2006-1377: CHANGING STUDENT BEHAVIOR: IT CAN BE DONE!

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Abstract

This paper presents some general observations extrapolated from the findings of on a two-year research project that the author feels have general applicability. The author suggests that although faculty members see many variables dealing with student behavior as unalterable, most are probably not. Common behaviors that are accepted include: coming to class unprepared, not doing the reading, not engaging in classroom discussion, not answering questions, turning in sloppy work, and turning in late assignments, to name but a few. The author does not accept the premise that such behaviors are unalterable. In the case of the specific research project the author conducted, the problem observed was that students seemed to regard their homework submissions as simply a product to be handed in, and the correctness of their solutions did not seem to concern them. Accepting this struck the author as the wrong approach in educating future engineers.

In the spring of 2004, the author instituted a methodology of peer review of all work handed in during the course aimed at improving the quality of student work in the Structural Analysis course (CE403). This effort became an iterative process, similar to any engineering design. The objective of the "design" was to increase student learning form the following sources:

- interacting with their classmates
- having to explain their own work
- correcting mistakes and errors in others' work
- learning their own abilities and limitations
- modeling the professional aspects of having work reviewed for correctness

After three iterations and several changes in the implementation of the methodology, the author was pleased with the result and satisfied that his goals were achieved. This paper will discuss the specific methodology, in an abbreviated form, but will strive to also reveal the author learned about implementing any such methodology aimed at changing student behavior. This paper will review some of the current research in the field and look at its implications for changing student behavior. The author will present his findings in terms of interim results of the efforts to change student behavior, student reaction to it, keys to success, and lessons learned.

Introduction

"If I accept you as you are, I will make you worse; however if I treat you as though you are what you are capable of becoming, I help you become that (Goethe).[1] This seems to imply a powerful charge to those of us dedicated to teaching. How often do we hear "that is just the way students are today"? Upon returning to teaching in the fall of 2003, after a six-year break, the author began to question whether he could change this behavior, or did he really have to accept it?

The author noted two disturbing trends upon his return to the classroom. First was that his students were not exercising the level of care with their assignments that should be required of young engineers. The author taught seniors taking Advanced Structural Analysis (CE491) that semester, a group who should have been well along their way in adopting the customs of the profession. Given the importance in engineering of doing quality work, it seemed reasonable that some more advanced level of care and concern should be exercised,, especially from students near the end of their undergraduate studies. The problem he observed was that students seemed to regard their homework submissions as simply a product to be handed in, and the correctness of their solutions did not seem to concern them. This struck the author as the wrong approach in educating future Civil Engineers (and Army Officers in our case). Influenced by much research on the subject, the author also believed that students should be more responsible for their own learning as well. If they were to truly learn the material, they must take more ownership of it and see it as more than a requirement to be met and endured. The second was that they were turning in assignments late on a regular basis, based on the belief that the penalty for doing so was "worth the cost."

The second problem seemed relatively simple to correct, the author simple told classes that late assignments would not receive credit, although exceptions might be made on a case-by-case basis with prior consultation with the instructor. This solved the problem immediately. In the following four semesters, the author received only one late assignment without prior coordination, and after receiving a zero, that student never again submitted a late assignment. This experience provided the first ray of hope that student behavior could be changed. The first problem, however, seemed much more complex to solve.

The author's initial idea was to have the students check each others' work prior to turning it in, a system of peer review. Each student would review another's work, looking for errors in their classmate's work or in their own calculations. The students would then have time to go back and correct their work. Each graded assignment would be peer reviewed by two other students in the class. It was thought that this would improve the quality of the work being turned in as well as help improve the students' learning. It was a simple idea ultimately aimed at changing student behavior.

The author quickly learned, however, that like all engineering design, developing a system to improve the students' leaning and changing their behavior was an iterative process. Each iteration produced results that led to revisions and modifications. Bit by bit, the author came closer to a "final design." In addition to learning a great deal about designing a workable methodology of peer review, the author also learned some lessons that had a broader application to any methodology aimed at changing student behavior.

The Nike Approach—"Just do it!"

