

Teaming Freshmen with Seniors in Design

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Introduction

The Department of Biological and Agricultural Engineering at Texas A&M University offers design-focused courses for freshman and senior engineering students. The senior-level courses constitute the curriculum's capstone design experience. Seniors work in teams of four to five on a design project suggested by industry clients. Many of these same projects are used in the freshman-level course. These projects are used to introduce freshmen and lower-division transfer students to the engineering design process and to illustrate job possibilities available to program graduates. A unique aspect of the freshman and senior design courses, and the focus of this paper, is the inclusion of seniors in the freshman design teams. These seniors assume the role of "senior leader" and serve as managers and mentors. As managers, senior leaders answer questions that the freshmen may have about their design projects or the design process. Senior leaders also facilitate group discussions and act as mediators during times of team turbulence. Finally, senior leaders provide a weekly performance evaluation for each of their freshman team members. Beyond their management responsibilities, many senior leaders provide mentoring to the freshmen in their teams. Senior leaders provide freshmen with information about instructors, summer internship opportunities, departmental laboratory and computer resources, and student clubs, among other topics. Placement of senior leaders in freshman design teams yields numerous benefits. Seniors get an opportunity to obtain management experience before graduation. Freshmen get an opportunity to meet others in their major and to receive much greater mentoring than can be provided through traditional instructor/student contact.

This paper describes the process through which senior/freshman teaming is achieved in these courses. In addition, the paper explores freshman, senior, and instructor reactions to the program.

The Senior Design Experience

The senior capstone design experience in Biological and Agricultural Engineering Department is a two-semester sequence consisting of a two credit hour course in the fall semester followed by a three credit hour course in the spring semester. The sequence is focused around "real world" design problems that are proposed by industry partners. The seniors are formed into teams of four

to five students, determined by their interests and background. In addition to the course instructor and industry client, each design team has a faculty advisor with whom they meet regularly. The class includes, as much as is possible, activities that would be expected in an industry setting. The students are expected to develop an engineering design solution to the problem, to budget time and money for the project, and to provide regular reports to the instructor, clients, and advisors. Mentoring of the freshmen design teams is a key component of the first semester of the sequence, with 30% of the final semester grade determined by the senior activities in managing and mentoring. The fall semester cumulates in the presentation of a design proposal and the submission of a written proposal by each of the senior teams.

The second semester course is focused entirely on the senior design. Activities continue as in the fall semester except that there is no corresponding freshman class, therefore there is no formal interaction between the senior and freshmen students. The spring semester cumulates in the presentation of a final engineering design and submission of a written design report by each of the senior teams.

The Freshman Design Experience

The freshman-level design course, Introduction to Biological Systems and Agricultural Engineering Design, is a required one credit hour course and was first described by Hiler¹. The course is taken by all first-time freshmen entering the department and by many transfer students, particularly those entering the department during their freshman or sophomore years. A few students from other departments who are considering biological systems or agricultural engineering as potential majors also take the course. Students meet twice per week, one hour for lecture and a second hour for recitation.

The primary educational objective for the freshman design course is providing students with a working knowledge of the engineering design process. Additional outcomes include introducing entering students to topics germane to biological systems and agricultural engineering and introducing students to the department and its engineering curricula. Finally, the course aims to excite students about the majors, initiate a sense of camaraderie amongst students, generate student interest in professional organizations, and facilitate mentoring by senior leaders.

The freshman design course uses semester-long design projects to teach the engineering design process. Students work on these projects in teams of three or four. Projects are primarily solicited from industry, but student design competition projects are also used. Typically, the same projects used in the senior capstone design sequence are used for the freshman course.

Industry representatives for each project are invited to campus at the beginning of the semester to present their projects to the freshman and senior classes. Students rank the projects according to their personal interests, and teams are formed based on these preference rankings. Steps of the design process: problem definition and development of design constraints, background research, ideation, alternative selection, design implementation and testing, and communication of design ideas; are covered sequentially in class. Each topic typically requires one or two weeks of class

time. The design step is discussed during the lecture meeting and the student teams implement the step for their design projects during the following recitation session. Students submit their work on each design step as a homework assignment.

