Ethical and Honesty Issues of Web-Based On-Line Courses Compared with Traditional Classroom Courses

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A number of Manufacturing Engineering Technology classes have been offered both on-line and, in other different years, as traditional face-to-face classroom presentations. Thus we had the opportunity to compare on-line and web-based courses. This paper discusses how issues of student honesty and copyright laws proved to be more problematic for web-enhanced and on-line classes. We found that material placed on-line requires significantly more time to apply and re-apply to receive copyright permission, while most printed materials, DVD's, and samples can be easily presented in face-to-face lectures without copyright problems. Exam and homework security was an issue.

Introduction

A number of Manufacturing Engineering Technology classes have been converted from traditional face-to-face classes to on-line web-based delivery, and later converted back to traditional face-to-face classroom presentations[1]. This gave us the opportunity to compare different features and advantages/disadvantages of on-line and web-based courses. Copyright, ethical, honesty, and security issues proved to be major considerations which consumed additional time and money when offering courses on-line[2].

There are a number of additional time issues with web-based courses, which gave less remaining time to handle copyright, ethical, honesty, and security issues. Filming, studio time, editing and submission for uploading to our web class-management system (D2L) were the most obvious issues which consumed instructors' time[2]. Quality of videos is a major issue in web-based instruction, so each lesson must be reviewed prior to release, if possible[3]. There sometimes were problems opening student submissions, and each submission took time to open, grade, and make available to students for review. If students scanned their submissions, the mailbox capacity was sometimes exceeded, and cleaning the memory took quite a bit of time. Yet, somehow we needed to find the time to handle security and copyright problems, along with handling ethical and student honesty problems.

Protecting the Privacy and Security of Student Work

Privacy and security of student work was an issue. Because University privacy rules (along with common decency) prohibit broadcasting private e-mail submissions, corrections, reprimands, and questions to all students in a class, without the opportunity for verbal classroom interaction we sometimes would answer the same questions multiple times using both telephone and e-mail. This meant that we often answered all inquiries individually. Care was required, because an e-mail sent can be forwarded to anyone by the recipient, including other students doing the same assignments. Care was (and always is) required to make sure that only the intended recipient receives a private e-mail. It is far too easy to accidently reply to all.

Copyrights and Intellectual Property

Protecting and complying with copyrights and intellectual property rights posed a major problem. Copyrighted materials require permission prior to putting it on-line, and some publishers charge a license fee. Many things are covered by copyrights. Circular 21 of the United States Copyright Office states,

> "What is copyright? Copyright is a form of protection grounded in the U.S. Constitution and granted by law for original works of authorship fixed in a tangible medium of expression. Copyright covers both published and unpublished works. What does copyright protect? Copyright, a form of intellectual property law, protects original works of authorship including literary, dramatic, musical, and artistic works, such as poetry, novels, movies, songs, computer software, and architecture. Copyright does not protect facts, ideas, systems, or methods of operation, although it may protect the way these things are expressed."[2]

An instructor cannot depend on the 'fair use' doctrine to justify putting copyrighted materials on-line. Circular 21 of the United States Copyright Office warns,

> "The safest course is always to get permission from the copyright owner before using copyrighted material. The Copyright Office cannot give this permission. When it is impracticable to obtain permission, use of copyrighted material should be avoided unless the doctrine of 'fair use' would clearly apply to the situation. The Copyright Office can neither determine if a certain use may be considered 'fair' nor advise on possible copyright violations. If there is any doubt, it is advisable to consult an attorney." [3]

When granted by the copyright holder, this permission is usually for only a limited time, so material carried over from one semester to the next required significant time and sometimes usage fees to re-apply and receive permission to put on-line. While we took reasonable efforts to protect copyrighted materials placed on-line with permission, we could not perfectly protect them. One protection was to change from downloadable Quick-time files to streaming video for copyrighted videos, but skilled students still could capture the streaming materials. In contrast, most materials, DVD's, and samples can be easily presented in face-to-face lectures without copyright problems, security issues, licenses, or fees under the educational fair-use principles.

Security for Exams and Quizzes

There was no reasonably secure way to proctor on-line exams or quizzes, except during the single face-to-face meeting which most on-line courses required. Some local institutions and libraries might be willing to offer remote exam proctoring services. However, a fair amount of effort, and possibly even some budget will be required to set up proctoring arrangements, preparing delivery, and arranging for returning exams and quizzes in a secure manner, taking additional time and money which may not be in the budget. But without some arrangement for remote proctoring, Security of quizzes and exams cannot be guaranteed.

Without proctoring, students are able to team up for exams, share information, and use any and all disallowed resources during an on-line exam. Some students allegedly participated in "quiz teams" where four or five students gather together for each quiz or exam. On a rotating basis, one student takes the exam, while the others watch and take notes. Then the remaining students take the exam, doing much better, of course. The students' roles rotate from exam to exam, so each student has a chance to copy. While randomizing questions can offset this problem a bit, it still does not fully provide security.

There is temptation to reuse much of old material from earlier classes when update classes, making it easier for student dishonesty in later classes.

Conclusion

Protecting student privacy is more problematic on-line. License permission and fees for copyrighted materials usually apply for only a limited time, and require vigilant maintenance. Exam and quiz integrity i=requires great care, and cannot be guaranteed without the use of remote proctors. All of these additional concerns require time, and sometimes money when putting courses on-line.

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Peer Grading:
Sometimes It Should Be Done

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Abstract
A problem-based method of teaching that engenders classroom discussion in lieu of lecture, and that fosters better study habits is presented. This method is especially recommended for lower-division introductory courses on technical subjects. This method is an example of the employment of inductive teaching and learning, as applied to a technical course (Prince and Flelder, 2006). Goals of the method are to motivate students to keep up with the course by establishing regular periodic study times, to move the student's focus from earning a grade to learning the material well enough to explain it to a classmate, to teach good written and verbal communication skills, and to rapidly identify weak students early in the semester so that they can be advised constructively and referred to appropriate assistance and campus offices. Results from this method, as measured by student evaluations of instruction, have been strongly positive.

Introduction
Lecture is the traditional way to teach highly technical courses. Lectures that take an entire class period have the advantage of offering lots of time to explain the details of a complex subject. Lecturing gives the instructor a sense of assurance that the students have been informed, but it is not clear that students can absorb the information presented in the lecture. On the other hand, students often to not know how to read textbooks effectively and so it may seem there is no alternative to lecturing in these technical courses.

In response to a 2006 paper by Prince and Felder (2006) in the Journal of Engineering Education, the author began experimenting with a problem-based method of teaching that engenders classroom discussion in lieu of lecture, and that fosters better study habits. Student learning outcomes have improved in terms of the enthusiasm of students for the course, the amount of material that can be covered in the course, and the early identification of struggling students. There may also be benefits in terms of retention of students in the course. It is not clear that students perform differently (better or worse) on tests during the course, but Prince and Felder's analysis shows that that, in the long run, students retain more of what they learn.

Peer Graded Courses Contrasted with Lecture Courses
No course is purely one style or another, but for a moment, consider how a predominantly lecture-style course usually works.

Prior to the course offering, the instructor reviews available textbooks and chooses one. Then the instructor develops a set of notes for the course to coordinate with the chosen textbook. An instructor teaching the course for the first time might take notes almost exclusively from the chosen textbook. A more experienced instructor might make notes based on a composite of knowledge in the field, but will still be constrained to coordinate notes with the outline of the textbook. The textbook becomes the primary organizational vehicle for the course. However, some students will not read much of the textbook, relying instead on taking notes during class.

The instructor uses the textbook-oriented notes for the classroom lectures, usually writing the notes on a whiteboard or presenting them via computerized projection while speaking. Students copy the notes, either by hand or by using a computer. The instructor's notes might also be made available to students as handouts or electronic files. Students may interrupt to ask questions, but they must take some initiative to do so, even if the questions are welcomed. The instructor periodically assigns homework, possibly weekly. Many students wait to the last minute to do the each assignment, then finish it in one sitting. If they encounter difficulties, there is usually not enough time to resolve them, so they turn in what they have. The homework usually is graded and turned back to the students for feedback. The students will review the homework just prior to the next test. There may also be a comprehensive final exam in the course which will prompt most students to review their homework again.

Consider how students might see the presentation of a particular subject in a lecture oriented course. Say the topic is, "Kirchhoff's Voltage Law" (KVL). The student probably is presented with KVL for the first time via a lecture since few students read ahead in the textbook. Some number of days later, the student will work a homework problem or two on KVL. This is the student's second exposure, but possibly days after the related lecture. Suppose now that the student does not correctly understand KVL and is unaware of the misunderstanding. He or she gets the homework wrong, but will only discover this after the homework is graded and returned, a few days after doing the homework. At this point the course has moved on to new subjects and so the homework will likely be saved away for study just before the test. Finally, the student will retrieve the homework before the test, maybe just the night before the test, and try to figure out what went wrong with the homework on KVL. This will be the student's third encounter with the subject. Again, this encounter occurs days or even weeks after the previous encounter. If the student does not succeed in understanding KVL while studying for the test, he or she might just go ahead and take the test anyway, hoping KVL will not appear on the test. The test is graded which offers a second opportunity for giving feedback to the student on KVL. If there is a comprehensive final exam the student may encounter KVL for a fourth time when studying for the final exam.

Altogether the student encounters the subject four times (Lecture, homework, study for test, study for final exam) and twice receives feedback that can be used for improvement (homework, test).

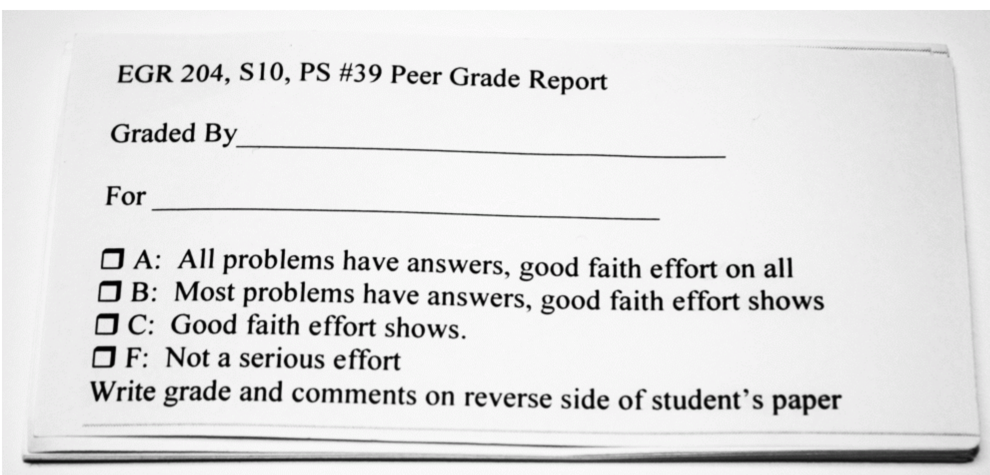
Peer Grading From the Instructor's Perspective

Now consider a different way of teaching the class that avoids long lectures and encourages discussion. Again, before the course starts the instructor reviews available textbooks and chooses one, but instead of preparing comprehensive course notes, the instructor prepares a list of homework assignments with coordinated reading assignments that cover the main subjects. The course becomes homework oriented and driven. Classroom time is used mostly to discuss homework.