The authorcame across some literature that seemed to confirm the value of his approach. One study suggested that a way to develop a student's metacognition, and thus their ability for life-long learning, is to view them and treat them as novices in the profession.[2] He also found that there is also a large body of research that indicates that students can achieve more when they are working and learning cooperatively.[3-12]

> *Weak students working individually are likely to give up when they get stuck; working cooperatively, they keep going. Strong students faced with the task of explaining and clarifying material to weaker students often find gaps in their own understanding and fill them in. Students working alone may tend to delay completing assignments or skip them altogether, but when they know that others are counting on them, they are often driven to do the work in a timely manner.* [13]

Other research shows that students learn better in small groups, especially if they are structured and deal with assigned readings and problem sets.[14, 15]

Armed with a view of what should be and a few ideas from research of how to improve student learning, the author clearly knew something must be done. The challenge was to find a way to make the students, at a minimum, check their work prior to turning it in, and hopefully improve their learning and develop their metacognition as well. This seemed to be a simple enough task, yet of course it was not.

During the spring of 2004, the author instituted a system of "mandatory collaboration" in the Structural Analysis course through forced "peer review" of all individual work. The goals were to increase student learning by:

- having students learn from their classmates
- having to explain their own work to others
- correcting mistakes and errors in others' work
- recognizing their own abilities and limitations
- modeling the professional aspects of having work reviewed for correctness

The hope was that as the students identified errors, they would gain skill in error tracking, finding the source of their errors, and become more independent in their ability to check their own work.

The author quickly put together the first iteration of peer review. He rather naively thought (or hoped) that a few simple instructions were all that would be necessary, the students would likely accept this (although grudgingly at first), some survey data would show that this was a great teaching system, and life would be better for all parties. Naturally this "pie in the sky" view did not correlate to the reality observed. This methodology was first instituted in the Structural Analysis course, a required course for civil engineering majors that had 41 juniors enrolled. The idea of peer review was presented in a portion of the course administrative letter which stated:

> *In order to ensure correctness, this semester I will often require you to consult with your classmates, or myself, and have them sign off on submissions to signify they are in agreement with your work. The goal is to have you check your work and learn from your classmates (peer review) as well learning from having to explain what you did. This is probably something new for most of you, but is a valuable part of your learning. It is critical that you show all of your work and leave "foot prints" so that it can be easily followed.*

They also were given a place on a table of contents sheet for each assignment to have other students initial that they had checked their work.

The initial results from observations proved the folly of the author's expectations of how this would work. While some students did fulfill all expectations, the author observed several students, directly in front of him and unashamedly, holding out a paper to classmates just prior to turning it in and saying, "Sign this and I'll sign yours." This was done with no effort to correct, or even look at, the work completed. There was also evidence of some students signing off on work as correct that was clearly not correct, and should have been readily recognized as such, due to the fact they themselves submitted correct work. Still others signed off on work that they themselves had not completed, making an accurate check nearly impossible to make. Clearly this was not the desired effect. The author's goal was never to devise a meaningless administrative requirement to turning in homework, yet for some of the students this clearly was all that was happening. The author did take class time to more fully explain the concept of peer review as he envisioned it, and slightly modified the statement students were required to initial, in the hopes getting a more cooperative response. Penalties were also assessed for not having work reviewed.

The author also surveyed the students midway through the course, roughly at the one-third and two-thirds points, after exams, to gauge their view of the peer review policy. The results were clearly mixed. While some students did see the value to it and were glad to have the requirement to check their work, others saw it as nothing more than an additional administrative burden and a waste of their time. Some students indicated that they would check their work with a classmate regardless of the requirement to do so. The data collected showed that 50% of the students did not see the value in the process or viewed it as just another administrative requirement.

As the semester progressed, the author did note a glimmer of hope as he observed that a significant number of students cited the help of their classmates in correcting their work. At the Military Academy, all outside assistance received on any work turned in must be documented and acknowledged in order to conform to the strict tenets of the Honor Code. Often citations to the effect, "Joe Doe explained to me that I had the wrong value here, and I now understand why it was wrong; I used the correct value, re-did the rest of the work on my own, and our solutions matched" were noted. Clearly this was the type of result the author was hoping to achieve. While the process was not a total success, the author was encouraged that some of the students were clearly benefiting from the peer review system.

