

Abstract # 23

## **An Applied Engineering Technology Program – A Partnership between University, Industry, and Community College**

Conference Key Areas:

- Continuing engineering education
- Industry and engineering education
- Learning formats specific for engineering education

Keywords: Engagement, Outreach, Distance Learning, Technology Degree Completion

### **1 INTRODUCTION**

Across the United States, manufacturers cannot find the needed trained technical individuals to fill staff positions in the areas of machining, design, and computer numerical control (CNC). The numbers of trained individuals in these areas are too low to support the typical hiring needs in regional industry. Typically, individuals who are being hired for these types of lower level technical jobs graduate from applied technology programs at the high school level. However, high schools across the county have eliminated or drastically scaled back these types of applied programs in favor of college preparatory programs, and thus, this population of high school trained potential employee is no longer available. In many areas, the manufacturing industry has turned to students graduating from the 2-year community college level to fill these sorely needed positions. The combination of technical skills which these students graduating from the community colleges possess, along the knowledge of foundation subjects like Mathematics, Physics, and Communications make these students more valuable to manufacturing companies. There are two caveats to the companies in the hiring of these better, more broadly trained and qualified students, the first is that they, typically, demand higher salaries, and the second is that they, typically, would like to complete their 4-year baccalaureate degree. The other opportunity available to the employer is to hire someone graduating from a technical program (Industrial Technology or Engineering Technology) at a 4-year university. However, this individual is typically over qualified for the entry level position, and requires higher starting salaries than the companies are willing to provide for this type of entry level position. I should be noted that once these individuals with higher or expanded skill sets are hired, the companies find that they have the needs for their skills. In fact many companies in the northern region of Illinois seek to hire students with expanded skills and the ability to further expand their capabilities and education to meet the need of the company. Thus, companies in the NIU region are also seeking additional sources of education for their technical employees.

Many universities have developed degree programs for technical employees. Some programs concentrate on a single set of skills, and some programs offer a complete degree program. In today's financial climate, the universities have a goal of efficiently delivering an educational program which allows students to complete a 4-year baccalaureate degree. To satisfy the need of industry, the degree in question is typically a technical 4-year baccalaureate degree. In the State of Illinois, there are many 2-year Community Colleges (see figure 1) which develop very well qualified technical students. To work efficiently and effectively with these colleges,

the authors have developed a unique degree completion program which allows technical students to progress from a 2-year technical degree to the 4-year baccalaureate degree. Many students that graduate from the community college system are of typical college age (19-22), however, there is a growing group of non-traditional students who are either married or place-bound. The work that is presented in this paper outlines this novel program. In addition, the types of skill sets that are required of the student upon graduation vary based upon the company at which they are hired. The program which has been developed allows the flexibility for NIU to work with students and companies to ensure that the needed skill sets are developed in the graduates.

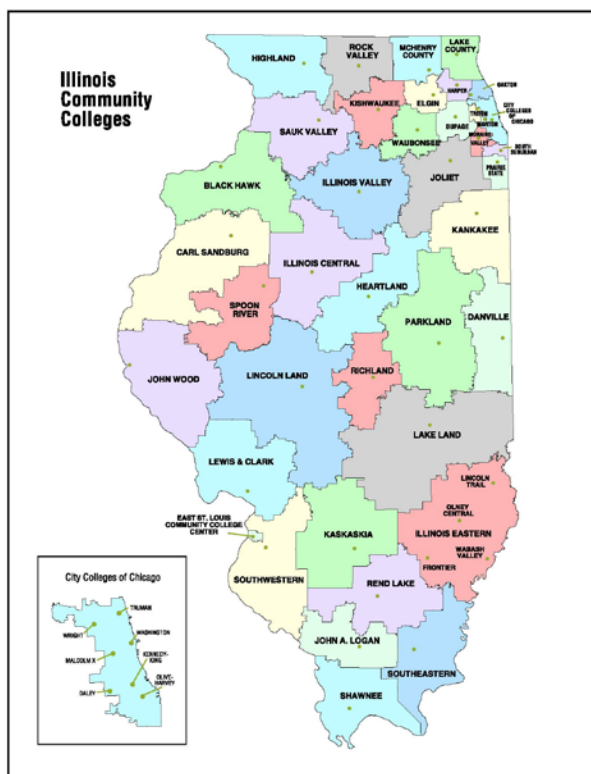


Figure 1 - Illinois Community College Distributions 2012)

