Revision of a Joint BME, ME, and EE/Comp. E Senior Engineering Design Seminar

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Abstract

In the fall term of 2003 the design instructors in BME, ME, and the combined EE/Computer Engineering senior design classes at Vanderbilt University collaborated in offering of a common one credit hour design seminar. The intent of the course was to jointly sponsor relevant guest speakers, to demonstrate the commonality of certain design topics, and to assist in the development of multidisciplinary design teams for projects in the four departments. Student grades were based upon attendance (a 5% loss per missed class) and a single end of semester term paper on one of several presented topics.

We reported last year\textsuperscript{1} on the initial results from that course structure. Students did not join multidisciplinary teams in significant numbers (BME’s 64 students gained only 4 outside majors, in exchange for 2 working on other major teams, for example.) Students resented the use of a sign-in sheet, and often would sign in and leave prior to a lecture. An end of term special student survey was done to elicit advice regarding this year’s offering.

Major changes were instituted this year. Attendance was taken randomly using a sign-out sheet and attendance at some seminars was based upon in-class exercises. The initial class period involved an in-class design team exercise in which each team was comprised of two BMEs, one ME, and one EE or Comp. E student. This exercise was purposely intended to be a “mixer” to facilitate development of acquaintance of students with other majors. An integrated list of potential design projects was generated for all majors (rather than each instructor posting a listing to their class) and each project posted had suggested majors for the team to be formed. Non disciplinary homework exercises were generated for most lecture topics.

The effect of these changes and the ensuing student body feedback will be discussed in this paper.
Introduction

Senior design courses at Vanderbilt University in the departments of Biomedical and Mechanical Engineering have long been stand-alone full year courses (3-3). Student exchanges between the design teams in BME and ME first took place in 2001-2002 school year, when 2 ME students joined BME teams. The Electrical and Computer engineering department began to require a senior design course in 2003-2004 for their majors requiring a design course (Electrical engineering and computer engineering), and the instructors involved agreed to collaborate on a common design seminar and in efforts to encourage development of multidisciplinary design teams.

The primary result of this effort was the initiation of a senior design seminar\(^2\). The catalog description for the course was posed as: “Elements of Professional Engineering Practice. Professionalism, licensing, ethics and ethical issues, intellectual property, contracts, liability, risk, reliability and safety, interdisciplinary teams and team tools, the role of codes, standards and professional organizations, career, entrepreneurship, human factors and industrial design.” The stated intent of the seminar was “… the development of design skills through lectures about elements of the design process. This course will include seminars on: professionalism, licensing, ethics and ethical issues; intellectual property, patents and VU patent policies; contracts and liability; risks, reliability, safety and the work environment; career issues including jobs; graduate and professional studies; entrepreneurship; use of the www and other information resources; and others. “

There were several motivating factors for development of this course. Capstone engineering courses at several engineering schools\(^3\) include “inter-departmental” or interdisciplinary design teams and our graduates indicate that they frequently work in an interdisciplinary environment. The curricular evolution reported here is part of an effort to provide our students experience in working in an interdisciplinary environment.

BME and ME courses had, prior to the introduction of this course, begun student design projects in November, after the formal lecture material had been covered in class. The design seminar which continued for the entire term in parallel with design project work, permitted design projects to be started earlier. Design credit in BME and ME was dropped to 2 credit hours with the 3\(^{rd}\) hour becoming subsumed in the design seminar. A second motivating factor was the desire to facilitate development of multi-disciplinary student design projects. It was hoped that a mix-and-match of majors might be accomplished by having the students in a common seminar where faculty were invited to give presentations on projects requiring interdisciplinary teams. Another goal was to be able to bring in quality speakers one time, rather than requiring three speakers for each of the three majors. To further facilitate students’ ability to participate in interdisciplinary design projects, a common guideline was developed for senior design projects. In a related endeavor, the primary faculty negotiated with the University administration to
allow outside companies sponsoring projects to maintain their intellectual property rights in exchange for submission of, and participation in, senior design projects.

Deliverables from the students were 1. Attendance (fulfilled by a sign-in sheet) and 2. A term paper on one of the lecture topics presented (with the exception of the careers and graduate school seminars.) The final grade for each student was based upon the term paper (graded by one of the instructors) discounted 5% for each class missed. The class met weekly from 4:10 to 5:00. Seminar speakers generally kept to the 50 minute time limit. The period immediately after the seminar was reserved for group meetings between interested students and persons needing interdisciplinary teams for their projects for the first half of the term. Seminar speakers generally presented using PowerPoint slide shows although two used a transparency projector. Two lectures originally planned for could not be filled (Entrepreneurship and Prototyping Processes), local speakers filled in (Contracts and User-Centered Design) for these sessions.

