

AC 2007-212: A SIX-YEAR REVIEW OF NEW COURSE DEVELOPMENT IN ELECTRICAL ENGINEERING TECHNOLOGY AT NORTHEASTERN UNIVERSITY IN THE AREA OF INDUSTRIAL CONTROL SYSTEMS REVEALS SUCCESSES AND FAILURES ? A CASE HISTORY

Jerome Tapper, Northeastern University

Professor Tapper is an Associate Academic Specialist in EET at Northeastern University in Boston, Massachusetts. He holds a BSEE and an MSIS both from Northeastern University. Jerry is a Registered Professional Engineer in the Commonwealth of Massachusetts with over twenty-five years of industrial experience. He is also the author of a tool-kit based text for electrical engineering technology students, Electronics for Engineering Technology and has authored more than 25 papers on the pedagogy of Engineering Technology.

Francis Dibella, Northeastern University

Professor Dibella is the current Director of the School of Engineering Technology at Northeastern University. He holds a Masters degree in Mechanical Engineering and is Registered Professional Engineer. Professor Dibella has written numerous papers on the subject of renewable energy.

Walter Buchanan, Texas A&M University

Dr. Buchanan is a Professor and Head of the Department of Engineering Technology and Industrial Distribution at Texas A & M University. He received his BSE and MSE from Purdue University and his PH.D. and J.D. from Indiana University. Walt is a P.E. in five states, and is a Past Chair of the Engineering Technology Division of ASEE. He has written more than 90 papers, and is a member of TAC of ABET and Past Chair of IEEE's CTAA

A Six-Year Review of New Course Development in Electrical Engineering Technology at Northeastern University in The Area of Industrial Control Systems Reveals Successes and Failures – A Case History

Abstract - In 1998, a new and innovative course concept was developed at the School of Engineering Technology at Northeastern University to address the need to modernize its electrical engineering technology program. During this time, the concept of the “lecture-lab” venue was conceived and utilized in the development of an Industrial Control Systems cadre of courses. Until this time, no such educational venue had existed at Northeastern. In order to develop such a new and innovative program concept, resources would be needed that were extremely expensive and well out of the reach of normal department budgets. In order to acquire the appropriate resources necessary to realize such a new program, corporate sponsors would be needed to assist in this matter. Major well-known corporate industrial control systems component manufacturers were approached for resource support for this program. Since the initial concept was conceived, two major courses have been developed and implemented over the past six years with several others being considered as cross-disciplinary platforms. This paper chronicles the progress and continued development of this program as it has evolved during this period. Of special value and interest here are the lessons learned from developing such a program and its affect on the engineering technology student population in terms of the program’s acceptance, popularity, worthiness and future. This paper specifically chronicles the evolution of the program with respect to curriculum, student successes and failures, student relationships with industry in terms of coop experiences, and after graduation employment. Over the past several years, many conference papers have been presented on various aspects of this program’s development and are used for reference in this paper.

Current Program Status

Today, the Electrical Engineering Technology program at Northeastern University is extremely successful. With the inclusion of state-of-the-art courseware, such as its Industrial Control Systems courses, the program has become among the most popular at Northeastern University’s School of Engineering Technology. Evolution from an experimental technical elective course to an impressive required two-course sequence is a testament to its extreme popularity due to it being powerfully relative to current industry requirements and needs. In fact, this relationship is the key to its great success.

Students from both the full-time day and part-time evening programs take this course sequence, which according to one of those students is...

”...two of the most, if not the most intensively industry related courses, I have ever taken.”

Electrical Engineering Technology Student

Student course evaluations for these courses have consistently been the highest in the department. Let us now go back to the beginning and examine the historical progress of these courses as it unfolded.

The Initial Concept

In 1998 several School of Engineering Technology (SET) department faculty members were having lunch, while discussing various department issues. One of the more important issues facing the department at that time was the problem of how to create a more interesting and industry-relative engineering technology program – an issue that has faced many an engineering technology department in the past and will probably continue forever. During that conversation, one of the electrical engineering faculty, Professor Jerome Tapper, suggested a possible new direction. The basis for his idea was based on his twenty years of industry experience in the “*Industrial Controls*” area. His suggestion was as follows.

“...Why don't we try a new avenue in the electrical area such as Industrial Control Systems, perhaps even a new style of course structure?”

Professor Jerome Tapper

The room went quiet as one of the other professors responded by asking – “just what is Industrial Control Systems?” Amazed at this response, Professor Tapper went on to explain what this area of electrical engineering technology was all about. In reality, this was a good thing, as it seemed that it would genuinely be a “new” idea and not one that would be a rehash of an old.

