Build It and Will They Come? Refurbishing and Restoring an ECET Curriculum

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Abstract
Since the 1990's, nationwide enrollment in engineering technology programs has been declining. It has become increasing difficult to attract and retain students. A number of reasons have been attributed to this trend including; outdated curricula, loss of manufacturing jobs, off-shoring of jobs and a weak economy. As a result, competition to enroll students interested in these programs is fierce and has become crucial to maintain a viable and attractive curriculum.

The Electronics & Computer Engineering Technology (ECET) department at the University of Hartford is completing a major restructuring of its degree programs. We currently offer two Bachelor of Science programs: Electronic Engineering Technology (EET) and Computer Engineering Technology (CET). The restructuring was needed to improve student recruiting and better prepare graduates for industry. The full-time and adjunct faculties of the department with assistance from its industrial advisory board (IAB) worked collaboratively over the past year to develop and implement the changes to the curriculum

The restructuring was based on the conclusion that we needed to change both what was being taught and how it was being taught. Leading us was our mission that technology programs, by nature, must equip graduates with "hands-on" skills that make them immediately useful in entry-level positions in industry. In addition, our curricula must keep pace with the rapidly changing fields within electronics and computer technology. We believe the new curriculum and pedagogy will accomplish that.

The restructuring consisted of course deletions, significant course modifications and many new courses. In addition, course tracks were formed within each program. For EET, there are now two tracks: Mechatronics, Communications and Networks, and for CET Programming and Microprocessor tracks are included.

This paper describes the details of our curricula restructuring efforts and the key changes designed to improve marketability, retention, and pedagogy. Our goal is to revitalize the programs in electronics and computer engineering technology and reverse declining enrollments.

Brief Justification
As the world of engineering and technology is an ever changing field, it is an ongoing challenge for higher education programs to keep pace with these changes. Since the 1990's, nationwide enrollment in engineering technology programs has been declining and as a result it has become increasing difficult to attract and retain quality students. A number of reasons have been attributed to this trend including; outdated curricula, loss of manufacturing jobs, off-shoring of

jobs and a weak economy. As a result, competition to enroll students interested in these programs is fierce and has become crucial to maintain a viable and attractive curriculum. The Electronics & Computer Engineering Technology (ECET) department has worked to complete a major restructuring of its degree programs to make them more attractive to prospective students while providing the education and skills necessary for graduates compete in the workforce. We plan to continue to offer two Bachelor of Science programs: Electronic Engineering Technology (EET) and Computer Engineering Technology (CET), with the addition of specific tracks within these two programs.

Curriculum Changes

The first step in our process was to evaluate our current curricula and identify its strengths and shortfalls. This was a very difficult and labor intensive process. Discussion was begun amongst the faculty and our industrial advisory board concurrently. The curricula and the individual courses were evaluated down to the topic level in both the theory and laboratory portions of all courses. Our technology program, as most technology programs are by nature, is designed to equip graduates with "hands-on" skills that make them immediately useful in entry-level positions in industry. This necessitated an evaluation of both the laboratory and theory content of each course.

During this portion of our analysis, we pondered many difficult and often philosophical questions regarding the curricula. In discussions amongst ourselves, with employers, graduates, and our IAB, we heard that graduates should be " well versed in the basics…", and they should have " an exposure to a variety of advanced concepts and technologies". The most difficult question that arose was "what are the basics?", and "how much of the curriculum should be spent teaching them?." The only conclusion we were able to definitively agree upon is that as time passes the breadth of knowledge that constitutes "the basics" continues to increase with emerging technologies. The problem is finding sufficient space and time within the curriculum to produce graduates within four years that are well versed in "the basics" and armed with specialized knowledge to make them attractive to industry.

The current curriculum in EET is a total of 128-130 credit hours which translates to 161 contact hours of classroom instruction and laboratory exercises. In CET, the totals are 128 credit hours and 158 contact hours. The curriculum of both programs is a mix of general education courses (English, Math, Science, Humanities and Social Sciences), Professional Electives (Economics, business, programming, etc) and Technical classes. We agreed to the pretext that the only portion of the curriculum to be changed would be the technical classes. The reasoning was that various outside constituencies such as accrediting agencies and the university itself has specific general education requirements, and it would be better not to reduce the numbers of credits devoted to these areas. The technical portion of our curricula is 75 credit hours is made up of 128 contact hours. Shown in Figure 1 and 2 are the existing curricula in EET and CET before any changes.