At West Point all students complete course-end surveys in all their courses. This is a unique, web-based system that has a series of Academy-wide questions, as well as questions that are department and course specific. In the course-specific questions, the students were also asked directly about peer review in the course and their opinion of its value. Table 1 shows the results of these questions. Two questions that are given Academy wide deal with students being responsible for their own learning and learning from their fellow students. These questions are posed as statements and students rate their agreement on a scale, with students strongly agreeing (5), agreeing (4), being neutral (3), disagreeing (2) or strongly disagreeing (1). In both these areas a slight increase was seen over previous semesters, see Table 2, CE403-2004 column. Of course these scores were fairly high to start with, so the significance of the gain is open to

debate, and while this cannot be shown to necessarily be a direct result of the peer review requirements, the author believes that peer review is at least partly responsible for this increase.

Question	Agreed	Neutral	Disagreed
Peer Review helped in turning in better homework	53%	25%	22%
Peer Review helped learn more in the course	36%	38%	28%
Peer Review is a valuable learning tool	40%	40%	20%

Table 1 Student Survey Results, Peer Review Questions

Statement	Average of prior Semesters with No review		Peer Review 2004		Peer Review 2005	
	CE403	CE491	CE403	CE491	CE403	CE491
This instructor encouraged students to be responsible for their own learning.	4.61	4.68	4.68	4.94	4.68	4.74
My fellow students contributed to my learning in this course	4.37	4.34	4.53	4.55	4.64	4.67

Table 2 Student Survey Results, General Assessment (USMA, Spring 2004/2005, CE403: Structural Analysis, and Fall 2004/2005, CE491: Advanced Structural Analysis)

If at first you don't succeed….

Hoping to avoid the pitfalls of the past and to make peer review truly a more valuable tool for students, the author revised the system when he taught Advanced Structural Analysis in the Fall of 2004. This course is an elective for seniors, and the 18 students in the course were all students who had taken Structural Analysis with the author the previous semester and thus had been exposed to peer review. The class was mix of the students who had done very well in Structural Analysis as well as those who had done poorly; in fact, the three cadets from the previous semester with the lowest grades signed up for the course. A handout was given to the students at the beginning of the semester to explain the policy to them. It was presented as a separate document, not just a portion of the course policy memorandum, and it was also the second semester they would have seen the peer review requirement.

An observation of homework submissions indicated the process was meeting with more success than the previous semester. Some students clearly continued to like the idea and appreciated the incentive to check their work for accuracy. The author also observed much more documentation of help received during the review process, but he noted that not everyone had yet bought into the approach. The author observed a few cases of students who would take the 5% cut for not having peer review done at all. He also noted that there were cases of students writing notes to the effect, "My work did not match my reviewer's work, but I could not find the error." Closer inspection of these comments usually found that peer review was almost always done within the 15 minutes prior to the turn-in deadline, thus allowing no time for reflection on the review or corrective measures. One of the positive results the author did note after the initial assignments was that the students would not sign off on incorrect work; they would note the problems with it or they would indicate work that was not complete at time of the review. During the first assignment, several students whose work was correct were penalized for signing off on **others'**

work that was not correct. Apparently this word got out and seemed to fix the problem on future submissions, and the bad habit of the previous semester was broken. This in itself was success, yet at an admittedly low level.

At the conclusion of the semester, the students filled out the end-of-semester course survey. As part of the course-specific questions, they were given three, open-ended questions dealing with peer review: How did PEER REVIEW help you in learning the material? Do you have any suggestions for me to make PEER REVIEW more valuable for cadets in the future? Will you use PEER REVIEW for future assignments, even when not required? Table 3 (CE491 2004 rows) summarizes the results of these questions. These results, although with a smaller sample, do reflect a much improved acceptance by the students of peer review. In answer to the first question, the 28% deemed in the middle provided a response that indicated that it was the mechanics of the process used that limited their success, largely due to their peers not being able to provide a timely review.

