

## Workforce Development in Mechatronics- A three year NSF-ATE project

### Dr. Niaz Latif, Purdue University Calumet (College of Technology)

Dr. Niaz Latif is the Dean of the College of Technology at Purdue University Calumet (PUC). Dr. Latif served as an Assistant Dean for Statewide Technology Administration in the College of Technology at Purdue University, West Lafayette, before joining Purdue University Calumet on July 1, 2007. He is the Principal Investigator of the 2010 NSF-ATE grant, "Meeting workforce needs of Mechatronics Technicians." Also, he is a Co-PI of another NSF-ATE grant, "Leadership Capacity Building for Manufacturing and Manufacturing Related Programs."

### Dr. Mohammad A. Zahraee, Purdue University Calumet (College of Technology)

Mohammad A. Zahraee, PhD, PE Professor and Assistant Dean for Graduate Studies College of Technology Purdue University Calumet

Mohammad A. Zahraee became Assistant Dean for Graduate Studies, College of Technology at Purdue University Calumet in 2010. He holds Bachelor Degree in Mechanical Engineering from Southern Illinois University, MS in Structural Engineering and PhD in Engineering Mechanics both from University of Illinois at Chicago. Mohammad joined Purdue University Calumet in 1989 and was the Head of the Manufacturing Engineering Technologies and Supervision Department from 1996 through 2007. He was also acting head of Electrical and Computer Engineering Technology Department from 2000 through December 2006. Zahraee served ABET from 1992 through 2010 as a program evaluator, commissioner (Accreditation Team Chair), as well as the national chair of the Engineering Technology accreditation commission of ABET during 2009-2010. He was recently elected to the ABET Board of Directors as a representative of American Society of Mechanical Engineers (ASME). A professor of Mechanical Engineering Technology, Mohammad chairs the Graduate Education Council in the College of technology, advises all incoming graduate students, and approves all graduation audits for MS students. MS in technology at Purdue University Calumet has over 150 students, the third largest enrollment for such degree.

### Mr. Aco Sikoski, Ivy Tech Community College

Mr. Sikoski completed his Bachelors of Science in Electrical Engineering at the University of Kiril I Metodi in Skopje, Macedonia. He continued his education at Purdue University where he obtained his Masters of Science in Engineering. Intermittently, Mr. Sikoski has consulted for various institutions and organizations. In 1997, he started his career at Ivy Tech Community College where he has stayed until present. He served as a professor, program chair, dean, and the campus Vice Chancellor. As a program chair and dean, Mr. Sikoski was involved in developing several technology and engineering programs, including the Energy Technology and Pre-Engineering Program. Developing programs to meet industry workforce needs and student's successes are his priorities. He served as an educational co-chair and chair of the curriculum committee of the Indiana Energy Consortium. He is a member of the Executive Board of Association of Technology Management and Applied Science and a visiting team member. Additionally, he serves on the advisory boards for College of Technology at Purdue University Calumet, Purdue University North Central and the Porter County Career Center.

### Mr. Branislav Rosul, College of Dupage

Dr. Branislav Rosul, Investigator Dr. Rosul completed his Bachelors of Science in Mechanical Engineering in February of 1984 majoring in Control Systems. Soon after he started to work as an Instrumentation Engineer in Teleoptic, Belgrade where he stayed for three years working on the Instrumentation Design and as a Project Engineer. During that time he worked on instrumentation and technology development of various industrial processes, from food to petrochemical and still industry. Academically, he continued on toward the Master of Science in Electrical Engineering at University of Belgrade. After completing his course work at the Belgrade University he transferred to United States in 1987 where he continued his work in the Controls area and Robotics at the University of Illinois in Chicago. He obtained Masters and then Doctorate in the area of Robot Control and Modeling of Multibody Systems in 1997 at the same

