are not yet at that juncture and may not be for some time. In the interim, this course greatly assists us by allowing us to assess and prove the above Program Outcomes specifically.

What about retention? Retention is a major thrust of RIT due to relatively low graduation rates within 6 years of commencing study. Multiple factors effect retention. However, it is generally believed that successful progress toward graduation is a key component toward improving retention. Extremely lengthy programs may tend to diminish the perception of progress. Management Topics for Engineers does only a little for this effort. However, the process of meeting Program, IAB, ABET and Institute retention initiatives by providing extensive technical skills and a breadth of *"soft skills"* via multiple discipline courses may prove to greatly assist us in the retention improvement endeavor. It is possible that an in depth review of all Programs including non Engineering Technology courses, may lead to more multidiscipline courses. This would yield less required courses and either shorter programs or more flexible programs or, happily, both. Time will tell.

Please take away from this paper the concept that it is possible to increase the breadth of ET programs and build so called *"soft skills"* into them and also more easily meet ABET Criterion 2 requirements. This can be done without further complicating programs and without increasing their length. It may also be possible to improve retention in ET programs.

References

1. Criteria for Accrediting Engineering Technology Programs, www.abet.org
2. Engineering Economy: Current Teaching Practices, ASEE 1999, Session 1339
3. Engineering Economy – A Follow-up Analysis of Current Teaching Practices, ASEE 1997, Session 1239
4. Retention Studies, RIT Internal Documents.

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Appendix A

RIT Computer Engineering Technology

Bachelors of Science Five-Year Program 2003-2004

This curriculum applies to students entering in the program in 20031, 20032, 20033 or 20034 Quarters

YEAR	COURSE NUMBER & NAME		FALL	WINTER	SPRING	SUMMER
	1105-051	First Year Enrichment I	0*			
	0618-101	Freshman Seminar	1			
	0618-220	Electronic Fabrication Techniques	2			
	0618-231	Technical Programming I	4			
	0504-225	Writing and Literature I	4			
	1016-230	PreCalculus or Math/Science Elective	4			
	1105-052	First Year Enrichment II		0*		
	0609-201	DC Circuits		3		**Summer**
1	0609-221	DC Circuits & Simulation		2		**Vacation**
	0618-232	Technical Programming II		4		
	1016-231	Calculus for Eng Tech I		4		
	0504-226	Writing and Literature II		4		
	0609-202	AC Circuits			3	
	0609-222	AC Circuits & Simulation			2	
	0618-301	Digital Fundamentals			4	
	1016-232	Calculus for Eng Tech II			4	
	- - - - - - -	Liberal Arts: Core			4	
	0618-303	Microcomputers	4			
	0609-203	Electronics I	4			
	1017-211	College Physics I	3			
	1017-271	College Physics I Laboratory	1			
	- - - - - - -	Liberal Arts: Core	4			
	0618-339	Microcontrollers		4		
	0609-361	Electronics II		4		**Summer**
2	1017-212	College Physics II		3		**Vacation**
	1017-272	College Physics II Laboratory		1		
	- - - - - - -	Liberal Arts: Core		4		
	0618-233	Technical Programming III			4	
	0609-362	Electronics III			4	
	1017-213	College Physics III			3	
	1017-273	College Physics III Laboratory			1	
	- - - - - - -	Liberal Arts: Core			4	
	0618-438	Digital Systems Design	4			
	1016-319	Data Analysis	4			
	1016-304	Diff. Eq. for Eng Tech	4			
	0535-403	Effective Technical Communication	4			
3	0609-407	Career Orientation	1		**Co-Op**	**Co-Op**
	0618-439	Electronic Design Automation		4	**Block #1**	**Block #2**
	0614-477	Networking Technologies		4		
	1017-320	Principles of Optics		4		
	- - - - - - -	Liberal Arts: Concentration		4		
	0618-561	Embedded Systems Design I	4			
	0609-333	Concepts in Systems & Signals	4			
	- - - - - - -	Professional Concentration Elective I**	4			
4	- - - - - - -	Liberal Arts: Concentration	4	**Co-Op**		**Co-Op**
	0618-562	Embedded Systems Design II		**Block #3**	4	**Block #4**
	0609-442	Advanced Electronics			4	
	- - - - - - -	Professional Concentration Elective II**			4	
	- - - - - - -	Liberal Arts: Concentration			4	
	0618-563	Embedded Systems Design III		4		
	- - - - - - -	Elective ***		4		
	- - - - - - -	Elective ***		4		
5	- - - - - - -	Professional Concentration Elective III**	**Co-Op**	4		
	- - - - - - -	Elective ***	**Block #5**		4	
	- - - - - - -	Elective ***			4	
	0614-440	Management Topics for Engineers			4	
	- - - - - - -	Liberal Arts: Senior Seminar			2	

*** Of the four electives, two must be Technical Electives, one a General Education Elective and one a Math/Science Elective.