

AC 2007-1511: STUDENT ENGAGEMENT AND FACULTY SCHOLARSHIP

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Student Engagement and Faculty Scholarship

Introduction

The undergraduate engineering programs established in 2001 at Western Kentucky University were structured with the goal of engaging students in the practice of engineering. To accomplish this it was necessary to attract faculty eager to practice engineering and to engage students in their scholarship activities. Promotion and tenure guidelines were established with a broadened definition of scholarship to foster such an environment. The definition included both traditional scholarship and engineering practice, with student participation being viewed as a very important component. An overarching goal is to have the students aware that the faculty is involved in the practice of engineering, and that the faculty shares this practice with the students. This includes both curricular and extra-curricular engineering projects. Thus, the creation of a project-based environment built around the practice of engineering has resulted.

Engaging students both in and out of the classroom is a means for fostering intellectual growth and contentment in students. In the undergraduate engineering programs this often means student engagement in activities that connect the concepts from lectures or textbooks to tangible engineering projects. In some academic environments the students in engineering programs may not acquire meaningful project experience in the areas of faculty expertise. This can be due, in part, to the expectations institutions place upon their faculty.

The professional growth and creative scholarly contributions of faculty is supported through the faculty reward system. Decisions regarding faculty merit pay, promotion, and tenure are based upon factors which include scholarly productivity. A compliant reward system will allow faculty to show their strengths, but should also (if not more importantly) allow for a breadth of acceptable activities particularly when student development is a direct result. Bringing together undergraduate student engagement in engineering projects and faculty scholarship is a challenge in many university environments. A reward system recognizing such activity as viable faculty scholarship can create an environment that supports faculty providing students with meaningful engineering projects.

Many engineering programs contain an environment where graduate student education through funded research efforts is a substantial component within the faculty reward system. These expectations often result in graduate students becoming the primary recipients of faculty engagement. Moreover, the reward system is often not supportive of faculty making contributions in ways that do not lead to publications in academic journals. This may discourage faculty participation in projects with industry where projects can involve generation of proprietary information. It can also inhibit faculty from spending scholarship time on projects within the university that do not lead to publishable information. Those activities can include significant practice of engineering.

It is important that the academic community continue to reflect upon the long term growth and competitiveness of engineering education. A focus on the academic institutes' most important product - the graduating student – should be a main factor in decisions aimed at improving the

educational experience. This should include the consideration that student satisfaction with their education when departing the campus, and when participating in engineering practice, can be facilitated via engagement in the scholarship of engineering with their faculty.

Background

The literature covering education of engineers is filled with information concerning change. This change takes many forms such as K-12 outreach, student recruitment/retention, undergraduates in research, and expectations of faculty performance. Change is prompted by many factors that include individual, industry, and national/global trends. Of particular relevance to this paper are trends in expectations of faculty, and in student engagement. This will be reviewed with the intent of highlighting some of the most recent work addressing this important area.

It is interesting to consider the perceptions of those just entering, or considering entering, the academic profession. They clearly understand that the global categories of Teaching, Research and Service must be attended to. What is less clear is the definition of success in teaching and in research. As an example, Jason Keith describes how entering into the position of engineering professor is in some ways similar to starting up a company.¹ This perception is based, in part, upon the premise that excellence and achievement is expected in all categories. Moreover, there is reported an increasing emphasis on more research for scholarship, even at many of the smaller, regional institutions.

There is a conventional knowledge within the engineering education community regarding the expectations of faculty at different institutions or in different faculty positions. As it relates to individual professional preferences, this has been categorized by Andrew Rose² as:

“Tenure-Track Position in Engineering at a Research University
Tenure-Track Position in Engineering at a Teaching University
Tenure-Track Position in Engineering Technology (ET)
Lecturer/Instructor Positions
Adjunct Positions
Visiting Professor”

The concept is that there are multiple options for a person wishing to enter the faculty ranks in academia. These can be separated based upon the amount and/or type of scholarship expected from the individual in the position. Scholarship expectations range from high for those on the tenure track at a “Research University” to very small for those in a Lecturer/Instructor position.

