Radian Belu, Wayne State University
Radian Belu is Assistant Professor at the College of Engineering, Wayne State University, Detroit, USA. He hold a PhD in Physics and the other in Power Engineering. Dr. Belu published over 55 papers in referred journals and conference proceedings. His research interests include power engineering, atmosphere physics, radar and remote sensing, physics and engineering education.
1. Introduction

The foundation for quality in product design and manufacturing is instrumentation and measurement, so it is somewhat surprising that Instrumentation and Measurements (I&M) has never been a major curriculum at universities \(^1-^7\). Ideally, a properly trained workforce of engineers and technicians should have expert skills in measurements and instrumentation to maintain higher productivity, and to improve safety standards in the industry. There is evidence \([1-12]\) that the complexities inherent in the new era of automation and intelligent systems require higher degree of skills and knowledge than can be provided at the artisan level. Prospective employees, as well as employees already on the job, need supplementary training to exploit new technologies, measurement, automation, and control systems. The use of I&M can be classified to three application schemes: 1) monitoring of processes and operations; 2) control of processes and operations; and 3) experimental engineering analysis. The first application is characterized as having only a monitoring function, while in the second the instrument serves as a component of an automatic control system. The third is for engineering problems that often require very extensive experimental studies. Industry now requires engineers who can compete in an environment characterized by reduced development times, lower development budgets, and increased expectations of high quality. These demands are presented within a new framework of intense global competition and shortages of qualified engineers apply additional pressure \(^4,^5,^7\). These facts support the necessity to improve and change the content of our I&M courses and laboratories. This paper describes the ongoing effort to establish a new I&M laboratory and course at our institutions.

1.1 Institutional Context:

*Wayne State University* is a Carnegie I Research Institution located in Detroit, MI, with an urban teaching and service mission. WSU is primarily a commuter school, which enrolls over 30,000 students having a mean age of 29 years. Our programs focus on application-oriented, analytical techniques, maintaining a close relationship between theory and practice by incorporating hands-on laboratories in the most of courses. WSU-DET houses dedicated laboratories for all its programs, including the Circuit Lab, the Control System Lab, the Microprocessor Lab, the Electric Machines and Instrumentation Lab, the Computer Lab, and the EET/MCT Projects Labs for the EET/MCT courses. This proposed project would utilize WSU-DET I&M laboratory, as well as the Focus:HOPE industrial facilities to develop and house the new, restructured cooperative/distributed I&M laboratory. *Focus:HOPE* - The Coalition for New Manufacturing Education, also called the Greenfield Coalition is made up of Focus: Hope’s Center for Advanced Technologies (CAT) – a leading edge manufacturing and education facility in Detroit area, and the academic partners Wayne State University, Lawrence Technological University, Lehigh University, University of Michigan, and University of Detroit Mercy;
as well as industrial partners Chrysler, Ford, General Motors, Detroit Diesel and Cincinnati Milacron, and the Society of Manufacturing Engineers. The goal of Coalition is to develop a new approach to the education of technicians, technologists and engineers working in the manufacturing field. The CAT is the primary delivery site for the curriculum. FH’s overall educational model entails hands-on training in the programming, operation, maintenance, and repair of manufacturing equipment, interdisciplinary study of pertinent mathematics, science, engineering, business, and general education courses, within an production environment.

The undergraduate ET programs at Wayne State University include a required three-credit laboratory-based course in Measurement and Instrumentation (EET3010). The EET3010 course includes three hours per week of lecture and laboratory to explore measurements, instrumentation, and data analysis. The FH curriculum includes two courses, Measurement Fundamentals and Instrumentation and Control, designed to give the students a background in measurement, instrumentation and PLC controllers, as well as error and data analysis. Both are the theoretical background of I&M, while the practical applications are part of a general technical education. The faculty and staff of the Center for Advanced Technologies (CAT) at FH are collaborating for this project. Planned major project activities include enhancing the I&M curriculum and setting up an industrial-based I&M laboratory at FH and WSU-DET. The support will be from the two institutions and possible educational grants.

