Collaboration: The Key to Preparing Engineering Managers

Wade H. Shaw
Florida Institute of Technology

Abstract

In this paper we develop the role of collaboration in an academic setting to offer a flexible graduate degree in engineering management. Collaboration among academic departments, among students and faculty, and among industrial partners is combined to provide a high quality experience for students. We share our efforts to support collaboration among students by using web-based conferencing tools and asynchronous course materials. Finally, we extend the collaboration model in the university to the professional environment where engineering managers work with associates in R&D, production/operations, and marketing to design and develop products and services. We believe that the same collaboration skills mastered in school extend to the workplace and prepare students for highly productive careers.

I. Introduction

The Engineering Management Program at Florida Tech has combined cutting edge technology with a collaborative work culture to steadily grow and meet the educational needs of a diverse student body [1]. By offering courses that are unique to engineering management using streamed media, web-based conferencing, and wireless communications our program has been able to rapidly adapt to changing needs in engineering education. We use the entire college of engineering as a source of technical focus courses, the MBA core from our school of business for key management courses, and specialized engineering management courses to prepare leaders in technology and business. This low cost approach allows us to attract a wide variety of technical specialists into our program that are welcomed by our university affiliates.

The key strategy that is working for us is to use technology to allow collaboration among students and faculty. The increasing complexity of engineering design that demands coordination of many diverse technical disciplines requires engineers and managers to use collaboration tools that can also be used in educational environments. This paper describes how we are using conferencing tools, discussion groups, case studies and design projects in an asynchronous collaboration. We have moved traditional lecture materials to media accessible on the web and focus our valuable face-to-face class time on creative problem solving. The collaboration that we have developed essentially becomes an asynchronous network for a community of users focused on specific outcomes.

Collaboration takes place within the traditional academic setting where students interact with other students and faculty as well as later in their careers where success is often dependent on effective relationships with other professionals in business organizations. Our goal in this paper is to extend the concept of collaboration among students to include the organizational level in a university where an engineering management program resides. Collaboration with industry and

other academic departments is key to building an effective academic program. We close with a short discussion of collaboration in an industrial setting where engineering management is practiced.

II. Collaboration within Engineering Management Programs

Engineering management programs have enjoyed steady growth in the last decade [2]. ABET recognizes the engineering management discipline and has for many years provided accreditation to programs residing in engineering colleges. Programs in "management of technology" have also been rapidly integrated into mostly business programs and this trend is likely to continue as traditional MBA programs move towards more generic and less technical roots [3]. Many variations of the engineering management degree are available ranging from highly design oriented programs to those with distinctive emphasis on project management, systems engineering, construction, and many others. Engineering management programs are intrinsically interdisciplinary and often integrate courses from the science, engineering, and management schools.

Our experience at Florida Tech is described here to illuminate how collaboration can yield an engineering management program that provides a unique learning opportunity to a wide range of engineers with diverse professional goals. Collaboration occurs at three distinct levels: the students and faculty, the academic departments, and with industry. Figure 1 depicts the collaboration opportunities and each will be briefly described.

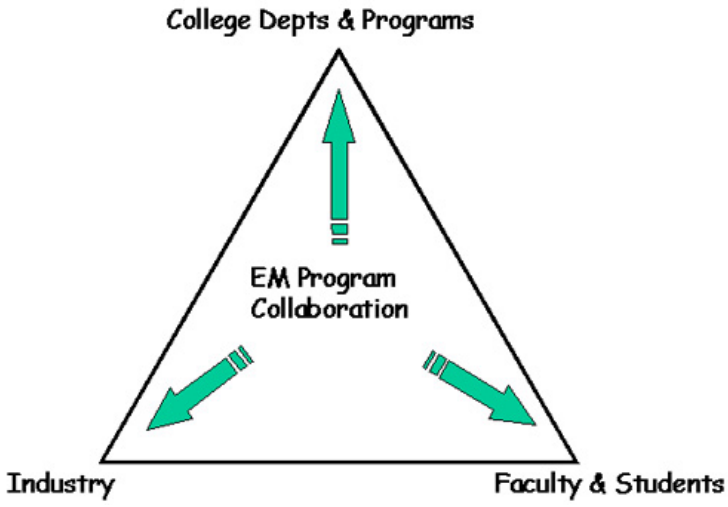

Figure 1. Opportunities for Collaboration within Engineering Management Programs

Academic departments

Engineering management is a discipline in itself as well as an integration of other engineering fields and the study of management tools and techniques. It is quite valuable to think of the unique fields of interest that would be best provided by dedicated engineering management faculty and then add to those key interests academic support from other programs. For example, courses in quality engineering are typically a core requirement for engineering management

programs and are not offered in either management programs with the design focus that engineers are looking for or from reliability engineering programs with the organizational focus needed by engineering managers. Project management is another example of a field of study useful to many students and key to engineering management success. We find that project management from management schools covers project planning and control but typically leaves out requirements engineering, lifecyle costing, or systems engineering issues.