This seems to imply that they did acknowledge the worth of the process, even if its impact was somewhat limited. One typical comment shows the students' recognition of the benefit of the process: "*Peer review was definitely key in helping me learn the course material on the problem sets-- when I didn't know how to apply something I learned in class, my peers were usually able to help me figure out what I was doing wrong, and how to correct it, which helped me learn more about the subject overall."* The fact that the clear majority readily indicated they would use it even when not required, and the 22% in the middle indicated they would some of the time, demonstrates the acceptance of this process as helpful in their studies. The responses to the call for suggestions to improve peer review dealt largely with ideas for allowing more time for review, the mechanics of having time to allow for review, and allowing more freedom in picking groups. Only one response suggested eliminating peer review.

In the Academy-wide questions, a positive trend was also noted on the two questions dealing with students being made responsible for their own learning and learning from their fellow students. Both showed a positive delta from the average score of the previous seven years and were, in each case, the highest score recorded (see Table 2, CE491-2004 Column). The author found these results very encouraging. Although admittedly the sample was small, only 18 students, the trends were positive, and clearly most students liked or recognized the value of peer review and found it valuable. The majority of the negative responses indicated that they that were due to the mechanics of making the process work, rather than the process itself. It should be noted that there were a few comments that could be typified by the following: *"It helped a lot, but that doesn't mean I have to like it."* The author clearly had not yet created 100% willing converts, but progress had been made. While hoping to see an improvement in the final exam grade average from a very similar exam used in previous years, none was observed. Overall course grades were higher, due to higher problem set grades, which were helped by having mistakes corrected prior to turning in the work.

Question	Semester	Positive Response	Neutral	Negative Response
How did PEER REVIEW help you in learning the material?	CE491 2004	56%	28%	16%
	CE403 2005	70%	10%	20%
	CE491 2005	57%	13%	30%
Will you use PEER review for future assignments, even when not required?	CE491 2004	61%	22%	17%
	CE403 2005	81%	5%	14%
	CE491 2005	76%	16%	8%

Table 3 Survey Results, Peer Review Questions (USMA, Fall 2004/2005, CE491: Advanced Structural Analysis, and Spring 2005, CE403: Structural Analysis)

Third time's a charm!?!

While the author was pleased with these initial results and remained convinced that peer review is the way to go, he realized he still had not found the final solution to accomplish this. The problem surfaced when he read peer reviews that said to the effect, "My work is wrong, but I can't find the error," and he saw that it was reviewed just minutes prior to turning it in. On the other hand, there were a significant number of cadets who clearly benefit, as he continued to see numerous documentation statements that indicated students were making corrections and understanding why they were needed. As the author sees it, the challenge is two-fold. First, it is to sell, or adequately market, this methodology to students as a valuable learning tool, as well a practice that is necessary in the discipline. The second is to set up a structure that inspires the students to actually conduct peer review as it is intended and needs to be done. This involves insuring that there is time for the students to review the work of others and reflect on their reviewed work and make changes if necessary.

In a blinding flash of the obvious, the author submitted his policy to peer review, prior to having it passed out to a new group of students in the spring semester of 2005. This was a group of students who would not have been exposed to this process in previous engineering courses. It only seemed logical that the author could benefit, as he hoped his students would, from a review of his work and ideas. The author consulted with Dr. Anita Gandolfo, Director of the Center for Teaching Excellence, COL Stephen J. Ressler, P.E., the Deputy Head of the Department of Civil & Mechanical Engineering and a noted engineering education guru, and MAJ Brad Wambeke, P.E., an instructor also in the Department of Civil & Mechanical Engineering who had previously taught CE403, Structural Analysis, and would teach the course again with the author in the following semester.

Feedback from my reviewers suggested six changes. First, the author learned that "peer review" is not an optimal name for the process because it is used often in a freshman-level humanities course where the cadets often dislike both the process and the course. The author's reviewer believed that my students' negative responses to the process might have been influenced by their prior experience of a different process with the same name.[16] Second, his reviewers suggested that the tone of the instructions should be less punitive in nature. Third, it was recommended that the tie to professional practice be emphasized as a main reason for this procedure. Fourth, students' own assessment noted that the policy would work better if there was more time to review the work prior to the submission deadline. Fifth, despite the recognized benefits of

assigning groups,[17] students and reviewers pointed out the unique structure and time constraints on cadets at West Point that often create inherent difficulties for cadets in trying to work with assigned groups. Sixth, his reviewers suggested a more formal process of recording reviews and reminding them exactly what the review should accomplish. Taking these comments into account a new policy was written (see Appendix A).