school. In the meantime he worked as an instructor at Oakton Community College and University of Illinois. Occasionally, Dr. Rosul has performed consulting for various institutions and organizations. In 1992 he started his career at College of DuPage where he stayed until present. First, as an instructor in Electro-Mechanical Technology and Manufacturing Technology and then, as a coordinator in Electronics Technology. In addition to practical engineering experience Dr. Rosul has significant teaching and research background. As a PI and co-PI Dr. Rosul has extensively worked with NSF on several grants and projects. Currently Dr. Rosul serves as an ABET evaluator for IEEE society. PROFESSIONAL PREPARATION University of Belgrade, Yugoslavia, Mechanical Engineering, Bachelor of Science, 1984 University of Illinois at Chicago, Mechanical Engineering, Master of Science, 1989 University of Illinois at Chicago, Mechanical Engineering, Ph.D., 1997 APPOINTMENTS Fall 1998 – Present Electronics, and Electromechanical Technology Professor and Coordinator, College of DuPage, Glen Ellyn, IL. Spring 1992 – 1998 Manufacturing and Electro-Mechanical Technology Professor, College of DuPage, Glen Ellyn, IL. Fall 1988 – 1991 Graduate Teaching Assistant, University of Illinois at Chicago, Chicago, IL. Aug. 1987 – 1988 CIS Instructor, Oakton College, IL . Winter 1984 – 1986 Project Control and Instrumentation Engineer, Project and Engineering Division, Teleoptic, Belgrade. Aug. 2001 - 2011 ABET Evaluator, IEEE Society. SELECTED PUBLICATIONS 1. Survey of Recent Results on the Robustness of Singularly Perturbed Systems, 30th Midwest Symposium on Circuits and Systems. 1987 p 516-519. 2. Linearization and Sensitivity Models Using Kane's Equations, Integrated Architectures For Robot Control and Programming, v.7:23, 1993. 3. College of DuPage Adaptive Model Technical Education, National Science & Technology Education Conference, Washington DC, October 19-22, 1999. 4. "Adaptive Model for Integrated Technical Curriculum", Connecting 2001 Beaver Creek, CO, Proceedings June 2001. 5. "Mecomtronics, and Integrated Technical Education Model", Intertech 2002, Proceedings, Santos Brazil, March 2002. NSF GRANTS NSF DUE-0101613: PI-Adaptive Model for Integrated Technical Curriculum, 2000-2004. NSF-DUE 0602593: Co-PI NETEC 2004-2008. NSF-ID 0724237: SBIR Phase II: Wavelength-Selective Lasers for Photonic Integrated Circuits. NSF DUE - ATE 1003668 ; Co-PI Meeting Workforce Needs for Mechatronics Technicians, 2010-2014

# Workforce Development in Mechatronics- A three-year NSF-ATE Project

## Introduction

Purdue University Calumet (PUC) in Hammond, Indiana was awarded a National Science Foundation Advanced Technical Education (NSF-ATE) grant for mechatronics workforce development in partnership with Ivy Tech Community College (ITCC)-Northwest Region, IN and College of DuPage (COD), IL. This project addresses participants' diverse educational background, multiple delivery options, college credits after completion of modules, and seamless transition among partnering institutions through mapping of college courses with modules. Furthermore, a major focus is on developing modules through enhancement of existing courses at different levels, and continuous improvement through assessment and evaluation of modules and modules delivery. This paper describes the project progress in the first 36 months. The following topics are discussed in this paper:

- *Module development and delivery*
- *Assessment and continuous improvement*
- *Participants transition from 2-year college to 4-year college*
- *Benefits of industrial and institutional partnerships*
- *Outreach activities*
- *Dissemination*

## Module development and delivery

A total of 32 modules were developed. Branislav, et.al (2011) discussed the details on modules developed, modularization process from existing courses and sequencing of modules for mechatronics curriculum. Latif et. al (2012) earlier reported on the project's progress in the first 16 months. Some of the accomplishments during the 3<sup>rd</sup> year (2012-2013) of the project are as follows:

- An active advisory board met three times during 2012-2013 period. The board has 18 members, 14 industry representatives, 3 community college representatives
- Nine new modules were developed, 6 modules in Fall 2012; 3 modules in Spring 2013
- Twenty-two modules were delivered- 7 from Ivy Tech, 4 from COD, and 11 from PUC. A total of 111 participants took the modular courses.
- Six students participated in industry internships. All internship participants are in the Mechatronics program at undergraduate and graduate levels. Not all of them took modular instruction, however the internship opportunities were due to active partnership developed under this project.
- Project-based learning was incorporated in 21 modules out of total 32 modules (66%)
- Twenty-two out of 32 modules have been delivered using Polycom Technology.

