

Leadership Coaching of Interdisciplinary Capstone Design Teams at LSU

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For over 30 years, Louisiana State University has had a two-semester Capstone Design course in the Mechanical Engineering (ME) Department. Within the last 3 years, that experience has expanded to other departments, as well. Currently, Electrical and Computer Engineering (ECE) and Biological Engineering (BE) participate in similar sequences and have students that participate in interdisciplinary projects with ME students. Observations of the students indicated that a need for introducing teamwork and leadership coaching to the students participating in interdisciplinary projects. Teamwork, mentoring and leadership coaching are currently offered in the College of Engineering's Peer Mentoring program. This interdisciplinary program is designed for all levels of students. These students tend to become team leaders and usually have better communication skills than their peers. These experiences have led to an effort to introduce teamwork and leadership coaching across the engineering curriculum.

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Introduction

Capstone Design courses provide students an opportunity to participate in a team environment to design and construct a product specified by a client. For most students, this is the first time they will apply all of their engineering coursework to solve a poorly posed problem. Most educational curriculums focus on the engineering skills needed to perform this task. However, success involves more than just analytic skills.

Leadership Coaching at Other Universities

Several universities have implemented programs to teach the skills needed for success in teamwork, leadership and Capstone Design. East Carolina University¹, Brigham Young University², and Rose-Hulman Institute for Technology³ have embedded leadership training throughout their curriculums. East Carolina University uses the Leadership Identity Development Model to incorporate leadership training through every student's undergraduate experience¹. Brigham Young University provides team feedback to the students in their chemical engineering classes². Rose-Hulman University integrates leadership experiences throughout students' academic careers³.

The long term goal at Louisiana State University (LSU) is to integrate leadership training throughout the undergraduate engineer's experience. This paper

documents the initial efforts to provide direct coaching on teamwork and leadership in the Capstone Design series to interdisciplinary teams.

History of Capstone Design at LSU

The Mechanical Engineering (ME) Capstone Design Program was established as a two semester sequence in 1981. Several modifications, such as a design notebook requirement for documentation and a panel of expert professionals to provide evaluation and critique, were introduced in the mid 1990's. In 2009, a poster session was initiated, along with safety training developed by the Industrial Engineering Department. Finally, a Capstone Design Fair, which introduces the students to proposed projects and sponsors, was started. Recently, special lectures by practicing engineers on reliability, project management, estimation, leadership and teamwork were also added.

A formal, interdisciplinary team component was introduced to the ME program in 2012 in collaboration with the College of Engineering and the programs of Electrical and Computer Engineering (ECE) and Biological Engineering (BE), adding a challenging, real-world experience to the learning opportunity for the students.

During recent years, the Capstone Design Program has also been enhanced through the addition of The

Frank H. Walk Design Presentation Room, and modern CNC tooling in the ME Shops, thanks to generous gifts by ME alumni Dr. Frank H. Walk and Mr. Bob Alford. More than ten ME Capstone Design projects have been awarded U.S. patents over the years.

Course Requirements

Throughout the Capstone Design Course, the students work in teams on a project assigned to them. Projects typically originate from industry, non-profit organizations, private individuals, or sources internal to the University (e.g. research or educational entities). Industry projects are highly desirable for their direct relevance to engineering practices. Teams are often interdisciplinary, depending on project needs.

The Capstone Design Program involves two consecutive courses and emphasizes both the design process and the delivery of a successful engineered outcome. Nevertheless, because the focus is on students' education, a successful outcome is emphasized but not guaranteed. During the first semester of the Capstone cycle, the student teams gain understanding of their project scope, formulate engineering specifications, develop conceptual solutions and designs, go through a concept analysis and selection process, carry out the necessary engineering analyses, and arrive at a final proposed prototype design, complete with engineering manufacturing drawings.

This proposed prototype design is presented to a panel of experienced professionals who provide assessment and critique. The student team submits a final report at the close of the semester.

