

2006-2465: ENGAGEMENT IN INDUSTRY: PREPARING UNDERGRADUATE ENGINEERING TECHNOLOGY STUDENTS FOR GRADUATE STUDY

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Engagement in Industry: Preparing Undergraduate Engineering Technology Students for Graduate Study

Abstract

As national and global economies continue to evolve, it becomes paramount that regional industries strive to remain competitive. The heavy loss of jobs in western North Carolina, particularly in manufacturing has led Western Carolina University to develop the Center for Integrated Technologies, which provides the avenue for regional industry to access university resources—personnel and facilities. *Engagement* is the title typically used to describe this relationship between industry and academia. The engagement process at Western Carolina has been successful in coupling graduate students with industry projects, and now it is being used to provide undergraduate students with that same exposure. One of the benefits of this undergraduate involvement is that there is now a conduit in place to generate additional interest in the graduate program, as well as a means for student and faculty to interact in an industrial project setting. The next step in this progression is to couple graduate students with undergraduate students, as they embark on challenging projects that will benefit regional industry.

Background

Situated in Cullowhee, NC Western Carolina University (WCU) is a comprehensive state university set in the mountains of western North Carolina. With an enrollment of approximately 8,700 graduate and undergraduate students, WCU has transitioned into an institution that serves not only its student body, but also the industry in the region. Western North Carolina has seen a dramatic decrease in manufacturing, textile, and wood products business over the past decade. The Society of Manufacturing Engineers reports that manufacturing jobs in the United States decreased by more than three million over the period from 1998-2004¹—the rural regions of western North Carolina experienced declines of similar proportions during that period. Comparable to the national average, the unemployment rate in North Carolina was 5.52% in November 2005.²

In February 2003 a regional summit was held at WCU to address the loss of jobs in western North Carolina. These leaders from industry, academia, and government concluded that it was crucial to link industry and academia through engagement by establishing a regional high tech center.³ WCU Chancellor John Bardo acted promptly with the creation of the Center for Integrated Technology (CIT).⁴ As noted by Ferguson, et al⁵ the center was equipped with a vast array of high-tech facilities to assist faculty, staff, students, and industry in this engagement effort, including:

Automated Rapid Prototyping:

- Stratasys FDM Titan[®]
- Stratasys Eden 333[®]
- ZCorp Z400[®]

Metrology and Reverse Engineering:

- Zeiss Contura HTG[®] Coordinate Measuring Machine (CMM)
- OGP SmartScope Flash 200[®] Video Measuring System
- ADE Phase Shift MicroXAM[®] surface mapping microscope

Machining Centers:

- HAAS[®] 2D Laser Cutting Center
- Four HAAS[®] Milling Machines
- Three HAAS[®] Lathes

Engineering Workstations:

- 50 Dell[®] Model WHL (Xeon processor)
- 21” LCD Monitors
- PRO/ENGINEER Wildfire[®]
- and other related engineering software

Integrated control systems laboratory with related equipment and software

Polymer and materials laboratory with related equipment and software

The engagement model at WCU varies significantly for the wide range in academic units across the campus. Engagement, from the perspective of the faculty member, is the interaction with industry to accomplish a task, whether it means solving a problem, developing a product, analyzing a process, etc. This access to university resources—faculty, students, facilities—has been welcomed with open arms by regional industry. University administration has put a heavy emphasis on the importance of engagement, such that each academic unit has incorporated it into its tenure and promotion process along with teaching, scholarship, and service.

With approximately 630 students, the Kimmel School of Construction Management, Engineering and Technology plays a key role in this engagement effort. Initially, engagement had taken the form of industry working with faculty and graduate students in the Masters of Science in Technology (MST) program. But over the past several semesters this effort has expanded into the undergraduate student population. The beauty of the engagement process is that its benefits are multi-faceted:

- the business benefits from the assistance working through its issue at hand, often using facilities not typically at its disposal;
- the business has an opportunity to expose itself to students and faculty at the university;
- the business has a chance to work in a low-risk situation with students—potential interns, coops, and full-time employees;
- students get hands-on experience in industry, allowing them to compare and contrast with their classroom experiences;
- students have an opportunity to evaluate a potential employer and that particular industry; and
- faculty maintain their industry exposure—collecting relevant data to introduce in the classroom.

