Date: 9/27/2019
To: Iowa State University Department of Engineering
From: Sean Gordon
Subject: Engineering Course Assignments Overhaul Proposal

Introduction

There is a problem with the implementation of homework or lab assignments in many of the engineering classes offered at Iowa State University. Improvements to these aspects of classes will allow an accelerated curriculum, giving ISU the edge over other engineering universities. This document details the plan to reform said classes by outlining:

- The current problem.
- Objectives of the project.
- The solution proposed.
- The methods to be used.
- Costs of implementation.
- Benefits of implementation.

Current Situation

The teaching ideal I have found most widely accepted is to transfer the largest amount of information in the smallest amount of time, preferably with the sanity of everyone involved still intact. However, engineering students at ISU are commonly faced with a dilemma; complete the assigned work, or learn the assigned material. Ideally these would be two sides of the same coin, but it has become apparent that, at ISU, over time they have become more mutually exclusive. The main reason for this drift lies with badly written homework and laboratory assignments, which can be broken apart further into lack of ties to the main course objective, lazy recycling and busy work, and fabricated difficulty resulting from imprecise instructions/wording and failure to lay groundwork.

To begin a semester, a class will usually outline the end goal, and maybe even lay out smaller milestones. This serves as a point of reference when completing assignments, giving a birds eye view to help interconnect concepts and finer details. This is important in order for a student to come out of a course with a full understanding of the material and its relations to other previously learned concepts, rather than a few fuzzily remembered mathematical formulas from the last week of class with no recollection of their uses. However, these milestones are easy to forget about in the hurricane that is a college semester, leaving any sort of direction washed away. This is compounded upon by the tendency for these goals to be mentioned once in the syllabus then never again, amplified even further when practicality necessitates a lab be disjoint

from the class, disorienting a student and leaving no clear direction or sense of progress with the current exercise.

Many departments are also prone to lazy recycling of materials and assignments fraught with busy work. While it is of course impractical to rewrite class material every year, information should at least be updated regularly relative to the rate of progress of the field in question. For example, including an eight year old graph to exhibit the growth of a field is perfectly acceptable, but reusing an assignment written in 2014 that references a table compiled 12 years earlier concerning cutting edge transistor sizes and properties is a little problematic. This type of recycling is commonly seen in many electrical engineering classes, as where ISU has pushed for standardization using Canvas as a medium, many EE classes use archaic HTML pages punctuated with broken links and outdated scheduling information, commonly not updated until finals. The aforementioned laziness is present in question design as well, where large portions of many assignments are essentially poorly camouflaged busy work. These questions are generally loosely related to the topic being covered, usually by integrating key words or values into the problem, but do not serve to significantly increase topic understanding or provoke any helpful speculation.

The crux of the problem lies in vague instructions, withheld information, and lengthy jargon. As noted by Mr. Christiansen in his article, *4 Ways to Deal with Vague Instructions and Problem Descriptions for Maintenance Work* [1], vague instructions result in wasted time, frustration, and loss of goodwill, common themes when conversing with the average engineering student about their current classes. Much of this malpractice appears to be a misguided attempt to artificially increase the class difficulty, and in turn increase its perceived validity, while another large chunk is just due to laziness. Oftentimes engineering assignments have a major problem with difficult, imprecise wording, adding unnecessary difficulty and distracting from the goal of education. A sizeable chunk of difficulty in many computer science courses can also be attributed to liberally cutting corners when preparing students for assignments. This can be seen in many ComS courses, where a class often assigns a project involving some non-trivial functionality, such as server ↔ client interaction, without any coverage of the material. This leaves new developers fresh out of ComS 227 floundering, but there are usually *just* enough students with prior experience with the topic, either from internships or personal study, that the approach works well enough to go unchanged.

Objectives

The goal of this project is to raise the standard of assignments in engineering courses to more efficiently educate students. This will benefit the university as well as the students. This proposed solution would:

- Create more effective homework and laboratory assignments by updating the current ones.
- Improve quality of engineering education at ISU.
- Decrease student dissatisfaction with engineering courses.
- Increase student understanding of a given class's material.

