IOWA STATE UNIVERSITY
Digital Repository

Agricultural and Biosystems Engineering Conference Proceedings and Presentations

Agricultural and Biosystems Engineering

7-2015

Administration of Team-Based Senior Capstone Course: Lessons Learned and Future Challenges

Gretchen A. Mosher
Iowa State University, gamosher@iastate.edu

Follow this and additional works at: http://lib.dr.iastate.edu/abe_eng_conf

Part of the Agriculture Commons, Bioresource and Agricultural Engineering Commons, Curriculum and Instruction Commons, and the Engineering Education Commons

The complete bibliographic information for this item can be found at http://lib.dr.iastate.edu/abe_eng_conf/459. For information on how to cite this item, please visit http://lib.dr.iastate.edu/howtocite.html.

This Conference Proceeding is brought to you for free and open access by the Agricultural and Biosystems Engineering at Iowa State University Digital Repository. It has been accepted for inclusion in Agricultural and Biosystems Engineering Conference Proceedings and Presentations by an authorized administrator of Iowa State University Digital Repository. For more information, please contact digirep@iastate.edu.

Administration of Team-Based Senior Capstone Course: Lessons Learned and Future Challenges

Abstract
Senior capstone courses provide an important mechanism for students to integrate and apply technical knowledge and skills they have acquired in previous coursework. Additionally, students are required to master a variety of professional skills, including teamwork, unstructured task completion, and project management to facilitate successful completion of a capstone course. Faculty also play an important role in the success of capstone courses. Sourcing and grading projects are common challenges for instructors. This paper will outline the challenges and best practices learned in the development and implementation of a senior-level capstone course in agricultural engineering technology, based on qualitative data gathered over several years. Specifically, strategies for defining, assigning, managing, and assessing projects will be emphasized.

Keywords
Curriculum, Education, Teamwork, Undergraduate, Senior capstone

Disciplines
Agriculture | Bioresource and Agricultural Engineering | Curriculum and Instruction | Engineering Education

Comments
This proceeding is from 2015 ASABE Annual International Meeting, Paper No. 152162359, pages 1-6 (doi: 10.13031/aim.20152162359). St. Joseph, Mich.: ASABE.

This conference proceeding is available at Iowa State University Digital Repository: http://lib.dr.iastate.edu/abe_eng_conf/459

2950 Niles Road, St. Joseph, MI 49085-9659, USA
269.429.0300 fax 269.429.3852 hq@asabe.org www.asabe.org

An ASABE Meeting Presentation

Paper Number: 152162359

Administration of Team-Based Senior Capstone Course: Lessons Learned and Future Challenges

Gretchen A. Mosher
Iowa State University, 3331 Elings Hall, Ames, Iowa 50011

Written for presentation at the
2015 ASABE Annual International Meeting
Sponsored by ASABE
New Orleans, Louisiana
July 26 – 29, 2015

Abstract. Senior capstone courses provide an important mechanism for students to integrate and apply technical knowledge and skills they have acquired in previous coursework. Additionally, students are required to master a variety of professional skills, including teamwork, unstructured task completion, and project management to facilitate successful completion of a capstone course. Faculty also play an important role in the success of capstone courses. Sourcing and grading projects are common challenges for instructors. This paper will outline the challenges and best practices learned in the development and implementation of a senior-level capstone course in agricultural engineering technology, based on qualitative data gathered over several years. Specifically, strategies for defining, assigning, managing, and assessing projects will be emphasized.

Keywords.

Curriculum, Education, Teamwork, Undergraduate, Senior capstone

The authors are solely responsible for the content of this meeting presentation. The presentation does not necessarily reflect the official position of the American Society of Agricultural and Biological Engineers (ASABE), and its printing and distribution does not constitute an endorsement of views which may be expressed. Meeting presentations are not subject to the formal peer review process by ASABE editorial committees; therefore, they are not to be presented as refereed publications. Citation of this work should state that it is from an ASABE meeting paper. EXAMPLE: Author's Last Name, Initials. 2015. Title of Presentation. ASABE Paper No. ---. St. Joseph, Mich.: ASABE. For information about securing permission to reprint or reproduce a meeting presentation, please contact ASABE at rutter@asabe.org or 269-932-7004 (2950 Niles Road, St. Joseph, MI 49085-9659 USA).

Senior Capstone Course Design

The senior capstone course represents a critical role in many engineering and engineering technology programs. According to Pembridge and Paretti (2010), a large number of engineering capstone projects span one or two semesters and involve teams of 4 to 6 students. The emphasis of many capstone courses is to facilitate students' application of technical tools, techniques, and knowledge learned previously to an open-ended, realistic, and creative problem-solving experience (Friesen & Taylor, 2007; Steiner et al., 2011; Hyder et al., 2014).