Figure 1. Existing Electronic Engineering Technology (EET) Curriculum

Course Name	Credit Hours	Class Hours	Lab Hours	Contact Hours	Course Name	Credit Hours	Class Hours	Lab Hours	Contact Hours
ASSOCIATE IN SCIENCE									
SEMESTER 1					**SEMESTER 2**				
EL 110 Intro to Electronics	3	2	2	4	EL 111 DC Electrical Fundamen	4	3	3	6
EL 113 Personal Computer Lab	2	1	1	2	Human/Soc Science Elective	3	2	2	4
EN 111 Engl I: Expository Comm	3	3	0	3	MTH 122 Precalculus for Techs	3	3	0	3
ET 111 Intro to Engineer Tech	1	1	0	1	PHY 120 Algebra-Based Phys I	4	3	0	3
MTH 112 College Algebra for Tech	3	3	0	3	All-University Curriculum	3	3	0	3
PG 111 Programming for Tech	3	3	0	3					
SEMESTER TOTALS	**15**	**13**	**3**	**16**	**SEMESTER TOTALS**	**17**	**14**	**5**	**19**
SEMESTER 3					**SEMESTER 4**				
EL 121 Solid State Devices	4	3	3	6	EL 232 Analog Circuits	4	3	3	6
EL 124 AC Electrical Fundamen	4	3	3	6	EL 233 Digital Circuits	4	3	3	6
MTH 232 Calculus I for Techs	3	3	0	3	EL 244 Indust Contr & Automa	4	3	3	6
PHY 121 Algebra-Based Phys II	4	3	3	6	EN 241 Engl II: Technical Comm	3	3	0	3
					MTH 241 Calculus II for Techs	3	3	0	3
SEMESTER TOTALS	**15**	**12**	**9**	**21**	**SEMESTER TOTALS**	**18**	**15**	**9**	**24**
PROGRAM TOTALS A.S.	**65**	**54**	**26**	**80**					
BACHELOR OF SCIENCE									
SEMESTER 5					**SEMESTER 6**				
EL 243 Communications I	4	3	3	6	EL 352 Communications II	4	3	3	6
Technical Elective (3-4)	3-4	3	3	6	EL 353 Industrial Instrumen	4	3	3	6
MTH 352 Diff Equations for Techs	3	3	0	3	ELN 361 Network Analysis	3	3	0	3
UP 242 Microprocessors I	4	3	3	6	UP 352 Microprocessors II	4	3	3	6
All-University Curriculum	3	3	0	3					
SEMESTER TOTALS	**17-18**	**18**	**12**	**27**	**SEMESTER TOTALS**	**15**	**12**	**9**	**21**
SEMESTER 7					**SEMESTER 8**				
Basic Science (Lab)	4	3	3	6	EN 481 Engl III: Adv Tech Comm	3	3	0	3
EL 351 Linear Integ Circuits	4	3	3	6	Professional Elective	3	3	0	3
Technical Specialty	4	3	3	6	Technical Specialty	4	3	3	6
All-University Curriculum	3	3	0	3	Technical Specialty* (3 or 4cr)	3-4	3	0-3	3-6
					All-University Curriculum	3	3	0	3
SEMESTER TOTALS	**15**	**12**	**9**	**21**	**SEMESTER TOTALS**	**16-17**	**15**	**3-6**	**18-21**
PROGRAM TOTALS B.S.	**128-130**	**108**	**56-59**	**164-167**					

