

## **A Curriculum Update from Electromechanical to Electrical and Information Engineering Technology at the University of Northern Iowa**

**Recayi Pecen      Teresa Hall      Jalaluddin Ahmad**  
**University of Northern Iowa   College of Natural Sciences**

### Abstract

This paper describes the outcome of efforts to reengineer the Electromechanical Systems program (EMS) at the University of Northern Iowa (UNI) to become Electrical and Information Engineering Technology (EIET). This will be the first four-year Engineering Technology Bachelor of Science degree program of its kind in the state of Iowa. The curriculum update has been approved by the curriculum committees at the department, college, and university levels and will start accepting new, transfer and redeclared student majors in the fall of 2002. Key features of the curriculum update include dropping the mechanical systems courses and adding specialized courses in electrical power, power electronics, analog/digital electronics, control systems, analog/digital communications, microcomputer technology, and computer networking. This new focus for the program will permit sufficient coverage of Engineering Technology design as determined in ABET-TAC to fully justify the term "Engineering Technology" in its name. Additionally, this paper incorporates material describing the mission of the program, a brief summary of articulation efforts with local and regional technical programs at community colleges, and a detailed description of the new curriculum for the EIET program.

### I. Introduction

In the early 1960s, the Electromechanical Systems (EMS) program was established at UNI as an automotive electrical systems technology program. The national energy crisis in the 1970s precipitated the incorporation of topics in energy and power systems. By combining several existing departmental programs that focused on energy, power, internal-combustion and other prime-mover technology, the program had evolved to include engineering technology and industrial supervision options by the late 1980s. At that time, few machine tools and other industrial systems were computer controlled or computer interfaced, thus the program did not address topics in digital technology, which also mirrored other similar postsecondary programs during that time period. However, recent industry trends indicate that digital electronics, information technology systems, and electronic communications technology have a great need for technical professionals. According to the Bureau of Labor Statistics (BLS), the fastest employment growth through 2008 will be in computer and information systems related areas [1]. Computer-related jobs were predicted to experience double-digit growth during the ten-year period from 1998-2008. Computer engineers and engineering technologists, computer support

specialists, computer systems analysts, and database administrators constitute the four most rapidly growing occupations in the US economy and are expected to increase by 108, 102, 94, and 77 percent, respectively [1]. According to the BLS, engineering technicians and related support occupations are projected to grow by 22 percent, adding 1.1 million jobs by 2008 [1]. Workers in this group provide technical assistance to engineers, scientists, physicians, and other professional specialty workers, and operate and program technical equipment and are in high demand. Conversely, the recent slowing of the economy in manufacturing and technology sectors, exacerbated by the recent tragedies in the US may have a short-term dampening effect on employment demand. Nonetheless, this new EIET program will be well positioned to provide much needed technical workers with skills in applied analog and digital technology to meet the growing needs of the industrial workplace.

## II. National Trends in EIET Programs

Brigham Young University (BYU) in Utah, Florida A&M, Savannah Technical College, and New Mexico State University are some of the institutions have already done similar updates and/or established new programs in Electronics and Information Engineering Technology or closely related curricula. For example, BYU Electronics Engineering Technology has evolved to become Electronics and Information Technology in 2001. New Mexico State University Engineering Technology Electronics Engineering Technology was updated to Electronics & Computer Engineering Technology Program in 2000. At Savannah Technical College in Georgia, the Electronics Engineering Technology and Electromechanical Engineering Technology A.A.S. programs combined to create the Electronics and Computer Engineering Technology major in 2000 [2]. There are now more than a dozen institutions in US that have pursued similar updates to meet industrial employment needs [3].

## III. Justification for the Program Update

The process to make changes in existing programs at any university requires background research, supporting documentation, and political savvy to achieve successful results. The following are some of the justifications supporting the EMS program update to EIET that were presented to the curriculum review teams:

- A review of local and regional job markets showed a large unmet need for Engineering Technologists with a BS degree in the EIET area. A survey of EMS program alumni and supporting observations by the program's advisory board expressed the need for a more contemporary flavor for the program.
- The new program will trade breadth for depth. Rather than teaching a wide variety of topics in mechanical, electrical and electronic systems, (and maintaining supporting laboratory equipment), the program will have a more focused curriculum that will allow the students to build depth in key areas such as controls and electronics. This change will maximize the usage of lab resources and allow for a more efficient use of funding for new equipment.