## 2 TRANSFER TO BACHELOR'S DEGREE PROGRAMS

Originally, junior colleges were seen as offering the first two years of the baccalaureate degree, relieving the universities from the pressures of accommodating the growing number of students seeking entry without the prerequisite skills to handle advanced research-focused work. Federal policies influenced the growth of vocational and technical programs within these junior colleges, renamed community colleges, and the Associate of Applied Science degree became a terminal degree that prepared students for careers in health and industry where technician positions were plentiful. These AAS degrees were not developed for transfer into baccalaureate programs and were generally heavy on technical field-specific skills and lighter on the general education and liberal arts and sciences which form the bulk of the credits within a bachelor's degree program [2]. As the technical side of health care and industry became more complex, there has been increasing pressure on graduates of AAS programs to return to school to complete bachelor's degrees. Public universities grappled with how to permit technically prepared students, some with extensive work experience and advanced non-collegiate industrial or military training, into university programs without forcing them to start again as first year students [2]. This problem has been particularly challenging for Northern Illinois University whose region is rich with community colleges, many of which are among the nation's largest institutions. Additionally, over half of the community colleges in the state lie within the university's region (Figure 2).



Figure 2 – Proximity of regional community colleges in NIU's region: each concentric circle represents 25 miles (not to scale).

In years past, the technical education required for jobs within the manufacturing sector was obtainable at the local community college through certificate or AAS programs. However, as manufacturing became more reliant on technology and required higher level technical skills, increasingly, graduates of the technical programs offered at community colleges are finding that employers are expecting job applicants, current employees and those expecting promotion into supervision to possess B.S. degrees. Thus, there was a definite need within the state of Illinois to provide a mechanism through which students possessing an AAS degree can complete a bachelor's degree in manufacturing-related technology [4]. To meet this need and to provide a model within the educational community, the NIU Department of Technology has developed an Industrial Management and Technology (IMT) bachelor's degree program which incorporates a unique mechanism to allow students who have graduated from or are currently enrolled in an AAS technical degree to obtain a B.S. degree in Industrial Management and Technology.

This program establishes a relatively seamless transition between the community colleges and NIU [5,6,7]. Due to the large number of autonomous community colleges, there were complexities that had to be confronted. These issues included, articulation between each community college and the university, advisement strategies to guide students to prepare for transfer, admissions procedures, outcomes assessment, and marketing the program.

The major challenge was program and course delivery, to meet the needs of the student population. A new delivery mode needed to be developed since the program was to target working adults who are bound by family and work obligations to specific times and places for classes.

### 3 INDUSTRIAL MANAGEMENT AND TECHNOLOGY PROGRAM

Students seeking a bachelor's degree in a technical field, such as manufacturing, electronics, machining, or welding technology, to name a few areas, have had two traditional routes:

1. Enter directly into a university program or
2. Attend a community college, obtain an associate's degree then transfer to a 4-year university.

The transfer route has grown in popularity as the cost of a residential education at a university moved out of reach for many students in the current economy. The route to transfer is carefully described for those pursuing the traditional transfer degrees (Associate of Arts or Associate of Science) into most liberal arts and sciences bachelor's degrees. Transfer is usually difficult in a vertically structured curriculum like engineering or technology, where most of the courses have detailed prerequisites. However, the structure in related programs at the various community colleges vary in their entry points, coursework, and prerequisites.

In addition, the opportunity to transfer is complicated by the wide variety of students. While many of the students in the 18-22 year old “traditional college-aged” population can “move” to the university, either by living on or near its DeKalb main campus, non-traditional students are place-bound with families and/or full-time employment. While the need for such a transfer-type program is clear, how can the Department support programs that need to be offered at multiple sites? Over the past fifteen years, the Northern Illinois University Department of Technology has developed a unique program which has resulted in a “3+1” Industrial Management and Technology (IMT) program. With an increasing current enrollment of well over 100 students (Figure 3), and a similar number of graduates, the off-campus program is offered using synchronous video and online formats. This program places much emphasis on the need for appropriate academic and procedural infrastructure, namely articulation, advising, testing, marketing, scheduling, and inter-college program development.