## Assessment, evaluation, and continuous improvement of modules

Individual modules have also been assessed and evaluated to determine if the learning outcomes were met or not. Where appropriate action items were identified to improve the module or module delivery. An example is presented in the Table 1, Table 2, Table 3, and Table 4.

Table 1: Assessment of course/module objectives through student assessments

| NSF-ATE MODULE 1-10, 2-10, 3-3 AND 3-4 (ECET 26200) - Programable Logic Controllers - Modular Offering for NSF-ATE  |   |                   |                      |                   |                       |                   |          |                   |          |                   |  |       |       |       |                            |
|---|---|-------------------|----------------------|-------------------|-----------------------|-------------------|----------|-------------------|----------|-------------------|--|-------|-------|-------|----------------------------|
| Assessment of Course Objectives through Student Achievement   |   |                   |                      |                   |                       |                   |          |                   |          |                   |  |       |       |       |                            |
| Instructor: Akram Hossain   |   |                   |                      |                   | Semester: Spring 2012 |                   |          |                   |          |                   |  |       |       |       |                            |
| Course Objectives   | Course Objectives Assessment Tools (Target Score = 70%) |                   |                      |                   |                       |                   |          |                   |          |                   | Students' Performance in the Course (Target Score = 3.00 out of 4.0) |       |       |       |                            |
|   | Assessment Tool 1                                       | Average Score (%) | Assessment Tool 2    | Average Score (%) | Assessment Tool 3     | Average Score (%) | Projects | Average Score (%) | Homework | Average Score (%) | E (4)  | G (3) | A (2) | P (1) | Composite Score (Out of 4) |
| 1. PLC Architecture, Software Tools<br>(a) Memory Map<br>(b) I/O Addressing Format<br>(c) Addressing Mode   | NSF -ATE Module 1-10: Exam I                            | 72.4              | Final Exam           | 78                |                       |                   |          |                   |          |                   | 3  | 4     | 1     | 0     | 3.25                       |
| 2. Understand and Construct Ladder Logic Programs<br>(a) Instruction Set Relay, Timer, Counter, Arithmetic, Comparison, File Instruction,   | NSF -ATE Module 1-10: Exam II                           | 70.7              | Final Exam           | 82                | Labs 2, 3, 4,6,7      | 82.2              |          |                   |          |                   | 3  | 4     | 1     | 0     | 3.25                       |
| 3. Manipulate data using PLC instruction sets<br>(a) Relay, Timer, Counter, Arithmetic, Logic, Mov, Comparison, File, Block   | NSF -ATE Module 2-10: Exam II                           | 75.8              | Final Exam           | 82                | Labs 5, 6             | 80.7              |          |                   |          |                   | 5  | 3     | 0     | 0     | 3.63                       |
| (4) Motion Control PLC/ Instruction: Control Servomotors with Motion  | NSF -ATE Module 2-10: Exam I                            | 73                | Project 1            | 90                | Project Lab 7,8       | 94                |          |                   |          |                   | 4  | 3     | 1     | 1     | 3.50                       |
| (5) Motor Sizing Using Basic Equations, Electronic cam using servomotor. Motion instructions.   | NSF -ATE Module 3-3: Exam I                             | 83.3              | Final Exam Problem   | 85                | Project 3             | 92                |          |                   |          |                   | 5  | 2     | 1     | 0     | 3.50                       |
| (6). Design and Configure graphical screens for HMI (Human Machine Interface) units<br>(a) A-B HMI, EATON HMI, Schneider 1200   | NSF -ATE Module 3-4: Exam I                             | 79                | Laboratory Exercises | 84.3              | Project 4             |                   |          |                   |          |                   | 4  | 2     | 2     | 0     | 3.25                       |
| Instructor's Comments:<br>- The instructor will address and take a corrective action on any objective whose outcome score is less than 70%.<br>- The course content/lecture was delivered through Synchronous Distance Delivery Method (SDD). Thus student feed back could not be collected. However, two in-class examination was given under direct supervision of the instructor. Thus the result of this assessment is based on the students achievement in exams as well as laboratory and class project performances. |   |                   |                      |                   |                       |                   |          |                   |          |                   | Number of Responses: 8   |       |       |       |                            |

