'Aunt Ada's Treehouse'

Instructor Reflections

Reflections/Tips: note that some of what is in this section is intimately related to changes that are suggested for the course and the project (i.e. the material in the next two sections of this document). As described in the introduction document, each class is 50 minutes in duration and the class meets three times per week.

1) Students were hungry for this experience. They exhibited enthusiasm for the in-class project activities by overcoming the limitation of the given lecture room (very rigid and packed seating); that is, during in-class activities, they moved about the room to join their teammates and exchanged ideas in a discussion type format. Qualitatively, a more unified feeling existed among the class, despite being a larger than usual section for our Strength of Materials classes (~50 students).
2) Students expressed very positive feedback to the team specific letters that were distributed between Parts (d) and (e); for the instructor, those letters were a labor-intensive part of the project (see next section).
3) Through the project, we covered buckling without ever "covering" buckling (i.e. in a traditional lecture format). I did a "Just in Time" partial lecture on buckling (see Delivery material for slides) but students were largely forced to explore this topic on their own and with their teammates.
4) Many students used commercial software to build their 3D model and, in some cases, to back up their own calculation of stress/deflection. No guidance was provided on commercial software so these instances reflected times where students made connections to tools to which they were exposed either in other courses or via co-curricular activities.
5) Students reported seeing EML being deployed in other courses and expressed a desire for more coordinated approaches to developing such curriculum! Many students, in their assessment, demonstrated a strong understanding of the goals of EML, as well as an appreciation for the impact that EML has on learning.
6) A number of in-class activities surrounding the project imply that some amount of lecture time will be surrendered to the experience. To be conservative, two lectures worth of topics should be discarded from an otherwise full syllabus to accommodate time needed to properly support this project.
7) If finite element analysis is not part of a course's typical coverage but an instructor desires to expose students to discretized methods for solving integrals, then additional lecture time for this topic must be budgeted. We dedicate about two and a half 50-minute lectures to cover introductory 1D finite element analysis. Notes to support such coverage are provided in the Delivery part of this module submission.
8) Much is left open-ended in this project so instructors must decide how much supplementary information should be given to the students, when the information should be shared, and how it should be disseminated (see tip #9). For example, shortly after Part (a) was assigned, an email was sent to all students, pointing out that Aunt Ada wants her treehouse (and, therefore, the trunk that supports it) to have a level high enough that she will be able to view fireworks that are periodically launched from a large campground ~5 miles away. Because the setting for her treehouse is in a forested area, this essentially forced students to design the trunk to be able to

reach heights above surrounding trees. No information was provided, though, on the forest except its location, which is local to Lehigh and easily researchable.

9) Instructors must decide how information dissemination to students will occur outside of class. For example, student questions about the project and the system being addressed that are intended for the 'customer' (e.g. emails directed to the instructor) can be answered individually, which rewards curious students/teams but increases instructor workload by forcing one to answer the same question multiple times. Alternatively, student/team questions can be answered in a forum style such that all students in the class can see all questions and answers.
10) In Part (e) of the project, a numerical analysis is required in which teams must ensure their design is stable against buckling; they must also compute the deflection of a non-trivial cross-section in a 1D loading condition (as well as the stress). Student teams were required to write a code to perform the stress/deflection analysis; related to this, Part (c) of the assignment was an individual assignment that asked students to construct a flowchart, or algorithm description, for such a code. In this way, I required all students to describe an algorithm but only student teams to create an actual code (more on this in items 11 and 12 below). Many students reported that Part (c) of the project was unnecessary and they would have rather gone directly to creating a code (see next section).
11) If a code is sought from students, instructors must either ensure that students have necessary pre-requisite coding skills or spend further lecture time on coding. The codes required to perform the numerical analysis are, from a coding point of view, relatively simple; discretized analysis is perhaps the more complex topic. Nonetheless, if students have no pre-requisite coding skills, this part of the project must be changed. In such instances, instructors can share a generic code with the entire class and force teams to modify it for their specific analyses.
12) Instructors must, then, be ready to audit this numerical analysis part of the project to, as best as possible, prevent a single team member (or two) from performing all of the numerical work with little or no contribution from other team members. As mentioned at the start of this document, please consult changes made (as well as the Adaptations document) for further information.
13) Instructors must decide if lecture time will be surrendered to allow for student team presentations. This can be a lively way to end the project.

Changes made to the class:

1) In older offerings of this class, three lectures were spent on energy methods and this permitted sufficient coverage to expose students to the calculation of stress due to impact loading. While certainly a useful addition to the syllabus, it was often remarked by students that the topic was, e.g., "just one more type of problem to have to learn before the final exam". Furthermore, energy methods are covered in extensive detail in our Advanced Strength of Materials class. Thus, to enable in-class time in support of this project, the lectures on energy methods were removed from the syllabus.
2) Prior to the implementation of this project-based learning experience, projects counted for 15% of a student's grade and there were two non-contextualized projects. In the same term in which this module was introduced, the second project in the class was also converted to a project based learning experience (see Webb's curriculum submission, "Sand Island Bridge Replacement"). Because these projects increased expectations on students, relative to the old projects, that portion of their grade was increased to 20%.

Changes suggested for the class/project:

1) This is specific to the way Statics and Strength of Materials are taught here at Lehigh; however, this project (or ones designed to replace this) are now being assigned in the final weeks of the term, rather than the first weeks in the term. Because the reasons for this are somewhat specific to Lehigh's progression through the material in the course, they are not recounted here. However, it is important to highlight that, since this project included discretized computation of integrals (i.e. via the finite element method) and because it addressed column buckling, there are strong arguments for having this be an end of term project, rather than the first project, in the course.
2) As mentioned above, the team letters were greatly appreciated by the students but they also introduced a large overhead for the instructor because each letter was personalized to mention specific design suggestions advanced by the students in Part (d). To try and minimize the time spent on those letters, a few templates were constructed (see Delivery material). While evaluating/grading each team's Part (d), details were added to that team's letter. Despite the use of a template, this was a time-consuming exercise. An alternate way to have the "customer" respond to the team's initial design suggestions may be desired. For this instructor, in a later term, an alternate approach was used that did not reduce the amount of time spent on this stage but was more enjoyable; that is, team meetings were held with the instructor and feedback was done verbally. This also felt more effective because students can ask questions about the information being delivered during the meeting.
3) There were too many parts. Part (c) should be eliminated. Parts (a) and (b) should be combined and that part of the project should be kicked off with a Think-Pair-Share in-class exercise. With those two changes, though, the project becomes purely team-based. This is not a bad thing but auditing student involvement is critical. In subsequent deployments of this curriculum module, it was required that each student on a team adopted a specific analytical exercise that was required by the project (e.g. one student did the buckling calculations, another did the stress analysis, and a third did displacement analysis). During team presentations (and in team reports), each student had to present their calculation and results.
4) Students were permitted an opportunity to assess themselves and their teammates regarding their effort on the project and this was made known from the start of the project. However, that assessment was only done at the end of the project. In subsequent deployments of this module, such assessments were requested during the project, as well as at the end.
5) Technical aspects of the (albeit, simplified) buckling analysis were challenging to some students. In subsequent deployments, a somewhat lengthier "Just in Time" lecture on buckling was used. A perhaps more effective method to be explored is some type of individual supporting exercise (this is another way to restore an individual "part" of the project).
6) A gallery walk of design ideas would be relatively easy in the right classroom space but has not yet been explored.