The changing expectations placed upon faculty in engineering technology programs is interesting to note. The conventional knowledge used to be that research scholarship is not a high priority for that faculty. Instead, a greater amount of faculty-student interaction was common as was a higher teaching load. As institutions reset their objectives, this paradigm is being altered.^{3,4,5} As example, Schneiderman reports that expectations of ET faculty seem to be becoming more directed towards traditional research-type scholarship.³ This is at odds with previous expectations where often these faculty would tend towards pedagogical scholarship and high student engagement.

Other trends in the engineering pedagogical scholarship community have been reported. The fact that more faculties are involved in the pedagogy of engineering education is manifest in the increased level of activity in ASEE and in the creation of centers focused on such activities.⁶ As previously suggested, it is somewhat typical for faculty in regional, undergraduate only institutes and for those in engineering technology programs to be involved in the scholarship of teaching. Some⁷ have considered the political ramifications of increased scholarship expectations while others⁸ have given thought to models for sustaining such research.

As the engineering education community strives to meet national goals of increased number of engineering graduates, the capability for the faculty to increase the numbers of students brought through their programs with involvement in projects or research is strained. To compound this, when faculty reward measures are based largely on scholarship, there could result a situation where the needs of students in the engineering program is partially left behind. This is often discussed as the situation that exists in the large, research-driven engineering programs having large graduate programs.

For several years there has been increased attention given to the role of undergraduate students in university research. Jemison, et. al. have described the programs at Lafayette college as contributing to the students ability to think critically, develop life-long learning skills, and be prepared for graduate education.⁹ Other institutes have also reported undergraduate research as a focus worthy of establishing a center.¹⁰ In fact, many institutes look favorably when undergraduates are given the opportunity to conduct research. Encouragement of faculty to engage undergraduates in this manner could be viewed as a means to increase scholarly productivity. It becomes sustainable when the institute provides an environment that rewards faculty for engaging students in their scholarship.

Encouraging faculty interaction with industry is one means to bring the “real” world into the academic environment. Many in industry recognize the benefits of such interaction and there are a growing number of partnerships being made. When such interaction is done in the context of undergraduate education a variety of opportunities can exist. These include industry sponsored projects such as the design and development of multi-disciplinary projects and increased opportunities for students to learn in the lab and in the field.¹¹ The creation of academic and industry collaboration on engineering projects brings some unique challenges.¹² From the academic perspective this may include a lack of recognition that this type of interaction is a valid form of faculty scholarship.

Scholarship Examples

When there is the objective of developing students as practitioners of engineering a broadened model for faculty scholarship may be needed at some institutions. To support such an objective, faculty scholarship activities can span a broad range if the common theme is student engagement. Undergraduate student participation in faculty scholarship activities can result in significant contributions and advancement of both fundamental knowledge and product development. Several student-centered projects are presented that have resulted in both

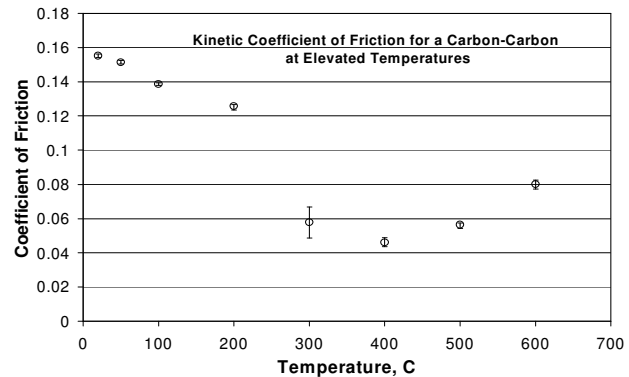
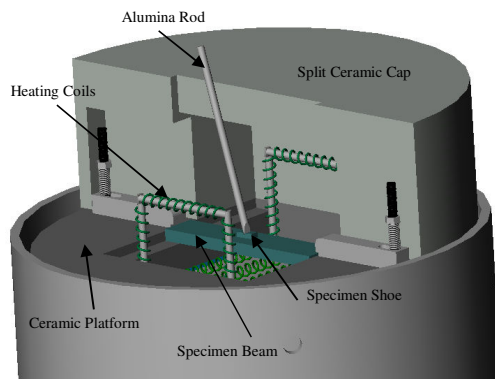