Engagement of Graduate Students

With a skill set that includes much hands-on experience, the MST students in the Kimmel School are excellent at this engagement effort. They have proven technically capable of tackling challenging problems, and are self-motivated problem solvers. The list of projects accomplished in recent years has been impressive, as detailed by Ferguson, et al.⁵ Some of these include:

Oak Ridge National Laboratory: In a partnership with Oak Ridge National Laboratory (ORNL), Asheville-Buncombe Technical Community College (ABTCC), and American Carolina Stamping (ACS), WCU was awarded a contract through the Department of Energy to develop a marketable hybrid water heating and dehumidifying unit. With \$945,000 in DOE funding, the team has developed a prototype that will retail in the \$600-800. Estimated annual energy savings for a typical family of four in the southeast United States are on the order of \$200. The grant has supplied tuition and a graduate assistantship to the lead graduate student on this engagement project. A Pro-E CAD model of the unit is shown in Figure 1.

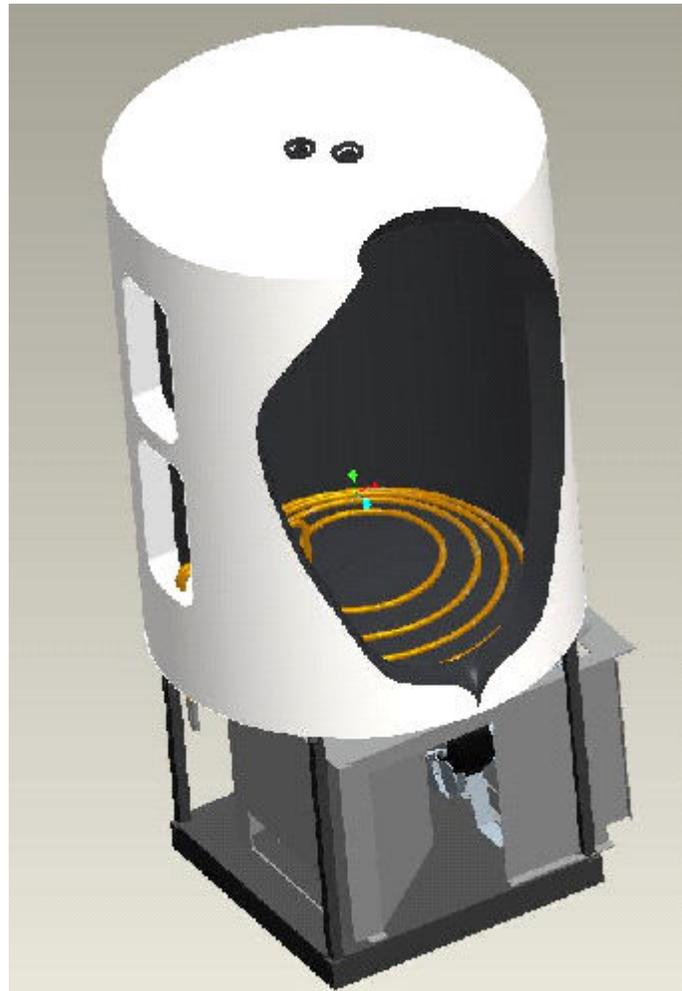


Figure 1: Hybrid Water Heater and Dehumidifier

Caterpillar: In the Spring 2003 semester, a MST graduate student worked with Caterpillar of Franklin, NC to design and implement a fixture to assist in the manufacture of their industrial seals. Specifically, the fixture eliminated the problem that Caterpillar had with multiple parts being fed into an induction heat treatment workstation.

Team Industries (formerly known as Bombardier Recreational Products): Team Industries in Andrews, NC manufactures connecting rods for Evinrude outboard engines. Their assembly plant in Wisconsin was repeatedly returning connecting rods for assembly misalignment issues, contending that a step on the exterior of two mating components implied a step existed on the more critical inner surface of those mating components. The Andrews plant argued that there was no correlation between the steps on the inner and outer surfaces. Two MST graduate students at WCU used the Zeiss Contura CMM and the design-of-experiments methodology to verify that the Andrews plant was indeed generating quality parts for the assembly plant.