The need to educate the students in the methodology was also noted. It was naïve for the author to believe that the students would know what to do automatically without significant instruction and coaching. The students had not encountered this in previous engineering classes, and the author and the other course instructor took care to prepare the students. Combined with a discussion of professional responsibility and ethics in the second lesson, the idea of peer review was explained and the policy was introduced and its implementation discussed; this took about two-thirds of a lesson and included examples and many details of what was to be done and why. During the first two submissions, copies of each review completed were copied and returned to the reviewing student with comments. Students who did a particularly good job were publicly recognized in class throughout the semester with the specifics of what made it a good and valuable review. Midway through the semester, the author's co-teacher discussed this methodology with his brother, a practicing mechanical engineer, who related how much their company uses review and a test they did that convinced them it was worth reviewing everything and that review saved money in the long run. This vignette was relayed to the students. All of this was done to ensure that the students saw the details as well as the big picture of what was being done with peer/design review.

After several assignments, the students suggested a slight modification to turn-in times to make them more in tune with their schedules and to make reviews easier to conduct in a meaningful way. This was adopted, and we received many comments to the effect that this change made it very reasonable. Clearly the students appreciated our changing the system, which no doubt led to their greater acceptance of it. The author believes this complete marketing of the program was instrumental in its acceptance and success, something that was previously missing.

The results from this third iteration (see Tables 5 and 6) indicated that the author had finally designed a tool that could achieve its desired results, but it certainly took work to get there! It became obvious to both instructors that as the semester went along, the quality of the reviews increased. Student reviews were commented on through the semester, and the author noticed more directed review and specific critiques of fellow students' work.

So what does it all mean?

This rather lengthy introduction to the author's experience with peer review is provided not as guide to implementing peer review in a course, that is described in more detail in other writing[18], but as an example from which he was able to draw some more universal lessons. In this example, the author was faced with a problem of trying to change student behavior, specifically getting them to take more ownership of their education and improve the quality of their work. Through several iterations, he was able to do this. What enabled him to achieve a level of success and actually change student behavior? The author believes that there were several key lessons learned that can be applied to other educational methodologies aimed at changing student behavior.

- **Market your plan**

If you want to change student behavior you must of course have a targeted objective. But more importantly for success, in addition to having good objectives, you must also carefully design your methodology and adequately "market" it. While marketing may not be a term that we like to associate with educational methods, it does capture what is required. The author's use of the term "marketing" reflects the practice of providing explanations to students to persuade and motivate them to engage fully in this or any educational methodology. When trying to change student behavior in a course, sometimes doing the right thing for the right reasons is simply not enough.

- **Be prepared for failure**

Expect designing a methodology to improve student learning to be like all design, an iterative process. The author was convinced that what he was doing was the right thing to do for many reasons, chiefly the link to professional practice and the value in improving student learning. Unfortunately, even with the best of intentions, it took three iterations before the process produced a degree of success in changing the behavior of the majority of students. The teacher must be willing to make changes to a methodology and tweak and adjust it continually in order to find the "optimum design."

- **Consult colleagues**

Peer review is a good thing—even for your educational methodology. This should be obvious in a profession that relies heavily on peer review of published work. The irony that the author was designing a methodology that involved peer review, yet he initially failed to do it should not be lost. Any methodology, however, like design (or a conference paper), can benefit from peer review. Outside points of view, even when not in the teacher's discipline are invaluable and can bring fourth insights that would not come to the teacher who created the educational methodology.

- **Listen to the students**

Giving the students a voice in the methodology or getting feedback from them on how it's working—and responding to it—pays huge dividends. By involving the students in the process the teacher helps them see themselves as 'stakeholders' in the process. This makes complete buy in all the more possible. The author believes this has a great deal to do with changing behavior.