- Engineering Technology is a profession in which knowledge of mathematics and science and laboratory experiences, are devoted primarily to the implementation and extension of existing technology [4]. Students in Engineering Technology programs acquire technical skills that enable them to solve production and system implementation problems and encourage them devise creative solutions in the industrial setting.
- The EIET program will provide classes that are more advanced and state-of-the-art electronics laboratory exercises for students transferring from two-year Engineering Technology programs at community colleges. Many graduates from Iowa community colleges with Electronics Engineering Technology A.A.S. degrees wished to transfer to complete a B.S. degree but were not interested or did not need the mechanical systems courses in the existing EMS program. The new update will be helpful in recruiting new students to the program and in meeting the needs of non-traditional students such as those currently employed in full-time industrial positions.
- With this update, credit hours for the program were reduced from 137 to 130, which eliminates disadvantages of being an extended degree program. The high number of hours required for a B.S. degree were due, in part, to the large number of general education course requirements at UNI, a liberal arts institution. This will enable students to work through the program in four years for traditional students and in two to three years for community college transfer students.
- The program will incorporate expanded coverage of analog/digital electronics and communications. By using the credit hours previously assigned to the mechanical systems, courses in advanced electronics, networks, controls and processes can be added. Thus, the students will have sufficient background to be useful in the design and implementation of computer networks in manufacturing environments.
- The refocusing of the program on cognitive skills development in electronics and digital technology area rather than manual skills development should be of interest to women. Currently, the EMS program has only two female students who have expressed greater interest in the EIET major. The program will function as a gateway into manufacturing and technical careers for students who might have been turned off by traditional manual-labor-intensive programs.
- Many employees are still not fully aware of the purpose of the EMS degree. Many times, when students applied for industry positions, the faculty must provide employers with additional information such as curriculum listings and course descriptions. Based on the personal experience of faculty in the EMS area, it is interesting to note that the first impression of employers have in general about EMS is considering it to be Emergency Medical Systems. EET or EIET are more common and standard terms for industry and academics in the electrical and electronics area. This will eliminate any initial misunderstandings when graduates submit their resumes to employees.

- The EMS program needed a wide variety of lab apparatus spanning all of the mechanical, thermal, fluid power and electrical equipment. It became very expensive to furnish enough updated equipment in mechanical and electronics area due to a very limited laboratory budget. Concentrating in only electrical and electronics area and eliminating needs in heavy mechanical equipment will improve the use of limited resources.

#### IV. EIET Program Mission Statement

The mission of the Electrical and Information Engineering Technology program at the University of Northern Iowa is to provide quality, hands-on and application-oriented education that produces professionals who will contribute to the advancement of engineering technology in the areas of electrical power, analog/digital electronics, industrial control systems, microcomputers, instrumentation, telecommunication and networking.

#### V. New Program's Major and Minor Curriculum

The EIET program's mathematics, computer science, and technical core courses are shown in Table 1. Compared with the existing EMS program, Algebra-based General Physics I and II have been replaced with Calculus based Engineering Physics I and II. However, students transferring from two-year community colleges may still use their Algebra-based college level General Physics classes to satisfy the Physics requirement. This is one pre-existing condition that resulted from the Industrial Technology Department's strong ties with Iowa community colleges in our efforts to develop articulation agreements.

Thermodynamics and Prime Movers, Mechanical Power Systems, Materials and Processes of Manufacturing, and Industrial Safety classes have been replaced with four new introductory level Circuits, Power, Analog, and Digital Electronics classes.

The other new classes in the revamped program are Electronic Telecommunications I and II, which will also include information on introduction to networking. Electronic Circuit Board Development has been updated to become Advanced Circuits and Systems. Industrial Electronics has been changed to be Advanced Analog Electronics. Digital Electronics is now Advanced Digital Electronics. Microcomputer Architecture and Instruction Set is basically an introductory level microcomputer class and renamed as Real-Time Industrial Computing with some minor modifications. Programmable Logic Controllers (PLCs) and Industrial Applications of Power Electronics classes remain the same. Power System Analysis is renamed Advanced Power Systems. The Research and Development I and II courses are renamed Senior Design I and II, respectively with a change in the number of credit hours to reflect minor content revisions.

Table 2 depicts the updated Electrical / Electronics Technology (EET) minor that had been established in the previous curriculum cycle. There existed a considerable amount of interest for the EET minor from majors in Computer Science, Technology Education, and Technology Management. As part of the EET minor degree program, the students are encouraged to take the

following classes from other departments and programs under the criteria of UNI University Electives. These included: Modern Optics: Holography and Imaging, Modern Optics: Lasers both from the Physics department, Technical Writing (English), Power Technology, Industrial Safety, Computer Aided Design (CAD) and Drafting, Industrial Materials, and Applied Fluid Power (Industrial Technology).