Solution

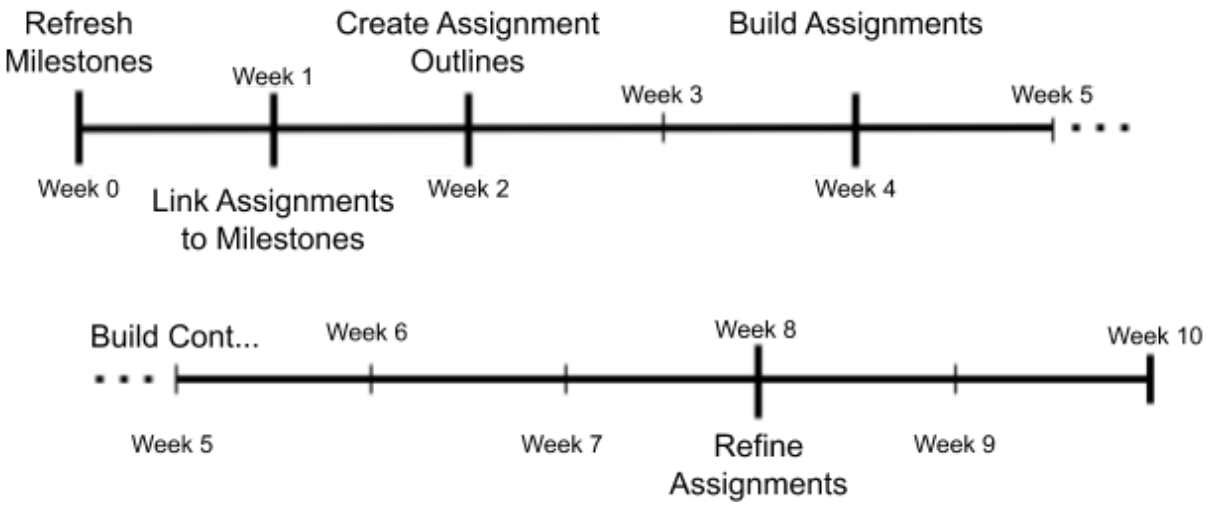
Solving the defined issues will require an update to the existing homework for each class, and a change of mindset to ensure that the problem does not reappear. The provided solution will detail what to change, and what it will take to do it. Research on effective teaching strategies and learning techniques will provide valuable insight and will facilitate an optimal strategy. The established curriculum for each class will not be changed, only the assignments built around it.

When revising the assignments, *Errors and Allegations about Research on Homework* by Marzano and Pickering [2] makes the point that "homework should not be assigned simply as a matter of routine," and should instead be used only when there is a clear benefit to student learning. Therefore, assignments should be modified to give pointed guidance towards the next learning milestone, and if said guidance is insubstantial the assignment should be dropped.

Methods -

This project will be split into several steps to be replicated for each class.

1. Refresh milestones
2. Link assignments to milestones
3. Create assignment outlines
4. Build Assignments
5. Refine Assignments



Cost statistics:

- Professor Wages: Glassdoor[3] lists ISU professor salaries at $114,400, and with an estimated total of 2,000 paid hours per year, the approximate hourly wage is $57.20.
- TA Wages: Glassdoor[4] lists ISU TA hourly wages at $11/hour.

Each hour of work represents one man-hour.
Each of the steps below must be reproduced once per class. -

1. Refresh Milestones - (1 week):
   The professor(s) of the course will, given prerequisite classes as a starting point and the class end goal as the end point, break the stretch into small, distinct knowledge milestones. The space between each milestone can itself be broken into smaller stepping stones if deemed necessary. This puts the class into perspective, as well as giving clear bases for assignments.
   Requirements -
   - Personnel: All professors of the course in question.
   - Facilities: A meeting location will be necessary for classes with more than one professor. Left to group preference.
   - Equipment: Some sort of note-taking medium, preferably one easily shareable, will be required. Left to personal preference.
   - Cost: 40 hours * $57.20/hr = $2,288.

2. Link Assignments to Milestones - (1 week):
   The professor(s) and any TAs of the course will take the created course milestones and decide where homework or laboratory assignments will be necessary.
   Requirements -
   - Personnel: Any professors of the course in question, as well as any TAs. If work is done by TAs, it must be reviewed by a professor.
   - Facilities: A meeting location will likely be necessary. Left to group preference.
   - Equipment: Some sort of note-taking medium, preferably one easily shareable, will be required. Left to personal preference.
   - Cost: 40 hours at a mix of $57.20 and $11. Max $2,288.

3. Create Assignment Outlines - (2 weeks):
   The professor(s) and any TAs of the course will use the created course milestones and their links to assignments to build outlines for the assignments. These outlines should subtly or explicitly direct students to the necessary stepping stones until each milestone. If any assignment is below a certain threshold of 'usefulness' it should be removed. Inspiration can be drawn from previous assignments.
   Requirements -
   - Personnel: Any professors of the course in question, as well as any TAs. If work is done by TAs, it must be reviewed by a professor.
   - Facilities: A meeting location will likely be necessary. Left to group preference.
   - Equipment: Some sort of note-taking medium, preferably one easily shareable, will be required. Left to personal preference.
   - Cost: 80 hours at a mix of $57.20 and $11. Max $4,576.