In addition to technical skills, capstone courses also require students to focus on a variety of professional behaviors, including teamwork, conflict management, customer service, and project management. Additionally, professional skills such as an understanding of communication, creativity, and critical thinking are also considered important components of a capstone course (Friesen and Taylor, 2007; Lantada, Bayo, and Sevillano, 2014).

The capstone experience discussed in this paper is part of an agricultural and biosystems engineering department. The department includes four majors: agricultural engineering, biological systems engineering, agricultural systems technology, and industrial technology. The author leads one of two sections of senior capstone courses for agricultural systems technology and industrial technology students. Students from the two majors in technology take the required two-course sequence in their final year of their degree program. Teams of three to four students are assigned a project in the middle of the first semester and complete the project by the end of the second semester.

The first course in the sequence is one semester credit and the second course in the sequence is five semester credits. Historically, the number of students enrolled in the author's section was approximately 20 students per semester. Enrollment has dramatically increased in the last four years, as shown in Figure 1. Increased enrollments have influenced the way the senior capstone course is taught, but the overriding goal is to keep the hands-on, problem-solving nature of the course.

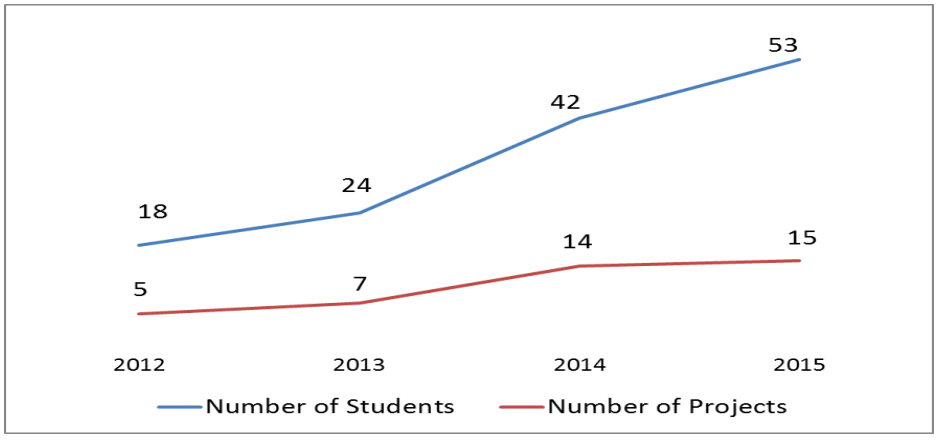

Figure 1. Students enrolled in senior capstone sequence: 2012-2015

Industry Projects

Historically, industry-sponsored projects have been the practice in the senior capstone course in the author's department. Although industry projects can provide great benefits to students, they have challenges that can make the management of projects tricky. Kauffman and Dixson (2011) suggest that a strong and structured administration and communication plan between industry and university is a key component for the success of university/industry collaborations. Magleby et al. (2001) and Friesen and Taylor (2007) examined the use of industry-sponsored projects and outline both positives and negatives to such projects from a pedagogical and university teaching perspective. A summary of their findings is shown in Table 1.

Table 1. Positive and negative aspects of industry-sponsored capstone projects

Advantages	Disadvantages
Enhances student motivation	Consequences of failure have greater impact
Creates realistic problems and environments	Recruitment of projects may be challenging
Faculty can observe student in non-academic environment	Intellectual property and liability may be of concern
Means of financial support and outreach with industry	Administrative procedures and protocols must be developed and managed carefully
May assist with career placement of students	Faculty may be uncomfortable outside of expertise

Anderson and Mourgues (2014) also recommend consistent involvement from the instructor throughout the project, pointing out that instructors are an important source of feedback and serve as a "continuity of knowledge". Furthermore, Magleby et al. (2001) and Anderson and Mourgues (2014) suggest that an industrial liaison person between the company and university plays a critical role in success. The liaison must be someone from the company who has a vested interest in the project, can provide adequate supervision to the students, and who is not intimidated by University policies and procedures.

Although industry-sponsored projects provide an authentic experience for students, the "real" nature of such projects can be risky because of the potential importance of the project and technical issues that must be resolved by student teams. Student teams are generally novices in the application of problem-solving techniques and project management and may need structure and guidance not necessary for a team of more seasoned professionals. Faculty must manage these expectations accordingly (Goldberg et al., 2014). Furthermore, as Anderson and Mourgues (2014) note, a great industry-based capstone project rarely occurs the first time around. They suggest patience and a willingness to adjust as needed to increase the likelihood of a positive outcome.