Figure 2. Existing Computer Engineering Technology (CET) Curriculum

Course Name	Credit Hours	Class Hours	Lab Hours	Contact Hours	Course Name	Credit Hours	Class Hours	Lab Hours	Contact Hours
ASSOCIATE IN SCIENCE (A.S.)									
SEMESTER 1					**SEMESTER 2**				
EL 111 DC Electrical Fundamen	4	3	3	6	EL 121 Solid State Devices	4	3	3	6
EL 113 Personal Computer Lab	2	1	1	2	EL 124 AC Electrical Fundamen	4	3	3	6
EN 111 Engl I: Expository Comm	3	3	0	3	MTH 122 Precalculus for Techs	3	3	0	3
ET 111 Intro Engineering Tech	1	1	0	1	PHY 120 Algebra-Based Phys I	4	3	3	6
MTH 112 College Algebra for Tech	3	3	0	3					
PG 111 Programming for Tech	3	3	0	3					
SEMESTER TOTALS	**16**	**14**	**4**	**18**	**SEMESTER TOTALS**	**15**	**12**	**9**	**21**
SEMESTER 3					**SEMESTER 4**				
EL 232 Analog Circuits	4	3	3	6	CET 351: Digital Circuits II	4	3	3	6
EL 233 Digital Circuits I	4	3	3	6	CS 114 Computer Programming I	4	4	0	4
MTH 232 Calculus I for Techs	3	3	0	3	EN 241 Engl II: Technical Comm	3	3	0	3
PHY 121 Algebra-Based Phys II	4	3	3	6	MTH 241 Calculus II for Techs	3	3	0	3
All-University Curriculum	3	3	0	3	UP 242 Microprocessors I	4	3	3	6
SEMESTER TOTALS	**18**	**15**	**9**	**24**	**SEMESTER TOTALS**	**18**	**16**	**6**	**22**
PROGRAM TOTALS AS	**67**	**57**	**28**	**85**					
BACHELOR OF SCIENCE (B.S.)									
SEMESTER 5					**SEMESTER 6**				
CS 115 Computer Programming II	4	4	0	4	CS 211 Assembly Lang & Architec	4	3	3	6
MTH 352 Diff Equations for Techs	3	3	0	3	M 114 Everyday Statistics	3	3	0	3
UP 352 Microprocessors II	4	3	3	6	UP 472 Microprocessors IV	4	3	3	6
All-University Curriculum	3	3	0	3	Professional Elective	3	3	0	3
					All-University Curriculum	3	3	0	3
SEMESTER TOTALS	**14**	**13**	**3**	**16**	**SEMESTER TOTALS**	**17**	**15**	**6**	**21**
SEMESTER 7					**SEMESTER 8**				
Human/Soc Science Elective	3	3	0	3	EN 481 Engl III: Adv Tech Comm	3	3	0	3
Professional Elective	3	3	0	3	Professional Elective	3	3	0	3
Technical Specialty	4	3	3	6	Professional Elective	3	3	0	3
Technical Specialty	4	3	3	6	Technical Specialty	4	3	3	6
All-University Curriculum	3	3	0	3					
SEMESTER TOTALS	**17**	**15**	**6**	**21**	**SEMESTER TOTALS**	**13**	**12**	**3**	**15**
PROGRAM TOTALS B.S.	**128**	**112**	**46**	**158**					

Proposed Changes

The proposed changes retained both programs, but created three course tracks as shown in the Table 1 below. Two course tracks were created for EET and one for CET.

Table 1. Course Tracks in ECET Department

Degree	Program	Track
Bachelor of Science	Electronic Engineering Technology	Mechatronics: industrial control, instrumentation and machine design
Bachelor of Science	Electronic Engineering Technology	Networks: communications, wireless networks, and telecommunications
Bachelor of Science	Computer Engineering Technology	Computer Technology: microprocessors, programmable logic and digital signal processing

The curriculum was redesigned so a core of courses formed the basis for all tracks in both programs. These core courses spanned all 8 semesters of the program and is shown below in Figure 3.