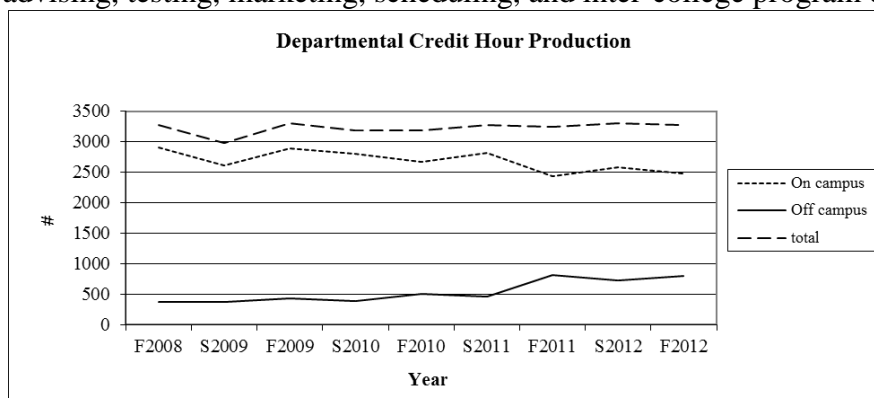


Figure 3 – On and Off-Campus Credit Hour Production

The BS in IMT degree was originally designed to break through the transfer barrier for those students who had earned a community college technical degree in manufacturing and industrial related technical areas. It provides basic and advanced education with both a strong technical component and a management/process component. On the main DeKalb campus, the Department has well equipped laboratory facilities to provide basic and advanced education in technical areas like plastics technology, manufacturing technology, environmental health and safety, and computer-aided design.

To meet the issue of the variation in the programs in the autonomous community colleges, the department developed a unique “special technical area of study” degree component which allows for transfer of this technical content from the community college. This Special Technical Area of Study allows students to be given 23 semester hours of credit at NIU for the technical courses completed in the related AAS degree at the community college. In addition to the 23 credit hours, the typical transfer student enters the NIU Industrial Technology with an additional 30-40 hours of accepted college credit, based on the general education course work which was taken as part of the AAS degree. Thus, much of the degree can be completed at a community college. The BS IMT degree requires 120 semester hours of credit for graduation, consistent with NIU’s bachelor’s degree requirements, which are broken down into the groupings shown in Table 1.

Table 1 – Distribution of Credits in IMT program

Number of Credits	Content Area	Taken At
23	Technical Portion of AAS Degree	Community College
18	General Education Core	Community College
9	English and Communications courses	Community College
20	Math and Science Core	Community College
7	General Elective courses	Community College and/or NIU
10	General Technology Foundations	Community College
27	Technology Management & Process	NIU
6	General Technology elective courses	Community College and/or NIU
120 total hours		

This program is “close” to a 3+1 program where 90 credit hours are taken at the community college level and approximately 30 hours are taken at NIU. As part of the Industrial Management and Technology degree, the following NIU Department of Technology courses are required of each student.

#### **REQUIRED PROGRAM COURSES**

- Tech 406 – Facilities Management
- Tech 404 – Supervision in Industry
- Tech 429 – Plant location, Layout, and Materials Handling
- Tech 434 – Human Factors in Industrial Accident Prevention
- Tech 391 – Industrial Quality Control
- Tech 492 – Supply Chain Management
- Tech 496 – Industrial Project Management

#### **ELECTIVE COURSES (minimum of two are required)**

- Tech 305 – Green Technologies
- Tech 402 – Industrial Training and Evaluation
- Tech 442 – Work Simplification and Measurement
- Tech 443 – Engineering Economy
- Tech 444 – Production Control Systems
- Tech 484 – Energy Management
- Tech 415 - Applied Industrial Experimental Analysis
- Tech 432 – Disaster Preparedness

### **5 OFF-CAMPUS PROGRAM DEVELOPMENT**

The IMT program has served well over 100 students during the past decade. During this time, the Department has offered a combination of live and distance video courses to satisfy the needs of the program [6]. During the time, students have expressed an interest in the program from other states, thus requiring a major change in the mode of instructional delivery. To satisfy the off-campus audience for this program, all of the coursework required for the program is now delivered in synchronously on-line.