Before each class, the instructor (or an assistant) grades any previously handed in homework. The instructor selects a section of the textbook for the new assignment and assigns homework that relates to that section of the textbook. The instructor posts this new assignment so that the class is aware of it. This can be done by writing it on a whiteboard at the start of class. However, course management software such as Blackboard, Desire2Learn, Moodle, etc. or a course web page can be very helpful for students since it eliminates transcription errors in keeping track of exactly what the assignment is and it is available 24/7. The instructor also prepares a short (about 15 minute) lecture to introduce the new homework assignment. The lecture assumes the students have not read the relevant section of the textbook. Since time is short, the lecture can only motivate the students to read the section. This is done by pointing out important definitions, equations, illustrations, theories, etc. and relating these to the challenges posed by the new homework assignment. The new homework assignment will be due at the start of the next class period for “peer grading” which is a form of structured small-group discussion.

The peer grading is done during about the first ten minutes of class (assuming a 50 minute class period). At the end of the 10 minute peer grading interval the peer grade forms are turned in to the instructor and the peer graded homework is returned to the student who authored it. After class, the students have an opportunity to correct any mistakes they may have discovered during peer grading. This same assignment will be due again at the next class period for regular grading.

When the class starts, the instructor collects two sets of homework. One set is the set (the newer set) that will be peer graded. The other set (older) is the set that will be graded the normal way. Then the instructor passes the peer grading set back to random students. There must be two important exceptions: First, no student gets his or her own paper back. Second, any student who did not turn in a paper for peer grading does not get a paper to peer grade. (That student will just have to wait patiently for peer grading to end.) As the peer graded homework is passed back to random students, blank peer grading forms are passed out along with the homework. A sample peer grading form used by the author is shown in Figure 1. The grading rubric is also shown in the figure. The goal of peer grading is to establish mutual accountability for attempting the homework so that all students are prepared to discuss the homework in class.


EGR 204, S10, PS #39 Peer Grade Report

Graded By______________________________

For ______________________________

❒ A: All problems have answers, good faith effort on all
❒ B: Most problems have answers, good faith effort shows
❒ C: Good faith effort shows.
❒ F: Not a serious effort
Write grade and comments on reverse side of student’s paper

Figure 1, A sample peer grading form.

Students are instructed to do homework on only one side of each sheet of paper so that the other side may be used by the peer grader for comments. This way the regular grader can also obviously distinguish between the student’s solution and the peer grader’s comments. After each student is done peer grading, she or he gets up, drops the peer grading form off at the instructor’s podium, and walks over to the student who was peer graded and discusses the homework with that student. The classroom becomes filled with chatter as students move about and discuss their homework. If two students have different answers, the students will naturally attempt to figure out who’s answer is right. (For a few problems they may have correct answers from the textbook, but no complete and known correct solution methods have been given.) Each student encounters two perspectives on the homework solutions other than his or her own. One is from the student she peer graded and the other is from the person who peer graded her paper. Students usually discuss the homework by way of comparing and contrasting their solutions and techniques. At the end of the peer grading time each student will have received his or her assignment back and will have an idea of how well the assignment was done. The peer grading process also tends to plant questions in the minds of the students on some of the more difficult aspects of the assignment.

While the students are doing peer grading, the instructor can return regular graded papers to the students. When it appears that peer grading is done, the instructor should count the number of peer grading forms turned in. Occasionally a student will forget to turn a peer grading form in. Also the forms should be checked for completeness. Occasionally a student will turn in a form that is missing a grade. At this time it is an easy matter for the instructor to walk over to a student and ask for a peer grading form to be completed.

After the peer grading is done the homework is discussed by the class as a whole. One way to initiate this discussion is to ask some benign question requiring students to categorize the homework, such as, “Which question was the hardest?” (To which a smart aleck might answer, “All of them” Just ask for a second opinion from the class!) Such simple questions will usually lead quickly to substantive questions. It is usually important however to make the students ask questions that require more than a, “yes” or, “no” answer. Questions such as, “Is the answer fifteen?” should usually not be directly answered. In answering questions it is productive to show students how to set up a solution to the problem, to name theorems or definitions that are relevant, to show how to check a solution for correctness and so forth. Possible a parallel but different problem and a complete solution can be shown by way of example.

After about 25 minutes of discussion, the last 15 minutes or so of the class period should be used for introducing the next assignment.

Peer Grading From a Student’s Perspective

Consider the tasks and interactions of a typical but fictional student by the name of “Armani.” Armani also interacts with “Jessie,” and “Rory.”

After class and before the next class, Armani will correct (or finish) the most recent past homework assignment. If needed, Armani will (re)read the textbook or find help from the professor, peers, or the campus academic resource center, etc. The urgency of this task will be apparent from the peer grading event that was held on this assignment. Armani will typically have two or three days from the time of peer grading until the final due date. This will be the fourth time Armani has encountered a particular subject (say KVL) in the course. (First the introductory lecture; second, working the homework prior to peer grading; third, the peer grading event.)

Also, before the next class Armani will try the new assignment. A diligent Armani will refer to the textbook and find help as needed and invent ways to check answers. Students like that would probably thrive under any form of instruction. However, maybe Armani will skip the assigned reading in an attempt to save time. Some answers will be correctly found, but many will not. If Armani does not have enough time or perseverance to finish well, the peer grading rubric will encourage Armani to at least think about and write something down for each problem. Also, Armani will want to seem as intelligent as possible while participating in peer grading to get some more tips on how to solve the problems. If Armani just writes garbage, Armani comes across during peer grading as a leech. A few experiences like that usually change behavior. Making homework look as intelligent as possible (with a minimum of effort) might require at least scanning the textbook for something that relates to the problems at hand. Students like this will particularly benefit from peer grading. A very few students will be totally careless. They would probably fail under any system of instruction.

In class, at the start of peer grading, by random chance Armani received Jessie's homework for peer grading. Also Armani's homework was given by random chance to Rory. Armani will review and possibly write remarks on Jessie's paper, then bring it to Jessie and discuss it. Armani will have to work from memory and from what is presented on Jessie's homework in order to grade Jessie's homework since Armani's paper itself is in the hands of Rory.

If Jessie's homework is too messy to read Armani will probably talk to Jessie about that in order to understand the work and thus grade it. This helps Jessie conform to conventional standards of writing. Also, Armani and Jessie will employ the vocabulary associated with the subject and thus become more fluent in speaking about a technical subject.

Armani will also be approached by Rory and another discussion will ensue. Before the end of this discussion both Armani and Rory will have received their peer graded homework back. Then Armani and Rory might make some direct comparisons of each others papers.

When peer grading ends Armani might have seen some contrasting answers from Jessie or Rory. During the discussion period following peer grading, Armani will ask questions of the instructor to try to figure out who is right (if one of them is). A lively discussion usually ensues, which the instructor must moderate in order to give all the students and topics adequate time.

When the new homework is introduced, Armani will take out a notebook and follow the presentation closely because this is a prime time to get some tips on how to do the next homework assignment. Finally, Armani might be in a hurry to meet a friend after class. About three minutes before the end of the class Armani will start packing up and will operate a backpack zipper loudly and in a random chorus with other similarly hurried students to remind the professor that time is nearly up!

Goals of peer grading

The method of peer grading presented here is designed to promote four goals:

1.) To motivate the students to establish regular periodic study times for the subject and to keep up with the course effectively.

2.) To change the focus of learning from earning a grade to understanding the subject well enough to explain it to a peer. Then indirectly, to drive the students to the textbook or other sources more often and to help them identify when to seek help and to do it as early as possible.

3.) To learn how to communicate about technical subjects neatly in writing and to give students opportunities to use the technical vocabulary that goes with the course.

4.) To rapidly identify students who need help and to get them connected with campus resources and services as needed. Indirectly, helping students in a timely way improves retention in the course and in the major.

Mechanics of peer grading

Peer grading requires a different type of preparation for the semester and for each class as compared to a lecture-style course. Before the semester starts it is helpful to have stacks of blank peer grading forms printed, similar to those shown in Figure 1. It is also a good idea to set up some type of course management software so that assignments can be distributed effectively. Since two sets of homework are turned in with each class period, keeping track of what is due with each class is more difficult than with a lecture style class. The author uses a Web page for this purpose, as illustrated in Figure 2.

DORDT COLLEGE ENGINEERING DEPARTMENT

INTRODUCTION TO MICROPROCESSORS AND DIGITAL CIRCUITS--EGR 204

(Spring 2010)

PROBLEM SETS

(Last update: 1/14/2010 2:38 pm)

PS #	Assigned	Due	Returned	Problems Assigned (In Mano & Kime unless otherwise noted)
				Read Ch 2 Sec 2-5, 2-6, 2-7 Do 2-15*, 2-16, 2-19*, 2-31
				Read Ch 2 Sec 2-3, 2-4 Do 2-7*, 2-11, 2-12*, 2-14 Note errata on **problem 2-12*** Note errata on **page 60, Figure 2-9(b)** Note on 2-14: "Optimize" means to "simplify" as shown by several examples in section 2-4.
				Read Ch 2 Sec 2-1, 2-2 Do 2-1*, 2-2*, 2-10*
				Read Ch 1 Sec 1-4 through 1-7 Also read about binary prefixes from **NIST** Optional--read more about binary prefixes **here**. Do 1-10*, 1-22, 1-24, 1-25*
1	1/13	1/15 1/18		Scan Chapter 1. Read Sections 1-2, 1-3 Do 1-4, 1-5, 1-6, 1-7*, 1-8, 1-9* Note: The answer to 1-5 must be exact.

