Design and Development of Open-Source Capstone Project Management Portal

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The capstone project helps students to apply the engineering fundamentals, prepares for future challenges, and provides an opportunity to work in teams while finding solutions to real-world, open-ended technology-related problems. With a variety of stakeholders (eg, students, mentors, examiners, coordinators, and heads) managing such a large project is a challenging task. In this paper, we present an open-source Capstone Project Management Portal, which aims to provide the facility to manage all the processes involved in a one-year-long project. Until now a large number of universities and colleges manage these processes manually or using semi-automated approaches. Research into the workflow of this entire system revealed major data inconsistency and redundancy issues leading to the development of the proposed open-source portal.

Keywords: Capstone, Semi-Automated, Data Inconsistency

Introduction

The Capstone Project is a two-semester process where students pursue mentored research or development of a solution on a problem of their choice, engaging with the scholarly debates in the relevant disciplines. With the guidance of the mentor, they produce an outcome that reflects a deep understanding of the overall learning of their engineering discipline. Students are strongly encouraged to choose a topic where they have some competence based on their academic work, professional experience, or exploration of future career options. The Capstone Project is both a valuable intellectual experience and also a vehicle through which students can demonstrate their research, analytical, and writing skills to either prospective employers or graduate and professional schools.

Several past research studies have shown the positive impacts of team-based capstone projects. Most of the projects in the industry are solved by multidisciplinary teams, and thus a similar approach in capstone projects provides a more realistic engineering experience for engineering students. However, this creates a number of practical problems for faculty and students at the university level, which must be resolved. This paper provides a high-level overview of the design of an online Capstone Project Management Portal that aids in the efficient exchange of knowledge between students and faculty, as well as the creation of Institute-wide Multidisciplinary Capstone Project teams.

Need Analysis

Every year across various departments of TIET approximately 2000 students participate in a Capstone project. Some of these projects are research-based while the majority of these projects are team-based. On an average, the team comprises 3-5 students mentored by 1-2 faculty mentors. Every faculty mentor has 10-15 groups to mentor. They are being evaluated by their respective mentors as well as a committee of faculty mentors and industry evaluators on many judging criteria as per the course learning outcomes.

The previous system involved a hybrid system that involved manual and semi-automated processes. Implementing the capstone project course, in the same way involves hefty processes. The existing scheme of evaluation involved regular checkups by each mentor for their respective teams and then scheduled panel judging rounds. But here, compiling the marks into the final result was a massive challenge as the entire data was being managed locally by the mentors. Keeping track of paper documents and keeping the details secure was a difficult task. When mistakes were made or changes/corrections were needed, a manual transaction had to be completely redone instead of a record update.

More significantly, the Covid-19 Pandemic has conspicuously shown the importance of having the right technology in place. All educational institutions had to move into an online mode of learning and faced a lot of issues in setting up an appropriate platform for their students. Though there were applications and tailor-made websites which facilitated online learning, the options were limited. And these limited times were not enough for the vast variety of courses and learners' demands.

Here we would keep our comparative research limited to implementation of Capstone Project Management system on such tailor-made websites like Google Classroom/Canvas/Moodle etc versus custom-designed portals.

These tailor-made websites have very limited and generic functionality and thus lack a lot of features that the Universities desire. For example, Google Classroom cannot be used to manage previously described capstone projects because there is no feature to make teams, manage mentors, and also fails to meet basic judging requirements. Customized portals like the Capstone Project Management Portal on the other hand can manage all such features. The biggest advantage of the Capstone Project Management Portal is that it is free of cost unlike paid applications like Moodle or Canvas. The source code of the Capstone Project Management Portal is available on Github and can be accessed by any university to set it up for themselves. The portal which has been set up in Thapar Institute of Engineering & Technology is live on: https://github.com/rkwap/capstone-project-management-portal.

Motivated by these advantages of customized portals, most of the reputed universities have built their own capstone portals and are carrying out the capstone project management through them. One such University is Georgia Institute of Technology who have built their own Institute-wide Multidisciplinary Capstone Design.