<b>Course #</b>	<b>Hours</b>	<b>Course Name</b>	
<b>Math and Computer/Science Core</b>			<b>Total: 22 hours</b>
800:060	4	Calculus I	
800:061	4	Calculus II	
800:072	3	Introduction to Statistical Methods	
810:035	3	C Programming OR 810:036 C++ Programming	
880:130	4	Physics I for Science & Engineering	
880:131	4	Physics II for Science & Engineering	
<b>Technical Core</b>			<b>Total: 51 hours</b>
330:037	3	Introduction to Circuits	
330:038	3	Introduction to Electrical Power and Machinery	
330:041	3	Introduction to Analog Electronics	
330:042	3	Introduction to Digital Electronics	
330:129	3	Introduction to Control Systems	
330:139	3	Advanced Circuits and Systems	
330:152	3	Advanced Analog Electronics	
330:156	3	Advanced Digital Electronics	
330:157	3	Real-Time Industrial Computing (RTIC)-Microcomputers	
330:160	3	Computer Aided Instrumentation and Interfacing (CAII)	
330:164g	3	Programmable Logic Controllers (PLCs)	
330:165	3	Electronic Communications I	
330:166g	3	Advanced Electrical Power Systems	
330:167g	3	Industrial Applications of Power Electronics (IAPE)	
330:174	1	Senior Design I	
330:176	2	Senior Design II	
330:184g	3	Advanced Controls and Processes	
330:1XX	3	Electronic Communications II	
Total Hours in Major including 800:072 & 880:130			<b>73 hours</b>
Free electives required by UNI			<b>17 hours</b>
Liberal Arts			<b>40 hours</b>
7 hours Gen Ed satisfied by 800:072 & 880:130			
<b>Grand Total for BS in EIET:</b>			<b>130 hours</b>

Table 1. The EIET Program Requirements

## VI. New Program Needs

The focus of this program is the preparation of students for technical careers in the electrical, electronics, and the computer sector. The current program's instructional facilities lacked major equipment improvements until the fall of 1999. In order to prepare the students for careers in electrical and electronics, the EIET program requires hardware and software tools in place that are representative of the condition in the industrial settings.

The EIET program has already received some equipment monies to purchase PLCs, control units, and software as donations from local companies such as Nestle, USA and Pinnacle Engineering Inc. A major contribution from the Deere and Co. Foundation is anticipated in the near future. That said, there still remain key areas of much need equipment including the following:

- Pentium-class computers, monitors, printers, and accessories.
- Various design software. (Current MultiSim 2001 with 20 station licenses solve many software needs).
- PLCs and PLC software particularly RS Logic 500 and better.
- Electronic instruments such as oscilloscopes, function generators, power supplies, logic analyzers, probes, accessories.
- Instrumentation items like A/D boards, sensors, and/or signal conditioners.
- Electronics and Mechanical assembly tools.
- Electric motors and transformers and accessory items.
- Industrial trainers of all types, particularly for PLCs to control fluid power systems.
- Analog and digital electronics communications trainers, and software (two telecommunications trainers have already been purchased).
- There are one up-to-date electrical machinery, and one brand new control systems trainer; these must be duplicated for improved access for lab activities. Currently, the instructor repeats the same lab with smaller groups a number of times due to the lack of trainers.

### **ELECTRICAL/ELECTRONICS TECHNOLOGY MINOR EET**

330:037	3	Introduction to Circuits
330:038	3	Introduction to Electrical Power and Machinery
330:041	3	Introduction to Analog Electronics
330:042	3	Introduction to Digital Electronics
330:129	3	Introduction to Control Systems
330:164	3	PLCs
330:035/36	3	C or C++ Programming
880:054/130	4	General Physics OR Physics I for Science & Engineering
800:060	4	Calculus I

Total EET MINOR Requirements: **29 hours**

Table 2. The updated Electrical/Electronics Minor for non-majors in the IT Department

One of the problems for the EMS program in the past was faculty turnover. Although there are three full-time faculty positions are allocated for the program, most of the time the program have had two full-time faulty members and two adjunct instructors, while the third full-time faculty position remained unfilled due to the need for such a broad range of qualifications under the EMS program. This issue should be solved before the program applies for ABET-TAC accreditation. Due to the liberal arts emphasis at the University, faculty salaries traditionally are lower than most engineering schools. However, many internal and external grant opportunities are available for faculty in addition to graduate school summer fellowships, summer fellowship grants from agencies like the Iowa Energy Center, Iowa Department of Transportation, Iowa Department of

Natural Resources, Iowa Department of Education. Summer semester teaching is also possible dependent on student needs and budgetary resources at the university.

## VII. Outreach and Industry Collaborated Other Activities

The EMS program has an industrial advisory board, which includes members from Deere & Company, Maytag Company, Rockwell Collins Inc., Alliant Energy, and Nestle USA. It is anticipated this board will continue to advise the EIET program in a similar fashion in the future.