Watauga Opportunities Inc.: This Boone, NC company provides employment opportunities for disadvantaged workers. Through the engagement process, Watauga Opportunities was able to work with WCU faculty, staff, and graduate students to develop a cost-effective mold for the blow-molding of plastic trays that hold Christmas tree ornaments, as shown in Figure 2. This project resulted in work being brought back to the U.S. from China, which tends to be the opposite of current trends; Watauga Opportunities expected to hire eight to 12 new employees as a result of this successful engagement project.⁶



Figure 2: Ornament Trays: CAD model, mold, finished product

There is a wide array of additional engagement projects involving MST graduate students, some of which are:

Borg-Warner Turbo Systems: Fall 2004, development of a turbo charger sensor to detect oil leaks.

U.S. GreenTech Inc.: Fall 2004, development of a patented 3D constraint-based solid model and rapid prototype of an Astroturf structural membrane. CAD and rapid prototyping models are shown in Figure 3.

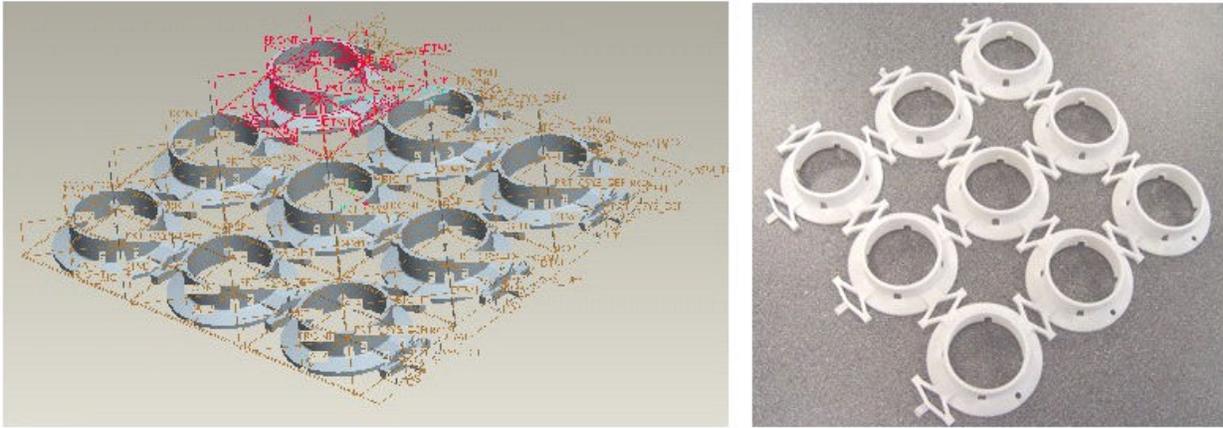


Figure 3: Astroturf structural membranes: CAD model, rapid prototype

Volvo Construction Equipment: Creation of airflow enclosure prototype for heavy trucks for the plant in Asheville, NC.

The success of these projects, coupled with the feedback from graduate students and industrial partners, provide proof that the engagement model is positively impacting industry, students, and the university. As Snellenberger, et al⁷ have noted, the importance of this relationship is critical to those involved, especially in a region that has seen such a decline in number of industrial jobs. The next front to approach with this engagement effort at WCU was to involve the undergraduate student population.

Engagement of Undergraduate Students

Industry response to WCU's engagement effort has been excellent. This introduces a problem, in that there are typically too many projects to accomplish through the efforts of the current faculty, staff, and MST graduate students. Realizing the benefit to graduate students, the faculty have begun to extend the same approach into their undergraduate classes, which can be a typical course that is project based or an independent study project. Some recent efforts to involve undergraduate students in engagement projects include:

Liberty Wood Products: This Franklin, NC based company produces wood products including custom countertops and cabinetry. They have developed a high-volume production line that produces the sides that are later assembled to make wooden picture frames. Drake Enterprises, the parent company to Liberty Wood Products, approached WCU to evaluate whether the picture frame line was a profitable venture or not. Without solid data capture in place, they were not able to evaluate the level of success of their line. Using the platform of an independent study project, a senior Engineering Technology major spent one day per week at the plant, applying lean manufacturing principles to evaluate the picture frame line during the Fall 2005 semester. His conclusion was that the company was operating that production line at a loss—over \$400,000 per year. Liberty Wood Products had not realized this loss, due to a lack of adequate measures, and the fact that success in other product lines overshadowed this deficit. His analysis provided several recommendations for improvement, as well as a numerical model to point at several opportunities for cost reductions that would not affect customer price.