The joint design seminar was offered in the fall of 2003. It was taken by 66 BME students, 50 ME students, and 20 EE/CE majors. Classes were held in a newly renovated multi-level amphitheatre design lecture hall which was one of the few rooms on campus adequate for such a large class size (136.) Students typically entered on the upper level, grabbed a drink, signed in, and then took places in the room.

During a few of the lectures, several students exited class during the lecture using the upper level exit. Attempts to remedy this led to students expressing dissatisfaction with the conduct of the course which led to the development of a questionnaire to evaluate the students’ opinions regarding the course and content.

The results of that questionnaire were reported here last year1. Changes made in the course structure based on that experience were as follows: 1. attendance continued to be mandatory, and was taken more discretely through an in-class exercise or an end of class sign-out sheet. 2. Rather than an end of semester term paper being the only academic requirement, most of the class sessions included a homework or an in-class exercise (12 of 14 classes had exercises). 3. Students were permitted, penalty free, one dropped homework and one unexcused “cut”. The class enrolled 173 students in 2004 and it was again surveyed under the new structure.

Results and discussion

This section will report on and discuss eight main results of the above mentioned questionnaire (n=57). Appropriate comparisons will be made and discussed with respect to the results obtained from a similar questionnaire (n=60) in 2003. A discussion of the results affected by the changes made this year will be discussed, with recommendations for future offerings.

1. The students were asked which of the lecture topics should be continued (1) or eliminated (0). The summary statistics for this are given in Table 1, next page.

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1. Proceedings of the 2005 American Society for Engineering Education Annual Conference & Exposition

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Table 1: Student questionnaire results, rank ordered seminar lectures for fall 2004 (n=57) and for fall 2003 (n=60).

<table>
<thead>
<tr>
<th>Lecture Topic</th>
<th>Topic Mean Score – 2004</th>
<th>Topic Mean Score – 2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graduate and Professional Schools*</td>
<td>0.95</td>
<td>0.98</td>
</tr>
<tr>
<td>Teams and Teamwork*</td>
<td>0.85</td>
<td>0.58</td>
</tr>
<tr>
<td>Intellectual Property*</td>
<td>0.84</td>
<td>0.98</td>
</tr>
<tr>
<td>Entrepreneurship</td>
<td>0.83</td>
<td>n.a.</td>
</tr>
<tr>
<td>Career Issues: Jobs and Placement*</td>
<td>0.81</td>
<td>0.95</td>
</tr>
<tr>
<td>Ethics*</td>
<td>0.80</td>
<td>0.86</td>
</tr>
<tr>
<td>Human Factors</td>
<td>0.75</td>
<td>n.a.</td>
</tr>
<tr>
<td>Product Liability*</td>
<td>0.73</td>
<td>0.80</td>
</tr>
<tr>
<td>Safety in the workplace*</td>
<td>0.72</td>
<td>0.77</td>
</tr>
<tr>
<td>Reliability and testing*</td>
<td>0.65</td>
<td>0.80</td>
</tr>
<tr>
<td>Contracts*</td>
<td>0.63</td>
<td>0.74</td>
</tr>
<tr>
<td>Labor and labor issues*</td>
<td>0.62</td>
<td>0.48</td>
</tr>
<tr>
<td>Designsafe and Risk Management*</td>
<td>0.59</td>
<td>0.79</td>
</tr>
<tr>
<td>Prototyping</td>
<td>0.50</td>
<td>n.a.</td>
</tr>
<tr>
<td>Finance and Accounting for Engineers</td>
<td>dropped</td>
<td>0.73</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>cancelled</td>
<td>0.63</td>
</tr>
<tr>
<td>Building the user into the development cycle</td>
<td>dropped</td>
<td>0.40</td>
</tr>
</tbody>
</table>

n.a. indicates that the subject was not applicable

* indicates that the lecture topic and lecturer were repeated

Discussion: Thirteen of the fourteen lecture topics given this last fall were recommended by the class as topics to continue in future year’s course offerings. Two of the lecture topics from 2003 were dropped in 2004 due to the low rating given by the class to the topic while one was cancelled as the lecturer had other obligations.

It is unsettling to note that of the ten repeat lectures (repeat topic and lecturer) that eight of the ten were given lower ratings in 2004 than in 2003, when indeed the content and delivery remained virtually identical in all but one case as perceived by the course moderator. The one exception was the lecture on teams and team development in which new content on personal problem solving skills had been added at the request of the moderator.
2. Students were asked to respond to questions regarding their understanding of material presented in the seminar on a scale of 1-5, with 5 being true and 1 not at all true. Results from this question are tabulated below in Table 2, below.

