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Onboarding Instructors in an Established Capstone Program

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Onboarding instructors into an established engineering capstone program can be challenging. Capstone courses are distinctly different from other engineering courses in their broad content, the application of prior courses, the interactions with entities external to the course and/or university, and the critical importance of student team dynamics. The onboarding process is greatly simplified when new instructors join an existing capstone program and are provided with a course template. However, challenges remain. This paper describes the onboarding process in the Multidisciplinary Capstone Program (MCP) at Oregon State University. The effectiveness of the process is discussed through the results of an informal survey of four recently new instructors. Results show challenges in time management, team formation and dynamics, interactions with external entities, understanding the instructor's role, variation in course deliverables, and course content. Also, instructor responses support the claim that teaching capstone is distinctly different from teaching other engineering courses. However, all agreed that joining an established course was a significant advantage and that the onboarding process was successful. The onboarding process presented here provides a framework for onboarding instructors into an established Capstone Program.

Keywords: Onboarding, training, capstone, instructor

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Introduction

Teaching an engineering capstone design course differs significantly from teaching a typical engineering class. By name, a capstone course is a culminating experience. Rather than simply using content from prerequisite courses, capstone requires students to apply prior knowledge to complete a comprehensive, real-world design project. Surveys show that, beyond core design principles, capstone courses also incorporate written and oral communication, engineering ethics, project planning, teamwork, and other academic and professional skills [1,2,3,4]. The extent to which this broad content is included and what is emphasized varies widely among capstone programs [5].

Determining the specific content for a capstone course is challenging. Strong arguments exist for including and emphasizing each of the broad topics mentioned earlier, as well as for various methods of implementation. For instance, the literature states the particular significance of communication [6], engineering ethics [7], and project planning [8]. However, it is not possible to cover everything in depth, so instructors are presented with the decision challenges of content trade-offs.

These decisions are typically a collaborative effort between the instructors who teach the capstone course and the relevant curriculum committee/s. However, this is not always the case and decisions can be made by the instructor on record for that term. In some instances, new capstone instructors will join an established capstone program and have the option to make those decisions or default to asking other instructors.

Joining an established capstone program as an instructor seemingly offers a solution: key decisions about content, emphasis, format, and scheduling have already been made, but challenges remain. Even if the course content is used with little or no change, it still must be learned. If changes are made, content must be created and fit within the existing course structure.

This paper examines the challenges associated with onboarding and training new instructors in an established capstone program. Recent research underscores that effective onboarding is both important and non-trivial [9,10,11]. Here, onboarding practices are explored through an informal survey of four instructors who recently began teaching capstone courses. The context for this work is the Oregon State University (OSU) Multidisciplinary Capstone Program (MCP), and the focus is on the experiences of these new instructors as they transitioned into the program. The paper is organized as follows: first, a brief overview of the MCP; next, a description of the onboarding process; then, a presentation of the survey responses; and finally, a discussion and conclusions.

The MCP Capstone Program

The MCP is a two-term sequence (ENGR 415 → ENGR 416) that provides students with a comprehensive engineering design experience. Each section enrolls approximately 80 students from across the college of

engineering forming a diverse technical environment. Students complete a full engineering design cycle: requirements development, concept design and evaluation, prototype or model implementation, testing and evaluation, and final delivery of documentation which includes oral presentations. Projects are categorized into two primary types: (i) Large Competition Teams, comprised of 15–50 students, which collaborate on distributed subsystems as part of complex, multidisciplinary competitions; and (ii) Small Sponsored Teams, consisting of 3–6 students, which pursue industry-sponsored or faculty-sponsored projects characterized by clearly defined individual roles and responsibilities. MCP also fulfills the university's Writing-Intensive Curriculum (WIC) requirement through requirements documentation, design reports, test plans, final technical reports, and informal writing. Each team is supported by a Sponsor Mentor (industry or faculty stakeholder) and a Technical Advisor (faculty or graduate student). Capstone instructors oversee curriculum delivery, evaluate technical and communication performance, manage design reviews, guide team dynamics, and ensure completion of engineering and WIC outcomes.