Upon matriculation at NIU, the students typically need about 22-24 courses to complete their B.S. degree. Approximately half of the courses must then be taken on-line at NIU and the other half at a local community college. Because the students are taking courses at two institutions, the advisor stays in close communication with each student to keep track of their progress at the various community colleges, to identify the appropriate courses at each of the community colleges, and to keep the students informed about any program offerings or

scheduling which might dictate how they proceed through the program. This individualized communication strategy is the critical factor in the retention of these students. The advisor is in regular contact with this group of students who typically need more advising than on-campus students, due to length of time in the program, their commitments to family and work that constrain their time.

## **6 CAPSTONE PROJECT**

One of the most important parts of the NIU Industrial Management and Technology curriculum is the capstone project course, Tech 496 (Industrial Project Management). This course has undergone several iterations over the past ten years. In its present form, the capstone course has the following objectives:

- To provide senior students with an open-ended culminating experience
- To utilize a subset of skills which have been acquired through major courses
- To provide interaction with industry
- To emphasize interdisciplinary team-work
- To integrate technical, oral and written presentation skills

The capstone course involves regional industry in its definition of projects and problems. As such, it provides an opportunity for the diversity of industry in the region and in the state to be revealed to the students and to be served by the university. The projects require rigorous integration of the manufacturing and supervisory skills that have been developed in the curriculum. After numerous discussions with the department's industrial advisory boards, it became clear that there is a specific need for technologists to develop skills of working in interdisciplinary teams, being able to present effectively and to design components and systems. Upon examining the departmental curricula, it was decided that these areas did not receive proper attention. As a result, the faculty undertook an effort to increase the numbers of courses in which presentation skills and teamwork are emphasized. The capstone course was redesigned to require students to work in interdisciplinary teams to complete an open-ended industrial-type application project and to overcome the hurdles that might lie on the path to the project's completion. The underlying theme for the course and the projects themselves is the opportunity for students to develop numerous successful solutions. Every project requires some form of research, design, analysis, and presentation. The students are expected to document all aspects of their projects and their interactions as a group and with industry.

One of the important aspects to the course is the inclusion of industry in the definition of the projects. At the end of the summer, companies in the Northern Illinois region are contacted to submit projects. In general, companies supply ideas and funding to complete the projects; they also provide project leadership. Therefore, the students not only work with the faculty project advisor on a week-to-week basis, they also work with members of the company regularly. This interaction ensures that the students develop workable designs, and they stay within the guidelines and timeline defined by the project. The funding provided by the companies gives the students the experience of ordering parts and components, and of working with suppliers to ensure that the components work together--a very valuable real life experience in industry.

## **7 CONTINUOUS IMPROVEMENT PROCESS**

The NIU faculty have developed learning objectives for the overall program and for the individual courses within the program. These outcomes are clearly delineated within each course syllabus. In addition, the Department has developed an in-depth assessment model to gauge the level of understanding for the specific learning outcomes. The assessment process [8] provides the Department and program with a clear path for continuous improvement. Assessment of the programmatic outcomes is carried out through the various stake holders in

the program; namely, faculty, current students, employers, industry, and alumni. The assessment process gives the department and its faculty a clear picture of how the graduates are performing in industry. Many different assessment tools are used in the process including direct and indirect means. The information collected as part of the assessment process is used by the department and the faculty in the continuous improvement process. Typically, faculty members use the information to enhance the learning opportunities and cover material differently, or alter the laboratories needed in a particular course. The department as a whole uses the information to determine the new directions for the curriculum or new laboratory skills that are needed within the given curriculum. The inclusion of industry input is invaluable in this assessment and renewal process. It is this information which helps drive the department to modify programs and create new areas of knowledge for our students. The process is also invaluable for the regional industry. The inclusion of industry allows the companies to assist in modifying programs to include the knowledge and skills needed now and into the future. This input is so meaningful to the industry partners that many some funding to assist the department in redeveloping laboratories and to provide student funding.