The concept was explained as follows. The idea was to create an industry oriented course, or sequence of courses, that would closely simulate an actual industrial environment. The idea being that a new type of teaching venue would be created that would contain both lecture and hands-on laboratory design work in the same course time period. Its format was coined the “lecture-laboratory venue.” The folks at this luncheon meeting all agreed that it was a unique idea that had merit. At that moment the College of Engineering dean happened to walk into this meeting. As he inquired as to what was going on, one of the folks at the meeting explained that Professor Tapper had a new idea that had merit and would be an excellent way to help revitalize the electrical engineering technology program. Interestingly enough, the first words from the dean in response to this was, “*What is it going to cost me..?*” This seemed like an interesting comment in that the dean had no idea of the details of our preceding discussion. The concept was then explained. The dean commented further by asking as to where we would get the equipment resources to start such a venture. It was explained that the department would solicit industrial manufacturers for equipment donations and believed that they would respond favorably. There was, however, one thing the dean could help with. – a physical space to house this new laboratory. The dean then responded by saying that if the appropriate “new” equipment could be acquired, he would see that an appropriate space would be made available.

The Beginnings

Within four weeks of this initial informal meeting, discussions were held with several local area industrial control systems distributors and their principals. In addition, several corporate district managers from Siemens Energy and Automation Corporation and Cutler-Hammer Corporation were separately invited to the Northeastern campus for a presentation and further discussion. It was during these discussions that the foundations of the “purpose for corporate donations reasoning” was finally understood and became crystal clear to the presenter, Professor Tapper. *The idea was simple; prove, through valid reason and example, to the prospective donors that it is in their best interest to donate their time and equipment to this effort.*^{1,2} Once this is made clear to these corporate executives, they will all want to “climb on the band-wagon” without much effort. A note of caution is in order here. From experience, never invite more than one corporation at a time to a presentation. Keep in mind that these folks are in business to earn money and are indeed in market competition with each other. Also, never mention that you are courting their competition. This will certainly turn them off – possibly forever!

The Floodgates Open

Approximately 12 weeks into this process, industrial control system equipment began to arrive at Northeastern’s doorstep. The problem at this point was twofold; where to store this stuff, and how to start building course curriculum around it.^{3,4} At his point there was no laboratory space for this new material – at all.

Enter the Development Office

During the course of receiving these generous donations, the question came up about whether the University Development Office was notified of these gifts. This situation had never come up before as Professor Tapper, the principal developer, was not aware of what the “Development Office” was even for at this point. Once acquainted with the Development Office system, thank-you letters were not only sent to the generous donors, but also to the dean’s office at Professor Tapper’s request.

Several months later, while walking through the College of Engineering building’s entry foyer, Professor Tapper happened upon the college dean who inquired as to what the letters were about that he had been receiving from the Development Office. He was reminded that these were the letters that represented the new state-of-the-art industrial control systems equipment for the new courses that we had spoken about several months ago. Professor Tapper then asked as to when could space be expected for this new venue. The dean exclaimed that he would look into it – and he did!

The First Laboratory Space

Several weeks after this chance foyer meeting with the dean, the School of Engineering Technology was notified that a small space was available. Upon examination, it was determined that this space had previously been a “small” chemistry type lab. In fact, when all was said and done, this space could only house a teacher and six students at most. Although this small area was not as sizable as expected, this was looked upon in a positive light. This lab could serve as a “pilot” test case for this venue. If it were to fail, there would be no great loss in dollars for

infrastructure development. However, if it were to be successful, a larger space would need to be found and remodeled to fit this unique new classroom/laboratory application.

Course Popularity Grows

The courses (two different ones that had been developed) were run in this space for about a year as day program courses. Having taught many other courses, the instructor, Professor Tapper, had a great deal of prior experience teaching both lecture and laboratory courses, but never had he experienced anything like the following.

As one of the Industrial Control Systems (ICS) course periods was coming to an end (three hours), all of the students in that course just kept on working without regard for time – well past the required three-hour course period. In fact, none of the six students seemed to know that Professor Tapper was even in the room with them. It was as if they were all hypnotized. The room lights had to be turned on and off several times to get their attention and notify them that the class period was over. According to Professor Tapper, he had never experienced that level of student interest and excitement in any of his classes since he had begun teaching. It was at that moment in time that something new was born and in fact had come into its own – *the industrial control systems lecture-laboratory venue*.