To address some of the issues in Table 1 and by previous literature on industry capstone courses (Magleby et al., 2001), several actions can be implemented to "standardize" the process of securing feasible capstone projects. A form for potential industry mentors is an important component of the standardization of the process. A template outlines the scope and deliverables ahead of time and forces potential clients to think seriously about the company's role in the project before the beginning of the project.

The use of a template form assists faculty and addresses several challenges identified by the National Academy of Engineering in their 2012 report. First, all projects are vetted by the instructor before acceptance, allowing projects to be appropriately scaled for the limited time frame. The form also requires capstone clients to outline their expectations ahead of time. Early planning and tempering expectations are suggested by the National Academy of Engineering Report (2012). Engaging industry partners directly (not through a student) or through the departmental advisory board are also practices recommended by the National Academy of Engineering (2012) that were implemented with the use of project forms.

The use of template forms facilitates communication between the university and the client, allows for enhanced planning and management, and provides a mechanism to discuss intellectual property, cost, and liability concerns up-front instead of in the middle of the project. The forms facilitate a simplified and standardized process, which is valuable to the instructor, the potential client, and the students.

Team and Project Selection and Management

A second major challenge in many capstone courses is that the project work is completed in teams (Paretti et al., 2011; Dym et al., 2005). Putting successful student teams together has been the subject of much previous research (Paretti et al., 2011; Michaelsen et al., 2004). While there is not one “right” method, several ideas were integrated to form the team selection and project assignment procedures in the author’s capstone course.

Capstone students complete formal survey instruments which assess their previous coursework and work style on the first day of class. At that time, they are also presented the opportunity to bring forward capstone projects that meet specific criteria presented in class. However, the most important component of the selection process for students is their completion of the “written bid assignment”. The procedure for this assignment is outlined below.

First, information on each project’s deliverables and scope are presented to the class. Using this information, students are to study the projects and select at least three projects that they would be willing to work. As part of the written bid assignment, each student describes his or her background, work experience, and how they handle deadlines and conflict. For each project of interest, the student describes why his or her background would be well suited for the specific project desired. Students may also identify classmates they’d prefer to work with or classmates they would prefer ***not*** to work with.

Although it is not always possible to honor every request to work with a specific classmate, requests to not work with a certain classmate were always honored. Generally, most of the students (less than 30 percent) do not indicate a specific person to work with or not work with. Students also understand that their preferences and ultimate assignments were driven almost entirely by their project requests rather than teammate requests.

The process for project and team selection lasts approximately three weeks. While the process of assigning teams and projects closely resembled putting a gigantic jigsaw puzzle together, the final outcome has been very positively received by students. Students have some control over their project assignment, giving them ownership in the project before it begins. Additionally, students have some say in the people they do or do not

work with. The process is also more inclusive for students who are quieter or who may not have close friends in the course.

Assessment of Students

One of the biggest instructional challenges of team-based capstone projects is the development of a fair and consistent assessment system. Dutson et al. (1997) suggest that evaluation of student capstone projects is inherently subjective and Brackin et al. (2011) point out that failure of the end product does not indicate that no learning has occurred. Therefore, project success is not always the best indicator of the quality of work by either individuals or by teams.

One way to integrate more team-based evaluation into a course is to provide multiple opportunities for peer evaluation (Bacon, Stewart, and Silver, 1999). To ensure full participation of all team members, a clear and specific vision for what is expected of all members of the team for successful capstone teams (Brackin et al., 2011). In addition to the instructor's evaluation their level of competence on expected tasks, each student is required to evaluate his or herself along with the teammates. Peer evaluation provides team members the means to address low performance by other team members. Scores from the peer evaluation scores given by teammates constitute approximately 25 percent of the final grade.

A second way to engage students in the process and to enhance accountability is by using low-stakes assignments (Elbow and Sorcinelli, 2011). In this course, students are required to individually submit a "synopsis" to their instructor after each instructor and team meeting. Team and instructor meetings occur every two weeks. By providing a synopsis of the content covered in the meeting, the synopsis forces the student to accomplish two tasks: 1) appropriate record-keeping on project details and 2) an indication of accountability for both attending and remaining engaged during the 40 to 50 minute instructor/student meeting. Although management and assessment of teams can be challenging, having a clear set of expectations and a structure for the consequences of actions and non-actions are a helpful component of the assessment plan.

