
AC 2011-40: INDUSTRY EDUCATION PARTNERSHIP: MECHATRONICS ENGINEERING TECHNOLOGY PROGRAM DEVELOPMENT

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Industry Education Partnership: Mechatronics Engineering Technology Program Development

Abstract

A new BS degree program in Mechatronics Engineering Technology had been conceived, developed and implemented at Purdue University Calumet. Prompted by an industrial need for trained technologists to design, build and service the type of complex, high speed machinery used in the package industry, Purdue University Calumet introduced its mechatronics engineering technology baccalaureate degree program two years ago. The program combines instruction in electrical control and mechanical design and provides students with exposure to programmable logic controllers (PLCs), conveyor systems, machine vision and servo motors, control and sensor logic as well as other technologies and various industry standards with primary focus on packaging machinery technology. In past two years, successful implementation of the program is evidenced through enrollment growth and, receiving of two National Science Foundation (NSF) grants, “A Mechatronics Curriculum and Packaging Automation Laboratory Facility,” and “Meeting Workforce Needs for Mechatronics Technicians”. The program established a knowledge and resource center to address the needs of the packaging machinery industry and the Mechatronics Engineering Technology program through learning, engagement, and discovery activities. An endowment has also been established to support the center. The industry and education partnership resulted in establishment of a state-of-the-art laboratory for the program and, opportunity for paid internship for all students in the program.

This paper provides a chronicle of the program development and implementation focusing on the active participation of industry partners and, the nature of industry-education partnership for long term sustainability of the program. This paper also provides specific examples on how industry-education partnership can be leveraged in securing resources at the local, regional and national levels to support and sustain the program.

Introduction

United States Department of Labor has acknowledged the importance of mechatronics to the packaging industry and to the US economy by publishing a hybrid-industry, packaging-oriented mechatronics competency model on the Career One Stop website.¹ “The National Council on Competitiveness estimates that 100 million new jobs will be created in the 21st century at the intersection of disciplines rather than in individual disciplines”². The need for multi-disciplinary programs addressing the industry need for graduates who can be multi-task oriented and understand the whole system is increasing as technology advances. A survey conducted in Texas showed that, of all the annual job openings in Mechatronics related workforce through 2012, sixty-four percent will come from the replacement of existing workers.² The same study showed the increased need of industry for “multi-craft” technicians with integrated skills. This unfulfilled need has caused significant impact on businesses thus making these industries less competitive globally. To win this economic war, U.S. industries are launching massive restructuring programs that include plant modernization and the retraining of

their existing industrial workforce. Industrial multi-skill training programs can be viewed as high quality, technical teaching programs, particularly when they are supervised and/or taught by an institution of higher education. A large number of workers in the region where the Purdue University Calumet is located are retiring and there has been a significant shift from mechanical design to a mechanical/servo/PLC driven design. The result is a large number of packaging companies in this region have a desperate need for graduates who can understand Mechatronics systems. The Packaging Machinery Industry is in serious need for engineering technicians who understand these more complex systems better and are prepared to perform from the first day on the job.

Prompted by such need for trained technologists to design, build and service the type of complex, high speed machinery used in the package industry, Purdue University Calumet introduced its mechatronics engineering technology baccalaureate degree program two years ago. The packaging machinery industry requires technical workforce who are trained and have knowledge in automation, electrical control, and mechanical design as machine designs have migrated away from the primarily mechanical approach. The mechatronics engineering technology program address this need by combining mechanical design, manufacturing, and electrical control within a foundational context of packaging machinery. The program prepares students for such jobs as machine designers, packaging engineers, automation specialists and service technicians in the growing field of high speed packaging. The program combines instruction in electrical control and mechanical design and provides students with exposure to programmable logic controllers (PLCs), conveyor systems, machine vision, sensor integration, and servo motors, as well as other technologies and various industry standards with primary focus on packaging machinery technology.

This paper provides a chronicle of the program development and implementation focusing on the active participation of industry partners and, the nature of industry-education partnership for long term sustainability of the program. This paper also provides specific examples on how industry-education partnership can be leveraged in securing resources at the local level.