During the next several semesters, word would get around to other students about these new and innovative courses that were being taught. Suddenly students started to make numerous inquiries as to the content of these new courses being offered. Student interest was blossoming.^{5,6} In fact, not only were students from the electrical engineering technology department inquiring, but computer engineering technology (CET) students also showed great interest!

New Corporate Donors Emerge

In 2000 the Industrial Control Systems courses had taken off with overwhelming student interest. During this time the solicitation for state-of-the-art equipment was also heavily underway. Many corporate sites were visited in addition to attending many regional industrial trade shows and conferences – ala networking. Many of these corporate “contacts” made at these venues were invited to visit the facility at Northeastern. There was however, one major and somewhat embarrassing problem still to be addressed. The laboratory space allotted for these courses was extremely small as mentioned earlier. There was only capability for a class of six students. The feeling was that not many corporate donors would want to participate given the very low student throughput capability of this venue. Remember, these folks are now looking toward what is in their best interest – future employees and greater sales through a more knowledgeable engineer. There would indeed be a need to explain the reason for the small size of this laboratory facility, if additional corporate donors were to feel comfortable in assisting with this project. Having corporate visitors was a very touchy situation at that time as in marketing – presentation is everything in the early stages of a project. Failure to perform early on could lead to corporate non-interest and possibly a disastrous development plan.

A New laboratory Space Emerges

The middle of the year 2000 seemed to be the beginning of the end of this new program, as without a continuous influx of additional state-of-the-art resources, the existing program would certainly stagnate and soon become obsolete. Enter the Dean of Engineering. After some discussion with the current Dean of Engineering, it was agreed that a larger space would be to everyone's advantage due to the extreme popularity of these courses in addition to the initial corporate interest. A quest for a new and larger space would begin. Interestingly enough, space is at a great premium at Northeastern, which made this search for space that more difficult. It was at this point that the Dean of Engineering formed a *Facilities Planning Committee* whose mission was to identify new and innovative ways to obtain teaching and laboratory space. During the course of this quest, a space was identified that would be a possible fit for the new Industrial Control Systems Laboratory. A 1000 – 1200 square foot space that was an existing older computer laboratory was located. Fortunately, this space was owned by the College of Engineering and upon further investigation, it was determined that over 84% of the students that utilized this facility were not from the college of engineering and that about 10 – 15 % of the students who also used this facility were not even from Northeastern University. Acquiring this space would be the start of the new Industrial Control Systems Laboratory facility and an appropriate lever to corporate donations.

After what seemed like a long planning stage, the architects in concert with the program developer, Professor Tapper, worked with various builders and created a truly state-of-the-art laboratory facility.

The First Class Enters

Some time in late 2000, the first class entered the new Industrial Control Systems Laboratory facility. What made this so interesting was that these students were the folks who had taken the first industrial control systems course in the “old” made over chemistry laboratory. It was truly exciting to watch their faces as they entered the new classroom/laboratory facility. This new laboratory facility now had the potential to allow up to 16 students to work in this state-of-the-art environment. Additionally, this facility was now a show place and could be proudly used to court potential industrial corporate donors. And so it did.

Corporate Donorship Part II

With the completion of the new Industrial Control Systems Laboratory facility, potential corporate donors could now see the importance of what was being done in this program and could understand that it would be in their best interest to help with this project.⁷ What is meant by *in their best interest* is that by helping to support this program, they would indeed be supporting themselves, as sooner or later they would need to start to supplement their own corporate work force with experienced professionals to sustain their market position. In addition, the smaller companies, who purchase goods and services from these corporate giants, must also maintain a competent work force themselves whose numbers are decreasing yearly as older workers retire or move on to higher positions within their own companies. In addition, these companies would now be able to hire experienced (Industrial Control Systems) Northeastern University Cooperative work students to supplement their own internal work force.

Some Student Statistics

As of January 2007, there have been more than 300 students from both the full time day and part time evening programs in Electrical Engineering Technology (EET) and Computer Engineering Technology (CET) who have taken these new industrial control systems courses.^{8,9} Of these students, at least ten percent have gone on to jobs related to this market.¹⁰ Some of these students, who are attending the part time evening program, are already working for companies serving this market and are taking these courses to help them move vertically within their companies, while others are simply taking these courses to give them added experience with control systems components and design concepts in ICS areas of which they have not been exposed. In all cases, these courses are now required for the BSET degree in the electrical area.¹¹

Future Development

As of January 2007, the corporate gifts-in-kind to this program have approached the \$2,000,000 mark. This is significant in that as technology evolves, gift donations of equipment today will no doubt become obsolete in the not too distant future. Causing these changes, among others for example, are changes in computer operating systems (OSs) as newer software programs being developed for industrial control systems may not be compatible with older OSs. This case has in fact become a reality for this program, forcing many of the existing in-house ICS hardware training stations to become obsolete. Newer control trainers are replacing older systems. This is also a case for staying on top of corporate donors, as sooner or later, currently used donated systems will in fact become obsolete – you can count on it!