Our collaboration with academic programs allows us to use the core MBA courses taught so well in the business schools to provide finance, accounting, organizational behaviour, and marketing. Then we also offer engineering management courses with a management emphasis (like technical marketing) that we count towards the management requirement for our MS degree. Likewise, we require 1/2 of the MS degree to be engineering courses drawn from our college of engineering and we prepare a unique program for each student. The engineering management courses that tend to emphasize design and analysis tools can be used to fulfill the engineering requirement for the degree. So, collaboration with our faculty in other departments and schools provides a very flexible program to meet the needs of a diverse student population at very low cost. An overview of our program and a multimedia presentation of our courses and requirements is available at http://www.fit.edu/AcadRes/engmgt.

Students and faculty

Collaboration among students and faculty is critical towards preparing students for engineering management careers. The engineering education literature is overflowing with reports that express the need for better communication skills, teamwork, and leadership in our graduates. We find that fostering a collaborative environment in the schoolhouse goes a long way towards improving these skills in our students. We have developed a series of "topics" courses that allow us to revise and restructure course content significantly between offerings. We use the "topics" course name to focus our teaching on a particular theme (like systems engineering) and yet retain the ability to recast the course each time it is offered to respond to each student group's needs. We have placed many multimedia files, audio tracks, and videos onto the web to supplement courses and to provide students access to materials asynchronously. We have used web conferencing systems extensively to allow students to work together on projects, interact with faculty, and to coordinate the asynchronous component of courses. Guests can log onto a completed conference system to view an example of this collaboration at http://engmgt.fit.edu:8080/~pe . An extract from an example of a web page is shown in Figure 2 where a syllabus has been used to organize media such as lecture slide sets, recorded audio tracks, and supplemental media like spreadsheets and simulation models. The links point to objects in an asynchronous media archive that students can use at any time.

Faculty collaboration is also improved with software tools and we are experimenting with virtual conference rooms for committee work, professional development, and service projects. The integration of multimedia tools with collaborative software and web hosted conference systems has dramatically changed the use of classroom time. Instead of lecturing on syllabus material that can best be viewed offline, the class time is used for discussion of material, design cases, and student interaction. A discussion of this phenomenon and tools that we use to implement our courses is found at http://engmgt.com/wshaw/seminars/techteach.html .

Course Item Description	Slides	Slides w/Audio	Audio Track	Item Notes or References
Introduction to Quality Systems Engineering	**	--	**	Course welcome, introduction to quality, definitions, and historical contributors
The Experience of Quality	**	**	**	The experience of quality as a human process
Robust Design: Part 1	**	**	**	Concepts in Robust Design and a Stress/Strength Product Model Demo
Robust Design: Part 2	--	--	**	Class Registration Example, introduce SPCEx software tool (see Software download area)
The Seven Basic Quality Tools: Part 1	**	--	**	Overview of the Basic Tools

Figure 2. Extract of a Course Support Table on a Web Page

Industry

Collaboration with industry is a key element of our program. It is the hardest to accomplish and potentially the most effective collaboration partner. The use of advisory boards and similar organizational structures are useful but not near as useful as relationships built with student interaction. Our efforts have been aimed at hosting student internships with industry mentors for graduate credit. The students establish a working relationship with an industrial supervisor who works with them to develop a project and to prepare a work plan. The industry supervisor provides a grade recommendation at the end of the term and students basically work in the industrial environment to earn their credit. The industrial sponsor may pay the student if they wish. Since establishing an internship relationship with industrial partners is not a perfected process, we do not require an internship nor do all students complete one. In time we believe that student interns in engineering will be a common practice in our engineering management program and one that industry will be eager to support.

III. Collaboration as Practicing Engineering Managers

Our focus on collaboration in the schoolhouse in motivated by two equally important considerations: first, the educational process is improved and students learn more about engineering management when they are engaged in collaborative efforts with faculty and peers; second, the practice of engineering management is intrinsically a collaboration of three key business processes (R&D, operations, and marketing) that must be mastered in order for them to compete in the marketplace. So, we offer some discussion of the collaboration opportunities in the economy depicted in Figure 3.