2. Project Aim, Motivating Rationale

- Develop a new structure for the I&M courses at WSU-DET and FH utilizing a newly developed and implemented distributed/cooperative laboratory, to perform real industrial measurements in an actual industrial environment. The course structure, incorporating actual industrial measurement settings, will enrich students’ understanding and ability to apply concepts in I&M, both theoretically and practically. Students will have hands-on practice selecting instrumentation, measurement, quality and process controls while utilizing the computer-aided measurements, analysis, and control of industrial processes. The first stage will involve the development of a cooperative and distributed laboratory at WSU and FH while also adapting industrial measurements, computer-aided analysis and processing. The second will consist of developing industrial setting measurements based on the FH facilities, while the third will involve integration of DAQ and online tools along with other components for the remote I&M experiments. The field of I&M has changed dramatically over the last three decades, as electronics, computers and sensors integration give a new meaning to the terms “instrumentation” and “measurements”. Modern measurement systems are usually highly complex, incorporating significant processing power to perform desired functions and tasks. As the available instruments and methods of measurements become more and more complex, educators in most institutions have started changing the content of their I&M courses.

- Modernization of laboratories and associated disciplines. This has been based on the following goals: creating a motivating environment for the practice of basic concepts and principles that allow experimental verification of fundamental laws and concepts,
provide opportunities for immediate correlation between theoretical and experimental results leading to the repetition of the procedures if necessary, and *stimulating team work and interaction throughout the laboratory sessions*, from experiments to design to the elaboration of technical reports. The course-support laboratory must be restructured to respond to these goals. The present equipment and instrumentation used in the FH and WSU-DET I&M laboratories are obsolete, and computer-based data acquisition is almost absent. To make the laboratories relevant to the industrial needs and support learning, there will be a balance between fundamentals of measurements, instrumentation and industrial process measurements and instrumentation, including intelligent process instrumentation, control and system validation, maintenance and supervisory procedures. There are very good industrial facilities at FH, which can be integrated in the new restructured and distributed I&M laboratory.

### 3. Laboratory Developments and Implementation

Explosion of technology and the integration of information science have generated new physical, chemical and biological sensors, new instruments and measurement methods, as well as the extended use of computers and the integrated measurement systems in process, manufacturing and quality control. Therefore, I&M education must cover: 1) *fundamentals of measurement techniques*, such as measurement methods of basic electrical and mechanical quantities, operation of basic measurement instruments, and error analysis; 2) *fundamentals of computer-aided measurements*, performed in an environment similar or the same as one found in the industry; and 3) *I&M industrial-oriented applications*, I&M playing an important role in monitoring and improving production quality, and in process and manufacturing control. A measurement can be considered a procedure for getting desired information from a signal and presenting the results in a useful form[^3-9, 12-17]. The introduction of computer-based labs has been proven tremendously useful for simulation and modeling. Instructors can now spend less time teaching mathematical details and theoretical aspects of the topics while focusing more attention to the implications in design, analysis and applications. It is desirable that the students can experiment in a university lab with the measurement and control of industrial systems and investigate the technological aspects of these systems. The results of the experiments in the laboratory are expected to reflect the trends in that specific industry sector. To make a positive, continual, and lasting contribution to I&M education, upon completion of the project, WSU and FH will:

- Establish a cost-effective and cooperative/distributed I&M laboratory on both the WSU and FH campuses to provide hands-on experiential education to a diverse-student population.
- The I&M (WSU-DET+FH) courses will be restructured in a sequence of modules, in agreement with the laboratory structure, each one suitable to be also used as short course or seminar.

Outcomes expected:

- Students will be able to apply the principles and practice of measurement, and the wide range of physical processes that may require measurement.
Students will acquire industry-based experience in the I&M technology and practice through a hands-on laboratory environment and the use of computer-based data measurement systems.

- Students will be able to identify the wide range of industrial processes that involve measurements, control and instrumentation applications, and apply the relevant aspects of information technology, data analysis, monitoring and processing.
- I&M courses will provide ample opportunities for students to learn by doing (active learning), in a real industrial environment.

**Additional outcomes expected:**

- Students will work cooperatively and be able to form effective teams.
- Students will practice and improve technical communication and report writing skills.
- WSU and FH will utilize the lab as support for advanced engineering applications in I&M and process control for senior undergraduate and graduate projects and research.

### 3.1 Planned Activities

Leveraging the strengths of each institution – FH’s reputation for innovation and education of highly-qualified industrial personnel and WSU’s experience in engineering research and producing talented Bachelor and Master level graduates – and pooling their respective resources (i.e. programs, faculty, facilities, location, and industry ties), a series of activities have been planned to realize the stated objectives.

**Table 1 - Course Syllabus (EET3010-WSU Instrumentation and Measurements)**

<table>
<thead>
<tr>
<th>Hour</th>
<th>Module</th>
<th>Syllabus</th>
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</table>
| 10   | I. General Concepts, Configurations, Functional Descriptions, Performance, Characteristics of Measuring Instruments, Measuring Devices | - Instructional Objectives, Role of Measurement,  
- Units, Measurement Standards, Errors, Signals in Measurement Systems,  
- Functional Elements of an Instrument, Active and Passive Transducers and Sensors, Static and Dynamic Characteristics,  
- Motion and Dimensional Transducers, Force, Torque, and Shaft Power Measurement; Pressure, Sound, and Flow Measurement,  
- DC and AC Meters, Signal Conditioning Circuits, Calibration and Compensation. |
| 6    | II. Data Processing; Voltage-Indicating and – Recording Devices; Data-Acquisition Systems. | - Data Transmission and Instrument Connectivity,  
- Standard and Calibration, Analog and Digital Meters, Electro-mechanical Recorders, Oscilloscopes,  
- Data Acquisition for Personal Computers. |
| 6    | III. Measurement Systems. Automatic Test Equipment                      | - Philosophy, Usage and Programming, Instrument Systems, Control, Interfaces, Design Applications,  
- Virtual Instrument using LabVIEW,  
- Integrated Measurement Systems,  
- Noise, Signal Interference and Corruption,  
They are as follows:
• Revise the I&M curricula at both institutions;
• Update equipment and instrumentation and make available for WSU-DET and FH students;
• Re-design experiments so the students can experience different types of engineering experiments in an industrial environment;
• Provide equipment for six laboratory groups to simultaneously conduct the same experiments;
• Implement horizontal and vertical integration of I&M laboratory with signals and systems, control, and manufacturing laboratories;
• Create internship and co-op opportunities, and plant visits, etc.
• Create supporting environment for delivery of short-course and seminars in I&M and process control, via modular structure of I&M Curriculum.

Revision of the I&M Courses Contents. I&M courses include laboratory work, which is often welcomed by students but deemed expensive by administrators. In our experience, laboratory-based courses are preferable to courses split between the classroom and the laboratory.

<table>
<thead>
<tr>
<th>Lecture Hours</th>
<th>Topic</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Module 1: Fundamentals of</td>
<td>• Accuracy, Calibration, Absolute and Comparative Measurements,</td>
</tr>
<tr>
<td></td>
<td>Measurements</td>
<td>• Temperature Transducers, Pressure and Strain Gauges.</td>
</tr>
<tr>
<td>6</td>
<td>Module 2: Measurement Devices</td>
<td>• Measurement devices: calipers, straightedge, surface plate, sine bar,</td>
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<tr>
<td></td>
<td></td>
<td>micrometer, mechanical, pneumatic, and electrical indicating gages,</td>
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<tr>
<td></td>
<td></td>
<td>optical comparator, coordinate measurement machine.</td>
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<tr>
<td></td>
<td></td>
<td>• Dimensions and tolerances in a measurement device</td>
</tr>
<tr>
<td>6</td>
<td>Module 3: Elementary</td>
<td>• Population, discrete and continuous variables, sample mean, median,</td>
</tr>
<tr>
<td></td>
<td>measurement statistics</td>
<td>mode, variance and standard deviation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Normal and exponential distributions, confidence interval, error</td>
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<tr>
<td></td>
<td></td>
<td>analysis.</td>
</tr>
<tr>
<td>12</td>
<td>Module 4 and 5: Instrumentation</td>
<td>• Analog and discrete signals, data processing and displaying, bridges,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A/D and D/A converters,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• OpAmp circuits and signal conditioning circuits, measurement systems.</td>
</tr>
</tbody>
</table>
Tables 1 and 2 summarize proposed I&M syllabi for WSU-DET and FH respectively, which will take one hour per week in lecture and two hours per week in the laboratory for fifteen weeks. The DET I&M course is based on materials from textbooks superscript 1,3, while FH measurement, instrumentation and control courses will use as a main reference superscript 6.

4. Proposed Distributed/Cooperative Laboratory

The proposed laboratory equipment and simulation software will further serve both educational and research activities superscript 7-17. Knowledge presented in lectures will be verified in a laboratory, while the course will provide students with a general knowledge of measurement techniques, and the automation of measurement processes and instrumentation, while developing practical abilities in order to better use and apply measurement and instrumentation. Experiments and exercises to be taught can be divided into three groups: 1) Basic exercises - which examine the practical abilities of measurement and instrumentation, and also knowledge of data analysis and processing, introduction to basic transducers and sensors, and basic circuits, etc.; 2) Advanced exercises - which present examples of experimentation techniques and procedures in various fields of mechanical, electrical engineering, etc.; and 3) Computer-based measurement problems- related to the automation of measurements, virtual instruments and applications, basic interface standards, used in measuring systems, software applications, etc. The multi-function distributed laboratory for teaching instrumentation and measurement systems that is proposed to provide training in measuring system design, will also be used for student senior capstone design projects or Masters Degree projects superscript 2, 4, 5.

4.1 Laboratory Structure

The laboratory experiments are designed 1) to reinforce and support the lecture-based course; 2) to emphasize the importance of corroborating the results of laboratory measurements which is accomplished through a comparison of expected and measured waveforms; and 3) to expose the students to the measurement techniques used in the industry in general. To achieve the above purpose, the laboratory experiments will be divided into two levels: Level I - deals with basic measurement experiments and techniques, which will strengthen student knowledge in general areas of instrumentation and measurements and Level II – which is for application projects in instrumentation and measurements for industrial practices. Tables 3 and 4 illustrate the laboratory exercises for Level I and II respectively.

(1) Level I Laboratory: Basic Measurements – Students will be able to identify the operating principles of measurement hardware and the problems involved in the analysis, design, and application of such equipment. The sequencing of the laboratory experiments is specifically designed such that the material in a given laboratory has already been presented in the lecture portion of the class.

(2) Level II Laboratory: Industrial Measurements – Students will develop increased competence in both the design and the use of measurement equipment. This is
implemented by consideration of both more advanced general concepts and also more sophisticated and specific hardware. Experiments are designed mainly to provide familiarity with actual instrumentation equipment and problems involved in its use.

**Table 3 - Level I Laboratory: Basic Measurements**

<table>
<thead>
<tr>
<th>Lab No.</th>
<th>Topics</th>
<th>Exercises</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LabView and Matlab Tutorials</td>
<td>Pressure, Level, Temperature, Flow Transducers</td>
</tr>
<tr>
<td>2</td>
<td>Transducer Functions</td>
<td>Strain Gauge and Piezoelectric Sensors</td>
</tr>
<tr>
<td>3</td>
<td>Transducer Functions</td>
<td>Torque and Power Measurements</td>
</tr>
<tr>
<td>4</td>
<td>Transducer Applications</td>
<td>Actuators, Photo-Detectors, Industrial Measurements</td>
</tr>
<tr>
<td>5</td>
<td>Transducer Applications</td>
<td>Accelerometers, AC and DC Displacement Measurements</td>
</tr>
<tr>
<td>6</td>
<td>Signal Conditioning Circuits</td>
<td>Bridges and OpAmp Circuits</td>
</tr>
</tbody>
</table>

**Table 4 - Level II: Industrial Measurements**

<table>
<thead>
<tr>
<th>Lab No.</th>
<th>Topics</th>
<th>Hand-On Applications</th>
</tr>
</thead>
</table>
| 1       | Dimension measurement               | • In-process gauging  
                        • Off-line gauging  
                        • Coordinate-measuring machine (CMM)  
                        • Surface-finish measurement  
                        • Displacement-to-pressure (nozzle-flapper) applications |
| 2       | Motion measurement                  | • Chatter vibration measurement in grinding machine                                  |
| 3       | Force, torque, and shaft power      | • Machining force measurement in CNC lathes and machining centers  
                        • Torque measurement in tool spindle in machining operation  
                        • Clamping force and torque measurement in fixturing devices  
                        • Power measurement in machine spindle  
                        • Strain gage applications |
| 4       | Process temperature measurement     | • Cutting tools temperature measurement                                               |

**4.3 Laboratory Work and Evaluation**

Each laboratory unit will be designed as an independent educational module, which typically will be composed of the following components: 1) A theoretical background to provide the theory for preparing experiments and simulations. Questions at the end of
Theoretical section will provide feedback to the student on the quality of his/her learning. 2) Experiments and simulations will be an integral part of each module. Another set of questions will be required to be answered at the end of each unit, after this part the final mark for each unit will be assigned to students. In each module/educational unit, a strong emphasis will be placed on engineering approaches to setting up problems and experiments, and on seeking solutions. The students will be allowed to perform experiments and simulations only after answering correctly most of the questions from section 2 of each unit. The test questions will be selected to reflect the background a student must have on the subject of the unit. Each student will be required to submit a technical laboratory report. 3) Team projects at the FH lab will link various objectives covered in evaluations 1 and 2 in a comprehensive manufacturing environment setting.

Ideally, students will form groups of four member teams to perform each laboratory module. Students will be encouraged to have members with different skills to compose a multidisciplinary team. The documentation of each laboratory module will be passed out well in advance. Each team works individually. Students will also receive a complete laboratory schedule. Evaluations will be based on the documentation rendered by the students at the end of each module. At the end of a module, the whole process will be discussed with the students, and the final grade will be assigned. Performance in the laboratory and the submission of reports will be a pre-requisite for entry to exams. The reports for each educational unit will be due two weeks after completion.

Integration with Other Laboratory Activities: The lab will not only support the WSU-ET and FH courses in I&M, but also support other laboratory activities in control, applied signal processing, mechanical and manufacturing. Both WSU-DET and FH are able to take the advantage of existing state-of-the-art industrial infrastructure at FH and the computer facilities in the WSU-DET. Additionally, the development of several short I&M courses in control, electro-hydraulics for training employees in local industries is planned.

The integration of the I&M distributed/cooperative laboratory with other across WSU-DET and FH:

Lab Facilities will include:

- Fully interfaced to PC based DAQ I&M, data acquisition and control software
- Integrated with Matlab/Simulink
- Custom-built DAQ hardware interface
- Custom-built experiments, such as temperature control systems, dual tank liquid level systems, coordinate axis motion
- Advanced experimental settings for senior student projects and graduate research

Implementation Timeline: The project will begin by procuring the requested equipment and software tools. Development of the laboratory modules and setup of the workstations will follow. The project will be implemented over a 15 months period. Assuming that project starts by June 1, 2006, the project implementation schedule will be as given in
Table 5. The first two modules are scheduled for initial delivery in the Winter 2007 semester, with a revised version, based on the evaluation and assessment plan, by the end of the semester, and the next two modules in the Summer 2006. By the end of the Summer 2006, all modules and sections of the courses and laboratories will be implemented. The development will be presented in the WSU-DET and FH Joint Industrial Advisory Board Meeting for interim evaluations, as Quality System Laboratory @ Focus:HOPE well as to our external evaluators. The results of these evaluations will be incorporated in the revision of the modules. The project will also be introduced in the Senior Project class (ET4999) and encourage students to participate in the development.

<table>
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<tr>
<th>Table 5 - Project implementation schedule</th>
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<tbody>
<tr>
<td>Development</td>
</tr>
<tr>
<td>Fall 2006</td>
</tr>
<tr>
<td>Winter 2007</td>
</tr>
<tr>
<td>Summer 2007</td>
</tr>
</tbody>
</table>

The faculty will be responsible for the development, initial delivery and modification, and revision of all five modules. One senior level undergraduate student with experiences in both LabVIEW and MATLAB programming will be hired to help in setting up the laboratory equipment, developing LabVIEW VIs, and programming MATLAB simulations. The WSU-DET will provide technical support for developing the Website and uploading it to the division’s server.

Role of Each Institution: WSU-DET will host the lab settings for Level I Experiments; while FH will host the Level II Experiments. WSU-DET will also provide software, materials and instrumentation that are available in current Instrumentation, Circuit and Control Labs. DET - a division of WSU College of Engineering, houses hardware and software support for on-line and distance learning, which will be used to facilitates communication between two campuses and remote experiments.

Expected Outcomes: Firstly, it will enable graduate students to exhibit closed competency gaps in instrumentation and measurements, as well as in technical and communication skills. Secondly, it will allow students to work with measurement, monitoring and control equipment similar to those that exist in industry. The development will enable students experience the latest advances in the computer-aided simulation, analysis, and design of measurement systems. Other institutions might utilize our developments through web page and online facilities. With this development in place, competent graduates will become technologists and technicians that manufacturing, automotive and other industries’ need. Hence, exposures to challenges in this field will
result in drawing more student attention to take careers in I&M, quality control, manufacturing fields, etc.

5. Evaluations and Assessment Plan

The evaluation plan will be twofold: (1) *A quantifiable measure of completions of the objectives* as stated in the proposed plan; (2) *measure of student learning and outcome*. Table 6 summarizes the deliverables and measures to be used for the evaluation of the completion of project objectives. A team formed by recent graduates of the DET and FH, industry representatives (among others the members of DET and FH Joint Advisory Industrial Boards) and other academic professionals (from Wayne State University, The University of Western Ontario, who agree to participate in evaluation-assessment process of this project) have been formed to receive direct feedback, assessment and evaluation of the project.

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Deliverables</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Configure and integrate the existing laboratory experiments for EET3010 and EET4200</td>
<td>Laboratory experiment menu for EET3010</td>
<td>Student evaluations; Student assessment; Feedback of the external evaluators</td>
</tr>
<tr>
<td>2. Design and develop new hands-on experiments, ex1-4.</td>
<td>Laboratory experiments 1-4</td>
<td>Student evaluations; Feedback of the external evaluators</td>
</tr>
<tr>
<td>3. Set-up six PC-based workstations and devise real time data acquisition;</td>
<td>Six PC-based workstations</td>
<td>Student assessment Feedback of the external evaluators</td>
</tr>
<tr>
<td>4. Develop or adept LabVIEW VIs for signal generation, display and processing.</td>
<td>A set of LabVIEW VIs for the proposed lab modules</td>
<td>Students’ feedback External evaluators’ feedback</td>
</tr>
<tr>
<td>5. Create documents for the theories and concept questions for each experiment.</td>
<td>Document posted online</td>
<td>Improvement in student performance Improvement in students’ lab reports</td>
</tr>
<tr>
<td>6. Develop computer simulation packages to enhance student learning of the theories</td>
<td>Simulation package available for download</td>
<td>Improvement in student performance Evaluation by external committee</td>
</tr>
<tr>
<td>7. Post the laboratory modules on the WSU-DET Website for delivery over the Internet</td>
<td>A Web site including all materials developed</td>
<td>Student evaluations; Evaluation by external committee</td>
</tr>
</tbody>
</table>

The faculty will present this project in DET’s and FH’s JIAB Meetings. Assessment of the laboratory sequence will be preformed on an ongoing basis with the objective of supporting continuous improvement. A multifaceted strategy will be employed, which will include monitoring quantitative measures of student performance (average scores on
tests, lab reports, etc.), traditional end-of-term student surveys, and faculty interviews. During the project we plan to incorporate alumni and our graduate’s employers' surveys, and external faculty assessments into this mix.

The following means will be used for collecting the measurements:

1. Measure student performance in laboratory using lab reports, memos, written final exams, and formal technical reports. We also will solicit student comments throughout the project.
2. Mid-semester and end of semester student evaluations of the modules will be obtained along with responses to questions about the hands-on experiments, computer simulations and module structure (surveys will conducted on WSU-COE Website).
3. Review exit interviews with graduating seniors. Feedback will be sought from graduate students about the effects the integrated multipurpose laboratory had on their progress. Feedback will also be obtained from employers about the skills of their new hires.
4. Solicit faculty assessment of student preparedness in each of five EET topic areas.

These evaluations will be utilized in the ongoing improvement of the integrated modular laboratory. Mid-semester and end of semester student evaluations of the modules will be used to improve, upgrade and modify the laboratory modules during this project, and for later laboratory upgrade and changes.

**6. Conclusions and Future Work**

This describes the undergoing efforts to establish a new course-supporting laboratory, with experiments in an actual industrial environment for a course in instrumentation and measurements. The future work will include the developing of on-line course materials, assignments, tutorials and simulation and experiments for a possible distance version of these courses. Besides the usual student evaluation run by the university, the faculty intends to run own surveys, one during mid-term exam and the other during the final exam, in order to have more student feedback, course evaluation and assessment. Inputs from instructors from other institution will be highly appreciated.

**References**