In the second semester, the student teams proceed with physical realization and testing of their designs. At the end of the semester, the teams deliver an engineered and tested device, which they defend in front of the same panel of professionals. A final comprehensive report is then submitted by each team, documenting their device as built and tested, as well as the associated design, realization and testing processes. Failure to deliver a finished device adhering to specifications may result in failing the course. In order to avoid this, any non-compliance with specifications must be explained, and viable solutions to address the root causes must be proposed.

In their journey through this two-course program, in addition to the conceptual and technical issues in design, the students have to deal with the challenges of teamwork, project and budget management,

procurement, redesigns, hands-on manufacturing and communications of all forms with their clients, technical support staff, vendors, supervisors and the public.

Interdisciplinary Experiences at LSU

In the fall of 2012, a push was made to emphasize student participation in interdisciplinary projects. Six teams participated in interdisciplinary projects ranging from the construction of a hydroponic growing-rack system for lettuce in a shipping container to the prototyping of an artificial anterior cruciate ligament for humans. The six teams were composed of 37 students (23 ME, 3 ECE, 11 BE).

In the fall of 2013, 15 teams participated in interdisciplinary projects. These projects included several student competitions (IEEE robots to SAE micro class aircraft), an aid for handicapped hunters, a multi-tap beer dispenser, and a demonstration of subsea engineering technology. The 15 teams were composed of 79 students (52 ME, 25 ECE, 2 BE).

To coordinate the departments involved and the interdisciplinary teams, an Interdisciplinary Capstone Coordinator was assigned to monitor the teams and coordinate departmental objectives for each student. During the fall of 2012, one thing became apparent – there was a lack of effective teamwork among the interdisciplinary teams.

In order to improve teamwork efforts among the teams, several lectures were given to the Capstone Design class as a whole. Interdisciplinary teams participated in bi-weekly meetings where team work and leadership coaching was performed.

Leadership Material

Initially, in the fall of 2012, one lecture was given on the topic of teamwork and the efforts needed to perform successfully in the Capstone Design course. In the spring of 2013, in the second semester, a formal lecture on the topics of personal development, teamwork and leadership was presented. A second lecture on the importance of relationships and networking was also presented.

From the efforts in the first year, two lectures were formulated to be given in the ME, ECE and BE classes. For the fall, a lecture covering personal development and teamwork, and for the spring, a lecture covering leadership skills are to be presented. Five resources are to be used as reference materials for each topic⁴⁻⁸.

The foundation of the personal development material is modeled after John Wooden's Pyramid of Success⁴. Coach Wooden developed the pyramid to teach personal development (industriousness, enthusiasm, self-control, alertness, initiative, intentness, condition, skill, poise, and confidence) and teamwork skills (friendship, loyalty, cooperation, team spirit and competitive greatness) to his players. The pyramid was formalized in 1946. Coach Wooden won 10 national championships in NCAA Division I basketball from 1964-1975. Habit Three (first things first) is also stressed from Covey⁶.

In addition to teamwork skills in the Pyramid of Success⁴, there is also discussion of the dysfunctions of teams⁵ and a presentation on team cultures⁶. As opposed to the presentation of team dysfunctions⁵, class discussion is pointed towards the material being presented from the point of view successfully functioning teams.

The leadership lecture begins with a review of the material presented in the fall and a reflection on the team's effectiveness. Material from Wooden⁴ is presented to finalize teamwork understanding and to start to improve leading the team. Kouzes and Posner⁸ present leadership from the point of view that leadership is a learned skill, just like dynamics and fluid mechanics. The presentation stresses leaders modeling, inspiring, challenging, enabling and encouraging.

Throughout these lectures, active-learning techniques allow the students to participate in activities to practice the material being presented with their Capstone Design team. These techniques include a think-discuss-share model, in which case studies and scenarios are presented for individual consideration, discussed in groups, and then shared with the entire class; peer assessments of classroom presentations and project work; and formal self-assessments of performance in multiple aspects of group work. Though the course is supplemented with occasional lectures, these active-learning techniques, combined with the project-based structure of the course as a whole, make the course a hands-on learning experience.