Portal Concept And Design

The student team reviewed the needs of the academic department and students to define the user needs for the two constituencies and conceptualize the workflow. The following features and requirements were identified:

1. Mainly three end-users were identified: they are Students, Faculty Members/Mentors, Course Coordinators/Administrators.
2. Students should be able to form teams, the team leader can add other students to his/her team.
3. Student teams should be able to submit 'bids' along with their project ideas to the available mentors.
4. The mentors should be able to view all the 'bids' made to them. Beyond that, they should have an option to accept or reject the bids/proposals.
5. The mentors should be able to view and download the data of their accepted teams from their dashboard.
6. The Administrators should be able to push announcements/notifications, set evaluation dates, add/remove mentors, create judging panels. Also, the administrators should be able to access and download the entire data of all the teams and mentors.
7. All the data should be downloaded in Excel sheets.

This identification of requirements was further extended to Non-Functional Requirements that are mentioned below:

- Performance Requirements: The Capstone Project Management Portal was being developed as the chief performance system for helping the organization in managing the Capstone course. Therefore it has been built to provide a hassle-free, smooth and user-friendly experience.
- Safety & Security Requirements: The database was required to be extremely secure. Each category of end-users should be given the required access rights and thus properly encapsulate and abstract the portal data. To avoid data loss due to database failure, a regular backup prompt must be sent to the admin.
- Database Management System (DBMS): The database design had to solve major data redundancy and inconsistency challenges by making sure that the design is normalized properly. Another challenge was making sure that it could be scaled if required in the future.

Beyond the above-identified objectives, the portal was expected to be user-friendly, easy to access, and available on any device. Upon analyzing these needs, the developers decided to make it available on a Web Interface. The application as it has to be built on a web must be having three major components which are Client-Side Interface i.e. Front-End, Server-Side Interface i.e. Back-End and Database for storing all the information. To develop the same they decided to use the following tech-stacks for building the portal:

1. Server-side programming: Python-based micro web framework Flask
2. Client-side programming: HTML, CSS and Javascript
3. Database: MySQL

System Workflow

The project has been set up on the University servers. Once activated, the site is under the complete control of the admin and the course coordinator. The admin and the course coordinator decide upon the list of available mentors.

Once the mentors are set up, the site is ready to be used by the students. The team leader can register his team on the website by adding all the members of his team. Upon forming a team, the students can send project ideas/proposals to the list of available mentors/faculty.

Fig 1. Capstone Project Registration

Beyond this, the role of mentor comes into play. The mentors have to log into their dashboards and go through the proposals. He/she then is expected to accept the proposals on which he decides to work along with the students. The portal gives the mentor an option to 'Add Group' or 'Delete Request'.

Fig 2. Accept Team Bid Request

One of the key features of the Capstone Project Management Portal was to manage the panel evaluations. This included scheduling the evaluation dates and making announcements of the same to the students and faculties. The same is taken care of through the interface provided only to the admin and course coordinators. They are provided with a functionality to decide upon the list of panelists and push an announcement regarding the dates. For the judging process, they have been provided with a feature to control the judging criteria and their weightage in the evaluations. The mentors and the judging panel are expected to follow the proposed scheme for marking students. Post evaluation the marks are fed into the portal through an interface provided. The interface for adjusting the judging criteria is shown below.

Fig 3. Setting Judging Criteria (Admin Tools)

The Capstone Project Management Portal serves one major functional requirement of data integration and reducing data redundancy and inconsistency. Beyond this, the portal also implements the feature to export the student/team data. The mentors have been given the access to download the data of their teams while the admin and the course coordinator can download the entire data of the course. All these downloads can be made into excel sheets as well.

Conclusion

Despite the well-known advantages of the capstone project, implementing it in the university across various departments had always been difficult due to the additional logistical burden in supervising faculty and University administration. This capstone project management portal, which facilitates secure and easy sharing of project information, makes the process

simpler. The good design of an online platform requires an easy-to-use user interface, the bare minimum of user choices, and useful online displays for various user classes. The capstone portal has been built on these fundamentals. It makes the entire procedure robust and modular and the scope of errors is reduced significantly. The design team is continually working on improving the user experience for all three user groups – administration, faculty, and students to reduce the logistical burden.

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