Table 2: Course update and Improvement

| NSF-ATE MODULE 1-10, 2-10, 3-3 AND 3-4 (ECET 26200) - Programable Logic Controllers - Modular Offering for NSF-ATE  |   |  |   |
|---|---|--|---|
| Course Update and Improvement   |   |  |   |
| Date Submitted: 6-15-2012 for SPRING 2012   |   | Date to be Reviewed: Fall 2012                   |   |
| Responsible faculty for the review: Akram Hossain(PUC), Course Instructor, Laboratory Instructor: Adam Beemer (COD)   |   |  |   |
| Type of Update  |   |  |   |
| <input type="checkbox"/> New Edition of the Text  | <input type="checkbox"/> New Text Adopted               | <input checked="" type="checkbox"/> New Software | <input checked="" type="checkbox"/> Teaching Method |
| <input type="checkbox"/> New Laboratory Equipment   | <input checked="" type="checkbox"/> Lab Material Update | <input type="checkbox"/> Teaching Initiative     | <input type="checkbox"/> Other                      |
| <b>Description of Condition Prior to/after Update:</b><br>- Performed several example problems in class<br>- Introduced understanding of kinematics and motion control.<br>- Servomotor sizing examples<br>- Two class projects entitled <b>Stacking Conveyor System and A Traffic Light Controller</b><br>- A new PLC system simulation software tool (LogicPro) was used by students to understand more clearly the discrete logic and ladder logic |   |  |   |
| <b>Assessment Methods Used to Evaluate Short or Long Terms Results:</b><br>- Exams<br>- Laboartory<br>- Projects  |   |  |   |

Table 3: Student assessment of learning outcomes

| NSF-ATE MODULE 1-10, 2-10, 3-3 AND 3-4 (ECET 26200) - Programable Logic Controllers - Modular  |  |             |                       |             |           |
|--|--|-------------|-----------------------|-------------|-----------|
| Student Assessment of Student Outcomes   |  |             |                       |             |           |
| Instructor: Akram Hossain  |  |             | Semester: SPRING 2012 |             |           |
| Student Outcomes   | Student Performance in the Course<br>(Composite Target Score = 3.00) |             |                       |             |           |
|  | Excellent<br>(4)   | Good<br>(3) | Acceptable<br>(2)     | Pass<br>(1) | Composite |
| a. As a result of this course, students' ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly-defined engineering technology activities can be rated as,   | 3  | 4           | 1                     | 0           | 3.25      |
| b. As a result of this course, students' ability to select and apply a knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies can be rated as, | 3  | 4           | 1                     | 0           | 3.25      |
| c. As a result of this course, students' ability to conduct standard tests and measurements, to conduct, analyze, and interpret experiments, and to apply experimental results to improve processes can be rated as,   | 5  | 3           | 0                     | 0           | 3.63      |
| d. As a result of this course, students' ability to design systems, components, or processes for broadly-defined engineering technology problems appropriate to program educational objectives can be rated as,  | 4  | 3           | 1                     | 1           | 3.50      |
| e. As a result of this course, students' ability to identify, analyze, and solve broadly-defined engineering technology problems can be rated as,  | 5  | 2           | 1                     | 0           | 3.50      |
| f. As a result of this course, students' ability to apply written, oral, and graphical communication in both technical and nontechnical environments, and an ability to identify and use appropriate technical literature can be rated as,                                   | 4  | 2           | 2                     | 0           | 3.25      |
| <b>Instructor Comments:</b><br>The composite score exceeds the target score that is set at 3.00 on the scale of 4. Hence the course met the specified criteria and no action is needed at this time.   | <b>Number of Responses: 8</b>  |             |                       |             |           |

Table 4: Continuous Improvement Plan for NSF-ATE PLC Module 1-10, 2-10, 3-3, and 3-4

| Semester    | Impetus for Change   | Action and Impact   | By Whom        |
|-------------|--|---|----------------|
| Spring 2012 | <ol style="list-style-type: none"> <li>1. Modularization of PLC course.</li> <li>2. Synchronous Distance Delivery (SDD) was required for participating 2-year college</li> </ol> | <ol style="list-style-type: none"> <li>1. PLC Course was divided in to four modules and this action facilitate delivery through SDD to participating institutions</li> <li>2. Motion control concepts were introduced for Mechatronics</li> <li>3. Human Machine Interface (HMI) was introduced for industry demand</li> <li>4. PLC Simulator was introduced resulted enhanced students understanding of discrete and ladder logic</li> </ol> | Faculty member |

## **Continuous improvement based on external evaluator's report**

Latif et.al (2012) reported on the summative and formative assessment of the project for the first 16 months. Improvement of the project has also been implemented based on the external evaluator's June 2012 report. Recommendations by the external evaluator (June 1, 2012) and corresponding actions and responses are provided below.