Foothills Industries: Also in the Fall 2005 semester, the Project Management course at WCU tackled a facility relocation project. Foothills Industries, a nonprofit corporation that employs and serves people with disabilities, was faced with relocating its 28,000-square-foot facility from one location in Marion, NC to a larger 45,000-square-foot facility in the industrial park in a different part of town. Foothills Industries manufactures and packages surgical drapes that are used in the medical industry. The 25-student class, composed of four graduate and 21 undergraduate students, was split into multiple teams, each of which tackled a different aspect of the logistical challenges of the move with graduate students assuming team leader roles. The class spent the semester planning the move of 15 pieces of large manufacturing equipment in two arduous days. Although the move was very demanding, and quite out of the ordinary for students, it was an outstanding exposure point for students to see the challenges faced in industry.^{8,9}

Consolidated Metco: ConMet is a company that uses injection molding to make parts for the large truck industry; they have several plants in the western North Carolina region. In the Fall 2005 semester ConMet's Canton, NC facility requested the assistance of an undergraduate student to aid in the redesign of an injection molding workcell. In this independent study project, the Engineering Technology senior used lean manufacturing principles to analyze the existing layout and implement several changes to eliminate clutter, as well as improve product flow.

Marketing Association for Rehabilitation Centers: MARC is a consortium of companies based in the western North Carolina region, supplying employment to people with disabilities. A partnership between MARC and WCU has already yielded several successful projects, such as the Watauga Industries Christmas tree ornament packaging and Foothills Industries relocation. Additional projects are being pursued through a senior projects course format in the Spring 2006 semester. The array of projects is being managed by a graduate student—the same student who performed the analysis on the Liberty Wood Products picture frame line as an undergraduate.

The engagement process at the undergraduate level has assisted in this transition from undergraduate to graduate student. With engagement being a critical component of the MST graduate student's curriculum, an undergraduate student has the opportunity to test the waters. Additionally, the faculty members have a chance to evaluate the quality of the student's work and level of self-motivation. Most of the MST graduate students at WCU have entered the program from the undergraduate ranks at WCU. If this trend continues, as it is expected to, the undergraduate engagement can continue to be used as a conduit to create opportunities for a mutual evaluation between faculty, student, and industry.

Conclusion

The engagement process at Western Carolina University has been a successful avenue for connecting regional industry with university resources—students, faculty, staff, and facilities. The projects that have been completed with the assistance of the MST graduate students have been highly successful with benefits to all those involved. Those projects that have involved the undergraduate population have also been beneficial, but in some cases have shown only marginal success. The dynamic here arises for several different reasons. First, most undergraduate students have a much wider range of classes than the typical graduate student; their effort

typically cannot be as focused as that of a graduate student, whose primary focus is that project. Second, some of the students who tackle these engagement projects have not developed the skill set to the level that most graduate students have. And finally, the graduate students have typically had more experience than the average undergraduate—in the classroom, laboratory, and the shop.

The next progression in the engagement model is to institutionalize the relationship between graduate and undergraduate students on these projects. Although a formal process has not been introduced, there are already efforts in place to accomplish this task, such as the case with the MARC projects. The Kimmel School is actively pursuing additional graduate assistantships that are targeted at specific engagement efforts. In those courses that are offered jointly as senior/graduate level, the graduate students will continue to take the leadership roles with higher expectations placed upon them. The graduate student involvement will provide several benefits to the engagement projects. For those longer term projects that span more than one semester, a graduate student can provide continuity on a project that involves different undergraduates. And the graduate student oversight can help to ensure a higher likelihood of success and a higher level of achievement. Additionally, as most graduate students have more recently completed their undergraduate degrees than the faculty members in the school, the graduate student can usually relate to the undergraduate better than a faculty member; this is the same phenomenon that makes peer tutoring more successful than faculty office hours in many cases.

The engagement efforts at Western Carolina University have been very successful in recent years. But there is much more that can be done. The enthusiasm of the students, both graduate and undergraduate, is a valuable resource that the faculty will continue to utilize. The coupling of graduates and undergraduates will provide a means of improving the projects, as well as an avenue for undergraduates to proceed to the graduate program.

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