

Design of an online portal to assist in the realization of Institute-wide Multidisciplinary Capstone Design

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The final culminating Capstone Design course provides students the opportunity to work in teams and apply their knowledge to design, build and test prototypes for solving real-world, open-ended design challenges. These challenges are at times students' own idea or are proposed by industry sponsors or researchers and faculty. Several research studies have shown both qualitative and quantitative advantages for students by working on multidisciplinary Capstone Design projects. All schools within various colleges of Georgia Tech currently only offer the traditional mono-disciplinary Capstone Design course and hence there exists no formal channel for students to collaborate and work together on multidisciplinary Capstone Design projects.

In the absence of a multidisciplinary Capstone Design course, the transition from traditional mono-disciplinary Capstone Design course raises issues of managing faculty teaching expectations, providing administrative support to faculty and students and forming multidisciplinary functional student teams. In order to assist with resolving these issues, an online portal was developed with an objective to support the implementation of multidisciplinary Capstone Design projects. Faculty and student input were solicited in order to conceptualize and develop the website to efficiently share information about multidisciplinary project ideas between students and faculty. A systematic work flow was conceived and implemented to enable formation of student teams from various schools and submission of project 'bids'. This paper presents the design of this web portal along with a discussion on the scope for further improvement.

Keywords: capstone, design, multidisciplinary, online portal

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Introduction

Capstone Design Course is offered as a project based culminating course in many undergraduate engineering programs. It is an integrative course where senior-standing engineering students synthesize solutions to "real world," open-ended engineering problems¹. Students taking Capstone Design course in various Schools within the College of Engineering (CoE) and the School of Industrial Design (ID) showcase their projects at the end-of-semester Institute wide Capstone Design Expo. Traditionally, at Georgia Institute of Technology, the course is offered mono-disciplinarily within each School² with the exception for a special section comprising of few students who participate in the joint Capstone Design course offering between School of Mechanical Engineering (ME) and ID.

Several past research studies^{2,3} have shown the positive impacts of multidisciplinary Capstone Design experiences. Most design challenges in industry are solved by multidisciplinary teams, and thus multidisciplinary projects provide a more realistic engineering experience for engineering students⁴. In order to enable multidisciplinary Capstone Design experiences, there are several logistical challenges to be

overcome by faculty and students⁵. This paper presents a brief overview of the design of an online portal which assists with efficient information transfer between students and faculty and helps in realization of institute wide multidisciplinary Capstone Design teams.

Although unique for Georgia Tech, an online marketplace for multidisciplinary Capstone Design projects is not completely unique. A marketplace for multidisciplinary multi-university Systems Engineering Capstone projects has been presented earlier⁴. The authors clearly presented the need and requirements for a marketplace primarily for sharing information on project ideas to faculty and students. However, the marketplace did not assist in formation teams, accept bids from students and/or make project-team assignments based on submitted bids. The design presented in this paper is the only known available design to the authors which truly alleviates the logistical burden of sharing information about projects, forming teams, accepting bids and awarding projects to the teams – all through one single website, with little to no faculty involvement.

Need for an online project portal

During Spring 2013, the Associate Dean for Academic Affairs at the College of Engineering (CoE) at Georgia Tech invited faculty and administrators from various schools within the College to collaboratively discuss possible pathways for developing a CoE or Institute-wide Capstone Design program. The faculty discussed several challenges, ranging from differences in curriculum requirements for individual schools, incompatibility between Schools having multi-semester Capstone Design sequence v/s a single semester, adequate scoping of projects, faculty load-sharing, etc. (some of which were similar to the ones already presented by Bannerot et al.⁵). Given the extremely large enrollments (around 800 students take capstone design every semester within CoE) and the other administrative challenges, it was decided that an Institute-wide Capstone Design Course (GT4823) be first offered by the School of Mechanical Engineering (ME) as a special topics substitute for traditional Capstone Design Course (ME4182) to a limited number of students. Other Schools would gradually “join-in” by allowing the GT4823 special topics course to be a substitute to their traditional Capstone/Senior Design course. In order to support the formation of multidisciplinary Capstone Design teams, it was found necessary to develop an online portal which would allow faculty and students to view and post project ideas.