## **8 INDUSTRY CONNECTIONS**

Northern Illinois University's Department of Technology was faced with the need to develop a unique program which allows students to utilize their 2-year AAS degree to obtain a technical bachelor's degree. If one examines the stakeholders and parties that benefit from this program, one sees the students and community colleges, however, the regional industry is a great beneficiary of this program. The employers in the NIU region are a diverse group, ranging from large to small, highly mechanized to more customized production, from food processing to aeronautics. However, all of these employers require well-trained technical individuals to create the products and services needed. With that said, the needs of the industries that hire our graduates are very diverse, and some of these manufacturers are included in the program development. The Industrial Advisory Board is a very critical component of Departmental assessment and development; from this board, much information is gained. The board meets with faculty to discuss new areas that need to be covered (or removed) from the curriculum. Due to the diversity of the board members and their companies, this discussion is needed such that the program produces well rounded students that can perform at a variety of different companies, in different industries. This ability to provide some direction is very well received by industry, and the input is used in course and program modification. The NIU Department of Technology has nearly 100% placement of our graduates, and most have several employment offers. It should be noted that there are many companies in the region around NIU, and many are included in discussions, external to the advisory board, on curriculum and laboratory issues within the department.

## **9 CONCLUSION**

The NIU Department of Technology has developed a unique program which provides students with a relatively seamless mode to transfer between 2-year and 4-year educational institutions, and obtain a technical bachelors degree. This type of program is beneficial to the community college, students, industry, and to the home institution (NIU). To provide a bachelor's degree program to meet such diverse needs, the department chose to build as much flexibility as possible into the design of the program by permitting students to receive a block of credits for the AAS degree completed rather than relying on the tradition of course by course articulation. To cover the wide region and the scheduling needs of working adults, the program sought to use the latest trends in synchronous on-line delivery methods. The program uses capstone projects and internship experiences in which the students work with supervisors and faculty.

While developing an innovative flexible program, the department maintained its focus on rigorous outcomes and continuous improvement through a variety of measures—both direct

and indirect while meeting its accreditation requirements. Employers and regional industry associations participate in many of the assessment strategies as did students during their final semesters, after graduation and several years into their careers. It is this feedback that assures the university that the program has met its goals of providing bachelor's degree skills in leadership and technology over a highly diverse industrial and educational region. The final result of this development is a student placement rate of nearly 100% and the regional industry has an added source of sorely needed, well-trained technical employees.

### 3 BIBLIOGRAPHY

- [1] Altbach, P.G., Berdahl, R.O., & Gumport, P.J. (2005). The contexts of American higher education. *American higher education in the twenty-first century: Social, political, and economic challenges* (pp. 1-11). Baltimore, MD: The Johns Hopkins University Press.
- [2] Cohen, A.M. & Brawer, F.B. (2003). *The American community college* (4<sup>th</sup> Ed.). San Francisco, CA: Jossey-Bass.
- [3] Illinois Community College Board (n.d.). *The system*. Retrieved from <http://www.iccb.state.il.us/colleges.html>.
- [4] Hawat, G. & Regis, H. (June 16-19, 2002) Articulated pre-engineering programs: How community colleges can be effective partners with universities. *Proceedings of the 2002 ASEE Annual Conference and Exposition*, Montreal.
- [5] Mirman, C.R. and Skattum, G. (February, 2003). Community college/university articulation: A programmatic approach in engineering and technology, *Proceedings resented at the 2004 ASEE Regional Conference*, Valparaiso, IN, February 2003.
- [6] Mirman, C.R., Sussman, M., and Deegan, S. Manufacturing Connections: A Technical Degree Completion Program which Promotes Partnerships with Industry and Regional Education Centers in Rural Locations – A Long-Term Case Study, *Proceedings of the 2012 Pascal Conference*, Brest France, June, 2012
- [7] Newman, R., Munukutla, L., & Robertson, J. (June 16-19, 2002) Building bridges with community colleges: Partnering for educational success. *Proceedings of the 2002 ASEE Annual Conference and Exposition*, Montreal, Canada.
- [8] Mirman, C.R. and Vohra, P. (June 22-25, 2003). Programmatic assessment within an engineering technology program, *Proceedings of the 2003 ASEE Annual Conference and Exposition*, Nashville, TN.