Instructor Onboarding

Over the past four years, five instructors have taught a Type 2 MCP section—small, sponsored teams—for the first time. Their teaching experience varied significantly—some had no prior university teaching experience, while others had taught numerous traditional courses. However, none had previously taught any capstone course before teaching MCP.

The significant differences between teaching capstone versus a typical engineering class were evident in the onboarding and training of the new instructors. Those with no prior teaching experience tended to more easily learn to teach MCP. Those with prior experience tended to find it more challenging to, for example, manage student team dynamics, accommodate project changes from sponsors, and coordinate the numerous and varied assignments in MCP. It should be noted a possible confounding factor in the level of onboarding difficulty was that the instructors with no teaching experience had MCP as their only teaching assignment.

Onboarding of the new MCP instructors consisted of giving them the MCP Canvas course template (Oregon State's Learning Management System), providing a list of projects, and including them in weekly Capstone Committee meetings. The new MCP instructors were also given Observer access in Canvas to previous sections in the weeks and months prior to their own capstone start. The Canvas template for their section of capstone was comprehensive and included the course schedule, deliverables, and all teaching and logistical content. The project list was complete with descriptions, sponsor contact information, and budget. The weekly Capstone Committee meetings are an opportunity for the MCP instructors and capstone instructors from other departments and units (e.g., electrical and computer engineering) to meet and discuss capstone-related issues and problems. One-on-one meetings with a senior capstone instructor were arranged as needed and gave the opportunity for the new instructors to learn and discuss topics in depth that they have issues and problems with.

Qualitative feedback from the four new capstone instructors emphasized that the template, project list, and meetings were all tremendously beneficial. They noted that providing the template-maintained consistency of the MCP course and enabled new instructors to use their course preparation time to learn at their own pace how best to approach teaching the course. Providing a project list allowed new instructors to focus on the teaching of the course rather than obtaining projects. Having access to a previous capstone Canvas provided opportunity to see how changes can be implemented based on the term's unique needs. Finally, they said the committee meetings may have been the most useful of all as they provided a very efficient and effective means of answering questions, learning from others, and understanding the teaching philosophies behind course content.

Instructor Experiences

Overall, the onboarding process was successful, and all five instructors had positive experiences teaching the capstone course. However, each encountered certain challenges. To better understand these challenges, each instructor was asked to identify five aspects of MCP they found particularly challenging when they began teaching the class. Four of the five instructors responded, and their feedback was organized into six categories, as described below.

The first category of new-instructor challenges was ***time management***. This includes scheduling meetings with student project teams and the weekly Capstone Committee meetings. The number, unpredictability, and urgency of student team meetings often meant meetings extended beyond normal working hours. One instructor explained: *"I would stay on campus later than I would have otherwise. With a young child at home, this made the term I taught Capstone slightly more difficult as I would sometimes get home late."*

Also mentioned were challenges in optimizing the course schedule and student time commitment for them (student) to best complete the design process. Another stated challenge was simply keeping up with the volume and subsequent assessment of capstone assignments. The sequencing and cadence of capstone assignments correspond to steps in the provided student design process framework. New instructors can struggle with

granting students due-date extensions when doing so will reduce the time available for subsequent assignments.

The second category of challenges was student ***team formation and dynamics***. While any course with student teams can create challenges for the instructor, capstone can be particularly difficult due to the length of the project (two terms for MCP), the complexity and scope of the project, and the stakes (many students want a successful experience to assist in subsequent employment pursuits). Specifically stated was the need to ensure each team was staffed to balance personalities and workstyles, to minimize conflict, and to provide the needed technical skills. One instructor described the difficulty of addressing team issues without disrupting relationships: "*Managing team dynamics—the issues the teams complain about—was hard to manage sometimes, since it's important to address them without causing more problems within themselves."*

The third category was ***interacting with external entities***. The MCP course requires instructors to interact with project sponsors to understand requirements, resolve conflicts, and adapt to changes. MCP also requires instructors to interact with external technical writers for the grading of student reports, as well as personnel (e.g., maker space managers, machinists) in multiple engineering departments. For instructors new to capstone, these interactions differed dramatically from typical engineering classes. One instructor captured this contrast by explaining: *"Unlike the mechanics courses I teach, Capstone required routinely interfacing with external entities like writing evaluators and project sponsors."*

The fourth category was the ***instructor's role in MCP***. Typically, an engineering instructor's role is clear, they are simply "the teacher". However, beyond teaching, in MCP the new instructors stated challenges in when and to what extent to influence and/or improve students' design choices. As one instructor explained: "*I remember trouble navigating conversations when I wanted students to consider alternatives, without making it seem like I was requiring them to change course.*"

Also stated was a need to have technical understanding of each project. This can be difficult in a course such as MCP in which projects come from across the College of Engineering. Related to this need to provide students with suitable technical support is the need to be a facilitator in connecting students with subject matter experts for guidance on their project.