Interestingly, there was yet another motivation within the School of ME, which provoked the development of an online project marketplace. The traditional Capstone Design course within ME is taught by 6-9 faculty members, each mentoring a section of around 30 students. For more than five years, the faculty teaching Capstone Design in ME has also been soliciting industry projects. Every semester, there were about 20 sponsored projects which have to be assigned to student teams. For the first week of class, students are under high pressure to form teams, look at project ideas and submit their ‘bids’, elaborating on the group’s skills and motivations to work on the project, to their respective faculty section instructor. The faculty team then compiles the priorities from each team and coordinates this information with other faculty to decide which team would be awarded the bid. This entire manual process of project-team assignment had the following drawbacks:

1. Too much burden on faculty to compile the necessary information from their students and share with other faculty (section instructors)
2. Narrow window of opportunity for students to learn about projects, form teams and submit their projects bids
3. Logistical issues involved with matching teams and projects. The process was cumbersome and not

transparent to students. This would often lead to lack of motivation.

To streamline the process of making project-team assignments and to support the realization of multidisciplinary capstone projects from other schools, the Office of the Director of Design & Innovation (DDI) in the School of Mechanical Engineering launched an internal project to create an online portal. A multidisciplinary student team comprising of juniors and seniors from the College of Computing, School of Electrical and Computer Engineering, School of Mechanical Engineering and the School of Industrial and Systems Engineering was assembled to develop the online portal.

Portal Concept and Design

The student team interviewed faculty and students to define the user needs for the two constituencies and conceptualized the work flow. The following requirements were identified:

1. Faculty, students and external users should be able to *submit* project ideas.
2. Faculty and students should be able to *view* all accepted projects for a particular semester along with information on which School’s participation is necessary for any given project.
3. Faculty in-charge of a specific section should be able to *accept or reject* projects within their sections. For example, a faculty in a particular school was not keen on mentoring student teams working on multidisciplinary projects that would involve a specific discipline/school.
4. Students should be able to *form teams*, invite other students to their teams and *submit ‘bids’* with priorities for projects of their choice.
5. Faculty should be able to view all teams within their section as well as their submitted bids
6. All students should be able to view how many bids have been submitted for a specific project. This would help them refine their ‘bids’ in case they believe that they deserve the project more than another team.

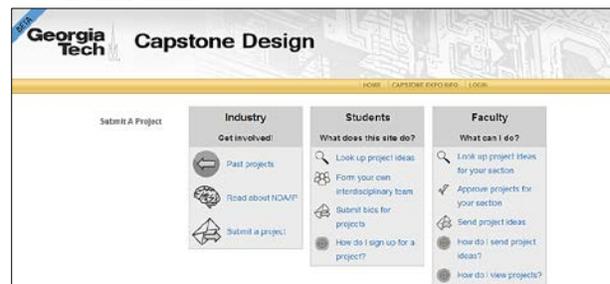


Figure 1 Screenshot of the homepage for the online portal

Since the site, as shown in Fig. 1 and available online at <http://capstone.design.gatech.edu/> was to cater

towards a primarily Georgia Tech audience, the site's navigation and appearance was made consistent with other Georgia Tech websites. The site was implemented using the Ruby-on-Rails web development framework.

Workflow System

The portal needs to be first *activated* by the website administrator (currently the DDI) by creating semesters, sections and assigning faculty to each section. Once activated, the site starts building a database of users and projects as they are submitted. An external sponsor can submit a project without logging into the site. The administrator can then edit the project description and accept/reject the project and specify which schools the project is most suitable for. Once accepted, the project can be viewed by faculty and students associated with the schools that it has been made available for. When students login, they first have to select the semester in which they will be taking the capstone course and the section they have registered for. If faculty or students submit project ideas, they also arrive on the admin page awaiting acceptance. This check ensures that the project idea is of appropriate scope for the course. Students can form groups, add and remove students, and submit bids for projects of their interest. All students, faculty and administrators can view the submitted bids and students can revise their submitted bids up until the deadline (typically by end of first week of the semester). This transparent view of the submitted bids allows students to learn from each other on how to submit stronger bids to enhance their chances to 'win' the project.

