

A NEW CAPSTONE SEQUENCE

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Abstract

At Grand Valley State University a new structure for the capstone course has been implemented. The course uses industry sponsored, multidisciplinary design and build projects. The capstone course takes place over two semesters. The first semester (winter) is used for design and the second semester (summer) is primarily focused on build and test. The new structure was successfully rolled out the winter and summer of 2017. This paper lays out the framework used and the lessons learned. In particular past years the student teams had difficulty scheduling faculty to attend their design reviews. The new framework removed much of the lower impact time faculty spent with the students and concentrated on the select items where faculty have a much higher impact. In addition an assessment plan is proposed for the proposed revised ABET criterion 3 student outcome five for the 2019-2020 academic calendar.

Introduction

The capstone sequence at Grand Valley State University is a two semester design and build sequence. The projects are primarily sponsored by local industrial partners. The projects are selected by the faculty working with the sponsors to insure projects with appropriate scopes are undertaken. The sponsors are encouraged to look for projects that are useful and add value for the company but have not risen to the top of the priority list. These 'backburner' projects have proven to fit the two semester model quite well. Regarding timing, the academic calendar and industrial needs do not normally synchronize to allow a sponsored senior project in the regular course of business. The engineering students at Grand Valley State University are all required to complete three semesters of coop with an industrial partner. If a sponsoring company has co-op students they often request that they be placed on the team. If the student agrees the faculty often place the student as requested. The placement of students on team with their co-op sponsors allowed more ambitious projects to be undertaken. Less time is lost through

miscommunication and learning how to accomplish tasks within the sponsor's organization.

Structure

The first semester of the course is primarily used for design. Table 1 lists the week by week expectations for the students and faculty. The last three weeks are blank. This is a buffer used to account for variability in the projects and the students. The second semester is reserved for building and validation testing. The project is complete when both the sponsor and faculty signoff on the project. Typically one or two teams each year need to defer their graduation date for four to six weeks due to their projects not being complete. This also serves as additional motivation to the students to complete their projects as soon as possible and to treat them in a very serious manner.

Table 1. First Semester Week by Week Expectations

Week	Student Tasks	Faculty Task	
1	Review proposal and create list of questions leading to specifications	Review questions and give approval to meet with sponsor.	
	Schedule meeting with sponsor.		
2	Meet with sponsor and create draft of specifications.	*Review Specifications	
3	Meet with sponsor and refine specifications.		
4	†Meet with sponsor for specification sign-off. Begin concept generation		
5	Concept generation and refinement.	*Review Concepts	
6	Review concepts with the sponsor.		
7	†Concept selection by sponsor		
8	Begin detail design		
9	Spring Break		
10	Peer Design Presentation		
11	Faculty Design Reviews	*Attend, Comment and Approve for Sponsor Review	
12	Send detailed design to sponsor		
13	Revise design and obtain approval top order parts.		
14	Project Allowance		
15	Project Allowance		
16	Project Allowance		

*Indicates an item that requires three faculty to approve.

†Indicates a sign-off is required by the sponsor.

Table 1 also highlights a major difference between the old and new structures when comparing faculty workload. The previous structure had two faculty assigned to each team. One faculty was designated as the lead faculty and the other secondary. This structure was in place to insure that a ‘second set of eyes’ reviewed the progress of the project. However, it was recognized that the added value was only realized during a few key points in the semester as tabulated.

Faculty Responsibilities

Each project has a faculty advisor. During the first semester, the advisor is expected to meet each week with the student team to review their progress. As the projects progress often more than one meeting is required each week. In addition to their assigned project the faculty are assigned two other projects to provide additional support. For these two additional projects they have a much smaller scope of work. They are expected to review and approve specifications, concepts and the final design. Two lessons learned from previous capstone experience: The sponsors and faculty advisor are encouraged to refrain from introducing their own concepts until after the students have generated their own. Experience has shown that if the sponsors or advisors offer their concepts too early the students will latch onto one of these concepts and neglect their own. The second lesson learned is scheduling the sponsor design review at the university. If the design review is held at the sponsor location often a senior member of the organization attends that has not been involved with the project and may offer comments and or suggestions. Due to the senior member’s status in the organization, these comments/suggestions are then transformed into requirements which grow the scope of the project. Conducting the review at the university minimizes the number of surprise guests at the design review. The faculty advisor duties for the second semester which is primarily concerned with building and validation testing are again to meet with the students each week or as needed. This flexibility is quite valuable. The team that has their advisor tells them we can skip this week’s meeting knows that they are on track. Conversely the team that needs an additional meeting each week knows that they are at risk for not completing their project on time. Where possible having the same advisor for both semesters is preferred for obvious reasons. If this is not possible having one of the faculty that acted as additional support works quite well. If this is not possible having the new faculty advisor attend the final design review is an excellent method for informing them to the status and scope of the project. Discussions with faculty at the end of the capstone sequence indicated that the new format seemed to result in less frustration for the students and faculty. In particular being assigned as one of the support faculty allowed them to put a higher priority on attending the design reviews.

Assessment

ABET proposed criterion three outcome five: The capstone design sequence was tasked with assessing proposed outcome five¹ "an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives" The assessment will measure the ability to function on a team. The team project documentation will substantiate whether or not the capstone projects provide an effective vehicle for leadership, collaboration, inclusiveness, goal setting, planning and meeting objectives. The plan for the 2018 senior projects is to use CATME surveys to assess the ability of a student to function on a team. The CATME surveys have been successfully used in the past to assess the ability of students to function on an interdisciplinary team. An end of semester survey will be used to assess the level of collaboration and inclusiveness that the students felt was evident in their projects. In particular the following two questions will be used.

Collaboration: Please rate the level of collaboration that was evident in your team 1 – No collaboration 5- Threw it over the wall 10 – No major surprises between project members.

Inclusiveness: Please rate the level of collaboration that was evident in your team 1- No Inclusion 5 – all members were asked for input during meetings 10 – all members felt comfortable giving and receiving feedback

The terms used in these questions are discussed during lecture. A review of reports and project websites will be used to assess to see if they provided a vehicle for ¹"leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives". The reports and websites include the work breakdown structure for each team and should fulfill the requirements of establishing goals, task planning and the ability to meet objectives.

Conclusion

The new framework was successful. Faculty time was more efficiently used for review of the specifications, concepts and designs. The new criteria will be assessed at the end of summer semester 2018 and discussed by the faculty and assessment committee.

¹ ABET, "Criteria for Accrediting Engineering Programs" pp 40, October 20, 2017