The fifth category was ***variation in course deliverables***. With such a variety among projects, ensuring consistency with grading was told as challenging. Not only are the projects all unique, but the variation of majors within the course provides challenging, particularly when the majors are outside the expertise of the instructor. An instructor commented: "*Each project was so unique with its own ease or difficulties, evaluating performance fairly from group to group was more difficult than, for example, a basic mechanics course where all students have identical assignments.*"

The sixth category was ***course content***, specifically dealing with MCP being the college's Writing Intensive Course (WIC). Balancing the writing and technical aspects of capstone can be challenging. The new instructors stated the challenges of both including the writing content and justifying its existence, a challenge highlighted by most (i.e., non-capstone) instructors who also teach a WIC course. An instructor explained: "*Highlighting the importance of WIC technical writing to engineering students was very challenging, since they find that WIC is a time-consuming, less value-adding component in capstone*."

Instructor Course Reflections

After teaching MCP, the new instructors were asked the following questions to facilitate reflecting on their experience.

The first question was "How would the five challenges given previously change if instead of joining an existing capstone program you had to create all of the required content yourself". Responses included, not surprisingly, an increase in workload but also a change in the type of work done in that projects would need to be obtained. One instructor stated that if they had not joined an existing capstone program, they would have been more proactive with project sponsors which would have been advantageous.

The second question was "What do you think are the biggest advantages of joining an existing capstone project instead of creating all your own content?". All the instructors replied with a saving of time and the corresponding ability to focus on student projects, support, and evaluation.

The third question was "Are there any disadvantages or problems with joining an existing capstone project instead of creating all your own content? What are they?" Two of the instructors stated there were no significant disadvantages ("*having an existing structure is nothing but helpful*"). The others stated the inability to tailor content to their teaching style and correspondingly the occasional inability to justify course content.

The fourth question was "How much of the existing structure did you use unchanged and how much did you change? What changes did you make and why?" All replied they used the provided course content either completely as provided or nearly so.

Discussion

The results of the informal survey support the hypothesis that teaching capstone is distinctly different from teaching other engineering courses and has its own

unique challenges. Specifically, as indicated by the new instructors, the key differences (challenges) are as follows:

- The amount and unpredictability of out-of-class time commitments.
- The importance of effective student team formation and timely problem resolution.
- The amount and importance of interactions with entities external to the university (e.g., project sponsors) and external to the instructor's home program (e.g., subject matter experts in other engineering departments).
- The tension between allowing students the freedom to make their own (design) choices with a desire to direct them to choices more likely to lead to a successful project outcome.
- The ability to equitably assess each student given the wide variety of projects and situations that arise.
- The ability to justify required course content such as OSU's WIC content.

Instructors' responses were consistent: joining an established course saved time and allowed them to focus on student success. All used the provided content with minimal changes. The only drawback was the limited ability to tailor the course to their own style.

Conclusions

Overall, the OSU onboarding process has been shown to be effective. The focus of this process is to familiarize new instructors with the existing MCP. The evidence provided in this paper shows that the MCP content provided to the new instructors was used with no significant changes or hindrances in having done so. With only a few minor exceptions new instructors used the existing MCP course with no changes and no regrets. The uniqueness of capstone was demonstrated in instructor comments, and all the instructors encountered significant challenges in their first teaching of MCP. The approaches to mitigate these challenges, provide a framework for onboarding instructors into an established Capstone Program.

The focus of this paper is on instructors teaching MCP for the first time. A direction for future work is examining how their teaching evolves. As they gain familiarity with opportunities to tailor content, they can better navigate the tension between using the provided materials and adapting the course to their own teaching style.

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