User Roles and views

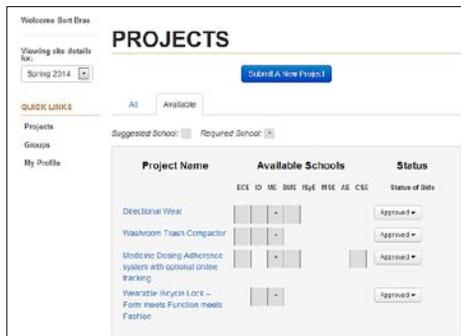


Figure 2 Project's view for Faculty

One of the key requirements of the web-portal was to provide users specific views. For instance, faculty would like to see the list of projects, accept/reject them for their particular section and view groups of students within their section. All users by default log into the site as student user and the admin can elevate specific users as faculty and specify the sections they are instructing. Figure 2 shows the view of the Project's page for a typical faculty. As shown, all projects accepted by the admin are

approved by the faculty as default. They have the option to reject a specific project if they wish. Doing so would make the project unavailable to the students registered in the faculty's section, and hence they will be unable to bid for the project.

When students login the site, they have options to view existing projects, submit project ideas, join existing groups and/or create their group. Only after they form a group, can they submit bids for any projects. The site also facilitates the formation of multidisciplinary teams. If a particular student is interested in working on a project, he/she could form a single member team and submit a bid for a project. All students can view existing teams and the team bids. By having access to this information, students from other schools who might be interested in working on the project can send a request to join the team. Upon joining, the new student member can edit/update the submitted bid to reflect the new status of the team. Figure 3 shows the typical view of the Project's page for a student. As shown, the student can view the projects that need his/her school's participation, as well as how many bids for the projects have already been submitted. The green icon shows that the student's team has submitted a bid for the project, whereas the yellow icon means that the student can submit a bid for the project on behalf of his/her group.

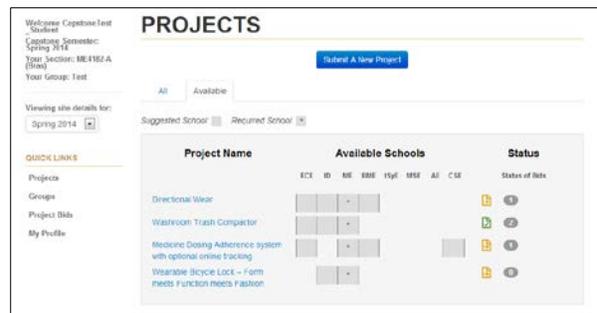


Figure 3 Project's view for Student

Experience and Outcomes

At the onset of the Fall 2013 semester, the beta version of this portal was made available to seniors taking Capstone Design in ME, ECE and BME. Three online presentations (on prezi.com) were designed and shared on the homepage to guide the users to easily navigate through the site and accomplish their task. During the first week of its launch, the site was actively used by around 300 students across campus, all of which were seniors interested in working on Senior/Capstone Design projects⁶.

A total of 34 sponsored projects and 19 student project ideas were accepted into the Capstone program using the site. 30 mono-disciplinary (mostly ME) and 8 multidisciplinary Capstone Design teams were assembled using the online portal. Most of the

multidisciplinary projects were either between ME and ECE or ME and BME with an exception of one ME/BME/ECE team. In all a total of 35 students from the Schools of ME, BME and ECE were able to participate in a multidisciplinary Capstone Design experience in the Fall 2013 semester. A few of these exciting multidisciplinary projects included an assisting robotic system for the human hand, an autonomous lawn mower, a gesture-based automotive user interaction environment and a rapid yet accurate full-vehicle metrology system, most of which were sponsored by corporate partners or local entrepreneurs.

Future Features

Currently, the web portal is managed and operated under the sole leadership of the School of ME. The Director of Design & Innovation approves all projects ideas with consultation and coordination from faculty in all participating schools. This burden or coordination among different schools can be distributed by creating a *capstone coordinator* role within the site, for each School (within Engineering and outside like Industrial Design, Computer Science, etc.). Assigning such a role to at least one faculty from each school would allow them to accept suitable projects directly from the web-portal. Although the back-end design of the site is quite developed and robust, the front end views need to be made more user friendly. The above mentioned features are slated to be added as part of a Capstone Design project for students in the College of Computing within Georgia Tech in Spring 2014.

Conclusions

Despite its well-known advantages for student learning, enabling multidisciplinary Capstone Design experiences across traditionally divided silos of Engineering is difficult due to the additional logistical burden on supervising faculty. An online portal, which enables open and transparent sharing of project information, makes the process simpler. An easy to use interface, bare minimum user options and helpful online presentations for different user groups are keys to successful implementation of an online portal. We hope that the online platform continues to encourage students and faculty from different disciplines within the Institute come together and work on real-world true multidisciplinary Capstone Design projects. The design team is continually working on improving the user experience for all the three user groups – external sponsor, faculty and students to reduce the logistical burden.

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