Freshman design students receive grades based on their performance on weekly homework assignments, a midterm exam, participation, and comprehensive final written and oral design reports. Feedback is provided to the teams through these homework assignments and during the recitation sessions. It is anticipated that student teams will use prior homework and feedback in developing their final reports. Participation grades are based on student self-evaluation, confidential evaluation by their teammates, instructor observation, and weekly evaluations submitted by the senior leaders.

Senior Leader Responsibilities

One or two senior leaders are assigned to each freshman design team. Senior leaders are instructed to provide management to the freshman teams, to evaluate overall team performance and the performance of individual team members on a weekly basis, and to provide mentoring as opportunity arises. The senior leaders are specifically instructed not to provide significant work on assignments given to the freshmen teams, but to serve in a managerial role. To reduce the opportunity for senior leaders to make significant work or idea contributions to the freshman design projects, senior leaders are typically assigned to teams working on different projects than the seniors are working on in the capstone design. For example, a senior working on a landfill cover design course might be assigned to a freshman team working on cotton gin automation whereas a senior working on the cotton gin automation project might be assigned to a freshman team working on the landfill cover design.

As project managers, senior leaders facilitate team activities by leading discussions, helping coordinate necessary out-of-class meetings, and reviewing student work on assignments. Senior leaders also facilitate student interactions by drawing out quiet students, ensuring equitable work distribution amongst team members, and, as necessary, helping resolve team conflict. Finally, senior leaders provide information about performance and dynamics of their assigned team to instructors through the weekly team evaluations. The weekly evaluation form used by senior leaders during the 2002 Fall Semester is shown in figure 1.

As mentors, senior leaders provide a wealth of information to the freshman design students on academic issues, departmental policies and resources, employment opportunities, and extracurricular activities. Senior leaders provide considerable informal academic advising especially related to desirable/undesirable instructors, interacting with faculty, obtaining quality academic assistance, and study strategies. Senior leaders are also instrumental in bringing new students into professional societies. Senior leaders assist new students with obtaining accounts to use departmental computer labs, course preregistration procedures and policies, and employment opportunities within the department and with other groups on campus. In addition to passing along information, senior leaders encourage new students to stay in engineering. Many of the senior leaders experienced disillusionment during their early academic careers. They are easily

able to identify with similar problems faced by the freshmen and sophomores who populate the freshman design course.

Weekly Performance Appraisal
 To be submitted weekly by AGEN/BSEN 479 students for members of their AGEN 150 team.

AGEN 150 student's name¹: _____

Based on their performance during the previous week, rate the student for each of the following categories:

	Exceptional	Very Good	Acceptable	Needs Work	Unacceptable
Interpersonal interactions					
Willingness to accept tasks					
Participation					
Preparation					

1. What materials/information did this student bring to class or to your out-of-class meetings?
2. What contributions did this student make to design discussions?
3. What assignments/materials/ duties did this student agree to complete before the next meeting?
4. What were your primary activities as senior leader? What mentoring or advice did you provide this week?

¹If absent, did this student contact you or other team members about missing class or team meetings?
 Yes No

Figure 1. Questionnaire used by senior leaders to provide weekly evaluation of freshman design course teams to course instructors.

Senior Response

The reaction of the senior leaders to the experience of working with the freshmen teams was collected during a focus group following the conclusion of the class. Overall, the seniors were very positive about their involvement with the freshmen teams. They were surprised to find that not advising the students on the same problems that they were working on in their senior design class was a positive aspect. Through this arrangement, they were not pulled into the role of a technical expert for their freshman team but became advisors on the process of finding the technical information needed to solve the problem. They also enjoyed serving as mentors to the students and advising them on what classes to enroll in for the next semester, the best professors to take, and how to survive at a large university.

The seniors commented that the use of real world problems in the freshman class was a positive experience and was cited by some of the seniors as something they fondly remembered from their freshman design class. There was some concern that the problems were too advanced for the freshmen, but the senior leaders felt that additional faculty interaction and more exposure to different sources of information could overcome this potential problem. Several of the seniors commented that the unconstrained approach that the freshmen were able to use gave the senior teams some fresh ideas for solutions to their own design problems.