Figure 2, Posting of homework assignments for a peer graded class. The first due date is for peer grading. The second due date is for regular grading. Assignments without dates will be assigned next, allowing students to work ahead.

The author weights each student's average of all peer grades as 2.5% of the entire course grade and the average of the regular homework grade as 7.5% of the entire course grade. (Thus the homework as a whole is worth 10% of the course grade.) Many students request higher weighting for peer grades and for homework grades, but higher weights encourage too much copying and cheating. Even these relatively low weights adequately motivate students.

Some students will be absent from class from time-to-time for various reasons (sports, work, music, illness or medical condition, etc.) These students can be instructed to give their homework to a classmate. The classmate then shepherds the homework through the peer grading process in class. This results in more papers to peer grade than there are students in the classroom to do the peer grading. Either the instructor can peer grade a paper, or if there are several, some students can be asked to peer grade two papers. The extra papers are then returned to the classmates who brought the papers to class.

In order to achieve the benefits of rapid feedback that peer grading can offer, it is important to grade all homework between class periods so that there is no grading backlog at all. It is also helpful to use course management software to distribute grades to students in a format that allows students to see the trends of their grades.

Finally, it is important to analyse the grades about every week during the first month or so of the class in order to rapidly identify students who need help. Figure 3 shows a spreadsheet of peer grades from an actual class the author taught. (The names have been changed.) Here a "4" represents an "A," a "3" is a "B," a "2" is a "C" and a blank or a dash is an "F." After just three peer grades (one week of class) it is clear that Jana Fulton, Jean Islos and Jarad Olthof, and Jenny Quade need help. Jenny and Jana's grades show improvement after intervention.

F	G	H	I	J	K	L	M	N	O	P
	Assignmer	Assignmer	Assignmer	Assignmer	Assignmer	Assignmer	Assignmer	Assignmer	Assignmer	Assignmer
John Adams	4	4	4	4	4	4	4	4	3	4
Jane Baker	4	4	4	4	4	4	4	4	4	4
Jim Colter	4	4	4	4	3	4	4	4	-	-
Jill Doe	-	4	4	4	4	4	4	4	4	4
Joe Elton	4	4	-	4	4	4	3	4	4	4
Jana Fulton	4	-	4	-	4	4	4	4	4	4
Jake Gross	4	4	4	4	4	4	4	4	4	3
Jerry Hoff	4	4	4	4	3	3	4	4	4	4
Jean Islos	-	-	-	-	-	-	-	-	-	4
Jeff Knopf	4	4	4	4	4	4	4	4	4	4
Judy Lubbers	4	4	4	4	3	4	4	4	4	4
Josh Miller	4	4	4	4	-	3	4	4	4	-
Julia Nydam	4	4	4	-	-	-	2	4	3	4
Jarad Olthof	-	-	-	-	-	-	-	-	-	4
Joy Pearson	4	4	4	4	4	4	4	4	4	4
Jenny Quade	-	-	-	-	4	4	4	4	3	2
Jason Ross	4	4	4	4	4	4	3	4	3	4
Jessica Stryd	4	4	4	4	4	4	4	4	4	4
Jordan Todd	4	4	4	4	4	4	4	4	4	4
Jodi Ulman	4	4	4	4	4	4	-	4	4	4

Figure 3, Typical peer grades from about the first three weeks of a peer graded course. Students in need of help can be rapidly identified.

Although peer grading has drawn strongly positive reviews from students on end-of-semester course evaluations, a few students will object to peer grading. These objections tend to fall into three distinct categories.

First, there may be students who simply don't want to do homework, and will not do it, no matter what the system is. One or two of these may be geniuses who are not challenged by the material. For the sake of saving time, they will prefer to listen to the classroom discussion before attempting the assignment, if they even attempt the assignment at all. They will also be willing to suffer the loss of peer grading credit (and possibly homework credit) since they will easily make up for it with perfect or near perfect test scores. Others might not be geniuses. They probably will fail for lack of a work ethic, no matter what style of course delivery is used. Either way, the student's objection to peer grading is really an objection, valid or not, to work in general.

Second, occasionally a student might be socially withdrawn or insecure when discussing mistakes on homework with another student. This type of student might turn homework in for regular grading but not for peer grading. The author attempts to reach out to such students and connect them with student organizations such as ASME, IEEE, or any affinity group that might be helpful. Grades do not typically measure social skill or self confidence, but this pattern represents an opportunity for the student to improve.

Third, there are students who object to peer grading because of the frequency with which they must do homework, compared to a weekly frequency. Perhaps they have heavy work commitments for three or four weeknights in a row. This complaint can be sidestepped by posting about a week of homework in advance. Then students who raise this objection can be asked to simply work ahead as needed. A few students will take advantage of this opportunity and truly benefit. In any case, complaints are avoided.

Results

Peer grading improves the attitudes of students toward the class and consequently improves scores instructors receive on student evaluations of instruction. The students get to know each other and the instructor better on account of the increased interaction. The author's institution has an open ended question on the prescribed evaluation from which asks, "What should the instructor continue doing?" In a recent peer graded class of 20 students, 14 responded to this question. Six of the responses were positive remarks about peer grading such as, "Peer grading is always helpful to me." In this particular class, there were no negative responses regarding peer grading in any portions of the student evaluations. Although sometimes there may be one or two negative remarks about peer grading, these are outweighed several times over by positive remarks.

More gets done in the course. More homework problems can be assigned since the students are working at them on a regular basis. More challenging work can be assigned since there are more opportunities to offer guidance in their solutions. More textbook pages can be covered since students are directed to the text more frequently. There is much more discussion in class and the discussion tends to be more focused on challenging issues.

Students develop better study habits. They learn that help is available if you tackle the homework early enough to have time to seek help before the due date. They learn constructive methods of collaboration such as discussing the theorems or techniques needed to solve the problem rather than answering simple questions such as, "did you get 52 volts for Problem 2?" In the author's experience, these good study habits get paid forward to other courses the students take later, even if those courses are not peer graded.

It is possible that retention could be improved by using peer grading. However the author has only had the chance to apply this technique to courses where retention was traditionally quite high, about 96% from the first week to the last week of the course. This was because the course was in the student's major. Thus the instructor does not have enough comparable data to make a statistically meaningful statement. Certainly students who are seriously struggling can be identified within two weeks. Help can be offered earlier by giving attention to peer grades earned on the first two or three weeks of assignments. In the author's experience, only about half of these identified students respond constructively. However, that is a few students saved from failure or lower grades, who otherwise would not have received help in time for it to matter.

Courses that work best with peer grading

Peer grading works best with freshman or sophomore level classes where students still are learning how to study and how to manage their time.

Peer grading also works best in class sizes of about 6 to 25 students. If there are too few students then familiarity causes less accountability. The author has used it in classes of up to about 35 students, but then the logistics of carrying out peer grading during class in about 10 minutes becomes difficult. There will be too many students desiring to ask question to give everyone a chance to participate in the discussion. The discussion time becomes harried. There will also be one or two students who become passive and allow others to ask questions for them.

The course needs a good textbook. Students will be learning primarily from the textbook and the book needs to have an adequate variety of problems to cover each main topic in the text. Sometimes supplemental information also needs to be provided in written form. There will not be enough class time to lecture over supplemental information.

Course management software such as Blackboard, Desire2Learn, Moodle, etc, can be very helpful for keeping the peer grading process well organized and for informing students of trends in their performance.

Conclusion

Students like peer grading because it keeps them on task with a regular, predictable, workload and because it helps them know when to seek help. Faculty members like peer grading because more gets done in the course, the students are happier, and course evaluations improve. Sometimes peer grading is what should be done!

Reference

Prince, M. J., & Felder, R. M. (2006). Inductive Teaching and Learning Methods: Definitions, Comparisons, and Research Bases. *Journal of Engineering Education*, 95(2), 123-138.

Author Biography

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Engaging Students in Learning through Cooperative Learning Strategies

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Abstract

Engineering education faces significant challenges as it seeks to meet the demands on the engineering profession in the twenty first century. The paper focuses on classroom-based pedagogies of engagement, in general, and *cooperative learning strategies* in particular. The paper is a follow up to previous work by the author on viable strategies to improve the classroom environment of engineering colleges. At the start, the paper relates author's preliminary findings on *teaching-learning* practices in selected engineering colleges, sheds light on the *pros and cons* of the *lecture format*, and identifies meanings and substance of different *active learning* protocols focusing on *cooperative engagement strategies*. Next, it identifies common barriers to *reformation* in general, and to the use of modern pedagogical skills in particular. It is also argued that any meaningful change in classroom practices today (dominated by traditional lecture-based methods) must be mandated and supported by the university administration. What is necessary to create a change, is for the department or college, to have a comprehensive and integrated set of components: clearly articulated expectations, opportunities for faculty to learn about new pedagogies, and an equitable reward system.

Introduction

"To teach is to engage students in learning." This quote, from *Education for Judgment* by Christenson et al (1991), captures the meaning of the art and practice of pedagogies of engagement. The theme advocated here is that student involvement is an essential aspect of meaningful learning. Also, engaging students in learning is principally the responsibility of the instructor, who should become less an imparter of knowledge and more a designer and a facilitator of learning opportunities. In other words, the real challenge in college teaching is not trying to cover the material for the students, as many of us practice today; but rather uncovering the material with the students! This is a call for all faculty involved with teaching engineering courses, and those who develop, and implement engineering programs , to consider not only the content that make up an engineering degree, but also how students engage with these materials. It is primarily a call to search for proper tools that can be deployed to stimulate learning.

In moving forward, there are numerous tools available to select from, including the models predicated on *cooperation*; i.e., working together to accomplish shared goals. Within *cooperative* *activities*, individuals seek outcomes that are beneficial to them and to all other group members (Smith et al 1981; Johnson et al 1991). *Cooperative learning* researchers and practitioners have shown that positive peer relations are essential to success in college. The positive interpersonal relationships promoted through *cooperative learning* are regarded as crucial to today's learning communities. They reduce uncertainties and increase the quality of social adjustment and integration into college life. Isolation and alienation, on the other hand, often lead to failure. Two major reasons for dropping out of college are: failure to establish a social network of classmates and failure to become academically involved in classes (Mckeachie et al 1986; Tinto 1994).