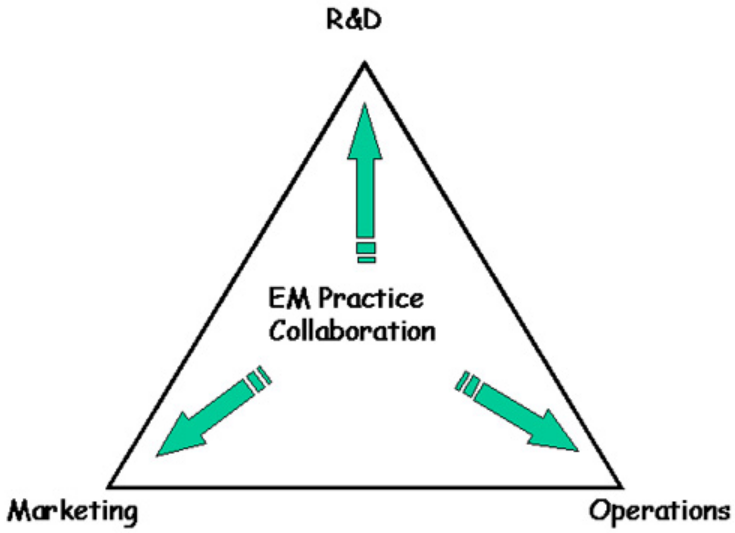

Figure 3. Collaboration for Engineering Managers in the Workplace

Research & Development

R&D is the organizational process concerned with the creation of knowledge. This process is inherently an attraction to engineers and scientists and a major component of successful organizations. It is important to also include the research that develops market knowledge and the sensitivities to the customer and their operational environment. This awareness of the environment from its legal, organizational, economic, and political dimensions is also an R&D function but is typically completely overlooked by traditional engineering disciplines. The key collaboration goal in the R&D world is the desire to integrate market conditions and operational capabilities into a product's design. Surely, the engineering manager will need to be comfortable with the R&D process and prepared to share knowledge with other professionals.

Production and Operations

The production and operations process is concerned with creating the product or service. Many issues in engineering management revolve around operational considerations of the plant, equipment, labor, and capital that translate raw material into economic goods and services. Collaboration in this process means effective use of R&D knowledge to develop manufacturing and service operations that meet performance requirements at acceptable cost and risk. Also, the collaboration with the marketing processes means that the products and services must be targeted to the proper customers using distribution systems and supply chains that are reliable. Even well designed products that are produced efficiently must be made available to the right customers at the right time.

Marketing

The marketing process is concerned with creating the customers. This process is frequently unknown and uncomfortable for engineers. Collaboration with the marketing process means understanding the customers needs before they do and communicating those needs in a manner

that design and development engineers can build products to meet the need. Engineering managers may be faced with developing a product concept with technology that isn't even available yet or may face distribution channels that are unproven.

IV. Summary

In summary, we have attempted to build a case to support the use of collaboration in engineering management programs in order to develop a strong and vibrant academic program. These academic programs that integrate collaborative tools and techniques provide the students and faculty with the environment to collaborate with others to improve their educational experience and increase the longevity of their learning. The collaboration skills learned in school are the same skills that will enable engineering managers to successfully design and develop products and services efficiently and effectively.

Our focus on collaboration with our sister academic departments has enabled us to provide students with a rich set of educational opportunities that many faculty can participate in. Our engineering management program is growing and attracting a diverse population of students. Collaboration with other engineering and management programs represents a low financial burden on our college budget. Collaboration with industry provides internships and a win-win situation for the student and the industrial sponsor.

In short, the collaboration skills of engineering managers in professional practice to coordinate the creation of knowledge, products, and customers is the same set of skills that can be used to create a dynamic and growing engineering management program at your university.

Bibliography

1. URL : http://www.fit.edu/AcadRes/engmgt; Engineering Management Program at Florida Tech
2. Badawy, M. K., Developing Managerial Skills in Engineers and Scientists, 2nd Ed., Nostrand-Reinhold, 1995.
3. Richards, L., "President's Corner", Engineering Management Journal, Vol. 10 No.4, Dec 1998.
4. Dutta-Roy, Amitava (1998) "Virtual meetings with desktop conferencing," *IEEE Spectrum* July 1998, New York
5. Gray, Sharon (1998) "Web-based Instructional Tools," *Syllbus* (September), San Jose, CA.
6. Denton, Denice (1998) "Engineering Education for the 21st Century: Challenges and Opportunities," Journal of Engineering Education (January 1998), Washington DC.

WADE H. SHAW

Wade H. Shaw is Professor and Chair of the Engineering Management Program in the College of Engineering at Florida Tech. He serves as the Executive Vice President of the IEEE Engineering Management Society. He completed a BS in Electrical Engineering, a MS in Systems Engineering, and a PhD in Engineering Management all from Clemson University. He is an active member of ASEE, IEEE, ASEM, IIE, INFORMS, and SCS. His research interests include simulation systems, quality engineering and project management and his support includes the DoD, NSF, NIST and private industry. He has developed several asynchronous learning courses and supports a number of web-based technologies for media distribution. In 1997 he served as a Visiting Virtual Professor to the Georgian Technical University in Tblisi. Currently he is working with a start-up company to design and install wireless internet services to deliver T1 class service at low cost to businesses, schools, and service organizations. Most of the media he has developed is available via wireless technology from his web page at http://www.fit.edu/~wshaw. He lives with his wife Susan and three sons in Melbourne, Florida.