Figure 1. Undergraduate student Chris Baldwin designed, built, and utilized a furnace modification for a tribometer to study the influence of temperature on friction coefficient.

traditional and seemingly non-traditional academic outcomes. This is made possible in part by a reward system that recognizes a broadened set of faculty scholarship activities – from industry interaction to traditional research and product development. These can be identified as the scholarship of engineering practice.

Undergraduate engineering students are very likely to seek employment while in school. When faculty conducting research designate funds for student employment, a mutually beneficial relationship can be developed. Forming a project that a student can take ownership of can lead to productive and rewarding engagement. The example shown in Fig. 1 demonstrates the efforts of a student employed part-time in a lab focused on studying friction behavior of carbon composite materials.

The apparatus was conceived and designed as a result of multiple brainstorming sessions between the student and the faculty member. Experience regarding viable designs was gradually shared with the student as the project evolved. While this required significant faculty time, the engagement was rewarding. A staff machinist assisted the student with some of the construction and that resulted in a broadened learning experience.

The above efforts lead to the generation of new knowledge and created publishable results. This is an example of a faculty member engaging an undergraduate student in traditional research, where some funds were reserved for employing the student. The student assessment of this activity indicated that learning of engineering skills was greater than had occurred in any one class undertaken. It was also identified as very satisfying due to the tangible results created that made use of the broad skill set developed as an engineering student.

Opportunities for undergraduate research are often made available through budgets set aside by some colleges and by external funds such as REU grants. When full-time effort is given by the undergraduate student, results similar to that which graduate students generate can result. An example of a student engaged full-time during the summer months in research is partially demonstrated in Fig. 2. The student was tasked with designing, building, and utilizing a system for simulating aircraft landing gear. Multiple design sessions between the student and the

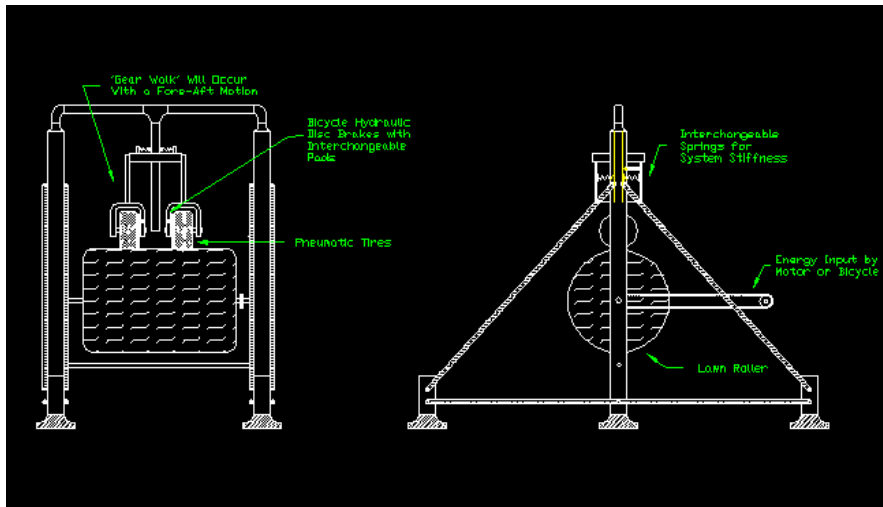


Figure 2. Undergraduate student Matt Bober designed, built, and utilized a subscale aircraft landing gear test system for evaluating brake performance and gear walk.