- **Be a leader**

You have to be able to convince students of the relevance of your methodology; i.e. this is what practicing engineers do. This can largely be a matter of persuading or motivating students to do what you want them to do. "Extensive research has shown that students learn best when they perceive a clear need to know the material being taught"[19] being able to tie what is done in the classroom to skills needed for future courses or better yet their future careers post college is a huge motivator to students.[20] If students believe that they really do need to know how to do something, they will tend to work harder at learning and do their best.[6, 21]

- **Don't focus on popularity**

The author also learned that students will not necessarily like a new methodology or embrace it, even if they agree it is useful. Students resist change, and anything they perceive to be creating work for them. One comment received in an end-of-course survey summed it up best when asked if the methodology helped in learning the course material: *"it helped a lot, but that does not mean I have to like it!"*

- **Consider the culture**

You have to know the culture of your students, where they are, what is affecting them and the constraints they face. While there is much educational research and many articles with tips and suggestions, the teacher needs to be able to understand the environment she and her students exist in and take that into account. The time constraints of the Military Academy schedule made assigned groups unmanageable for the type of collaboration the author was interested in, despite all the benefits touted in the research of assigning groups. Showing a willingness to change and make adjustments based on situations in the students' lives wins big points for the teacher and certainly helps in improving student-teacher rapport.

- **Don't just tell; show and demonstrate**

Don't expect students to know what you want them to do; you will in all likelihood have to teach them how to do what you want them to do. This is nothing more important than preparing the students to learn. The idea is certainly not new, yet seems to be often overlooked, as the author did initially. Some, I believe correctly, recognize "bringing students to the point of readiness as a significant part of teaching."[22] Like any other new skill or subject, students must be taught it. Skills need to be developed by a structured process, which includes educational methodologies.[23] This can be a concern in typical courses with full to overflowing syllabi. Where can a teacher find room to teach the mechanics of a learning tool when there is barely enough time to cover the *required* subject mater? The author suggests that if a teacher is trying to change student behavior, there must be a valid educational reason for wanting to do so. If there is justifiable reason, then we should expect to have to spend time to accomplish it. The author feels it is better to take that time and achieve deeper learning though a new methodology, possibly at the expense of a topic, than to just go along with methods that might cover all the topics but only achieve surface learning.

- **Be aware of the costs**

It does take time and effort. The author had hoped that by having students turn in work that was reviewed and hopefully corrected, it would cut down on the time requirements in grading. This was realized to great extent as the semester went on. However, the time saved was probably offset by the time expended to read and comment on the reviews the students did.. There was also the initial time devoted early in each course to preparing copies of each review and returning them to the reviewers. The author certainly did not realize significant time and effort savings from this methodology; yet that was never an objective. He suggests that for any new

educational strategy teachers will have to expect to expend time and effort to get students started and functioning effectively. As in many things, there are no short cuts to achieving quality in education.

- **Just do it!**

Finally, the author believes teachers should borrow a thought from the Nike Corporation. If a teacher has new methodology in mind, "Just Do IT!" Even an effort that is not as well thought out as it should be or presented with the proper motivation will likely achieve some benefit for at least some of the students. The risk in applying a new methodology is essentially zero, so there is almost no reason to not try something. Provided reasonable forethought accompanies the idea, it is essentially a no-lose situation to try to implement it. If it does not work, the teacher, with a bit of analysis, is poised to improve, change, and modify the methodology in a second (or third or fourth or…) attempt to change student behavior. To the author's mind there is no reason not to try out any new idea that has a chance of improving student learning.

Summary

The author firmly believes that student behavior with respect to learning is rarely an unalterable variable. Changing behavior not only is possible, but often is necessary to improve learning. The teacher is the leader in the classroom and must use a variety of techniques and strategies to ensure learning occurs.[24, 25] Teachers can change student behavior though the reasoned and logical use of educational methodologies. While the change may be resisted by students and may not succeed at first, it can work! As educators interested in increasing student learning, it seems we must be willing to take the time and energy needed to change those student behaviors that do not promote good learning.

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Appendix A: Peer review policy, 2005 version.