1) *A well-defined enrollment management plan needs to be developed by the three partner institutions in order to increase the number of students entering the Mechatronics Technology program. The plan could include development of a website, radio/TV ads, brochures, print media and other means of marketing venues. Furthermore, there needs to be a focused effort to attract underrepresented student population to the program.*

### **Response:**

- **Website Development** - <http://webs.purduecal.edu/et/mechatronics/>  
A website was established to fit recruitment of potential students. A graduate student with a computer graphics background updated the website to include video of current students discussing their thoughts on mechatronics and the mechatronics degree program. Links to industry partners and their career opportunities were also developed.
- **Radio/TV Ads**  
The University Relations department has been contacted and is available as a resource to develop a marketing campaign. With the recent completion of the website content, this same material is available to be translated into a format for radio/TV ads.
- **Brochures**  
A Mechatronics Engineering Technology brochure has been developed. The brochure was distributed to local K-12 guidance counselors and received positive feedback. Suggestions for improving the brochure were incorporated into the design and updated brochures were printed.
- **Print Media for Marketing**  
A Mechatronics Engineering Technology poster has been developed. The poster was distributed to area 2-year colleges with associate degree programs with which articulation agreements are in place.
- **Video Clip and Brochure**  
Ivy Tech Community College has developed a video clip and brochure with current students and faculty. <http://www.ivytech.edu/ivy-institute/mechatronics.html>
- **Underrepresented Student Population**  
Local school districts with large percentages of underrepresented student population were contacted and students were invited to attend a day on campus exploring "Engineering Technology." The visit included hands-on sessions, presentations and demos to expose the students to the many different career opportunities available in the Technology field. How math plays an important role in those careers was discussed so that the students can make an early decision to prepare academically for college.

2) *The educational partners need to develop a strategic plan to ensure the sustainability of the grant after 2013. This plan should include short and long term goals, incentive for prospective students, revenue sources, commitment of senior administration and local*

industry. Such a plan will assist the institutions in addressing some of the current challenges such as modules scheduling.

Response

- Modules developed under this project are from existing courses and therefore will sustain since they are required courses in all three partnering institutions, PUC, COD, and ITCC.
- Because of articulation agreements between partnering institutions, students from these institutions will be able to transfer courses to PUC’s BS in Mechatronics Engineering Technology program.
- The sustainability will increase as the articulation agreements between PUC and the partnering institutions (two-year colleges) are in place. The project received a supplemental NSF-ATE grant of \$24,998 to accomplish this initiative.
- Distance education technology (Polycom Technology) acquired through this project will also allow delivery of modules, both lectures and laboratories to remote locations

Participants seamless transition 2-yr to 4-yr

There is clear career path through certificates and associate degree programs offered in participating institutions. Once an individual completes the modules, he/she will receive credits for existing courses leading to certification and associate degrees. These modules are mapped into the existing courses as shown in Table 5. The table identifies courses for which students receive credits after completing appropriate modules. During 2012-2013, 4 students ITCC, 99 students from PUC and 8 students from COD completed different modules and have already received college credits. Transfer Guides have been developed with COD and ITCC.

Table 5: Mapping of modules into existing courses at community colleges and university