faculty member resulted in a virtual design as indicated. The student then built the device, learning with the aid of a staff machinist, and put together a data collection system learning the use of Labview in the process. Utilization of the device followed with data collected that showed how the landing gear can “walk” during braking. Not only did the device function as a research tool, but it also attracted considerable attention from braking industry representatives. The student presented the project to an industry board, and was eventually offered employment. The student was later interviewed to assess the perceived value of the project as an undergraduate experience. The opportunity to put engineering design skills to work and to bring a project from concept to completion was communicated to be of very high value.

The previous projects demonstrate student engagement in scholarship in a traditional manner. Projects were completely contained and guided within the academic environment. Results were shared with a broader community. This form of engagement appears often in the academic setting. The faculty involved is rewarded indirectly through the creation of publishable information. When publications are not likely faculty may shy away from such engagement since the environment they work within does not recognize the effort as scholarship, despite the significant practice of engineering and mentoring that can take place.

When activities include direct interaction with industry engineers on their projects a great deal of insight is gained by the students involved. An example of a multi-disciplinary effort with a regional industry is provided in Fig. 3. The faculty member was contacted by a brake drum manufacturer seeking assistance in developing a better understanding of product performance. Several tasks were identified and distributed to different students for completion in either a lab course (solid mechanics lab) or as extra-curricular projects. Their efforts, directly guided and mentored by faculty, were gathered for presentation to the industry engineers. The students had opportunities to present their efforts, and gain insight into the needs of practicing engineers. Having a project that allowed them to practice the concepts they learned in the classroom while seeing the true application of the activity was identified by the students as invaluable. The effort was overseen by the faculty member, and the scholarly artifact generated was a presentation (proprietary). This form of student engagement in faculty scholarship can significantly

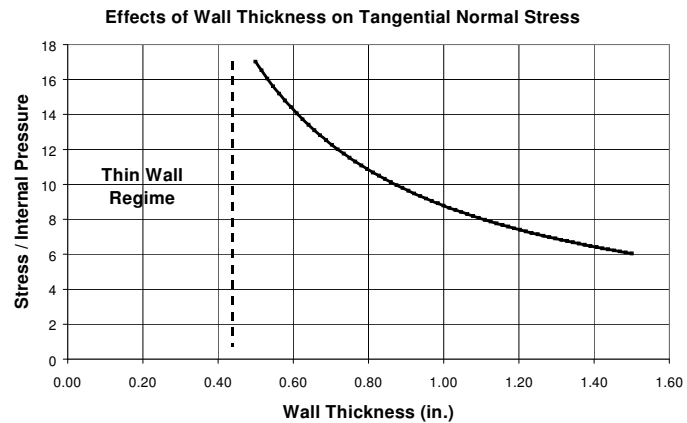


Figure 3. Evaluation of brake drum performance. Students Chris Aud, Evan McCasland – shell properties: Jason Arterburn and Matt Gribbins –stress distribution, Ashok Anumula – fracture characterization.

contribute to student development, yet can be difficult for faculty to support in many academic settings.

For many colleges multiple industries lie within their geographic region that can benefit from having relatively small projects or services conducted on campus. This type of activity is exciting for students to be involved in, and they are often eager to participate without reimbursement for extra-curricular contributions. An example of such a project is demonstrated by Fig. 4 where a regional manufacturer of aluminum die-cast products was in need of some material property testing. A relatively simple project in appearance often contains certain complexities that allow the student to better understand the realities of engineering practice. Concepts such as testing according to standards, and related procedures, become immediately apparent to the student. Since the student understands that the information being generated is to be used in the “real world” there is a certain sense of importance to the work being performed. This goes far beyond what the classroom experience alone can provide.

As it turns out, this type of student engagement takes considerable faculty time since they are the ones ensuring the quality of the product. The project shown in Fig. 4 had a short report as a deliverable to the industry sponsor. This scholarship of the practice of engineering may not be valued by the academic community, despite the benefits gained by all who are directly involved. It is simply a non-traditional form of scholarship that has significant value in the engineering education environment, and can be recognized in the faculty reward system.



Figure 4. Student Rusty Welborn, tested the mechanical properties of die-cast aluminum.

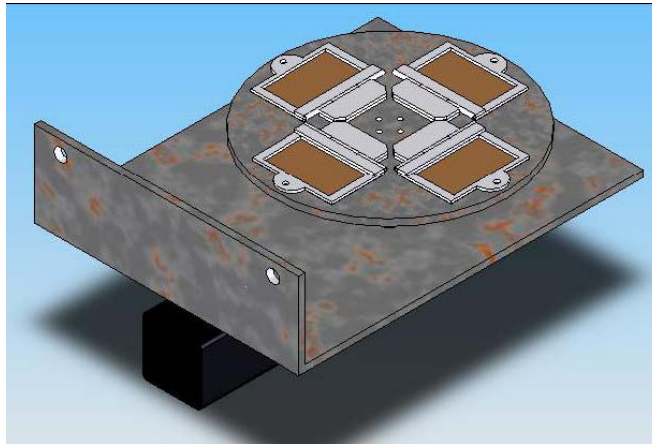


Figure 5. Students David Brown, David Kleinholter and Jimmy Sandusky provide a regional aluminum sheet manufacturer with a design as their senior capstone design experience.

Team projects serving as a capstone design experience, where students interact directly with industry, are typically accepted as significantly contributing to student development as engineers. When the project is formed to create a device for the industry partner, and engineers from that industry are directly involved in mentoring the team, the learning experience mimics that which is often found in engineering practice. In that case there is team interaction to solve a problem and produce an artifact with oversight provided by the sponsoring agent. Such is the example provided in Fig. 5 where a team developed a device to be used in the process line at a regional aluminum sheet product manufacturer. This also involves a considerable amount of effort by the faculty member involved. However, in this case the deliverable being generated is typically not something that allows for faculty scholarship. This is scholarship of the students in the practice of engineering. A faculty member may take such a mentoring role and often receive little other than a small teaching load for such student engagement.

One area where faculty may be encouraged to participate, yet little traditional scholarship may result, is in the development of new technologies and the formation of spin-off businesses. How this fits into the traditional role of faculty scholarship is often ill defined. These activities may generate proprietary information not available for peer evaluation. At the same time, such endeavors are extremely time consuming and faculty may devote much of their scholarship time in developing such technologies. There needs to be a means to provide rewards for faculty who pursue such activities, particularly when student engagement occurs.

One approach used that ensures significant student engagement is to have multiple projects conducted by various students that, when combined, form a meaningful contribution to the development underway. In a project to develop a new composite material a student was tasked with designing, building and utilizing an infiltration system as shown in Fig. 6. This occurred while the student was a paid undergraduate research assistant on an externally funded project. Multiple design review sessions between the faculty member and student resulted in a viable design that the student constructed with partial assistance from a regional metal-working company. The information ultimately gained from the experiments conducted with the system has not been published due to the proprietary nature of the work. Reports to the funding agency



Figure 6. Undergraduate student Brandon Bibelhauser designed, built, and utilized a system for pressure infiltration of a new composite material.

have been the primary tangible faculty scholarship from that project. The project provided the student with an opportunity to engage in the practice of engineering, and become familiar with the pressure vessel industry.