What the future holds is anyone's guess. Developing this program has been a very exciting, productive, and rewarding ride for not only the developer, but also the students who are the beneficiaries of this project. By the response of the students in their course evaluations, there has never been one negative comment about the courses.

Summary

Developing this program has had its ups and downs. It has not gone without its failures. Much of the rationale behind the so-called failures here was the lack of understanding of the “total” market in which we were dealing. There are many levels to the corporate structure of which each has its own responsibilities. Knowing and understanding each of these should lead to a more efficient and successful venture in the future. Lack of this understanding will certainly lead to certain disaster. The key recommendation to others seeking to do similar things is perseverance. Persistence and planning is the way to success. At this point there is no telling as to where this industry/education relationship will take us. One thing is for sure, the sooner one starts, the faster one can expect results. By the way, results will not happen overnight.

The bibliography references at the end of this paper are very useful as a guide to successfully developing a program of this sort. Many hours have been put into writing the materials presented there. Take advantage of the six years of development of this program and use these references well. By the way, students still need to be reminded that their class period has ended, as they still

seem to be hypnotized during their classes here. We can only guess that when students really get interested in something, they do not want to give it up – addictive maybe!

Bibliography

- ¹Tapper, Jerome, "Building Industry Partnerships, The Key to Creating State-of-the-Art Laboratories," *Proceedings of CIEC*, Presented February, 2000, Orlando, FL, Session CIP/ETD 345
- ²Tapper, Jerome, "Building Industry Partnerships by Enticing Industry to Work for You," *Proceedings of A.S.E.E.*, Presented June, 2000, St. Louis, MO, Session 2647
- ³Tapper, Jerome, "Creating Industrial Partnered Curriculum, A Work in Progress," *Proceedings of CIEC*, Presented February, 2001, San Diego, CA, Session ETD 345-3
- ⁴Tapper, Jerome, "Industry Driven Curriculum Development, the Key to Successful Courseware," *Proceedings of A.S.E.E.*, Presented June, 2001, Albuquerque, NM, Session 3247
- ⁵Tapper, Jerome / Buchanan, Walter, "Industrial Partners Provide Progress Report Card Feedback On Newly Developed Industrial Control Systems Laboratory," *Proceedings of A.S.E.E.*, Presented June, 2002, Montreal, Canada, Session 1448
- ⁶Tapper, Jerome / Buchanan, Walter, "Engineering Technology Students Gain Insight into Real-World Engineering Problem Solving by Providing Solutions to Industry Provided Senior Design Projects in Industrial Control Systems," *Proceedings of A.S.E.E.*, Presented June, 2003, Nashville, Tennessee, Session 1649
- ⁷Tapper, Jerome / Buchanan, Walter, "Clarifying Industry's Corporate Donor Giving Cycle – Economy's Effects," *Proceedings of CIEC*, Presented January, 2004, Biloxi, Mississippi, Session 4421
- ⁸Tapper, Jerome / Buchanan, W.W., "Cross Disciplinary Curriculum Courses in Engineering Technology Offer Students A Larger Vista of Educational Experience – A Short Discussion," *Proceeding of the 2004 ASEE New England Section Conference*, Northeastern University, Boston, Massachusetts, April 2004
- ⁹Tapper, Jerome / Buchanan, Walter, "Creative EET-MET-CET Course Curricula to Meet Industry Projected Market Needs," *Proceedings 2005 ASEE Conference for Industry and Education Collaboration*, Presented February 2005, Savannah, Georgia, pp. 36811-14.
- ¹⁰Tapper, Jerome / Buchanan, Walter, "Creative Course Design at All Levels Aids Engineering Technology Students in Adapting to and Being Accepted by Industry More Readily" *Proceedings of CIEC*, Presented Feb., 2005, Savannah, Georgia, Session ETD 368
- ¹¹Tapper, Jerome / DiBella, Frank / Buchanan, Walter, "A Comparative Observation of Full-Time Versus Part-Time Engineering Technology Students With Respect to Attitudes, Performance, Reliability, Maturity, and General Professionalism as Related to Industry Oriented Courses Such as Industrial Control Systems," *Proceedings of A.S.E.E.*, Presented June, 2006, Chicago, Illinois, Session 3548