The purpose here is to renew the call for deployment of more effective instructional strategies in the classroom, stressing on *cooperative learning* practices as a viable alternative to the traditional (low-interaction lecture-based) environment that has gripped the engineering education in most institutions, for decades. The paper sheds light on: theoretical roots, current practices, and suggestions for redesigning classes-if need be- to help break the traditional lecture dominant pattern when *cooperative learning* protocols are deployed. The paper shows how *cooperative learning* can advance academic success, quality of relationships, and psychological adjustments and attitudes toward the college experience. A number of relevant questions do come to mind, including: What needs to be done to move the process forward? What are the key components of successful deployment of *active learning* in general and *cooperative learning* in particular? How to foster and expand the community of engineering faculty who decide to use *cooperative learning*? What plans /resources needed to institutionalize pedagogies of engagement including *cooperative learning*, at the department or college level? Achieving change needed does require a collective effort by all involved, namely: the institution, the faculty, and the students.

Teaching/Learning Practices Today: Findings through Interviews

To get first-hand information on teaching practices in selected colleges, the author arranged to meet with faculty members and administrators from various engineering colleges, in an effort to learn, first hand, about current teaching and learning practices, and, instructors' views on ways to improve the classroom environment. A total of 24 faculty members were receptive and responded voluntarily – on a rather short notice - and expressed their views orally, supplemented with written statements. The main headings/questions raised by the author, during the interviews, were:

- Have you been exposed to *active teaching/ learning strategies,* and have you kept up with recent developments in the arena of *pedagogies of engagement?*
- Are you willing and able to deploy any of those strategies (*pedagogies of engagement*) if and when the need arises?
- If you were to select one such *strategy* which one would it be? And why?
- Preliminary information reveals that *strategies of engagement* are seldom used; and if at all, only by a few and on a limited basis? Why?
- Do you believe that *active learning strategies* should be deployed in your department and/or college? And if so, what are the barriers?
- Based on your experience, what would you suggest to add or change in your teaching strategies that would improve the classroom environment?

While answers to the above noted questions varied considerably from one member to the next; there were, nonetheless, some agreements amongst many, on certain issues that would be worthy

of consideration. The general consensus of views/opinions expressed by the majority of the faculty interviewed by the author asserts and/or amplifies the following points:
First, nearly all faculty members have been exposed to one form or another of *active learning* through work shops and seminars offered at their universities' Learning Centers. Some have acquired the knowledge on their own, i.e., through their own personal endeavors. ***Second,*** all have expressed their wish to learn more about *active learning strategies*; and most do not believe that they are sufficiently competent to deploy an *active learning strategy* as yet- in the courses they will be responsible for in the near future. ***Third,*** with regard to the strategy they would chose or deploy, the majority had no specific preference, and have argued that a specific method is best viewed as "a good choice" only when placed within a context that considers the overall experience and outcome, including: goals and objectives, the nature of the subject, and the capabilities and readiness of the students to embark on a new undertaking. ***Fourth,*** many have expressed their wish to improve their classroom strategies within the framework of traditional methods, arguing that there is a great deal of room for improvement within the traditional lecture approach. ***Fifth,*** some members have stressed the point that the success of any *active learning strategy* requires students' active participation- raising the question whether students are ready and willing to become active participants in the process? ***Sixth,*** most faculty members were mindful of the time and energy required to become a more effective instructor; and, at the same time, apprehensive and concerned that teaching is often undervalued in comparison to research.

The interviewed faculty members have been teaching undergraduate classes at their present institutions for a minimum of five years. Most of the classes taught by the aforementioned faculty are small size, seldom exceeding 35 students per class. The lecture format dominates the seen. There seem to be less interest (by most of the faculty interviewed) in the process by which the course content is delivered and more of a concern whether the rate of delivery would allow the instructor to finish the course on time. The views expressed, leads one to believe that it is highly unlikely that new more effective *teaching-learning strategies* would be deployed any time soon, unless drastic measures are undertaken. The author is more convinced now than ever, that deployment of *active learning strategies*, would happen only if the institution mandates it!

The Pros and Cons of the Lecture Format

When asked why he lectures, one faculty responded: *"It is tradition. It was part of my training, and seems to dwell in me and seems like what I should be doing. I feel guilty when I am not lecturing"* (Creed 1986). This candid statement suggests one of the great dilemmas faced by all who teach at the post-secondary level. Lecturing is virtually synonymous with teaching. It was the dominant method by which we were taught - and it is the method by which most of us teach. When discussing potential change in current *teaching–learning* strategies, many faculty become defensive, and discussions may quickly degenerate into heated debates where sides are clearly drawn. Over-exuberant advocates of *active learning* have, unfortunately, not been able to persuade many of us who have grown accustomed to traditional teaching. Better approaches in persuading traditionalists appear necessary. The challenge is to choose a suitable method at the appropriate time. Understanding the *pros and cons* of the lecture method is a helpful start.

Lectures have a number of characteristics that makes them, for the right subject matter, desirable in the classroom (Bonwell and Eison 1991). It does, to a great extent, depend on the abilities and experience of the lecturer. An able and committed lecturer can accomplish the following:

1. Relate the material proficiently and effectively, in a manner that reflects lecturer's personal conviction and grasp of the subject matter;
2. Provide students with a thoughtful, scholarly role model to emulate;
3. Supplement the subject matter with current developments not yet published, or interject lecturer's own views derived from his/her own experience whenever applicable;
4. Organize material in ways to meet the particular needs of a given audience;
5. Efficiently deliver large amounts of information , when the need arises, without confusing his/her audience;
6. Underscore key points, simplify complexities, and illustrate with facts and figures, and arrive at conclusions.

The effectiveness of the lecture varies inversely with the difficulty of the material presented, and listeners retain factual material better when presented in short sentences rather than in long sentences. Speaking extemporaneously is more effective than reading from lecture notes, and it is desirable to change the pitch, intensity, and timbre of one's voice (Verner and Dickinson 1967). These characteristics presume that the lecturer is an enthusiastic and knowledgeable scholar. But, we realize that most campuses have a few that fit this description, and can be labeled as gifted practitioners who could keep most students interested during the formal 50- minute lecture. Even if it is assumed that most engineering lecturers possess these necessary characteristics, research has shown that *the exclusive use of the lecture in the classroom constrains students' learning.*

For those instructors who would like to go beyond the traditional methods of lecturing, a number of effective strategies, promoting *active learning,* are available to choose from. If a faculty member is hesitant about selecting one or more of these *active learning strategies,* because some questions exist about its comparative effectiveness with the lecture method, he or she should consider the following: *research has shown, beyond the shadow of doubt, that these strategies do deliver content as well as lectures while providing diverse presentations that enhances students' motivation and achievement, and helps in building up desirable personal traits.*

Promoting Student Engagement Using Cooperative Learning Structure

As noted earlier, relying solely on the traditional lecture approach, no matter how competent the lecturer is, fails to *engage students in learning*, thus indirectly deprives students of learning experiences and opportunities that could only materialize utilizing *engagement strategies*.

Under the umbrella of *engagement strategies*, there are numerous models available to select from, including the models predicated on cooperation - working together to accomplish shared goals. Within *cooperative* strategies individuals seek outcomes that are beneficial to themselves and beneficial to all group members within the class (Smith et al 1981; Johnson et al 1991). The work by Johnson, Johnson, and Smith (1991) indicates that students exhibit a higher level of individual achievement, develop positive interpersonal relationships, and achieve greater levels of academic self-esteem, when participating in a successful *cooperative learning* environment.

Cooperative learning practitioners have shown that positive peer relations are essential to success in college. The positive interpersonal relationships promoted through *cooperative learning* are regarded by most as crucial to today's learning communities. They increase the quality of social adjustment to college life, reduce uncertainties about attending college, and increase integration into college life. Isolation and alienation, on the other hand, often lead to failure. Two reasons for dropping out are: failure to establish a social network of classmates and failure to become academically involved in classes (Silberman 1996; Prince 2004). *Cooperation* is more than being physically near other students. It is actually a state of mind. A willingness to open up to others, exchange information and views with others, and accept the fact that working together is more beneficial to all involved in the exercise. For a *cooperative learning* experience to be successful, it is imperative that the following be integrated into the class activity (Lowman 1980; McLeod 1996; Prince 2004):

- Positive Interdependence- Students should perceive that they need each other to complete the planned activity.
- Face to Face Interaction- Students should work together in planning, executing, and arriving at conclusions. They should share the work load, and share the credit. Thus promoting each others' learning.
- Accountability- Each student's role and performance is to be assessed, and the results are those of the group (and for the group). Keeping track of the contribution and knowledge gained by each member could be monitored, as well, by either testing each and every student in the group, or by randomly selecting a group member (or members) to be tested, and thus proxy for the group.
- Sharing known skills- Students who possess certain knowledge or skills (examples: computer skills, laboratory skills, data reduction skills, presentation skills) should be willing to pass it on, and/or share it with their group members.
- Collaborative Skills- Groups cannot function effectively if members do not have (be willing to learn) or use some needed social skills. These skills include leadership, decision making, trust building, and conflict management.
- Monitoring Progress- Groups need to discuss amongst themselves whether they are achieving their set goals; also, need to prioritize the scheduled activities, introduce changes if need be, solicit advice and assistance with the consent of the instructor, and maintain effective working relationships among the members.

Success in implementing *cooperative learning* is attributable, in large measure, to: proper planning, efforts, dedication, and foresight of the instructor. Experience definitely is a major factor. A proper start for instructors wanting to try *active learning* for the first time (including *cooperative learning*) is to step into it gradually, and to seek continuous feedback as to how the course is going and how the students feel about it. In addition, he/she can tap into documented sources, attend seminars/workshops on the subject matter, and discuss planned activities for his/her course with experienced colleagues who can offer constructive comments and advise.

Barriers to Change in the Classroom

To address adequately why most faculty have not embraced recent calls for educational reform, it is necessary first to identify and understand some common barriers to instructional change that seems to apply in America and elsewhere, and have been reported on in the literature (Bonwell and Eison 1991). Most of these barriers are applicable to engineering colleges- and include:

- The powerful influence of educational tradition,
- The discomfort and anxiety that change creates,
- Faculty self-perceptions and self-definitions of roles,
- Lack of well-defined incentives; also, lack of proper guidance to embark on the change.

There are also specific obstacles associated with the use of a new format in teaching, i.e., for example, when using *pedagogies of engagement* approach:

- The potential problem/difficulty that may result from not covering adequately the assigned course content in the limited class time available;
- The increase in the amount of preparation time;
- The lack of needed resources to proceed with the new method, when applicable;
- The difficulty of using *active learning*, or any variation thereof, in large classes.