Industry leadership

It all started with one faculty member's longtime involvement with packaging industry. This involvement created mutual awareness of industry workforce need and opportunities available at an academic institution to meet such need. This Mechanical Engineering Technology faculty member had been consulting part-time on mechanical design at a medium-sized packaging machinery company. The packaging machines are usually custom-designed mechanical systems integrated with OEM electrical control products to achieve system integration for product flow and packaging (e.g. six water bottles wrapped with clear plastic). Such system requires technologist with knowledge in automation, controls, and mechanical design. The president of the company had also actively promoted to the faculty members the opportunity available to the School of Technology if it would offer an academic program that would produce such workforce. The basis for such request was for the following two reasons: 1) Industry needs employees with competencies in electrical, mechanical, automation, and control, and 2) No institutions in the region were addressing this specific need.

However, any academic curriculum change requires faculty involvement and must go through the curriculum approval process within the institution. Therefore, selling the idea to the faculty members from both Electrical Engineering Technology (EET) and Mechanical Engineering Technology (MET) programs were essential. Therefore, the President of the company in cooperation with the Packaging Machinery Manufacturer Institute (PMMI) made it possible for several EET and MET faculty members to travel to and attend PACK EXPO, an annual PMMI event for all packaging machinery industry. The President (currently, the Chairman of the PMMI Board) had been actively involved with the PMMI, the national professional association of the packaging machinery industry. At PACK EXPO there was over 1500 companies exhibiting, in 1.1 million square feet, equipment that featured primarily custom mechatronics designs. The faculty members understood the need for a Mechatronics program.

To initiate the curriculum process, a team was formed of EET and MET faculty members, and industry professionals. The company President articulated the importance of such team to his peer group and convinced the industry professionals to participate in the curriculum development process. The team met several times on campus, and the participation by industry professionals made the curriculum relevant to the industry. Also, the industry partners appreciated the direct response by the institution on meeting their need. The company President also facilitated several plant visits for faculty members. After each plant visit, the curriculum got adjusted and became more relevant to industry. Faculty members saw the industry need and job opportunities for their students, and the industry professionals saw the commitment from faculty members. The program description and the plan of study are available at the Purdue University Calumet's Department of Engineering Technology website.³

While the curriculum was being developed (reshaped), the company President helped the Dean of the School of Technology form the "Dean's Executive Council (DEC)" which would ultimately serve as the advocacy group to support the development and approval of the program by the commission of higher education. The DEC also helps sustain the program through gift-in-kind for laboratories, cash for student scholarship, and experiential learning opportunities for the students in the Mechatronics program. Furthermore, the company president provided significant financial backing and technical support on a regular basis and personally funded an endowment to support the program.

The initiative to develop and implement the Mechatronics Engineering Technology program was a response to the regional packaging machinery industry's expectation from the university and its leadership. The challenge was to articulate the need and justification for such program to the institution and ultimately to the commission of higher education. Not only was it important to show the support for the program by the industry but also to show documented commitments from industry to sustain the program. The program was launched and is being sustained by the generous support from industry in areas of curriculum development and enhancement, laboratory development, and internship/experiential learning for students. Of all the industry partners, six key industry partners have been significantly involved with the program. Out of these six partners, 3 are system integrators, 2 are OEM products manufacturers, and 1 is the publisher of the largest trade journal for the industry. Representatives from these industries serve on the mechatronics program advisory board, the advisory board for the

knowledge and resource center for packaging industry at the School of Technology, and promote the program at the regional, national, and international levels. These industries provide internship to our students, and sponsor funded design/development projects. They also provided state-of-the-art industry standard equipment for laboratories and significant technical help through their full-time technical personnel.

The national professional association, Packaging Machinery Manufacturers Institute (PMMI) has been an integral partner from the very beginning of the program development. In fact, their participation has enhanced the curriculum that is aligned with the competency levels in Mechatronics⁴ as endorsed by the US Department of Labor.⁵ PMMI has provided scholarship for students every year, supported faculty members and students travel to PACK EXPO (the annual trade show), and provided funding through their education foundation. PMMI regularly promotes the program through their national outlet. PMMI has provided training and technically relevant support for the professors and program. PMMI has also provided visibility for the program through articles in the trade press and exposure at their technical conferences.