The EMS program at the University of Northern Iowa has also organized a number of workshops through the UNI Continuing Education Programs for local manufacturing employees in Basic Electricity and Electronics, and Data Processing. These workshops have been well received and have served as a promotional tool for the program. In the future, workshops in information technology, communications and networks are a possibility.

Iowa is a state whose economy is based on agricultural products and services and the EIET program is designed to also help Iowans in this area. There are still many remote farms in Iowa whose energy is supplied at a very expensive cost due to the locations and long distance to power lines. The program has developed a number of workshops in wind and solar energy applications to help Iowans to supply their own power needs through eco-friendly resources [5-6]. One good solution is solar pumping for summer days are an excellent solution for irrigation needs of farmers. The EIET program should also have relevance via control and monitoring of such systems in the form of data transmissions.

IEEE - UNI Section is also active in inviting guest speakers from local industries. Some speakers from Deere & Company, Rockwell Collins, Inc., and Alliant Energy have been of great interest to students in these seminars.

The John Deere Product Engineering Center (PEC) also is very interested in EIET program from a research and applications perspective. PEC would like to use the program as a vehicle to explore ways that John Deere can effectively link with UNI's IT Department. This would support proposed senior design projects, which enhance Deere's scope and ability to reach Deere Customers, i.e., farmers and other users inside and outside the state of Iowa. PEC is also interested in exploring various avenues in which the EIET program can collaborate on the knowledge base between provider and user. Furthermore, Deere PEC believes that EIET programs have the potential to effect technology change in how agricultural (Ag) vehicles communicate to each other, with a focus on an increased understanding of the situational Ag environment.

## VIII. Community College (CC) Articulation Agreements

The current enrollment in EMS Program is 47, and there are also 6 EET minors. The program has average 10 to 15 students transferred from Iowa Community colleges annually. UNI Department of Industrial Technology has established a number of articulation agreements with all Iowa

Community Colleges. Although it is called 2+2 program, students generally complete the BS degree requirements in 4 ½ to 5 years due to their part time or full time job opportunities in John Deere Company, and other local industry. John Deere company is one of the best and the most common companies to work part-time or full-time for EMS/EIET juniors and seniors, since the company also pays about \$1,000 per academic year tuition reimbursement in addition to regular hourly pay. Currently, the new EIET program also requires to update all the current electromechanical and electronics engineering technology articulation agreements from Hawkeye CC, Des Moines Area CC, Kirkwood CC, Clinton CC, Southeastern CC, Northeast Iowa CC, Iowa Central CC, Indian Hills CC, North Iowa Area CC, and Iowa Western CC which is the only Iowa CC that has ABET-TAC accreditation.

## IX. Conclusions

This paper described reengineering of the current four-year Electromechanical Systems Program (EMS) at the University of Northern Iowa to become Electrical and Information Engineering Technology (EIET). This will be the first four-year Engineering Technology Bachelor of Science degree program of its kind in the state of Iowa. It is expected that the EIET program will contribute to the advancement of engineering technology in the areas of electrical power, analog/digital electronics, industrial control systems, microcomputers, instrumentation, telecommunication and networking by producing quality professionals. Two most important targets of the EIET program will be increasing student recruitment, and perceiving ABET-TAC accreditation in the earliest convenience.

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## RECAI PECEEN

Recayi Pecen holds a B.S.E.E. and an M.S. in Controls and Computer Engineering from the Istanbul Technical University, an M.S.E.E. from the University of Colorado at Boulder, and a Ph.D. in Electrical Engineering from the University of Wyoming. He has served in the University of Wyoming, and South Dakota State University. He is currently an assistant professor and program coordinator at the University of Northern Iowa. His research interests and publications are in the areas of AC/DC Power System Interactions, power quality, and grid-connected renewable energy applications. <http://www.uni.edu/~pecen>

## TERESA HALL

Teresa Hall is an associate professor and program coordinator for Manufacturing Technology in the Department of Industrial Technology at the University of Northern Iowa. In addition to her academic duties, she currently is a member of the Certification Oversight and Appeals Board for the Society of Manufacturing Engineers and is chair-elect for the Waterloo Chapter of SME. She has a B.A. in Industry, a M.A. in Technology and a Ph.D. in Industrial Education and Technology and is a Certified Manufacturing Engineer. Her research interests are in the areas of manufacturing resource management, curriculum development for technical / professional programs and e-learning.



JALALUDDIN AHMAD

Jalaluddin Ahmad is currently an assistant professor in the Department of Industrial Technology at the University of Northern Iowa. He served as a Visiting Assistant Professor at Texas Southern University during the academic year of 2000-2001. He holds an MS and a PhD from the University of Houston, both in Electrical Engineering. Dr. Ahmad's research interests are in the following areas: Electromagnetic Well-Logging, Data Acquisition and Processing, Data Communication, and Technology Education.