Perhaps the single greatest barrier of all is the fact that: faculty members' efforts in employing a new approach would involve risk- the **risk** that students would not participate. Additionally, faculty members may feel a loss of control, or be criticized for teaching in unorthodox ways.

Faculty universally "know" that their institution expects excellence in teaching, but relatively few campuses have critically examined and discussed explicitly how "excellence" is best achieved and assessed. Research has shown that faculty perceptions about the underpinnings associated with "superior teaching" clearly place "knowledge of the subject matter" well above all other considerations (Blackburn et al 1980). A provocative analysis of metaphors about teaching and learning in higher education describes the "Container- Dispenser model"(Pollio 1987). Knowledge is a substance, material, or source of power, instructors are containers (filled with content, material, and facts), and students are vessels (wanting to be filled up). It seems apparent that faculty whose view of teaching and learning could be represented by the "Container-Dispenser model" would be especially concerned about covering content.

A. The feedback circle in the classroom: Faculty and students share many expectations regarding the proper role that each plays in teaching and learning- those perceptions having been formed in traditional classroom settings. For example, many faculty members are very specific about how they learned to teach - "modeling" themselves based on their own experiences from their student days. Most can not point to a powerful role model in their past who consistently and skillfully used *pedagogies of engagement* in the classroom. For this reason, if no other, it is not surprising that faculty seldom use strategies promoting engagement practices.

Students' resistance is another element of the feedback circle. Some students will always resist the use of *pedagogies of engagement* because of their contrast to the more familiar passive listening role to which they have become accustomed. Listening to faculty talk is not only familiar to students; it is also a considerably easier one! Often, and as noted in the literature, students do communicate their displeasure with nontraditional instructional approaches, which in turn encourages the use of more traditional teaching methods (Bonwell and Eison 1991). Students' maturity, academic growth and intellectual development play a major part in their response to unfamiliar and novel teaching and learning strategies. The work by Perry (1968) suggests that "dualistic learners" want structured lectures in which faculty describe clearly and precisely what they need to know. Such students expect the instructor to maintain control over the class and to simply present the facts. They believe that a student's role is to pay attention, to take notes, and to memorize the material presented. "Dualists" typically find class discussions confusing and a "waste of time." Chances are that only in a later stage of intellectual development- the relativism period- students begin to assume responsibility for their own learning, view class participation as an exciting opportunity to exchange differing perspectives, and become willing to participate and critique each other. What would it take to entice students to become active participants at an early stage? Undoubtedly, pre- college exposure to *pedagogies of engagement* – if at all possible- would lighten the burden on faculty and students in adopting and implementing *active learning pedagogies* in college.

B. Feelings of discomfort, anxiety and indecisiveness: Experiencing some degree of anxiety in response to one's initial attempts to try something new is probably a universal trait. So it is when faculty consider trying new and different ways of teaching. Faculty resistance to change in their classroom practices is the norm. Professors tend to be conservative, favoring old, tried-out methods and viewing innovations of any kind with considerable apprehension. Little evidence exists today to suggest that the picture has changed much in recent years. For many faculty, things are the way they are because that is the way they have always been; further, most find the majority of traditional teaching practices more comfortable than not (Bonwell and Eison 1991).

C. The self-definition of roles: Expectations about faculty members' roles and responsibilities are often categorized under three areas: *teaching*, *research*, and *service*. Though institutional settings, climates, and prevailing practices naturally tend to vary; currently, on many, campuses considerable tension exists with regard to the relative importance that should be placed on each. "The language of the academy is revealing: professors speak of teaching *loads* and research *opportunities*, never the reverse" (Bonwell and Eison 1991).The greatest paradox of academic work today is that most of the faculty teach most of the time, but, unfortunately teaching is not the activity most rewarded by nor most valued by the system at large. These three categories do provide faculty members with the universally recognized cornerstones for personal self-definition; and the same three create inherently conflicting pressures for faculty members' attention, time, and energy. To the extent that campuses provide greater recognition and rewards for research and research grants over teaching, the likelihood of faculty members' seriously and significantly making efforts to improve instruction is reduced. Administrators – at department/ college/ or institutional level - have always praised good teaching but rewarded research! Even professors themselves do the one (*teaching*) but acclaim the other (*research*).

D. The lack of incentives to change: Faculty members see few incentives to change, for several common reasons. ***First and foremost***, is the pervasive belief that "we are all reasonably good teachers?" ***Second***, there is a very limited financial incentive, if any, to devote time and effort acquiring alternatives to traditional approaches of classroom teaching. ***Third***, the perception shared by most faculty that time and effort spent pursuing research and research money, is more rewarding, from an institution point of view, than time spent improving one's teaching skills. ***Further,*** the personal costs of trying new innovations are often high, and innovations are acts of faith requiring that one believes that they will ultimately bear fruit and be worth the personal investment, often without the hope of immediate return. Given that most faculty view themselves as above average, and that change can involve high personal costs, faculty members who attempt alternatives to traditional approaches are relatively few. Therefore, little reason exists to try new approaches, particularly when one's self-perception is: He/she is an above average teacher.

Looking Forward?

A root question: What is an engineering education for? – should be on the table for an evolutionary debate, referring, in particular, to the future of engineering education. What engineering students need to learn, and ***how*** can they best learn it, as well as ***how*** can engineering schools best teach it? The **"How"** is at the crux. Changing the *status quo* is never easy, but time has come for colleges to turn a "new leaf" and begin moving in the direction of *active learning strategies*, in general, and *cooperative learning* environment in particular.

The author is convinced that unless, and until, the institution requires it, i.e., makes it "mandatory", academics will continue to pursue their present course. While paying lip service to "teaching excellence," most institutions do not provide clear and visible support and/or rewards for innovative teaching. Therefore, institutions have implicitly endorsed the *status quo* of "traditional" classroom instruction. The author believes that in addition to mandating the "change", an effort should be made to create a climate for improvement in classroom instruction by changing the social and cultural norms that have prevailed for decades. Such an effort should permeate throughout the academic arena, re-defining the role of teaching faculty, underscoring the fact that learning is a consequence of students' engagement with the subject matter, and emphasizing that the simultaneous presence of interdependence and accountability are essential to learning. The specifics of such an effort ought to include the following:
i) Rid classroom teaching environment from prevailing passive approaches to learning, and plant the seeds for active learning protocols throughout the public education system. Propagate the idea that: Student-teacher interactions are a "priori" to stimulate learning at all levels.
ii) Provide the manpower and support necessary to "in-house" education units and/or centers that define, promote, and encourage the art of appropriate teaching, including active learning protocols. Scholarly research about teaching, should be encouraged, valued, and discussed.
iii) *Provide instructors with clear and consistent communications about expectations regarding teaching*. Faculty become frustrated and confused when told that teaching plays a vital institutional role, but to find out that rewards are for research. Effective teaching should also be rewarded, and poor teaching needs to be remediated through training and development programs.
iv) Encourage instructors, when using alternative instructional strategies, to meet the needs of students' learning styles. Students' learning styles are inherently different (Dunn 1990).
v) Target new instructors, in particular, and help them to make the transition from traditional methods to active learning strategies. Young faculty must feel that it is all right to try a new strategy, even if the first trial is less than satisfactory.

Some institutions have lately attempted to meet some of the noted objectives by relying exclusively on teaching awards. This modest approach has not worked! More effective initiatives are needed to infuse a commitment to proper teaching and *active learning strategies* throughout the system. The real key to establishing a supportive environment for innovative teaching is to create a university-wide administrative structure that promotes, rewards, monitors, and publicizes excellence in the classroom. If and when such a structure is established, its prime mission would be to approach the different departments, and groups within the university hierarchy- seeking ideas, plans, scenarios, to translate the "mandated" change into reality. Common questions that are likely to come up include: How to get started? What steps should be taken to **move forward?** Who should initiate the process? What guarantees its success?

Invariably, different scenarios may be arrived at, and faculty members who have had some prior experience, and/or have the self-confidence in deploying *engagement practices* should be given the opportunity to lead in this effort. However, leaving change up to individual faculty members without a supportive culture that values effective teaching/learning pedagogies for classroom reformation and educational development, doesn't work. Piecemeal efforts- an initiative here or a success story there - could result in pockets of improvements but will not change the *status quo* as a whole. What is necessary, from author's perspective, to plant the seeds and sustain the "change", is for the university (i.e., the department, the college, the group) to arrive at a comprehensive and integrated set of components: clearly articulated expectations, a reward system aligned with these expectations, and opportunities for faculty to acquire new pedagogies.

Concluding Remarks

To keep pace with fast changing global marketplace, engineering education has to undergo major "reformation" including revitalization of the classroom environment. There is concern among faculty, graduates and others–*supported by feedback from faculty interviewed recently by the author* - that current teaching practices (traditional teaching) have adversely affected outcome.

The paper reviews the *pros and cons* of the traditional lecture approach, sheds light on common forms of *active learning* most relevant for engineering faculty, identifies barriers to reformation, and argues that the introduction of classroom-based pedagogies of engagement can help break the traditional lecture–dominant pattern . One way to get the students actively involved is to adopt a *cooperative learning strategy*: dig below superficial levels, learn "to learn" and not just to pass the test, get to know their classmates, and build a sense of community with them. It is important that when seniors graduate they have acquired the skills needed to work cooperatively and are able to balance personal relations and be contributing members of their communities.

This is a call for engineering faculty and program developers, to consider not only the content and topics that make up an engineering degree but also how students engage with these materials. It is also a call for the faculty to learn the new ways of teaching, and strive to develop and achieve a high level of pedagogical knowledge and competence. In the dialogue between administrators and faculty, needed to bring about the change, faculty will rightfully identify barriers including the time and resources needed to embark on the change. Also, should request authorization to experiment with new ways of teaching without risking low teaching evaluations.

With regard to implementations, author's findings assert that classroom practices today have remained, by and large, very traditional. Therefore, unless the "change" is mandated by the institution, it is highly unlikely that the classroom environment would witness any noticeable shift toward *classroom engagement practices*, any time soon. If and when the "change" is mandated, the challenge then will be: How to infuse the new pedagogies without causing disruptions or trigger some undesirable consequences? Said another way, is there an optimum balance between maintaining traditional lecture-based practices and the deployment, in part, of an *active learning pedagogy?* If so, what does the balance depend on? (Level of course? Type of course? Students' background? Instructor's abilities and skills?). Implementation of said "change" may have to be carried out in phases over time. "Change" will only be brought about through the determination of the leadership (deans, department heads, etc.), required support and resources, and faculty willingness to change their current classroom practices.