| <b>Mapping of Electrical Modules into Existing Courses at COD, IvyTech, and PUC</b> |                          |                                     |                              |  |                          |
|---|--------------------------|-------------------------------------|------------------------------|--|--------------------------|
| <i>COD</i>  | <i>COD credit (hrs.)</i> | <i>IvyTech</i>                      | <i>IvyTech Credits( hrs)</i> | <i>PUC</i>                                 | <i>PUC credits (hrs)</i> |
| <b>ET 1100:</b> 1-1, 1-2, 1-3   | <b>3</b>                 | <b>INDT 113:</b> 1-1, 1-2           | <b>3</b>                     | <b>ECET 214:</b> 1-1, 1-2, 1-3, 1-4        | <b>3</b>                 |
| <b>ET: 2112:</b> 2-2, 3-8, 3-9  | <b>3</b>                 | <b>INDT 103:</b> 2-2, 2-3, 3-8, 3-9 | <b>3</b>                     | <b>ECET 212:</b> 2-2, 2-3, 3-8, 3-9        | <b>4</b>                 |
| <b>ET: 2410:</b> 1-10,2-10,3-3,3-4  | <b>3</b>                 | <b>INDT 205:</b> 1-10, 2-10         | <b>3</b>                     | <b>ECET 262:</b> 1-10, 2-10, 3-3, 3-4      | <b>3</b>                 |
| <b>ET 2255:</b> 2-1, 1-10, 3-1, 3-9   | <b>3</b>                 |                                     |                              |  |                          |
| <b>ET: 2510:</b> 2-1,3-1,3-2,3-10   | <b>3</b>                 |                                     |                              | <b>ECET 217:</b> 2-1, 3-1, 3-2, 3-10, 3-11 | <b>3</b>                 |
| <b>ET 2273:</b> 1-4,3-2, 3-10, 3-11   | <b>3</b>                 |                                     |                              |  |                          |
|   |                          | <b>INDT 206:</b> 3-3, 3-4           | <b>3</b>                     |  |                          |

| <b>Mapping of Mechanical Modules into Existing Courses at COD, IvyTech, and PUC</b> |          |                                    |          |                                    |          |
|---|----------|------------------------------------|----------|------------------------------------|----------|
| <i>COD Courses to modules</i>   |          | <i>IvyTech Courses to modules</i>  |          | <i>PUC Courses to modules</i>      |          |
| <b>MANUF: 1141:</b> 1-5,1-6,2-6,2-7   | <b>3</b> | <b>INDT 201:</b> 1-5, 1-6,2-6, 2-7 | <b>3</b> | <b>MET 230:</b> 1-5, 1-6, 2-6, 2-7 | <b>3</b> |
|   |          | <b>DESN 221:</b> 1-7, 2-4          | <b>3</b> | <b>MET 118:</b> 1-7, 2-4           | <b>3</b> |
| <b>ET 1120:</b> 1-8, 1-9  | <b>3</b> | <b>DESN 103:</b> 1-8, 1-9          | <b>3</b> | <b>MET 100:</b> 1-8, 1-9           | <b>3</b> |
| <b>MANF 1160:</b> 1-8,1-9,2-5,2-9   | <b>3</b> |                                    |          | <b>MET 213:</b> 2-4, 3-5           | <b>3</b> |
|   |          | <b>DESN 222:</b> 2-5, 2-9          | <b>3</b> | <b>CET 260:</b> 2-5, 2-9           | <b>3</b> |
| <b>MANF 1151:</b> 2-8, 2-11   | <b>3</b> | <b>MTTC 110:</b> 2-8,2-11          | <b>3</b> | <b>MET 142:</b> 2-8, 2-11          | <b>3</b> |
| <b>ELMEC 1420:</b> 3-6,3-7  | <b>2</b> | <b>DESN 214:</b> 3-6, 3-7          | <b>3</b> | <b>MET 214:</b> 3-6, 3-7           | <b>3</b> |

Benefits of industrial and institutional partnership

Industry partners have provided the following support for the project, a) experiential learning, b) student employment, c) Paid internship, d) gifts-in-kind for laboratory enhancement, and e) faculty professional development. The project had the following active industry partners: ARPAC Group, Triangle Package Machinery Company, Oystar Jones & Company, Inc., Morrison Container Handling Solutions, Rockwell Automation, Lenze Americas, Mitsubishi Electric Automation, APACKS, B&R Industrial Automation Corporation, and Bimba manufacturing.

PUC has developed modern labs through continuous support from industry. For example, PUC received a recent endowment to support a laboratory from its industry partner, Morrison Container Handling Solutions. Furthermore, industry and institutional commitment and support for manufacturing/industrial technology, computer laboratory / software for process technology, pneumatics, and hydraulics trainers, CNC simulation equipment, PLC and robotics equipment acquired during the past two years are also indicative of the future support to sustain the project. Now the program has the named laboratory, Nick and Nancy Wilson Mechatronics Engineering Technology Laboratory, and a Mechatronics Engineering Technology Laboratory in Partnership with Mitsubishi.