The seniors were introduced into the mentoring process with limited coaching from the instructors. While this was an initial concern for the instructor of the senior class, after completing the class, the students felt that they managed the experience well and did not need additional coaching. Observation by the instructors would support this belief. Many of the classes in the curriculum utilize teaming, so the students have been exposed to a wide variety of team situations by the time they become seniors. Early in the semester, the seniors were exposed to an exercise in developing design objectives. The outcome of this exercise was discussed with the seniors with respect to working with the freshmen on their design objectives. The seniors also completed exercises on project management related to scheduling and allocation of resources. These project management exercises were reviewed with the seniors not only in relation to the seniors' projects but also as the exercises would apply to the freshmen projects. There were some specialized situations where an individual senior leader conferred with one of the instructors about a problem with the team and this process appeared to work well in resolving problems. In the future, the instructor for the senior leaders will encourage the students to compare methods and discuss individual strategies in a seminar format.

Freshman Response

Students in the freshman design course consistently report positive experiences with their senior leaders. Freshmen provide a confidential evaluation of their senior leaders at the end of the course. When asked what grade they would assign their senior leader, the vast majority of freshman design students responded "A". Specific comments freshman team members made about their senior leaders follow:

- "(She) was very easy to get along with, and she did a good job of keeping us on track."
- "He did not try to control us, he instead guided us. He answered any questions we asked. Good job."
- "They were supportive and they always helped out when they could. They gave good advice and it was nice to have someone with experience to guide us."
- "Both (our senior leaders) were available for help when we asked for it, but they made us think out the problem ourselves."
- "She did a good job helping us but not acting as our teacher or superior. Good guidance."
- "He always wanted to know what we were doing and when we were meeting out of class. When he didn't get everything in class he would call and find out what we decided...he would help me with other things too."

Perhaps the most telling proof of the favorable impression senior leaders have on the freshman design students is the willingness of former freshmen design students to serve as senior leaders when they reach that point in their curriculum. Until the 2001 Fall Semester, service as a senior leader was not required. Most senior leaders signed up for one credit hour of independent study. However, a number of seniors who did not need the hour of credit offered to volunteer their time as senior leaders. When these seniors were asked about their willingness to volunteer time, they specifically cited their positive experiences with senior leaders when they were freshmen.

Faculty Response

The incorporation of senior leaders into the freshman design class has, for the most part, been a positive experience for the students and instructors. For the seniors, it places them in the position of taking a leadership role within the group. While some of the seniors have voluntarily taken on leadership roles with various student organizations, many in the class found this to be a new experience. The seniors were asked to evaluate their team members in writing weekly, and were challenged to separate their personal feelings from their professional assessment of the freshman performance. In many cases, the seniors were advising freshmen teams that were working on a different design problem than the one that they were assigned in the capstone design course. This challenged them to function not as the technical expert, but in an organizational and management role. The instructor for the senior class found there to be a number of benefits to the seniors in business and management skills that will be useful in their professional careers.

For the freshman design course, inclusion of senior leaders with the freshman teams provides significant benefits with negligible costs. Interaction with the senior leaders provides the freshman teams considerably more project management and advice that an instructor could provide alone. Moreover, since the senior leaders are much closer to the freshman design students in age and experience, they are more approachable. Finally, the senior leaders are able to provide mentoring that faculty cannot. The senior leaders have had the same courses that the freshmen must take, have had personal experience with various instructors, and view the department and curriculum from a student's perspective. In the freshman design course, the effort and time needed to bring senior leaders into the design teams is minimal. Some time is required to match senior leaders with freshman design teams and some in-class time is required to introduce the senior leaders and explain their responsibilities and roles.

For the senior design class, the most significant cost was the loss of the class time used to work with the freshmen class and to observe their final presentations. Material that would have been covered in the fall semester was deferred to the spring in order to provide this time. In all other regards, the cost was negligible as the instructors worked together to coordinate the classes and to optimize resources. Coordination of class schedules and meeting times was facilitated by the department's undergraduate coordinator and was critical to making the class work as designed.

In future years, additional instruction will be provided to the seniors as to the amount of input to provide to the freshmen teams. In some cases, there were solutions proposed by the freshmen that were not physically possible and the senior advisor for that team should have prevented those

from going forward. The amount of interaction between seniors and freshmen varied, due in part to individual personalities, but the seniors could use additional coaching in the mentor role.

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Biographical Information

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