The myth expressed by some faculty that *"I am willing but they won't let me"* is a common response from faculty members to calls for reform in education. To the contrary, and as eloquently expressed by Combs (1979):*"Teachers may not be able to change the educational system, but the variations possible, within an ordinary classroom, are almost limitless."*

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Developing Academic, Professional and Life Skills in Undergraduate Engineers through an Interdisciplinary Peer-Mentoring Support System

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1. Introduction

Undergraduate engineering programs prepare students for a career in engineering by building knowledge of fundamental engineering concepts and developing skills in engineering design. Due to limitations on program credits, broadening the student's education beyond the required engineering coursework is typically limited to mandatory humanity and social science electives. Developing academic, professional and life skills can be a challenge due to the rigor of undergraduate engineering programs, yet these remain key factors in students' ultimate success and satisfaction with their careers. While students are expected to develop abilities to network with peers, teachers and professionals in the field, this skill is rarely taught explicitly.

Furthermore, degree accreditation boards, such as ABET, require accredited programs to achieve outcomes which include: an ability to function on multi-disciplinary teams; an understanding of professional and ethical responsibilities; the broad education necessary to understand the impact of engineering solutions in a global and societal context; a recognition of the need for, and the ability to engage in life-long learning; and a knowledge of contemporary issues. These outcomes are difficult to fully achieve in major courses alone.

In conjunction with a National Science Foundation-sponsored scholarship grant (NSF #0631111), we have developed a program called MAX (Mentored Academic Experience) Scholars that addresses these needs. The engineering, engineering technology, math, biology and computer science students selected as MAX Scholars receive financial support and an opportunity to develop academic, professional and life skills through a weekly scholars' seminar. Interdisciplinary group work, peer mentoring and mentored research or internship experience are also incorporated into the seminar course and scholarship requirements.

Bates et al. (2010) provided an overview of the MAX Scholars program, details on the scholarship selection process, benefits for involved faculty and suggestions for implementing a similar program at other institutions. This paper will focus on the weekly seminar attended by the MAX Scholars and discuss its key successes in facilitating interdisciplinary group work across Science, Technology, Engineering and Math (STEM) majors, building community amongst the scholars, and helping them develop academic, professional and life skills.

2. Background

The MAX Scholar program seeks to understand and address (1) the significant challenges facing students that contribute to decreased retention and to guide students through their STEM program; and (2) the need for connection and community for STEM majors across disciplines. These goals, combined with interdisciplinary experiences and overall academic and professional development, drive the structure and topics covered in the MAX Scholar seminar.

Literature, gathered from higher education, K-12, and organizational psychology, clearly supports the importance of community in influencing engagement and a broadening of cognitive performance beyond the purely technical (Goodenow, 1993a; Goodenow, 1993b; Ryan & Patrick, 2001). Engineers with a broader world view will be poised to lead valuable technical innovation in the 21st century (National Academy of Engineering, 2005).

A greater sense of connection to community, ranging from the immediate (belonging) to the broad (affiliation) level can enhance retention, thereby delivering greater numbers of engineers and STEM scientists to the technical workforce. This theory is supported by the K-12 body of literature, where belonging and membership in the school community are proven to influence dropout rates (Center for Educational Statistics, 1993). In addition, higher education research cites lack of community (isolation) as a primary reason for women to leave engineering fields (Brainard & Carlin, 1998) and connection to faculty community as a strong contributor to Hispanic student persistence in academic endeavors (Kraemer, 1997).

In contrast to the traditional view that attrition of STEM students was the result of a beneficial "weeding out" of inferior students from these difficult fields, Elaine Seymour states "We did not find switchers (from STEM majors) and non-switchers to be two different kinds of people. They did not differ by performance, motivation, or study-related behavior to any degree that was sufficient to explain why one group left and the other group stayed". In other words, "good" and "bad" students alike leave STEM fields. Therefore, noncognitive factors must play a role. Improvements in retention, resulting from increases in connection to community, are fundamentally supported by the higher education model of social integration developed by Tinto (1975, 1987, and 1993). Furthermore, a sense of belonging can result in increased feelings of security, stronger self-concept, self-respect and coping abilities as these students move from academia to the workplace (DeNeui 2003).

3. MAX Scholars Seminar

One of the unique aspects of the MAX Scholars program is the focus on overall development of the scholarship recipients. The recipients, as defined by the program criteria, are diverse: multiple majors, male, female, nontraditional students, students with different ethnicities, religious affiliations, backgrounds, and family structure. The MAX Scholars attend a weekly seminar as part of the requirements of the program. The seminars are the primary mechanisms to build the academic, professional and life skills of the undergraduate scholars. In addition, students develop a sense of connection to the university and community amongst the scholar cohort. Finally, an investigative project completed by teams of scholars from different majors facilitates interdisciplinary discussions addressing broad science topics and builds relationships amongst scholars. The weekly seminar plays a critical role in strengthening faculty-student interactions, facilitating peer mentoring, developing work/life balance skills, learning how to be both a leader and a member of an interdisciplinary team and building community. Figure 1 highlights the key input factors and output development for a MAX scholar.

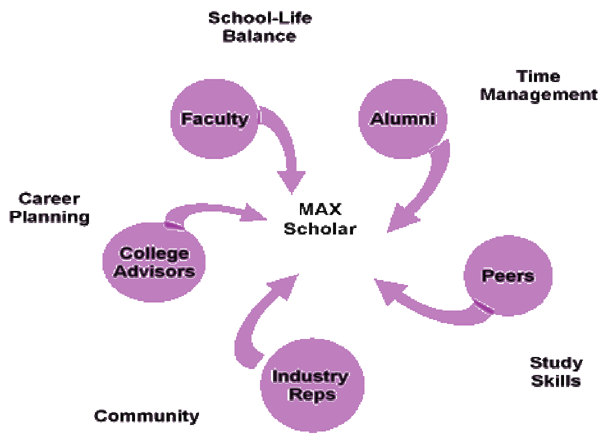

Figure 1: A model of the input factors and output skills gained by MSU MAX scholars.

Along with interdisciplinary project work, a typical set of seminars for a semester includes:

1) Introductions and assignment of reflection papers describing students' goals and obstacles
2) Resume formats and preparation
3) Preparing goals and small group discussion of resumes
4) Learning styles
5) Small group discussion of goals (grouped by year)
6) Job fair preparation and summer internship discussion
7) Interview skills with paired practicing
8) Mentoring
9) Guest speakers from industry and faculty
10) Study skills
11) Graduate school preparation
12) Assessing progress towards goals (grouped by year)
13) Interdisciplinary group projects
14) Work/life balance

Topics 3, 6 and 10 were all in small groups divided by major, allowing for stepping-stone peer mentoring. Other small group discussions were divided by class year or affinity groups based on learning styles, life situations or extra-curricular activities such as athletics. Several areas of scholar development achieved through the seminar are highlighted in the remainder of this section.

Mentoring

The MAX Scholar program strengthens faculty-student interactions through both the seminar and advising that occurs outside of the classroom. Peer mentoring (or stepping-stone mentoring) is used to address sophomores as they transition into the rigor of their advanced studies, juniors as they move into leadership roles and seniors as they enter the work force or graduate programs. The MAX Scholars are a leadership group that not only offer support for each other but also take on active, both formal and informal, peer advising that serves as a safety net for lower-division students. This net is typically built around study groups reinforced with active faculty mentoring and support for peer-mentoring. With the community of STEM scholars, we reinforce mentoring that is maintained after graduation.

Interdisciplinary Teams

The MAX Scholars are assigned a project each semester as part of the seminar course. The projects are completed in interdisciplinary teams of 3 – 4 students each. For example, a typical team consists of students with various majors such as biology, math, computer science and engineering. Member selection varies but is designed to promote interdisciplinary group interaction. In previous years, the students considered various aspects of global warming after a research presentation about plants in the Antarctic by Dr. Christopher Ruhland (MSU, Biology). Another project was inspired by assigned reading, a novel with an environmental theme. During the following semester, students discussed ethical issues related to environmental science, with framework provided by Dr. Craig Matarrese (MSU, Philosophy). The students also developed academic advising modules to be presented to first year STEM students. These modules are currently incorporated into college advising seminars available for all students. The scholars take part in leading these seminars, helping develop their communication skills and supporting outreach goals. For each project, the groups were led by seniors who were responsible for organizing final presentations.

Professional Networking

A LinkedIn group called "MSU MAX Scholars" was created to help current scholars, alumni of our program, and faculty stay connected. The group is especially beneficial to alumni who are launching their careers and current students looking for mentoring or internship experiences. This resource helps them quickly build their professional network and stay connected with the MAX Scholars community. Throughout the year, the seminar helps scholars build networks by hosting speakers from industry, graduate school and alumni.

Career Placement

Topics related to career and graduate school preparation are covered during the weekly seminar. Setting goals, reflection on progress towards them, and writing resumes are fundamental topics. Outside speakers from industry, university services and alumni discuss interviewing skills, job negotiation strategies, and preparation for their early career years.

Research/Internships

MAX Scholars are encouraged to participate in either a research or internship experience during their educational years. Scholars engage with faculty and industry mentors on projects that apply their discipline to real-world problems. The program facilitates this through mentoring, networking and development of career placement skills. Scholars are strongly encouraged to present their research results or internship experiences at conferences, including our university Undergraduate Research Conference. Travel funds are available and encourage presentation at regional, national or international meetings.

Presentation and Communication

Through the interdisciplinary group projects and research and internship experiences, MAX Scholars develop strong oral and written communication skills. In addition, students learn how to present for small and large groups, within and outside of their major.

Work/Life Balance

The seminar provides scholars with an opportunity to develop skills for success that extend and strengthen academic and professional development, facilitating personal development such as work/life balance skills. Seminar sessions include discussions on personal wellness such as nutrition and exercise. Active participation in a yoga session reinforces the need to maintain personal/professional balance during the rigor of academic pursuits. Each semester, the scholars are expected to attend an athletics or fine arts event on campus as a group. By "requiring" outside activities as part of the seminar work, students experience the benefit of engaging in social activities outside of their discipline and their established social networks. Additionally, we find that STEM students often strive for perfection and benefit by balancing studying with activities associated with quality of life.