The benefits of partnership between 2-year colleges and PUC are as follows, a) a seamless transition from a 2-yr to a 4-yr college through existing and new articulation agreements among partnering institutions improved student recruitment and retention, b) collaboration among faculty members from partnering institutions allowed leveraging instructional/teaching resources, and c) new laboratory facilities were developed at partnering institutions

### **Project Outreach Activities: Student visits**

The Mechatronics Engineering Technology program has received a lot of publicity during the NSF-ATE project implementation that resulted in student visits from middle schools and high schools. Following is the list of such activities at PUC and ITCC.

- 4 students from a community college who were interested in transferring to the 4-year mechatronics program visited the Mechatronics and the Manufacturing labs.
- 12 students from Huntington North High School who were interested in mechatronics visited the Mechatronics and the Manufacturing labs.
- 35 freshman students from Bloom Trail High School had an expanded campus tour of the Engineering Technology Labs, including the Mechatronics labs.
- 80 students (freshman and sophomores) from New Tech Innovative Institute visited the campus to explore engineering/engineering technology as a career path.
- 30 7<sup>th</sup>/8<sup>th</sup> grade students visited the campus from Gavitt Middle School to explore engineering/engineering technology as a career path.
- 22 Hammond Area Career Center students visited the campus to see the EET program, but they also visited the Mechatronics and the Manufacturing labs.
- 12 students from the Porter County Career Center and 35 students from La Cross High School have visited Ivy Tech Community College.



## **Dissemination through conference presentation and conference proceedings articles**

The project PI, Co-PIs, key personnel, and participating students presented conference papers related to project activities at various conferences. Following is the list of papers.

- Fathizadeh, M. (Accepted for Publication, 2013 ). Implementation of a New Mechatronics Engineering Technology Degree Leveraging Industry. *Technology Interface International Journal*. Paper No.:T13-S-14
- M. Fathizadeh, G. Cabrera, M. Werthman and G. Zawislak, (2013), “Implementing Industry Leverage to Establish a New Automation Equipment Training Center.” *Conference Proceedings of the American Society for Engineering Education Mid-Atlantic Section*, Brooklyn, N.Y.
- Latif, N., Zahraee, M., Sikoski, A., Rosul, B., (2012) Manufacturing Workforce-report on NSF-ATE project pertaining to Mechatronics Technician Development. [CD-ROM]. *2012 Proceedings of the Annual Conference of the American Society for Engineering Education*, June 10-13, San Antonio, Texas
- Latif, N., Wilson, N. (2011). Industry Education Partnership: Mechatronics Engineering Technology Program Development. *Proceedings of the 2011 American Society for Engineering Education Annual Conference & Exposition*, June 26 – 29, 2011, Vancouver, BC. Canada.
- Rosul, B., Latif, N., Zahraee, M., Sikoski, A (2011) Modular Curriculum Development for Mechatronics Technicians. *Proceedings of the 2011 American Society for Engineering Education Annual Conference & Exposition*, June 26 – 29, 2011, Vancouver, BC. Canada.
- Hossain, Akram, Mohammad Zahraee, Remote Demonstration of Packaging Machinery & Mechatronics Systems via Public Network, ASEE Annual Conference, [CDROM]. *Conference Proceedings of the American Society for Engineering Education*, Atlanta, GA
- Hossain, Akram, Tanima Zaman, Collision Avoidance and Path Planning of an Autonomous Mobile Robot, [CDROM]. *Conference Proceedings of the American Society for Engineering Education*, Atlanta, GA
- Hossain, A., Kadir, H., Zahraee, M., (2012). Frame by Frame Analysis and Diagnosis of a High Speed Packaging System Using Fastec In-Line Network-Ready Camera Vision Equipment, [CDROM]. *Conference Proceedings of the American Society for Engineering Education*, San Antonio, TX.
- Hossain, Akram, Tanima Zaman, HMI Design: An Analysis of a Good Display for Seamless Integration between User Understanding and Automatic Controls, [CDROM]. *Conference Proceedings of the American Society for Engineering Education*, San Antonio, TX.
- Fathizadeh, M. (2012, January 24). Mechatronics is the future, despite the global economic slowdown, packaged goods sell briskly. *Packaging World*, p. 42.
- The videos displayed in the following link represent a typical course session from COD, Ivy Tech and PUC: <http://webs.purduecal.edu/technology/nsf-video/>

## **Overall project status**

Overall project status is provided in Table 6. The project is now in its 4<sup>th</sup> year under no-cost extension. The objectives that are not fully met are being addressed during this year. This project helped the growth of the BS degree program in Mechatronics Engineering Technology, from 22 students (Fall 2012) to 52 students in Fall 2013.