Table 2: Class statistics for the series of questions “the seminar enhanced my …” on a scale of 1-5, with 5 being very true.

<table>
<thead>
<tr>
<th>The BME-EECE-ME 297 seminar enhanced my</th>
<th>Average, 2004</th>
<th>Average, 2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>understanding of intellectual property+</td>
<td>3.51</td>
<td>3.84</td>
</tr>
<tr>
<td>skills in engineering team work+</td>
<td>3.23</td>
<td>3.25</td>
</tr>
<tr>
<td>understanding of the role of human factors in design*</td>
<td>3.02</td>
<td>n.a.</td>
</tr>
<tr>
<td>capabilities to deal with supervisor/employee issues in the workplace environment+</td>
<td>3.02</td>
<td>3.02</td>
</tr>
<tr>
<td>skills and insight into strategies for entrepreneurship*</td>
<td>3.00</td>
<td>n.a.</td>
</tr>
<tr>
<td>understanding of contracts in engineering projects+</td>
<td>2.98</td>
<td>3.00</td>
</tr>
<tr>
<td>capability to deal with ethical issues you listed above+</td>
<td>2.96</td>
<td>3.42</td>
</tr>
<tr>
<td>risk management and safety skills+</td>
<td>2.96</td>
<td>3.23</td>
</tr>
<tr>
<td>skills in organizing safety programs for the workplace</td>
<td>2.89</td>
<td>3.17</td>
</tr>
<tr>
<td>strategies which will permit you to navigate the shoals of product liability+</td>
<td>2.89</td>
<td>3.04</td>
</tr>
<tr>
<td>ability to plan a product test+</td>
<td>2.87</td>
<td>3.05</td>
</tr>
<tr>
<td>ability to plan my career+</td>
<td>2.74</td>
<td>3.11</td>
</tr>
<tr>
<td>ability to integrate rapid prototyping into the design process*</td>
<td>2.72</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

n.a. indicates that the topic was not applicable  
* indicates new lecture, + indicates repeat lecturer and topic

Discussion: The level of understanding, based on student perceptions, did not fare as well as in the 2003 class. All but one element was judged less valuable in terms of the learning experience by this year’s class.

3. “What do you think might be done to improve attendance and participation?” was the next major inquiry made of the class. A variety of responses were recorded, several of the most common are detailed below:

- get better speakers (15 responses)
- have mandatory attendance (or use in-class buzzers or other) (15)
- have class earlier in the day (7)
- have more in-class homework/exercises (6)
- have less homework or busy work homework (3)
- have free food and prizes/bribe us (3)
Discussion: In 2003 it was noteworthy that several students suggested adding assignments to the class, rather than having a grade dependent solely on attendance and a term paper. It should be noted that the few comments on homework exercises about nullified each other this year. The suggestion regarding use of personal response systems was mentioned in 2003 and in 2004, but was not followed up due to the additional costs that would be incurred. The 2005 senior class will be the first class which is required to have a laptop computer thus collection of real time feedback using software such as Silicon Chalk will be considered. Recruiting better and more interactive speakers was also a common suggestion each year. Noteworthy was the final comment regarding the balancing act that we are performing.

4. One of the major objectives that we wished to accomplish with this seminar was increased interaction between majors, especially on design teams. We therefore asked: “What can be done with this seminar to better serve as a vehicle for formation of multidisciplinary teams?” Responses included:

- have more in-class or homework involving multidisciplinary group work (13 responses)
- discuss/warn about/encourage multidisciplinary teams (6)
- have multidisciplinary projects (4)
- have more majors (2)
- have more interaction in and out of class (2)
- post projects earlier (1)
- force the issue (1)
- structure is OK as is (1)
- do personal assessment before teams are made (1)

Discussion: In 2003 few multidisciplinary teams were formed (3 of 24 in BME, 2 of 11 in ME, and 1 of 4 in EE/CE). In 2004 we added an exercise in the first class to introduce the students to each other, using a multidisciplinary design project as an example. We further generated (in 2004) a common design project list, with a suggested mix of majors on each project. If a student was interested in a project or a group needed a student from another major to add to a team, this was posted on the web site listing. Time was allotted
at the end of the lecture session for student groups to meet with prospective advisors and form teams. There were substantial improvements in the number of interdisciplinary teams formed with 13 of 26 BME teams, 5 of 8 ME teams and 6 of 10 EE/CompE team composed of interdisciplinary students for 2004-5. We plan to add additional in-class exercises to increase this percentage for 2005-6.