Life-Long Learner

Awareness of the self as a learner and the development of metacognition improve the chances that a student will be a life-long learner. Along with projects on topics outside of their major, the seminar is used to discuss learning styles as it relates to the overall process of learning. The seminar, offered as pass/fail, provides an opportunity for the students to be engaged in learning without the pressure of receiving a letter grade. The interdisciplinary discussions on science-related topics facilitated by the group projects have been a highlight for scholars. They have enjoyed the opportunity to learn and discuss science-related topics in a stress-free (i.e., grade-free) environment. The scholars also attend the annual Nobel Conference held at a neighboring college which hosts scientific presentations by prestigious researchers from all over the nation, providing an excellent opportunity for our scholars to grow as life-long learners.

4. Conclusions

There is a synergy between the recruitment, retention and professional development aspects of MAX student scholars. Professional development fuels retention of these students as they are encouraged by the life skill development and mentoring. Research/internship experiences, networking and career placement skills increase confidence and prepare students for a professional career. As these students share their enthusiasm and confidence with incoming students, a springboard for recruitment arises. For example, one of the scholar assignments was to prepare a presentation, both written and oral, on what they are passionate about in their major and how that area is connected to other STEM disciplines. Helping students articulate this serves as both a retention and professional development effort. Similarly, our scholars give a short presentation to introductory freshman orientation classes within their major. The underlying purpose of outreach activities is to help our MAX Scholars fully invest in their STEM major and future career, but it also plays a key role in recruitment of new STEM majors.

The MAX Scholar seminar could be implemented as a professional development seminar for programs with or without associated scholarships. While it may be difficult for engineering programs to connect with other majors, this type of program creates a space for students in biology, computer science and math as well as multiple types of engineering to interact. It offers true interdisciplinary experiences in a one credit seminar that could be more broadly incorporated into programs seeking to fulfill ABET criteria.

5. Future Enhancements

Through collaboration with the Iron Range Engineering (IRE) program and pending continuation of funding from the National Science Foundation, we plan to award approximately four scholarships per year to IRE students. Although granting MSU engineering degrees, the IRE program and its students are physically located in northern Minnesota at Mesabi Range College. These four scholarship recipients will be fully integrated into our MAX Scholars cohort. They will attend weekly seminars via interactive video feed and will participate in interdisciplinary teams. For example, a team working on a project and presentation would consist of 3 students in Mankato and 1 student in IRE. The team members will have to learn how to communicate and work together effectively despite the geographical separation. In today's marketplace, industry teams regularly consist of members at different company and client locations. Developing skills in distance communication and working effectively with people in different geographic locations will be a valuable asset for our scholars as they enter the marketplace or graduate school.

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Understanding Individual Personality Types and Their Effect on Team Dynamics in a Senior Design Project Course

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Abstract

Prospective employers expect graduating engineers to be knowledgeable in both scientific/technical and engineering management aspects. It is often a challenge to include engineering management content in a tightly packed engineering curriculum. The challenge must be met by carefully selecting key engineering management topics and implementing them across the curriculum. The Senior Design Project course in Mechanical Engineering at UW-Platteville is one course where there is a relatively better opportunity and relevance to address some engineering management topics. Engineering management or management for that matter is broad in scope and includes knowledge in many areas such as cognitive processes, social processes, and project management processes. The course focuses on teams undertaking real world industry projects wherein effective team dynamics is very important. Personality types of individuals greatly affect team dynamics. Understanding of personality types and their effect on team dynamics contributes to the knowledge of cognitive and social processes in engineering management. This paper addresses the topic of personality types of individuals and their effect on team dynamics in the Senior Design Project course. Students are helped to understand and find their individual personality type in a 4-Level Artisan-Idealist-Rational- Guardian model and in a more detailed 16-Level model. Students also learn how to utilize the knowledge and differences of personality types amongst individuals to enhance better team dynamics while managing and solving industry projects.

The Need for Engineering Management for Engineering Students

The American Society for Engineering Management defines Engineering Management as a unique discipline that uses engineering skills and knowledge in managing large scale projects. It links all other types of engineers from civil and mechanical to chemical and electrical in accomplishing organizational results through the leadership of knowledge-workers and the appropriate application of technology[1]. Prospective employers expect graduating engineers to be knowledgeable in both scientific/technical and engineering management aspects. It is often a challenge to include engineering management content in a tightly packed engineering curriculum. The challenge must be met by carefully selecting key engineering management topics and implementing them across the curriculum. Engineering management or management for that matter is broad in scope and includes knowledge in many areas such as cognitive processes, social processes, and project management processes. These complex relationships are been well known and have been and will be studied for years[2]. The Senior Design Project course in Mechanical Engineering at UW-Platteville is one course where there is a relatively better opportunity and relevance to address some of these engineering management topics.

The Senior Design Project course focuses on teams undertaking real world industry projects wherein effective team dynamics is very important. Personality types of individuals greatly affect team dynamics. Understanding of personality types and their effect on team dynamics contributes to the knowledge of cognitive and social processes in engineering management. This paper addresses the topic of personality types of individuals and their effect on team dynamics in the Senior Design Project course. Students are helped to understand and find their individual personality type in a 4-Level Artisan-Idealist-Rational- Guardian model and in a more detailed 16-Level model. Students also learn how to utilize the knowledge and differences of personality types amongst individuals to enhance better team dynamics while managing and solving industry projects.

Personality Types and Instruments for their Assessment

The earliest rigorous work on personality types dates back to the work of Carl Gustav Jung (1875-1961)[3]. Isabel Briggs Myers (1897-1980), together with her mother Katherine Cooks Briggs, extended Jung's theory of personality types, adding two important aspects. These were the recognition of the existence and roles of the auxiliary processes and the addition of the Judging (J) and Perceiving (P) preference[4, 5, 6]. Thus Jung's eight types (2*2*2) were extended to the Myers-Briggs' sixteen types (2*2*2*2). Sixteen "Myers-Briggs Type Indicators" (MBTI) arise from every possible combination of one selection from each pair of dichotomies as shown in Figure 1 (ISTP, ENTJ are two example types of the possible 16). The abbreviations E, I, S, N, T, F, J, and P as shown will be used throughout this paper.

Extroversion	E	Introversion	I
Sensing	S	Intuition	N
Thinking	T	Feeling	F
Judging	J	Perceiving	P

Figure 1

The MBTI has been and continues to be used worldwide and is an instrument developed specifically as a tool for the general population, and is therefore inherently benign. As a founding principle, no one type is any better or worse than any other and the test candidate has the final say as to his or her type designation[6]. In its basic form, MBTI is a 93-item instrument used worldwide for psychological type classification and is available in many different languages. The MBTI has been around for over 60 years and has been used in a number of occupational settings. MBTI instrument intends to find an individual's preference to the four dichotomies mentioned above as follows[7]:

Putting attention and getting energy by spending more time

- in the outer world of people and things (E) or
- in the inner world of ideas and images (I)

Paying more attention to

- information that comes in through the five senses (S) or
- the patterns and possibilities seen in the received information (N)

Making decisions by putting more weight on

- objective principles and impersonal facts (T) or
- personal concerns and the people involved (F)

Liking to live in a world of a more

- structured and decided lifestyle (J) or
- flexible and adaptable lifestyle (P)

The choice between E or I is about orientation, S or N is about cognitive perceiving function, T or F is about cognitive judging function, and J or P is about attitude of the functions. Myers stated that the interaction of these orientations, functions and attitudes are what makes up the personality types.

The Keirsey Temperament Sorter II (KTSII) is an instrument developed by David Keirsey[8], a contemporary of Isabel Myers. The test is available online as a 70-item instrument that has only two possible responses for each item[9]. Keirsey follows the MBTI tradition of using 16 types but condenses through a tree-like structure into four temperament groupings called Artisans, Idealists, Rationals, and Guardians. Fundamentally, Keirsey looks at the four possible combinations between abstract or concrete in communicating and cooperative or utilitarian in achieving goals. Artisans prefer concrete communication and utilitarian goal achievement traits, idealists prefer abstract and cooperative traits, rationals prefer abstract and utilitarian traits, and guardians prefer concrete and cooperative traits. Linkage of the four KTSII types to the sixteen MBTI types is another classification. Artisans prefer S and/or P, idealists prefer N and/or F, rationals prefer N and/or T, and guardians prefer S and/or J. Just like MBTI, KTSII is widely used in industry and education.

Administering KTSII and gathering information from Senior Design Project Students

Different ways of teaching the topic of personality types and enabling students to find out and reflect on their personality type are possible. The approach taken in the Senior Design Project course is to give out a Questionnaire shown in Figure 2 for each student to fill out first. As can be seen in the Questionnaire, Question I is answered by taking the KTSII test online and entering the result as per the test. The remaining questions II through X are answered as per the students' personal opinions. It can be seen that question II, III, VII, VIII, IX and X directly address the principles of Keirsey's classifications described above. Also, question IV, V, and VI address more-in depth aspects of Keirsey's classification of personality types. Finally, responses to questions VII, VIII, IX and X help compose the 16-level MBTI demographic information. Please note that administering questionnaires that involve human subject research in areas such as behavioral sciences or personality types will often require permission from appropriate authorities or committees. Maintaining anonymity will also be often a strict requirement.

QUESTIONNAIRE

QUESTION I

What is your Temparament (or personality type) **as per the result of the test** you took at keirsey.com? (**Check one**)

ARTISAN: ____ IDEALIST: ____ RATIONAL: _____ GUARDIAN: _____

To each of the following questions II through X, select an answer that best describes you in **your opinion**:

QUESTION II: In communicating, are you _________________________ (Abstract or concrete?)

QUESTION III: In achieving goals, are you _________________________ (Cooperative or Utilitarian)?

QUESTION IV: What are you most proud of about yourself? (Select ONE from the following):

a. Of the degree to which you are graceful in action
b. Of the degree to which you are empathic in action
c. Of the degree to which you are competent in action
d. Of the degree to which you are reliable in action

QUESTION V: What do you respect the most about yourself? (Select ONE from the following):

a. Of the degree to which you do good deeds
b. Of the degree to which you are daring
c. Of the degree to which you are benevolent
d. Of the degree to which you are autonomous

QUESTION VI: What are you most confident of about yourself? (Select ONE from the following):

a. Of the degree to which you are strong willed
b. Of the degree to which you are respectable
c. Of the degree to which you are adaptable
d. Of the degree to which you are authentic

QUESTION VII: Are you more of an extrovert (E) or an introvert (I)? ______(E or I?)