DESIGN REVIEW POLICY

It is important in Civil Engineering to take the steps necessary to get the correct answer. Remember Hammurabi's Law? In the "real world" practice plans, drawings and specifications are reviewed and a responsible licensed PE is required to stamp them. In academia publications and research are also subjected to peer review prior to publication.
Thus, this semester all your problem sets will be reviewed by two of your classmates prior to their being turned in. This approach to having your work reviewed is called DESIGN REVIEW, and this idea, if not our process, may be familiar to you from other courses. The objective of DESIGN REVIEW in our course is two fold. First and primarily, it is to help increase **your** learning and knowledge of structural analysis by having you review work of your classmates, as well as requiring you to have to explain your own work to them. It will also give you a good idea of your relative strengths and weaknesses in the various topics we will cover this semester. It is expected that when disagreements in answers or approach are encountered you will take the time to discuss them and determine if an error or misunderstanding of a concept does exit, and if so how to correct it. In order for this to happen you must prepare your work in a timely manner in order to allow it to be adequately reviewed. It must also be clearly presented to allow your reviewers, your classmates, to easily follow it.

So how will we incorporate DESIGN REVIEW into CE403? Remember the goal is to help you learn the material more completely. As an incentive to make sure that you treat this part of the assignment as importantly as the calculations and other work you do, DESIGN REVIEW will count 10% of the possible grade on each assignment and provide an opportunity for you to earn additional points as well. Each of you must provide two design reviews of each assignment and have your work reviewed by two different people. You are encouraged use many different reviewers throughout the course, and may not use the same reviewers for consecutive assignments. You will notice that each assignment has two deadline attached to it. The first is the time you are required to have the work and design review completed. The second time, typically 1 day later, is the time the work is to be turned in for grading. This will allow you to go over the design review comments, make changes to your work, or decide that no changes to your work are necessary.

How do you conduct a DESIGN REVIEW? First you must have completed the work in order to review your classmate's work! There is a DESIGN REVIEW Sheet provided with each assignment, a copy of which is attached here. This sheet will have a space for each reviewer to annotate the time they reviewed the work and the results of their review. It will also have a place for you to write down what action you take after the review is completed. So what are you looking for? Certainly you are looking to see if the "final answer" is correct, but more than that you are checking to see if the work follows and applies the appropriate theory and methodology, is it clearly presented, does the work makes sense, is it complete, and finally **do the answers make sense** (this is hugely important for you as a budding engineer!).

What is not helpful in this process? Providing a bogus DESIGN REVIEW; examples of bogus DESIGN REVIEW include, but are not limited to:

- Checking off on work you have not done yourself.

- Checking off as correct work that is wrong, yet you got correct.
- Checking off on work with very basic and obvious deficiencies.

In the unlikely event that a bogus DESIGN REVIEW takes place, the reviewer will be penalized. You will not be penalized for a bogus DESIGN REVIEW if your design review group all comes up with a wrong answer, assuming you all think it is correct and that is a logical assumption based on the work shown. Similarly, you will not be penalized if after review you all think the other's work is wrong and no one can convince the other members to change their answers. This rare case must be fully explained by all parties, however, with reasons why you are convinced your answer is correct. Remember, ideally you will all only provide genuine and accurate DESIGN REVIEW, so there should be no penalties. Especially good design reviews, those that are thorough, clearly provide meaningful comments that will help the engineer, offer insight, and demonstrate the reviewer's care and understanding will be given bonus points. In addition, at the end of the semester, we will have awards for the top Design Reviewers.

DESIGN REVIEW 1 Date/Time Review Completed:_____

Does the work follow and apply the appropriate theory and methodology? YES ☐ NO ☐ Explain below

Is the work complete and easy to follow? YES ☐ NO ☐ Explain below

Do the answers make sense? YES ☐ NO ☐ Explain below

REVIEWER COMMENTS:

REVIEWED BY:_____ Initials:_____

DESIGN REVIEW 2 Date/Time Review Completed:_____

Does the work follow and apply the appropriate theory and methodology? YES ☐ NO ☐ Explain below

Is the work complete and easy to follow? YES ☐ NO ☐ Explain below

Do the answers make sense? YES ☐ NO ☐ Explain below

REVIEWER COMMENTS:

REVIEWED BY:_____ Initials:_____

ENGINEER'S COMMENTS: