Industry Partnerships at Western Carolina University: Live Projects that Work

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Abstract– Western Carolina University is committed to provide opportunities for students to engage in real-world projects that not only benefit the student, but an external constituency also. WCU has several mechanisms in place that allow collaboration between the university and industry. The university developed a Quality Enhancement Plan (QEP) that encourages students to create connections between what they learn inside the classroom and the outside world. In addition, Western Carolina has adopted the Boyer model for engaged teaching. The Boyer model supports the creation of a learning environment that incorporates discovery, integration, analysis/application, knowledge transmission and transformation, and the understanding of real world issues. In the Engineering Technology department, the Integrated Systems Project class has been the vehicle to allow students the opportunity to engage in these real-world projects. This paper will present the approach taken to implement the projects and specific successes that have been realized through the class.

Keywords: Engineering Technology, industry partnerships, engagement, capstone classes, project based learning

INTRODUCTION AND BACKGROUND

As a part of its central mission of teaching and learning, Western Carolina University routinely assists individuals, industries, and businesses in Western North Carolina through the expertise of its faculty, staff, and students [1]. Dr.John Bardo, Chancellor of WCU, has the belief that education is not complete without engagement with the community. In his State of the University address in 2004, he reiterated that the future of the region and the state will require a much closer integration of the University with the region's people, businesses, governmental entities, and non-governmental organizations [2]. In response to the chancellor's directive, several mechanisms have been put in place that allow collaboration between the university and industry. As a result of its reaccreditation process with the Southern Association of Colleges and Schools (SACS), the university developed a Quality Enhancement Plan (QEP) that encourages students to create connections between what they learn inside the classroom and the outside world. In addition, Western Carolina adopted the Boyer model for engaged teaching which supports the creation of a learning environment of application. The Boyer model focuses on discovery, integration, analysis and application, knowledge transmission and transformation, and the understanding of real world issues. The university also subscribes to the Stewards of Place model, adding to the emphasis of public engagement. Further, the Engineering Technology Department at WCU stresses Project Based Learning (PBL) as a concerted effort to employ the Boyer model.

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Quality Enhancement Plan

The Quality Enhancement Plan (QEP) is a requirement for Western Carolina University's reaccreditation by the Southern Association of Colleges and Schools (SACS). According to SACS, universities will submit a QEP that will address the following issues.

- Include a broad-based institutional process identifying key issues emerging from institutional assessment
- Focus on learning outcomes and/or the environment
- Support student learning and accomplish the mission of the institution
- Demonstrate institutional capability for the initiation, implementation, and completion of the QEP
- Include broad based involvement of institutional constituencies in the development and proposed implementation of the QEP, and
- Identify goals and a plan to assess their achievement [3].

WCU's plan, entitled **Synthesis: A Pathway to Intentional Learning**, was designed to help students create connections between what they learn inside the classroom and outside of the classroom and to afford faculty, staff, and students more opportunities to collaborate with the outside world. The plan will be monitored regularly by SACS to see how well it is working. In five years (2012) and then ten years (2017), SACS will re-examine the QEP to determine if the university is making good progress on the plan [4]

The QEP will be implemented gradually over the next 10 years until, ultimately, it will affect each school, department and student. As it continues, it will develop students who are intentional about their academics, their co-curricular activities, their internships and co-ops, and their long range career goals. It is hoped that students will develop a better context for their learning and experiences, and a deeper mastery of their discipline. Specifically, students will demonstrate proficiency in the following areas.

- Identify their aptitudes, abilities, and interests and articulate their future goals and aspirations.
- Modify behaviors and values in response to knowledge and skills gained from their academic and co-curricular experiences, and
- Recognize the synthesis of their university experiences and evaluate those experiences relative to their future education and career plans [4].

The Boyer Model

In addition to the QEP, Western Carolina has adopted the Boyer model for engaged teaching. Ernest Boyer created a vision in which university professors would be rewarded for creative works in a non traditional way. At most universities, professors are considered for tenure on the basis of their contributions in the areas of research, teaching and service. Boyer argued that if universities are to continue advancing forward, a new vision of scholarship is required, and that research alone will not secure the future of higher education or the country at large [5]. Boyer maintained that the academy should reward faculty in all four areas of scholarship; scholarship of discovery, integration, application, and of teaching. Of particular interest to Western Carolina, is the scholarship of application. Most universities require faculty to perform some sort of service as a part of their duties. The scholarship of application looks at service more from the perspective of *engagement*. Once information is discovered, it may then be applied. Scholars might ask the question "How can knowledge be responsibly applied to consequential problems?" Once theory and practice converge, engagement becomes scholarly. As it is understood at WCU, the scholarship of application seeks to discover how the university may assist with external problems [6]

Stewards of Place

The Morrill Land-Grant Act and The Wisconsin Idea encourage public universities to aid states and localities in addressing issues affecting the common good [7]. Colleges and universities demonstrate daily their commitment to "public engagement," or the propensity to assist their communities through outreach, applied research, and service learning [8]. According to the AASCU, public engagement is:

> **Place-Related** - While the demands of the economy and society have forced institutions to be nationally and globally aware, the fact remains that state college and universities are inextricably linked with the communities and regions in which they are located. Exercising "stewardship of place" does not mean limiting the institution's worldview; rather, it means pursuing that worldview in a way that has meaning to the institution's neighbors, who can be its most consistent and reliable advocates.
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> **Interactive** - The etymology of the word "engage" speaks to the intertwining or meshing of entities. In this context, engagement refers to a spirit of give and take by the university and its partners. For institutions, this means occupying the role of learner as well as teacher. For community and regional partners, this means looking to the university as a resource, not necessarily as "the answer."
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> **Mutually Beneficial** - Engagement should inure to the benefit of both parties involved. These initiatives should expand the learning and discovery functions of the institutions while enhancing community capacity to address and resolve the issues they confront. The work of the engaged institution is to be responsive to public needs in ways that are appropriate to the institution's mission and academic strengths. Engagement initiatives should also build greater public understanding of and support for the campus as knowledge asset and resource.
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> **Integrated** - At a campus level, engagement must permeate all levels of the institution, and be integrated into its policies, incentive structures, and priorities. At a departmental level, engagement cuts across the imperatives of teaching and scholarships to bring unparalleled opportunities for the entire campus community - faculty, staff, and students [8].

Project Based Learning

The integration of project based learning is certainly not new and has been implemented across an array of varied disciplines. As suggested by Greenburg [9] and Nelson [10], responsibilities of carrying out the project shifting to the student while the teacher serves more in a mentor role. Fink [11] further describes the PBL approach as a method that encourages creativity, independent thinking, and proactive self-directed learning. Support for PBL in Engineering Technology include realistic environments that are more similar to those students will encounter when entering the work force, project focused solutions rather that theory focused calculations, and the integration of knowledge from a variety of non-traditional classroom resources. To fulfill the Engineering Technology program goal of nurturing technical professionals with strong experiential skills, the focus is on applied scientific knowledge and engineering principles rather than traditional engineering theory and engineering design as stressed by both Kumar [12] and Grinberg [13].

INTEGRATED SYSTEMS PROJECT

In the Engineering Technology department at WCU, it has been rewarding to see the university follow our philosophy of collaborating with industry that has been in place for many years. One specific vehicle for student engagement has been the Integrated Systems Project class. The class, essentially a senior capstone class, is focused on an applied project that integrates student competencies gained over their entire WCU experience. Preferably, students will identify and refine a project worthy of three semester hours. While the project can be across a wide array of disciplines, it should focus on the student's area of professional interest, as well as being applied and practical. In other words, rather than just an academic exercise, outcomes should be generated that are beneficial to the student and the region as a whole. The project should enhance the community, the region, or a specific industry in the region. The project should also result in a new product, a redesigned product, a process improvement, or a facility redesign that extends the resources of the university to the community in general. Ultimately, the project should also be thought of in terms of its overall value to the community or the industry.

At the successful completion of this course, the student will be able to:

- organize, plan, and implement a project that integrates two or more electrical, hydraulic, or mechanical systems;
- work successfully in a team environment;
- demonstrate skill in project planning;
- integrate concepts from prior coursework in their curriculum;
- complete a project from design requirements to final prototype or product;
- effectively present technical material in written and oral form

Specific course requirements include a proposal, weekly status reports, the written project paper, and a presentation. The proposal should be a 1 to 2 page summary of the project, including a statement of the problem, specific goals and objectives, project approach and methodology, and the actual deliverables that will result from completion of the project.

The student is expected to spend a minimum of 80 hours (5 hrs. per week x 16 weeks) on the project. Most projects will take at least twice that. In order to fully document the project, a weekly status report is submitted to the professor to detail the progress of the project. It is hoped that this will also serve as a reminder for students to pace themselves and complete the project on time. Reports generally log processes, activities, and time spent.

The primary requirement for this class is the completion of the project and resulting written report. Using a prescribed format, documentation must be submitted completely describing the project. All sources of information must be cited, including texts, reference books, journals, magazines, sales brochures, web sites or other pertinent sources. The suggested length is 10 pages.

The student or student team must also prepare a 15 minute presentation highlighting the findings of his/her research. The student should use Power Point or other accepted methods of presentation highlighting the major sections of the written report. Photographs, video clips, and other documentation methods should be used to supplement the presentation.

PROJECT EXAMPLES

At Western Carolina University, engagement must be as much a part of a personal teaching philosophy as it is a requirement for all tenure-track faculty. Engagement with industry is understood as a mutually beneficial relationship for industry and students, and is a part of our culture at Western Carolina University. In the past several years, many successful projects have been conducted with external constituencies with outstanding results. New products have been developed, processes have been improved, communities have been assisted, and jobs have been saved. Most importantly, students have been provided with real-world experiences that will benefit them greatly in their careers.

Parker Hannifin Corporation

Working with a small Parker plant, the student assisted in the development of an assembly fixture that reduced assembly time on a particular hydraulic valve assembly line. The student designed and built the fixture and when implemented, the fixture shaved off 20 seconds per valve over 150,000 valves per year. At $65.00/hr., the company realized an annual savings of $54,166. Add to this a reduction in repetitive stress injuries like trigger finger and carpal tunnel and the savings are immeasurable.

Leviton Manufacturing Co. Inc.

This project involved the process improvement an assembly line at a Leviton plant that manufactures electrical components. The student did an efficiency study over a period of time and came up with four recommendations: to eliminate second shift, to reduce the number of operators per line, to improve both health and productivity, and to reduce ergonomic problems. The company accepted the recommendation as presented and realized $144,000 in savings.

Merchants Distributers Incorporation

The objective of this project was to provide MDI management with the tools necessary to make an important decision regarding the future of grocery shopping. The concept of shopping for groceries over the internet was explored and perfected. The student developed and piloted the program, made recommendations on space utilization, and designed the work area for implementation. The pilot was well received by MDI and the project was allowed to move forward. Projected yearly sales for the program are estimated to be $1,000,000. It was determined that the possibility to exceed this expectation would be easy, depending on the acceptance of the program in the marketplace. With a world wide market, the potential to making a great profit will be undeniably great.

Penske Racing Inc.

In this example, the student worked with Penske Racing Inc. to design, test, and manufacture a new rocker arm (Spec 2) that would enhance performance in a R5P7 Dodge engine that competes within the NASCAR Sprint Cup and Busch Series. After prototyping, tests proved the Spec 2 rocker arm was lighter and created .04" more valve lift and generated more horsepower and torque without sacrificing reliability. The gains in horsepower and torque were:

- 6l ft. lbs. of torque for a total of 543 ft lbs@ 7100rpm.
- 11 hp for a total of 841 Horsepower at 9200rpm.

Results from the Penske team cars from the first race were encouraging. The #12 car qualified 3rd and the #2 car qualified 7th. In the highly competitive world of NASCAR, qualifying in the top ten can be worth hundreds of thousands of dollars in sponsorship and winnings.

Corning Cable Systems

Corning Cable Systems was awarded a contract to be the sole supplier of fiber optic cables to AT&T. With the new business, Corning Cable Systems was also asked to cut cables to precise lengths and ship directly to the customer for shorter lead times. The goal of this project was to reduce the cost of shipping fiber optic cables from Corning Cable Systems to AT&T directly, in order not to hurt the bottom line margins. In the process of reducing cost, the on-time delivery, quality, and overall customer satisfaction should not be demoralizing in any way to AT&T.

This project was very successful in saving Corning Cable Systems in excess of $300,000 a year and had an overall NPV of $1,200,000 over 5 years. This project was also successful in that it was completed in an 8 week period, which was in record time considering all of the modification to the coiling head, documentation updates and changes, and the extensive training that took place. This project was also recognized for the "Operations Excellence Award,"one of the most prestigious awards given to employees by Corning Cable Systems.

Continental Teves Inc.

Continental Automotive's ES-Test Lab used large amounts of HD-50 (Dot 3) brake fluid to bleed and test brake calipers one time and then the fluid was disposed of as non- hazardous waste. The request from Continental was to reduce cost on testing fluids and lessen the environmental impact of waste oils. The objective was to develop and design a system to mechanically recycle and reuse the brake fluid at least one extra time, then label and segregate from new fluid containers and finally track while being used through the recycled process.

The outcome of this project was demonstrated to the staff at Continental Automotive through a Cost Improvement Activity (CIA). The new system was set-up and displayed, and the used fluid was recycled back through the filtration device as an example to management. The positive results of this cost savings project and minimal waste oils disposed on the environment played a major role in its implementation at Continental.

The results demonstrated the reduction of new brake fluid was about half when compared to previous monthly usage. The brake fluid usage in 2007 was 12 fifty-five gallon barrels. This new system used only 6 new drums of fluid and 6 recycled drums over a one-year span. The annual savings to Continental was estimated to be over $7,000.

The Timken Company

Bearings utilized in critical Aerospace applications are individually serialized for traceability in the event of an in field failure or to support a recall due to suspect product in the field. Over a 12 month period, the Timken Shiloh plant experienced 8 customer returns due to improperly identified product. In addition to damaged customer relationships and an increased risk of liability, several hundred man hours were spent re-inspecting, reworking and documenting the returned product. The accepted identification process involved several steps and touched many hands, resulting in the aforementioned problems. The student analyzed the problem and presented a plan to improve the process. By eradicating this issue:

- Fewer customer returns occurred due to the mislabeling of product and over a hundred reactive man hours was saved
- The Shiloh plant regained its customer satisfaction and customer relationships which are important to the Timken business and the employment of Rutherford County
- The packing operator can do her job more effectively and in less time because the system is now robust

Total benefits are expected to exceed $50,000 annually while improving customer relationships and protecting over $20,000,000 of business.

EDUCATIONAL MERIT AND CONCLUSIONS

The educational merits of this approach reach well beyond the traditional bounds of the university and have a significance in demonstrating the transfer of knowledge from theory to application.. This is evidenced through students' abilities to clearly define goals and problems within an organization, implement Lean Manufacturing principles, manage projects efficiently, and perform engineering economic analysis showing cost saving potential. Secondly, the students demonstrated problem solving and analysis skills more thoroughly through projects with local and regional companies.. This was demonstrated by their capabilities of developing and using computer tools to analyze specific problems, as well as determining appropriate methods for system analysis and quality improvement. Finally, the ability to transfer knowledge from courses to successfully solve problems in different applied engineering areas was effectively demonstrated and recognized by regional corporations for which the projects were performed.

Educational merit was also shown by the uniqueness of this approach. It is worth noting that these skills are not always explicitly taught in engineering curricula where the focus has been on content and analytical skills of specific engineering disciplines. Industry and the Accreditation Board for Engineering and Technology (ABET) nonetheless does expect engineering graduates to have well developed computer skills[14]. The approach implemented in the ET program at Western Carolina University provides a logical and systematic method for building on theory and effectively implementing project based learning methods. Through immediate feedback, students can gain a better understanding of problem definitions, problem solving, and analysis techniques. Further, as evidenced by student projects, the ability to apply theory and knowledge gained from lectures was demonstrated in a more positive manner when compared to traditional methods that rely on only theoretical scenarios.. In summary, the approach of integrating learning through industrial projects was demonstrated to be a win-win outcome for students, local and regional companies, and the university**.**

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