Institutional leadership

The School of Technology used to offer BS and AS degree programs in Manufacturing Engineering Technology which had a very low enrollment and the number of graduates per year was less than five. So, the School was asked by the commission of higher education what to do with the program. Two options were available, either eliminate the program or reshape the curriculum into a new one to meet emerging market need. The opportunity was timely to reshape the curriculum into the Mechatronics Engineering Technology. At the same time two separate academic departments were merged in the School of Technology which placed all MET and EET faculty members in the same academic department. This created a synergy among them to come up with this new and innovative curriculum. The Dean had articulated the proposal to the University administration with documented evidence of workforce need and the industry support for the proposed program. During every step in the process, the company President accompanied the Dean to every event pertaining to curriculum and program development and provided continuous support as needed. The Dean had arranged meetings between the company President and the highest University officials for them to hear first hand on workforce need in Mechatronics field. The proposal for the new program was approved by the commission because of the significant industry commitment and support, and for demonstrated workforce need in the field. Dean had advocated for the laboratory space for the new program and the institution provided the laboratory space. The laboratory was developed through gift-in-kind from 10 different industries representing packaging machinery industries and Original Equipment Manufacturers.

Advisory board

One of the key elements to generate interest and sell the concept of new academic program to industry partners starts with the leadership of one or two industry professionals who champion the cause on behalf of the institution to their peer group. It is the responsibility of the institution leadership to articulate the scope and benefit of new program to these leaders and introduce them to the highest administration of the institution to establish the institutions level of

commitment. This helps them have the confidence to articulate the case to the peer group on why partnering with the academic institution will benefit the industry. It is important that the advisory board members are selected in consultation with these leaders to include articulate and respected members of their peer group and relevant stake holders in the industry. These individuals understand well the need for leveraging relationships and seeking resources for the program through their networking and contacts. With the help of industry leaders, the Dean's Executive Council (DEC) was formed. The functions and the responsibilities of the DEC members are as follows:

- Advise on issues related to the learning, discovery and engagement mission of the School of Technology. Provide feedback to the School on overall subject matter relevancy in today's workplace environment to ensure that scholastic teachings keep pace with business and technological evolutions.
- Initiate and develop mutually beneficial partnerships between the School of Technology and business, industry and government.
- Develop resources in the form of scholarships, endowments and gifts for program, student and faculty development in the School of Technology.
- Provide opportunities for internships and co-op positions for School of Technology students and provide employment opportunities for the School's graduates.
- Contribute in some financial manner to the School of Technology. This can be in a variety of capacities, e.g., grants, scholarships, work projects, etc.

The Presidents/CEO's of these companies serve on the Dean's Executive Council and meets twice a year to provide advisement and guidance for program improvement. They provide letter of commitment for any federal grants application, attends events on campus and meets with legislatures and university officials as needed.

Mechatronics laboratory

The laboratories in the mechatronics engineering technology program offers hands-on experience in both the electrical and mechanical areas of designing, installing, and troubleshooting the complex equipment that produces and packages all of the items consumers purchase daily. Students learn advanced programming techniques, interfacing automated equipment, sensor design, machine design, and troubleshooting in this lab. Total industry support for this lab exceeded \$1 million and specific equipment donations were received from OEM and the system integrators (the packaging machinery industries). Some of the equipment donated are high speed digital camera, labeling machine, photo eye, conveyers, automation equipment, lab simulator, inverter machine, PLC's, motors and drives, HMI's, and two complete packaging system from two companies.



Figure 1: The Mechatronics Engineering Technology Laboratory showing two complete packaging systems

Center for Packaging machinery Industry

The School of Technology at the Purdue University Calumet has established a knowledge and resource center for packaging machinery industry. The vision is, to be the premier resource center for the packaging machinery industry through a mutually beneficial partnership between the industry and the School of Technology. The mission of the center is to address the needs of the packaging machinery industry and the Mechatronics Engineering Technology program through learning, engagement, and discovery activities. The specific goals are:

- Provide technology solutions to the packaging machinery industry through sponsored projects
- Provide education and training to packaging machinery industry professionals
- Provide experiential learning opportunity to Purdue University Calumet's students
- Provide an avenue for all interested faculty members to pursue collaborative efforts in grantsmanship and scholarly work
- Provide professional development opportunity to faculty members
- Engage faculty and students in industry projects related to the packaging machinery industry
- Be a national training facility for the Original Equipment Manufacturers (OEM) products used in the packaging machinery Industry
- Be a depository for case studies related to packaging machinery Industry products and processes

