Synergy of Applied Research and Education in Engineering Technology

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Abstract

Engineering technology programs at Texas A&M University are housed within a College of Engineering that enjoys ever-increasing success in research productivity. Faculty across the country who serve in engineering technology programs are often attracted to those programs primarily because of their desire to devote most of their time working with students in the classroom and laboratory, while minimizing the time devoted to research. An important question that must be continuously addressed is: how do engineering technology faculty, who live in an environment of research expectation, combine their classroom and laboratory teaching interests with research interests? This paper will discuss a process for bringing together what many faculty feel is a dichotomy between teaching and research. How engineering technology faculty might develop a rewarding career in both teaching and research will be outlined.

I. Introduction

Many engineering technology faculty in the United States are employed at universities where research is an integral part of the university's mission. Faculty performance at those schools is measured in various combinations within the triad of teaching, research and service. In engineering technology the word research is often replaced with the words applied research to distinguish between engineering and engineering technology types of research. Typically, applied research is done in response to an industry need and involves the application and synergy of existing knowledge and technology. In contrast, engineering research generally tends to focus on the creation of new knowledge.

The purpose of this paper is to describe some successful processes through which engineering technology faculty at Texas A&M University are combining their teaching and research activities. That process has led to the outline of a model that might be applied in other programs. It should be pointed out that at present there are no graduate engineering technology programs at Texas A&M. In this discussion, "teaching" activity includes: classroom and laboratory instruction, curriculum and laboratory development (to include the acquisition of new resources), the scholarship of teaching, and the dissemination of results through publications and presentations. "Research" activity includes: acquisition of resources to support the work, the creation of new knowledge, the synergy and application of existing knowledge, working with teams of students, and the scholarship of research through publications and presentations[1].

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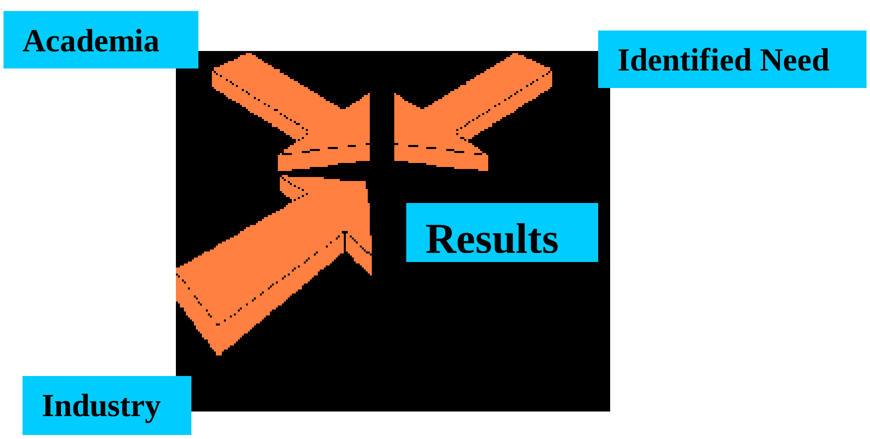
II. Desired qualifications and attributes of engineering technology faculty

The necessary ingredient for success in engineering technology teaching and research is a faculty willing and able to lead change. Programs must possess a critical mass of faculty who can "make things happen."

Attributes of successful engineering technology faculty are separated into several categories, including leadership/management, technical curiosity as well as communication prowess. A faculty with good management and leadership skills is usually a servant leader[2] while remaining a team player and can be best described as a "champion with a cause" that is able to develop a plan and execute it in "industry time". Technical and professional curiosity are expressed through a strong desire for change with an entrepreneurial spirit and a willingness to be a “trail blazer” by challenging the status-quo and looking for new opportunities for themselves as well as their colleagues. Communication prowess is demonstrated through effective dissemination of activity through participation in local and national professional meetings (scholarship) and excellent communication skills with the ability to market new ideas and concepts within the university and industry. Finally, the overall goal of this faculty member is the ability and desire to assist in the professional development of colleagues (be a mentor and to procreate the necessary ingredients for success), while staying on the cutting edge of industry needs through various professional development activities, such as summer internships in industry, continuing education and research projects sponsored by industry.

III. A Model That Produces Results:

Identified need + Academia + Industry = Results



Where results for academia include: faculty "in tune" with industry needs through on-site fellowships, graduates prepared to meet industry's needs, resources for new or upgraded labs and curriculum enhancement, funded applied research projects which results in increased faculty interest, motivation and enthusiasm about their academic career. "Winning" faculty actively identifying and pursuing related opportunities leading to increased faculty scholarship activity.

Results for industry include: graduates prepared to be productive immediately upon employment, increased access to students and faculty, timely and useful research deliverables on projects which involve industry personnel (leading to energized industry partners). Another major result for industry is the ability to guide and impact educational development activity as well as applied research directions. Finally, industry gains an increased understanding of academic operations and an awareness of academia's needs.

Faculty and industry representatives must work well together to optimize the results of the partnership. Some desirable attributes of engineering faculty were outlined above. In a similar way, some attributes are needed in industry personnel to increase the likelihood of having a successful partnership. An industry champion must have a fundamental understanding of academia and recognize the mutual benefits of a partnership with academia. He must be recognized as an expert in the technology being implemented. Furthermore, he must be willing to be an active participant in the process that will result in a synergy of education and research. It is beneficial if he has resources at his disposal to invest in the curriculum changes being implemented, or at a minimum, a significant ability to influence corporate decisions with respect to university funding. Finally and foremost, he must find working with faculty and students stimulating, productive and rewarding.

IV. Industry Partnerships in Education and Research

The key to developing a dynamic, relevant engineering technology curriculum, coupled with productive applied research activity, is having a clear understanding of the driving forces within each organization.

What does industry want?

- Access to students
- Access to faculty expertise
- The opportunity to impact curriculum in a way that "shapes" graduates

What do faculty want?

- Resources (for curriculum and lab development and for applied research)
- Time to be productive, thus making an impact on their students and profession
- A high level of interaction with industry
- To deliver a current, relevant curriculum with modern equipment in labs

Recognition of what industry and faculty want is the first step required for a faculty member to establish contact with industry personnel. If there is a common need between the faculty member and industry personnel, the relationship grows in scope and depth. To forge a true partnership requires at least one faculty and one industry "champion". While the partnership may grow into one with an entire program or department, it usually begins in a niche area with the two champions working closely together to form the alliance.

V. Threads that connect education and research

The following "threads" weave the fabric of education and research:

- Engineering technology faculty's high motivation to work closely with students
- Applied research results are readily transferable to the classroom and laboratory
- Students are highly receptive to "cutting edge" applications of technology
- Students who work with faculty on research projects provide a "test bed" for the faculty to shape research results in a way that leads to effective integration of research process and findings into the curriculum.
- Since the very nature of engineering technology is application, faculty take responsibility for continuously integrating "current practice" into their courses.
- Because of the need for graduates to "hit the ground running," industry is often more interested in sponsoring and funding educational development projects (keeping courses and labs current and relevant) than research projects. At institutions where research is a fundamental aspect of their mission, it is incumbent on engineering technology faculty to present proposals to industry that contain both educational development and research components. However, those components can and should be closely linked. For example, a new laboratory can be developed to serve both teaching and research needs. Industry is motivated by and endorses this synergy of teaching and research because industry recognizes that their future employees are being educated and trained by "up to speed" faculty who are involved in both teaching and research.

This "package deal" approach to industry-academia partnerships produces enthusiasm, power (recall power is energy in motion) and vitality in each partner, resulting in an ever-expanding set of opportunities. Scholarship becomes a natural product of successful teaching, educational development and applied research activity. People who are enthusiastic about their work naturally want to publish and present their accomplishments and contributions in a variety of professional settings and forums.

VI. An example of industry partnership development

In 1998, a group of Electronics Engineering Technology faculty at Texas A&M University decided that the analog portion of the curriculum needed a complete overhaul. Traditionally, the digital course sequence had enjoyed a continuous industry support and evaluation, thus it was already state-of-the-art. Also identified in these discussions was a need to find a way to recombine the analog and digital course sequences somewhere late in the academic career of the students. The most logical choice for this capstone type course was a relatively new technology known as Mixed-Signal circuits. At that time (and still currently) Texas Instruments was the world leader in Mixed-Signal circuits, and thus was of primary interest as the corporate sponsor for our curriculum changes.

From the Texas Instruments view, a detailed analysis of graduating students from all universities in the area of Analog or Mixed-Signal circuits (in particular Mixed-Signal testing) revealed a critical shortage in manpower. The analysis revealed that TI alone would require 85% of the world production of new engineers to maintain their current business strategy. This led to the decision to task a leading corporate expert in the area of Mixed-Signal testing (Mark Burns – TI Fellow) and a leading academic expert (Gordon Roberts – McGill University – Canada) with the development and publication of a book in the area of Mixed-Signal Testing for introduction into targeted academic institutions.

Discussions between Texas A&M University and Texas Instruments were held in Spring 1998, leading to the decision to have a faculty "champion” (Dr. Rainer Fink) work on site at Texas Instruments in conjunction with Mark Burns and Gordon Roberts in the development of course materials for the new book. The summer was funded by Texas Instruments as a faculty fellowship.