4. Build Assignments - (4 weeks):
   The professor(s) and any TAs of the course will use the created assignment outlines to create complete assignments. When creating questions, emphasis should be placed on clear, concise writing. Include the milestone/stepping stone the assignment is moving towards at the top of the document, and ensure the direction is clear from question to question. When jargon is necessary, either because it is unavoidable or to acclimate the student to the vernacular of the field, it should be used sparingly, ensuring it can be understood through context clues or that it is easy to research. Each assignment must only use concepts that have already been covered, unless in the special case of disjoint labs (which must start ahead out of practicality). In the case where an assignment must use a concept or detail not previously taught, it must be clearly explained or adequate reference provided. Inspiration or complete questions can be pulled from previous assignments, as long as they are up to standard.
   Requirements -
   - Personnel: Any professors of the course in question, as well as any TAs. If work is done by TAs, it must be reviewed by a professor.
   - Facilities: A meeting location will likely be necessary. Left to group preference.
   - Equipment: Some sort of note-taking medium, preferably one easily shareable, will be required. Left to personal preference.
     Some sort of document building medium, such as LaTeX, will be necessary. Left to personal preference.
   - Cost: 160 hours at a mix of $57.20 and $11. Max $9,152.

5. Refine Assignments - (2 weeks):
   The professor(s) and any TAs of the course will take the created assignments and refine them further, ensuring clarity and completeness of vision. This is the time to make sure the assignments line up with the desired class milestones. The language used in each assignment should be inspected by multiple different people as well to ensure it meets standards.
   Requirements -
   - Personnel: All professor(s) of the course in question, as well as any TAs. Multiple people should review each assignment.
   - Facilities: A meeting location will likely be necessary. Left to group preference.
   - Equipment: Some sort of document building medium with editing functionality, potentially with version control, will be required. Left to group preference. Suggested software: Google Docs, Microsoft Word.
   - Cost: 80 hours at a mix of $57.20 and $11. Max $4,576.

Total maximum cost is estimated at 400 man-hours and $22,880 per class.
These estimates assume the cost of document mediums are negligible or already provided by ISU.

Benefits

These improvements to the assignments for a given engineering course will provide the following benefits to the university:

- Considerable increase in course effectiveness:
  - Improving engineering course assignments in this way will remove the need to choose between completing assignments or learning material.
  - Drastically lowered student frustration with the course will retain interest, keeping student engagement high.
  - By creating assignments in such a focused manner, student efforts will be guided toward the end goal of the course much more directly.
- Increase in course throughput:
  - With more efficient coursework, classes can be accelerated, fitting the same curriculum as before in a smaller time frame.
  - With less time needed for completion of the course curriculum, remaining time can be spent on review, increasing depth of topics, or possibly an enlarged curriculum.
- More favorable course reputation:
  - If a course is more easily digestible, more effective, and more focused, the student opinion will reflect the positive changes.

- With a more effective course, average student understanding of the material will increase. A more knowledgeable student body will reflect positively on ISU and will attract higher quality students and employers.

Conclusion

While the engineering department at Iowa State University is esteemed for good reason, it is not without its problems. These improvements to the assignments for an engineering course will remove much of the contempt felt by the engineering student populace for the current state of the engineering department, further growing ISU's reputation as a respected engineering university. For more information about the proposed changes, contact Sean Gordon at SeanGordonkh@gmail.com.

References

[1] Christiansen, Bryan. “4 Ways to Deal with Vague Instructions and Problem Descriptions for Maintenance Work.” *Maintworld*, 29 May 2018, https://www.maintworld.com/Asset-Management/4-Ways-to-Deal-with-Vague-Instructions-and-Problem-Descriptions-for-Maintenance-Work.

[2] Marzano, Robert J., and Debra J. Pickering. “Errors and Allegations: About Research on Homework - Robert J. Marzano, Debra J. Pickering, 2007.” *SAGE Journals*, 1 Mar. 2007, https://journals.sagepub.com/doi/abs/10.1177/003172170708800709.

[3] “Iowa State University Professor Salaries.” *Glassdoor*, 20 June 2019, https://www.glassdoor.com/Salary/Iowa-State-University-Professor-Salaries-E23963_D_KO22,31.htm.

[4] “Iowa State University Teaching Assistant Salaries.” *Glassdoor*, 20 May 2019, https://www.glassdoor.com/Monthly-Pay/Iowa-State-University-Teaching-Assistant-Monthly-Pay-E23963_D_KO22,40.htm.