Figure 3: Common Core for all EET & CET tracks

The Color coding key is as follows:

Math Courses | Technical Courses | Programming Courses | General Ed Courses

English Courses | Science Courses | Engineering Technology Courses

Numbers in cells correspond to:
Total Credits hrs, Theory contact hrs, Lab contact hrs, Total contact hrs

Program Tracking by Semester							
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
MTH112 College Algebra 3 3 0 3	MTH122 Pre-Calc 3 3 0 3	MTH232 Calculus I 3 3 0 3	MTH241 Calculus II 3 3 0 3	MTH352 Differential Equations 3 3 0 3	Humanity Soc Sci Elective 3 2 2 4	AUC Elective 3 3 0 3	Prof Elective 3 3 0 3
EN111 English I 3 3 0 3	PHY120 Phys I 4 3 3 6	PHY121 Phys II 4 3 3 6	EN241 English II 3 3 0 3	Basic Science (Lab) 4 3 3 6	AUC Elective 3 3 0 3	EN481 Tech Writing 3 3 0 3	
ET111 Intro to ET 1 1 0 1	ECT121 Electronic Circuits 4 3 3 6	ECT231 Intro to Semicond 4 3 3 6	ECT36x Prog II C 3 2 2 4	AUC Elective 3 3 0 3	AUC Elective 3 3 0 3		
ECT111 Intro to Electronics 4 3 3 6	ECT122 Digital I 4 3 3 6	ECT 222 Digital II 4 3 3 6	ECT242 Microproc I 4 3 3 6			ECT471 Sr Project Design I 3 1 5ed 6	ECT472 Sr Project Design II 4 3 3 6
ECT113 Comp App for ET 2 1 1 2							
ECT112 Prog I VB 3 2 2 4							

The changes to the curriculum in the core electronics courses were:

- Core electronics courses were compressed (Fundamental of Electricity, DC, AC and Solid State and Analog Circuits courses went from four to three courses)
- A second programming course, C language, was added
- Network analysis course was dropped
- Digital electronics course was moved forward to the freshman year
- Second digital electronics course was added
- Two senior project courses were added

The department discussed each of these changes and the challenges faced by shuffling the course sequencing within the curriculum. The compression of the core electronics curriculum was achieved by eliminating some topics on transistor biasing as well as semiconductor materials. The addition of a second programming course was roundly debated, but the majority felt that having two programming languages would be a valuable asset, and C language remained a useful language in many engineering applications, e.g. microprocessor coding.

The decision to eliminate the network analysis course was easier since the majority felt that there were significant software tools available to analyze and model complex circuits, and the course had become outdated. It was also suggested by employers and graduates that La Place-based circuit analysis was not a skill required for many graduates.

A harder decision was the movement of the first digital course to the second semester in an effort to improve retention. It was the consensus that if students ended their freshman year with some digital skills, they would likely return the next year. Our experience is that students find digital electronics easier to grasp then analog circuits. By adding digital to the freshman year, we hoped to offset this difficulty by providing a course that students typically excel in during the same semester. A second digital course was also added to the curriculum to address what we felt was a deficiency in the curriculum.

A two semester required senior project design course sequence was added to the final two semesters. This was a significant departure from the previous curriculum where we had a one semester, optional senior project course. Our reasoning for this addition was that it would provide a capstone experience for all students, and we could incorporate topics on project management and teamwork. We also felt that two semesters would provide students greater time to plan and execute a design project. Most of the debate centered around the number of credits and laboratory time for the course. By structuring the course with both theory and scheduled laboratory time, we felt that we had improved the students chance a achieving a successful design project. By providing project management structure with weekly progress reports and meeting times we hoped all students would successfully complete the senior design courses.

The second half of the curriculum revision was the creation of the three tracks or concentrations. These tracks were added to improve the marketability and attractiveness of the programs while catering to the needs of local and regional employers. The three tracks are shown below in Figures 4, 5 and 6.

Figure 4. Mechatronics Track

Mechatronics Track of EET Degree				
Semester 4	**Semester 5**	**Semester 6**	**Semester 7**	**Semester 8**
ECT241 Analog & Solid State Devices 4 3 3 6	ECT351 Linear Integrated Circuits 4 3 3 6	EL244 Industrial Controls 4 3 3 6	EL353 Industrial Instrumentation 4 3 3 6	Technical Elective 3-4
	MET236 Statics 3 3 0 3	MET243 Mechanics of Materials 4 3 3 6	MET363 Machine Design I 4 3 3 6	MET484 Automation Systems 4 3 3 6