Over the course of the summer, a clear understanding of the course material was acquired by Dr. Fink and a proposal was developed to have two new courses (due to the volume of material to be covered, two semesters of lecture and laboratory were required) at Texas A&M University in the Fall 1998. Incorporated in this three year proposal was everything required for a major curriculum change to redirect students into the area of Mixed-Signal testing. Funding categories included: laboratory facility renovation, laboratory furniture, laboratory equipment, faculty and graduate student salaries, technician salary, scholarships and some discretionary funds. In addition to funding described above, a joint effort between Texas Instruments and Teradyne Inc. placed a new Teadyne A567 Advanced Mixed-Signal Tester at Texas A&M. This is the only Teradyne A567 in academic use in the United States and is valued at approximately $1,300,000 (another A567 resides at McGill University with Gordon Robert’s group).

Laboratory renovation was started and completed over Christmas break, under budget and on time. The first Introduction to Mixed-Signal test and Measurement class was taught in Fall 1998 and the first Advanced Mixed-Signal Test and Measurement class was taught in Spring 1999, as indicated in the proposal.

In an attempt to enhance interaction with Texas A&M, a further plan was initiated in the Spring of 1999 to have Dr. Jay Porter join Dr. Fink at Texas Instruments in the Summer of 1999. The goal of the new interaction was to utilize Dr. Porter’s expertise in LabView to develop a low cost version of the curriculum being presented at A&M with the Teradyne A567. This curriculum could then be distributed to additional schools. Dr. Porter’s interaction over the summer led to another proposal to fund the development of the low cost curriculum as well as fund research in the area of virtual instrumentation. Curriculum development has been under way since Fall 1999 and is currently being implemented at Prairie View A&M University.

Also over the summer of 1999, several research projects in the area of test time reduction or test methodology and hardware development were identified by Dr. Fink which would be funded with full overhead. Research opportunities such as these were originally outlines as a major requirement of working with tenure track faculty at a research based university.

In Fall 2000 an additional opportunity arose out of the Mixed-Signal Test initiative: the addition of another faculty Dr. James Ochoa in the area of Digital testing in conjunction with Motorola. As with Texas Instruments, a major need for students and a proven track record with Texas

Instruments made Engineering Technology an attractive opportunity to expand the academic horizon of future engineers. Currently Dr. Ochoa is in the final stages of negotiations for the funding for another major academic proposal to create a laboratory (Motorola Digital DNA Test Laboratory) similar to the Texas Instruments Mixed-Signal Test Laboratory in the area of digital test.

Since funding from the original three year proposal to Texas Instruments ends at the end of Summer 2001, a proposal was generated in the Summer of 2000 to request funding for an additional three years in the Mixed-Signal Test Initiative. All funding categories were maintained in the new proposal with a significant increase in funding requested for scholarships. Funding for the additional three years has been approved.

VII. Conclusions

The interaction between faculty and industry is a very rewarding opportunity as long as both parties are aware of the requirements of the other. Industry must be educated to the requirements placed upon a tenure track faculty and the university must be sensitive to the academic needs of industry. Curriculum changes required by industry must be implemented with industry speed. Only this way can industry get students that are ready to hit the ground running. Also, industry must be willing to invest in the career of the faculty champion, even if it includes funding research with full overhead. Industry must be aware of the requirements of publications placed on faculty. It is great to have funded research, but if it is top secret, no publications can be generated from the work, thus more work must be funded. In general, the main benefactors of these interactions are the students. Currently, the Mixed-Signal Test Initiative has a 100% placement rate of qualified graduating seniors either at Texas Instruments or at Teradyne. Feedback on the initial performance of these students has been outstanding, leading to the continued funding of the educational and research process.

Bibliography

1. Boyer, E.L. *Scholarship Reconsidered: Priorities of the Professoriate.*. The Carnigie Foundation for the Advancement of Teaching (San Fransisco: Jossey-Bass, Inc., 1996).
2. Frick, D.M. and Spears, L.C. The Private Writings of Robert K. Greenleaf: On Becoming a Servant Leader. (San Fransisco: Jossey-Bass, Inc., 1990).

RAINER FINK
Rainer Fink was born in Speyer, Germany in 1966. He received the B.S., M.S. and Ph.D. in biomedical engineering from Texas A&M University. After finishing his Ph.D., he simultaneously taught analog electronics in the Bioengineering Program and the Department of Engineering Technology at Texas A&M University. In august, 1996, he joined the Electronics Engineering Technology faculty at Texas A&M University as an assistant professor. Dr. Fink is the director of the Texas Instruments Mixed-Signal Test Laboratory at Texas A&M University and the 1999 – 2000 Monague Center For Teaching Excellence Scholar. Dr. Fink is also a Research Adjunct Professor of Electrical Engineering at the University of Arkansas, Fayetteville. His research activities include mixed-signal testing, analog circuit design and biomedical electronics.

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Jay R. Porter joined the Engineering Technology program at Texas A&M University in 1998 as an Assistant Professor and currently works in the areas of mixed-signal circuit testing and virtual instrumentation development. He received the BS degree in electrical engineering (1987), the MS degree in physics (1989), and the Ph.D. in electrical engineering (1993) from Texas A&M University.

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