Current Leadership Training – Peer Mentors

The College has provided mentor and leadership training through the Peer Mentor Program. Mentors must attend 8 hours of basic mentor training and earn volunteer points. The training that Peer Mentors undergo aims to prepare students for the upcoming semester, as well as careers in industry. The main topics covered are teamwork, conflict resolution, leadership

styles, preventing sexual harassment, inter-generational communication, cultural awareness, and safety.

The mentor and leadership training utilizes topics from Covey⁶, Wooden⁴ and Maxwell⁹⁻¹¹. The leadership portion of the training is supplemented with lectures from military leadership trainers, industry partners and team-building activities with the student organization leaders^{12, 13}.

Experiential learning through training and developing the next generation of engineering leaders became a critical part of the program. Several layers of increasing responsibilities are built into the model. Students are encouraged to become team leaders. Once a student shows competency, they are then encouraged to be leaders or officers in the program or their field of interest. Examples include session leaders for camp, group leaders for class, or chairs of the robotics program. The group leaders manage younger mentors (team leaders) and their protégés, as well as mentors to the team leaders whenever one has a question or concern that he or she cannot deal with individually. This model of developing leaders has proven to be effective.

The graduation rate of participants in the Peer Mentor program is approximately 30% higher than that of the college as a whole. Over 90% of the officers in the program are leaders in the college. Currently, enrollment in the Peer Mentor program is 125 mentors^{13, 15}.

Determining Effectiveness

For the 2012-2013 academic year, a preliminary survey of the Capstone Design students was collected. The students were asked to rank the usefulness of the material presented related to personal development, teamwork and leadership on a Likert¹⁶ scale. Over 70% of the students valued the leadership material presented. Less than 25% felt neutral towards the material, and 6% found no value in being exposed to the material. Additional data will be collected in future years.

Long Term Goals

At LSU, communication skills are taught across the engineering curriculum through a series of communication-intensive courses¹⁷ facilitated by the campus-wide Communications across the Curriculum (CxC) program. Instead of students enrolling in just one course, such as technical writing, and then being expected to apply it in a variety of rhetorical situations, they are exposed to various forms of communication

techniques (oral, written, visual, technological) and trained on how to effectively apply those techniques in discipline-specific communication-intensive courses.

The goal of the leadership coaching initiative is to model the CxC program¹⁷ by teaching teamwork and leadership skills through the curriculum from freshman to senior year through classes such as the introduction to engineering class, laboratory classes and Capstone Design (Figure 1). In addition to lectures, teams formed in each class and lab will be individually coached through team issues that arise. The Peer Mentor Program will also be used to model progressive leadership training of participants in the leadership coaching initiative.

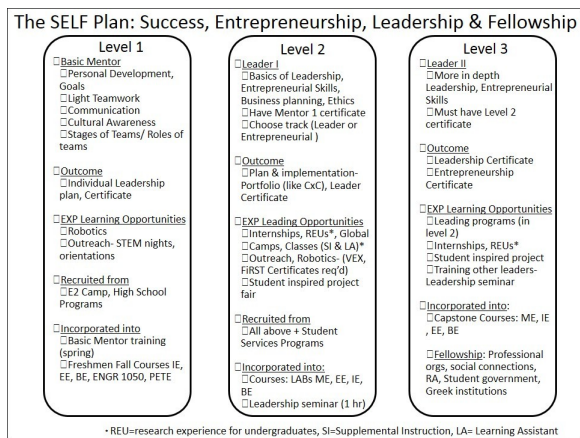


Figure 1: Current plan for exposing students to leadership and entrepreneurship throughout the curriculum

Faculty development workshops will allow faculty and graduate students an opportunity to learn how to introduce topics to these classes and to provide experience in various teamwork training opportunities.

Through these efforts, LSU will develop an effective leadership coaching program, to which all undergraduate and graduate students will be exposed.

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