Table 6: Overall project status at the end of 36 months

|  |   |                                     |
|--|---|-------------------------------------|
| <p><b>Goal one:</b> Augment and reorganize six to eight existing electrical and mechanical engineering technology courses into thirty-two enhanced modules at three different tiers. Completion of all modules at each level will allow them to receive a certificate of completion at levels I, II, and III.</p>                                      |   |                                     |
| <p><u>Objective 1:</u> Form an advisory board including all constituencies within to help with input towards development of modules. board should meet twice per year.</p>   | <p>An advisory board with 18 members has been formed. Fourteen industry representatives, three community college representatives, one high school representative.</p>               | <p>Objective 1 met</p>              |
| <p><u>Objective 2:</u> Develop 8 to 12 modules per year, starting from level-one (beginner’s level) modules.</p>   | <p>Developed all 32 modules during first 36 months of the project</p>   | <p>Objective 2 met</p>              |
| <p><u>Objective 3:</u> Deliver nine modules in year one, followed by ten modules in year two and eleven in year three. Delivery of modules may lag the development by a few months</p>   | <p>All modules have been delivered at least once during first 36 months</p>   | <p>Objective 3 met</p>              |
| <p><b>Goal Two:</b> Incorporate <i>experiential learning</i> in each module level so that the modules are meaningful, practical, and interesting to students and professionals.</p>  |   |                                     |
| <p><u>Objective 1:</u> To provide 10 internship opportunities in industry in year one, 15 in year two, and 20 in year 3 of the project.</p>  | <p>Total number of internship participants was 12</p>   | <p>Objective partially met</p>      |
| <p><u>Objective 2:</u> To expand the companies supporting internship and hiring interns from at-least three companies in year one to at-least 5 companies in year two and 7 companies in final year of the project.</p>  | <p>Total active industry partners are about 8</p>   | <p>Objective 2 partially met</p>    |
| <p><u>Objective 3:</u> To assure that at least 50% of developed modules include an experiential learning component</p>   | <p>Sixty-six percent of the modules include project-based learning</p>  | <p>Objective 3 met</p>              |
| <p><b>Goal Three:</b> Incorporate <i>innovative delivery</i> of lecture and laboratory material. This includes: remote interactive delivery, synchronous online delivery, remote laboratory functions, asynchronous delivery, and delivery using virtual classroom with students having 24/7 remote access anytime, anywhere, and on any platform.</p> |   |                                     |
| <p><u>Objective 1:</u> deliver each module using at least one of the alternative delivery method</p>   | <p>Modules were delivered using Polycom Technology, streaming videos, asynchronous delivery</p>   | <p>Objective 1 is met</p>           |
| <p><u>Objective 2:</u> Implement the delivery of these modules from the source institution to other partners with reasonable rate of increase of modules being delivered in multiple ways. This rate will be decided after the first year</p>  | <p>22 modules have been delivered using polycom technology. Total number of students participated from outside the responsible institution who delivered the modules totals;316</p> | <p>Objective 2 is met</p>           |
| <p><u>Objective 3:</u> Market and offer a reasonable number of basic modules to area high school students using at least one innovative delivery method</p>  | <p>Increased number of visits of middle school and high school students to learn about the Mechatronics program on campus.</p>  | <p>Objective 3 is partially met</p> |

## **References**

- Latif, N., Zahraee, M., Sikoski, A., Rosul, B., (2012) Manufacturing Workforce-report on NSF-ATE project pertaining to Mechatronics Technician Development. [CD-ROM]. *2012 Proceedings of the Annual Conference of the American Society for Engineering Education*, June 10-13, San Antonio, Texas
- Rosul, B., Latif, N., Zahraee, M., Sikoski, A (2011) Modular Curriculum Development for Mechatronics Technicians. *Proceedings of the 2011 American Society for Engineering Education Annual Conference & Exposition*, June 26 – 29, 2011, Vancouver, BC. Canada.

This project is funded through the NSF-ATE grant (Award Number: 1003668) for the project, *Meeting Workforce Needs for Mechatronics Technicians*