- Establish program criteria for Mechatronics Engineering Technology-related educational programs

The center in its second year has already received an endowment from an industry partner to support the operation of the center. The School has provided resources to support the center director, clerical help, graduate students, and office space. An active advisory board has been formed that represents industry professionals, high school teachers, and college faculty. The responsibilities of the advisory board are to provide advice and guidance for academic programs, center operation, and federally funded projects. The center is currently engaged in 5 industry funded projects that supports graduate students and faculty time. These projects deal with the noise reduction, thermal control, innovative design, and process efficiency pertaining to packaging machinery.

National Science Foundation (NSF) grant

After the implementation of the BS degree programs, the faculty members in School of Technology submitted NSF grants proposals to enhance the mechatronics related courses and adopt modularized and alternative delivery of the courses to benefit the employees of the industry. During two years 2008-2010 the School received two NSF grants. One was \$613,862 grant from the National Science Foundation (NSF) entitled, “Meeting Workforce Needs for Mechatronics Technicians,” It has been a partnership among three universities and colleges—Purdue University Calumet, College of DuPage (IL) and Ivy Tech Community College—and the packaging industry. The project involves experiential learning by all participants in summer. The packaging machinery industry provided the commitment for experiential learning opportunities for all participants during the three year project period. The project addresses workforce needs of the packaging machinery industry and other industries that require mechatronics knowledge and skill of its workforce. The grant supports course augmentation and modularization, as well as the integration and innovative delivery of experiential learning within the courses, enabling students to apply their knowledge.

In 2009, School of Technology has received \$149,372 NSF grant to support continued research and development of courses and facilities within the program. The award supports continued research and development of the courses and facilities within the new Mechatronics Engineering Technology Program at Purdue University Calumet. Five courses are being significantly enhanced to implement the latest in high speed automation equipment. In these enhanced courses students will experience similar environment that typically encountered at the entry –level job in the mechatronics field.

Both NSF funded projects require experiential learning by participants. In support of the grant, the industry partners committed to 70 internship slots for the students. Internship in industry augments students learning by providing real life experience in an environment that the student will encounter after graduation

Student success at the national level design competition

The program has 23 students as of Fall 2010. Two years in a row, students from the program participated at the national design competition sponsored by PMMI. In 2009, at the PACK Expo in Las Vegas, PMMI introduced the first-ever competition, which required college student teams to address a unique, real-world packaging challenge. Through a member of the DEC, the institution was asked to participate in the student design contest. The challenge was to create an automated palletizing system that combined production speed and efficiency with low cost and maintenance. In response, the competition called for the student teams to produce a paper and 20-minute presentation about their solution. A three-student team from the School of Technology's mechatronics program received the first prize, \$4,000 scholarship.

The Student Design Contest held again at the PACK Expo in Chicago in November, 2010. The contest challenged packaging students to use Packexpo.com and PACK EXPO International to find a conveying-related packaging line solution. Students from 9 schools competed; the team from School of Technology's mechatronics program was awarded 2nd Place. Their solution took into account environmental impact, energy consumption, ease of use, and cost considerations. All team members felt the knowledge learned and the experience of seeing their future careers in front of them was very rewarding. This learning beyond the classroom provided students with opportunity to solve real world problems. The PMMI Education & Training Foundation provided the \$2,000 scholarship funds.

The participation by students in the national design contest promoted the program at the national level. It also allowed students to visit with the potential employers for networking, to understand types of jobs and job opportunities in the packaging industry. Industry also learned about the program as evidenced through several requests received by the program (after the PACK Expo) for student interns and graduates for full time jobs.

Summary

The Industry-Education partnership resulted in the followings: 1) a new BS degree program in Mechatronics Engineering Technology program, 2) formation of an active advisory board to advise, and help sustain the new degree program, 3) integral partnership with the national professional society, 4) state of the art mechatronics laboratory, 5) A knowledge and resource center, 6) two federal grants in support of the mechatronics curriculum and workforce development, and 7) students success at the national design competitions.

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