Figure 5. Communications & Networking Track

Communications and Networking Track of EET Degree				
Semester 4	**Semester 5**	**Semester 6**	**Semester 7**	**Semester 8**
ECT241 Analog & Solid State Devices 4 3 3 6	EL243 Electronic Communications I 4 3 3 6	EL352 Electronic Communications II 4 3 3 6	ELxxx Network Protocols & Architecture 4 4 0 4	Technical Elective 4
	ECT351 Linear Integrated Circuits 4 3 3 6	ELxxx Data Communications 3 3 0 3	ELxxx Digital Signal Processing 4 4 0 4	Technical Elective 4

Figure 6. Computer Engineering Technology Track

Computer Engineering Technology Track				
Semester 4	**Semester 5**	**Semester 6**	**Semester 7**	**Semester 8**
CS114 Computer Programming I 4 4 0 4	CS115 Computer Programming II 4 4 0 4	CS220 Database Structures 3 3 0 3	Technical Elective 4	CS365 Datebase Arch& Systems 3 3 0 3
	UP352 Microprocessor Systems & Arch 4 3 3 6	UP362 Microprocessor Interfacint 4 3 3 6	ELxxx Network Protocols & Architecture 4 4 0 4	Technical Elective 3-4

Each of the tracks was designed to provide a concentration or specialization in a specific area within the electronics and computer engineering technology area. Although students were not required to take courses specifically within a track, it was strongly recommended that they do. The prerequisite structure of the course sequences within each track virtually assured that students stayed within a particular sequence or track. Each track began in the semester four, which was the second semester of the sophomore year. If a student chose to change tracks, this initial course would often be applied elsewhere in other tracks to satisfy the technical elective credit.

The mechatronics track provided specialization in an area that blends the disciplines of mechanical engineering technology and industrial automation. Students were required to take two sequences within this track. The second row in Figure 4 (in red) shows the industrial automation and control sequence of courses. Students started with advanced analog circuits, moved to a linear integrated circuits course, then advanced to industrial electronics and controls, industrial instrumentation and signal conditioning before finishing with an automation course.

Students also had the ability to select a technical elective course in their final semester. The second sequence in the bottom row in Figure 4 outlines mechanical engineering technology courses. The first is Statics, followed by Strength & Mechanics of Materials followed by a Machine Design course, and concluding with Automated Systems. We felt this track provided

students with the knowledge necessary to gain employment in the manufacturing, automation and fabrication industry.

Maintenance, upgrading, and implementation of automated systems and support of manufacturing operations provides significant employment opportunities within our regional area. Our goal was to provide a strong background in electronics and automation systems with an appreciation for the mechanical constraints and limitations placed on these systems.

The communications and networking track targeted skills and knowledge necessary to gain employment in the analog and data communications industry. Students were required to take a sequence of courses that provided them with additional knowledge of electronic devices and circuits common to this area. Courses in RF design and data communications were built into this track. Networking architectures and communication protocols were added in later courses.

The computer engineering technology track concentrated on supplementing the student's basic knowledge of electronics with a strong emphasis on digital electronics, microprocessors and peripheral interfaces. This track also provided high level software programming and computer operating systems/hardware. The courses shown in blue in Figure 6 are taught out of the computer science area of the university. This sequence also allowed students to obtain a minor in computer science by taking two additional courses. The learning objectives were a strong knowledge of network systems, protocols, computer system architecture, programming languages, and database structure. We believed that graduates would be able to work closely with engineers in a variety of fields by providing computer related expertise often required to integrate complex systems. Computer support for engineering and industrial applications had been targeted previously by our IAB as under-represented in the curriculum.

Conclusion

This curriculum revision project within the electronics and computer engineering technology programs at the University of Hartford has provided the opportunity for the department to put a fresh face on its programs and curricula. Through the addition of the track system and the complete overhaul of the core curriculum, it is hoped that we will achieve a new level of success attracting and retaining students. The new curriculum was an integrated effort by the faculty, alumni, employers and our IAB. It took many hours of hard work and difficult decisions to produce a curriculum that we felt would revitalize the department. We have built it, but will they come?

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