Final Implications

Teaching a capstone course to students in agricultural and industry technology is a challenging endeavor, but advanced planning, patience, and an effective management plan are all helpful components of a successful course. Several other components also need careful attention. These include:

- Determining the feasibility, definition and scope of the project before the course begins
- Scheduling of resources and time – for faculty, clients, and students – to successfully complete the project
- Management of uncertainty that is inherent to open-ended design and the guidance of students who may have various levels of competence and confidence in their abilities to resolve the uncertainty
- Policies on the resolution of conflict – between students, disagreements on project details, keeping expectations on both sides in check, and other critical items as they arise

Even with attempts to standardize the process, the selection, management, and evaluation a successful capstone project remains somewhat of an art rather than a science (Brackin et al., 2011). Several items should

be considered in the administration of senior capstone projects. First, contemplate the benefits and costs of using industry-sponsored projects. Second, think in advance about how to construct student teams and about the methods you could use to assess your students and resolve team conflict, both individually and as a group.

Finally, remember that although poor experiences provide valuable learning for students, a successful project energizes all participants – the students, faculty, and the industrial client. In addition to an excellent learning experience, a positive project gives the students confidence in their skills and abilities and may provide a beneficial long-term relationship to the industrial sponsor and the institution, leading to further opportunities for capstone improvement and evaluation. Leading a capstone course is challenging, but advance planning and a consideration of student, client, and instructor needs facilitates a rewarding experience.

References

Anderson, D. & Mourgues, C. (2014). Industry participation in construction capstone courses: A company's experience. *Practice Periodicial on Structural Design and Construction*, February 2014.

Bacon, D.R., Stewart, K.A., & Silver, W.S. (1999). Lessons from the best and worst student team experiences: How a teacher can make the difference. *Journal of Management Education*, 23(5), 467-488.

Brackin, P., Knudson, D., Nassersharif, B., O'Bannon, D. (2011). Pedagogical implications of project selection in capstone design courses. *International Journal of Engineering Education*, 27(6), 1164-1173.

Dutson, A.J., Todd, R.H., Magleby, S.P., & Sorensen, C.D. (1997). A review of literature on teaching engineering design through project-oriented capstone courses. *Journal of Engineering Education*, 86(1), 17-28.

Dym, C., Agogino, A.M., Eris, O., Frey, D.D., and Leifer, L.J. (2005). Engineering design thinking, teaching, and learning. *Journal of Engineering Education*, 94(1), 103-120.

Elbow, P. & Sorcinelli, M.D. (2011). Using high-stakes and low-stakes writing to enhance learning. A chapter in *McKeachie's Teaching Tips (13th ed.) (pp 213-234),* by M. Svinicki and W.J. McKeachie. Wadsworth: Belmont, CA.

Friesen, M. & Taylor, K.L. (2007). Perceptions and experiences of industry co-operators in project-based design courses. *International Journal of Engineering Education*, 23(1), 114-119.

Goldberg, J. Cariapa, V., Corliss, G. & Kaiser, K. (2014). Benefits of industry involvement in multidisciplinary capstone design courses. *International Journal of Engineering Education*, 30(1), 6-13.

Hyder, I., Arnold, D., Calvo-Amodio, J. & Parmigiani, J.P. (2014). Using graduate assistants as project advisers for externally-sponsored capstone design projects. *International Journal of Engineering Education*, 30(1), 101-111.

Kauffman, P. & Dixon G. (2011). Vetting industry based capstone projects considering outcome assessment goals. *International Journal of Engineering Education*, 27(6), 1231-1237.

Lantada, A.D., Bayo, A.H. & Sevillano, J.D.J.M. (2014). Promotion of professional skills in engineering education: Strategies and challenges. *International Journal of Engineering Education*, 30(6)B, 1525-1538.

Magleby, S.P., Todd, R.H., Pugh, D.L., & Sorensen, C.D. (2001). Selecting appropriate industrial projects for capstone design programs. *International Journal of Engineering Education*, 17(4/5), 400-405.

Michaelsen, L.K., Knight, A.B., & Fink, L.D. (2004). *Team-based learning: A transformative use of small groups in college teaching*. Stylus Publishing: Sterling, VA.

National Academy of Engineering. (2012). Infusing real world experiences into engineering education. National Academy of Engineering: The National Academies Press, Washington, D.C. Downloaded July 25, 2014 from:

www.nae.edu/File.aspx?id=65103.

Paretti, M., Layton, R., Laguette, S., & Speegle, G. (2011). Managing and mentoring capstone design teams: Considerations and practices for faculty. *International Journal of Engineering Education*, 27(6), 1192 – 1205.

Pembridge, J.J. & Paretti, M.C. (2010). The current state of capstone design pedagogy. Presented at the *American Society of Engineering Education Annual Conference and Exhibition*. Louisville, KY.

Steiner, M. Kanai, J., Hsu, C., Alben, R., & Gerhardt, L. (2011). Holistic assessment of student performance in multidisciplinary engineering capstone design projects. *International Journal of Engineering Education*, 27(6), 1259-1272.