5. The students were last asked “What topic(s) would you suggest adding? A sampling of the primary responses follows:

- structure is ok, don’t add anything (3)
- career paths (3)
- law/medicine/business (2)
- management and management skills (2)

and entrepreneurship, consulting, sales, group dynamics, donuts, technology trends, government: private interactions, more cool lecturers, industry speakers, Meyers Briggs, synergy, design tools, manufacturing, drafting, networking, documentation, marketing, web design, concept maps, scheduling, life after college, group meeting times (in place of lecture), better jobs, six sigma.

Discussion: No area of interest clearly stands out in this list, but several of the topics will be considered for next year if an interactive dynamic speaker can be found for the area.

6. Students were asked to identify some of the ethical issues which they expected to encounter in their career. Their responses included:

- cost v safety (9 responses)
- stem cell use (5)
- safety (5)
- whistle blowing (4)
- intellectual property (4)
- Health Insurance Portability and Accountability Act (HIPAA) (3)
- testing on humans (3)
- ethics (3)
- sexual orientation/discrimination (3)
- cost cutting (2)
- medical care: cost (2)

and contracts, risk, time constraints, honest testimony, medical, racial, immorality, hiring and firing, safe vs. safe enough, liability, workplace safety, and public interest (1 each.)

Discussion: No single area dominates this list. The variety of issues identified speaks to the variety of interests and career goals of the class, and at documents (for ABET and others) the fact that our students do have an interest in ethics.
7. Students were asked to reflect on the course and to give suggestions for improvements as well as criticisms. Their responses included:

Suggestions for improvement/negative comments:

- make the class less boring (6 responses)
- make the class more interactive (3)
- homework was annoying (3)
- make it more “real world” (2)
- engage the class more (2)
- have more non-engineering speakers/broaden topics (2)
- use a single screen for displays (1)
- move this to the junior year (1)
- don’t do group activities (1)
- have only guests, not our professors (1)
- have food (1)
- link the speakers and topics (1)
- instead of homework, require one job or graduate school application per week (1)
- add contracts

What was good?

- “love the drinks” (3)
- good to see the non-technical side of design (2)
- homework was helpful (1)
- the entrepreneurship and team lectures (1)

Discussion: It requires an extremely dynamic speaker to engage all of the students involved in this type of class. Holding the class at 4 PM on Wednesdays involved some schedule sacrifices and no other time worked. The availability of caffeine in the form of free drinks was meant to help alleviate sleepiness and addition of doughnuts might provide a sugar peak to further raise the intellectual activity level.

8. Students were requested to recount skills they acquired through the seminar that they found most important. These responses included:

- team development/group dynamics (28 responses)
- contracts (10)
- intellectual property law (12)
- liability (8)
- career website/applications (7)
- risk assessment and mitigation (7)
- labor law (6)
- graduate school options (5)
• safety (4)
• legal issues (3)
• workplace safety (3)
• the job market (3)
• organization (3)
• ethics (3)
• entrepreneurship (3)
• Google/web searching (3)
• Reliability, human factors, leadership, communication, resume writing, prototyping, how to not sleep through this class (2 each)
• Planning, tools, engineering and other fields, testing, networking, career paths, human factors (1 each).

Discussion: New on the list this year was the first element, which was purposefully requested of the lecturer on team dynamics. It was gratifying to see this item identified by the students as we consider it one of the more important elements in the conduct of design projects in the design classes. The remainder of this list fairly well mirrored the lecture series, with the exception of the comment about developing the skill to not sleep through the class. Two observant students did note that two of the four professors did indeed nod off during one of the lectures!

Conclusions:

Our second offering of a common engineering design seminar was not without “growing pains” but substantial advances in the numbers of interdisciplinary teams formed reflects a major success. Many students disliked the timing, the form of the presentations (lecture), and the lack of interaction between lecturers and students. The absence of complaints about a “low bar of requirements” encountered last year reflects a student perception of higher intellectual content in the current offering. The students expressed an interest in most of the lecture topics and recommended keeping most of them.

The faculty in charge of this course will meet and study the above reported results. The year 2005 will see additional innovation in the course structure, such as the addition of more in-class multi-major group activities, incorporation of real time feedback employing laptop computing and additional of refreshments including sugar such as cookies or doughnuts. Our Dean will be invited to “launch” the seminar and emphasize the need for interdisciplinary activities such as this seminar and joint project work. There is also some serious current discussion of expansion of the interdisciplinary design seminar to include the Computer Science and Civil Engineering Departments.

Thanks to the NCIIA and to the NSF (partial support under Award Number EEC-9876363) for assistance in this endeavor
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2 http://vubme.vuse.vanderbilt.edu/design/ for the course web site.


5 http://www.silicon-chalk.com/overview.htm