In the same composite material development program a pair of students undertook a project to design, construct, and utilize a device for scratch testing of the new composite material. The device, shown in Fig. 7, was the result of several student-faculty meetings where various test approaches, research needs, and specifications were covered. Once the device was built, the students used it to measure the scratch resistance of the new material and many existing materials. The development of the device, and process for making it happen, were viewed by the students as being their most meaningful experience at that point in their college experience. The students went on to characterize and document multiple material properties, process attributes and market conditions for the new material. This engagement of students in the practice of engineering by the faculty member is consistent with some models for faculty rewards. However, it did not produce large amounts of traditional scholarship such as peer-reviewed publications. It did involve the practice of engineering by the students.

Summary

Engaging undergraduate students in the practice of engineering requires a significant commitment by the faculty. Facilitation of this it is possible through a faculty reward system that encourages a connection between faculty scholarship and student activities. At Western Kentucky University new promotion and tenure guidelines were established to create a projects-based environment focused on the scholarship of engineering practice. The guidelines for faculty scholarship include a broader set of activities than existed before. Traditional research is good if undergraduate students were involved (there are no graduate programs in place), but it was not the main focus. Of paramount importance is the engagement of students in the practice

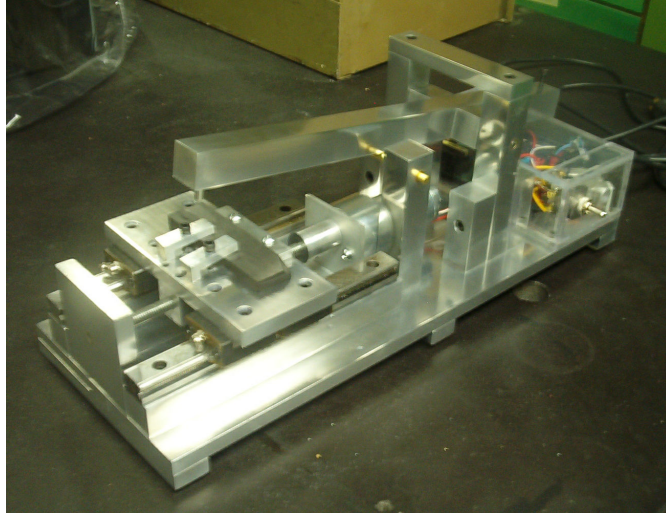


Figure 7. Undergraduate students Matt Seibert and Ryan Farris designed, built and utilized a device used for determining the scratch resistance of a new composite being developed.

of engineering. Just what that practice would be largely depends on the individual, but does include activities that traditionally were not counted as scholarship. Contributions to industry, development of new products and technologies, development of new knowledge are all considered practice. The overarching goal is to have the students aware that the faculty are involved in the practice of engineering, and that the faculty share this practice with their students. This includes both curricular and extra-curricular projects.

The need to have faculty scholarship defined for the benefit of the engineering student is certainly not novel. Recently there has been a task force looking at how a faculty reward system could be constructed to aid the development of students in the realm of engineering practice.^{13,14} While much of their discussion is focused on the engineering graduate student, the ideas hold for undergraduate education as well. Of particular relevance here are the statements:

“Whereas existing faculty reward systems are adequately designed for research-oriented faculty ... they are insufficient for professionally oriented faculty who teach and practice in the professional realm of creative engineering practice for technology development and innovation. ... Thus, a broader definition of scholarship for engineering practice is required. The Task Force believes that professional scholarship should be defined as original creative work based upon intensive background investigation, study, or practice which results in a meaningful creative work or tangible outcomes. For engineering, this involves the creation of new “ideas” or “concepts” that result in the solution of meaningful hopes, wants, and needs of people or industry in the form of new / improved / breakthrough products, processes, systems, or operations. This is the essence of engineering practice itself.”¹⁴

Such a broadened definition of scholarship has been implemented in the engineering programs at WKU. The environment created is one that requires faculty to focus their efforts on the engineering student, and ensures that they are exposed to the practice of engineering. This is the nature of engaging engineering students in faculty scholarship at WKU, and is one intended to mimic the educational structure in professions such as medicine and law.

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