QUESTION VIII: Do you notice information more by Sensing (S) or by intuition (N)? ______ (S or N?)

QUESTION IX: Do you make decisions more by thinking (T) or by feeling (F)? _____ (T or F?)

QUESTION X: Would you like to live in a world run more by judging (J) or by perceiving (P)? ______ (J or P?)

Figure 2

Representative Sample KTSII Test Results for Senior Design Project Students

Results from KTSII test for one particular semester for a particular course section of students in the Senior Design project class are discussed next. It should be pointed out that the results are representative of results from past tests but several more tests in future semesters are planned to increase the rigor of the results and inferences from those results.

The results in Figure 3 below are for a group of 30 students in a particular semester section of the Senior Design Project course who took the KTSII test. The results are shown by a team-wise breakdown for team dynamics purposes besides composite results for the whole class.

	TEAM A	TEAM B	TEAM C	TEAM D	TEAM E	TEAM F	Total	%
Artisans	2	0	0	0	1	2	**5**	**17**
Idealists	1	0	0	0	0	0	**1**	**3**
Rationals	0	1	0	0	0	0	**1**	**3**
Guardians	2	4	5	6	3	3	**23**	**77**
Total Responses							**30**	

Figure 3

The composite percentage demographics of Artisans, Idealists, Rationals, and Guardians shown in the extreme right column of Figure 3 is shown as a bar chart in Figure 4 below:

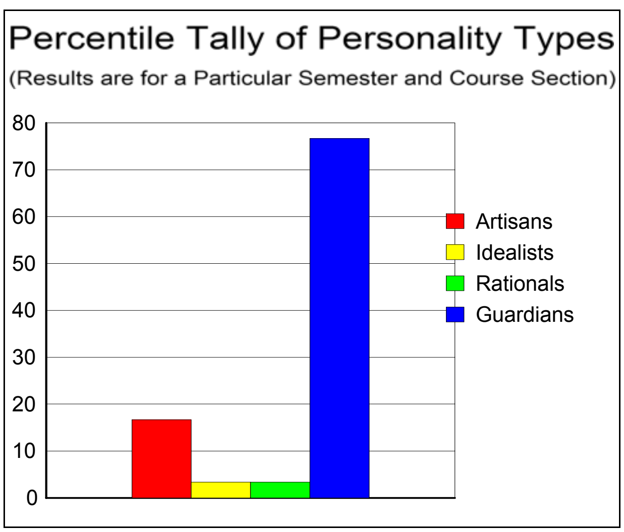

Figure 4

Besides the tally of raw KTSII test results shown in Figures 3 and 4 above, tallies have been of student responses to Questions II, III, VII, VIII, IX, and X and their comparison to assumptions of what those responses are through the underlying theory as described earlier for the KTSII personality type outcome. A sample for one team is shown in Figure 5 next.

Team A

Students' Own Assessment	Member 1	Member 2	Member 3	Member 4	Member 5
Communicating: Abstract (A) or Concrete(C)	C	C	C	C	C
Achienving Goals: Cooperative(C) or Utilitarian(U)	U	C	C	U	C
Extrovert(E) or Introvert(I)	E	I	E	I	E
Sensing(S) or Intuition (N)	S	S	S	N	N
Thinking (T) or Feeling (F)	T	T	T	T	T
Judging (J) or Perceiving (P)	J	P	P	P	J
Test's Assessment					
Communicating: Abstract (A) or Concrete(C)	C	C	C	C	A
Achienving Goals: Cooperative(C) or Utilitarian(U)	C	U	U	C	C
Extrovert(E) or Introvert(I)					
Sensing(S) or Intuition (N)	S	S	S	S	N
Thinking (T) or Feeling (F)					F
Judging (J) or Perceiving (P)	J	P	P	J	
Artisan (A) or Idealist (I) or Rational(R) or Guardian(G)	G	A	A	G	I
Test"s Prediction Accuracy	75%	75%	75%	25%	50%

Figure 5

Analysis of the Results

The raw number tally and hence the percentage tally of the four personality types show that a vast majority of graduating mechanical engineering seniors in the program are of the Guardian type (77% in the sample). This has been the trend in past studies but more such studies are planned for the future to draw more robust conclusions. It has also been that the 20 to 40 % balance of other types fluctuates between Artisans, Idealists, and Rationals. In the sample example, the 23% balance is made up of 17% were Artisans, 3% Idealists, and 3% Rationals. As for the test's prediction accuracy on detailed aspects such as responses to questions II and III, and two of questions VII through X, results vary from 25% to 100% bur rarely 0%. It should be noted that just one wrong prediction drops the assessment by 25% as only responses to four questions are considered. Finally, as pointed out earlier, responses to Questions VII through X help gather information on the Meyers Briggs 16-level type categorization. For the sample in question, the results tallied as shown in Figure 6 which typifies a widespread distribution.

ISTJ: 4	ISFJ: 3	INFJ: 1	INTJ: 3	ISTP: 4	ISFP: 0	INFP: 0	INTP: 5
ESTP: 1	ESFP: 0	ENFP: 1	ENTP: 1	ESTJ: 2	ESFJ: 0	ENFJ: 0	ENTJ: 5

Figure 6

Teaching/Learning Outcomes from the Study

Students are given back their questionnaire after results are tallied. Anonymity of the responders is maintained even to the instructor because students only put their own secret password on the back of their questionnaire so that they can pick up their particular questionnaire. The 4-level personality types as per the KTSII theory and the 16-level personality types as per the MBIT theory are then discussed with the students. For example, the preference of Artisans to be concrete in communicating and utilitarian in achieving goals as well as their preference to sensing (S) and perceiving (P) traits are shared with the students. As for the 16-level types, students are given handouts of the high-level description of the sixteen personality types and told to assess how the description for their particular type (such as ISTJ) matches their own understanding of their personality. For example, the description for ISTJ is as follows: "*Serious and quiet, interested in security and peaceful living; essentially thorough, responsible, and dependable; well-developed powers of concentration; usually interested in supporting and promoting traditions and establishments; well-organized and hard working; work steadily towards identified goals; usually accomplish any task once mind is set to it.*[10]" Students find this "personal-level" assessment to be very valuable and gain a respect for the scientific nature of the study. Students also learn that their demographics are not weighted very much towards any one particular type in the 16-level categorization but heavily weighted towards the Guardian type in the 4-level categorization. Students are apprised of the implications of that dominance. For example, an intuitive idea inference from other designs could help a project which may not be identified if the whole team has a preference only towards sensory information. The effect of personality types on team dynamics are also shared with the students. The helpful outcomes of the awareness of personality types on team dynamics are emphasized. For example, when the project manager is aware that his or her team is dominated by extroverts including the project manager himself or herself, it helps the project manager to play more of the role of listener (introvert) for better team meeting outcomes. It should be pointed out that it helps the instructor also to improve the teaching methods based on the personality type study. For example, a dominant group of Guardians means that they like a more ordered process of learning. This may require that more handouts be given to supplement the lectures for instance.

Summary and Conclusions

The Senior Design Project course in Mechanical Engineering at UW-Platteville is one course where there is a relatively better opportunity and relevance to address some engineering management topics. The course focuses on teams undertaking real world industry projects wherein effective team dynamics is very important. Personality types of individuals greatly affect team dynamics. Understanding of personality types and their effect on team dynamics contributes to the knowledge of cognitive and social processes in engineering management. This paper addressed the topic of personality types of individuals and their effect on team dynamics in the Senior Design Project course. Results from personality type tests in a 4-Level Artisan-Idealist-Rational- Guardian model and in a more detailed 16-Level model were gathered, analyzed, and inferences drawn. The study showed a dominance of Guardian personality type in the graduating mechanical engineering student group. How students utilize the knowledge and differences of personality types amongst individuals to enhance better team dynamics while managing and solving industry projects were also discussed.

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Residential Wind Turbine Testing Using a Battery Charging Configuration

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Abstract

This paper describes the efforts put toward testing and validating four residential wind turbine systems set up in battery pack charging configurations. The goals of the research project will be described along with a description of the system design for each turbine. In addition, the format and sampling techniques of the collected data will be described along with example data collected from the project. Finally, the paper concludes with a discussion of possible future projects associated with the wind turbine site and test facility.

Background

This project begin in 2008 as part of a state grant intended to provide a "consumer reports" viewpoint regarding the cost, installation, functionality and suitability of a residential wind turbine system for consumers in Minnesota. The grant allowed for the purchase and installation of four different wind turbine systems on campus at a designated site with a minimum of wind obstructing trees and structures and having a small site building to be used for battery energy storage, data collection and associated electronic equipment, and for the storage of project tools. The systems were chosen based on rated power output, cost, availability, and suitability for a battery charging configuration. The original project intent was to install grid connected systems. This was later changed to reduce interactions with the campus sub-grid and to allow fully independent operation[1]. The ability to generate power regardless of the grid status was considered a strong advantage even though the typical residential installation would incorporate a grid connect system. The four turbines were chosen from four different vendors and manufacturers and encompassed two different styles, vertical axis and horizontal axis. Two of the turbines are horizontal axis types and were installed via monopole at sixty feet (A standard height as suggested by various manufacturers.). Two of the turbines are vertical axis types and were installed via monopole at eighteen and twenty feet respectively due to manufacturer recommendation and standard installation design information. All four turbines are rated at power ranges between roughly two and three kilowatt peak outputs. The four systems are 1) Skystream 3.7 (Southwest

[1] To be compliant with electrical codes, any wind turbine supplying power to the grid must be capable of being isolated under conditions of grid instability (power outages) or for maintenance. This would necessarily lead to occasions of zero power output from the turbine.

Windpower), 2) ARE 110 (Abundant Renewable Energy), 3) UGE 3kW (Urban Green Energy), 4) S322 (Helixwind).

The test data consists of wind speed, wind direction and temperature data collected at roughly twenty feet and fifty five feet and per minute resolution of turbine output power (i.e. power factor corrected power derived from sampled voltage and current) for each turbine. The data is collected and stored in a computer located at the site. There were a significant number of delays in the installation and configuration of the systems due to a number of factors outside the control of the author and therefore the amount of test data collected as of 2010 is minimal, however early results demonstrate the capability of the installed systems and completion of the project tasks is ongoing. The next section will describe the system components for each battery charging system and the methodology for data capture.

Battery Charging Systems

The battery charging system for each of the four turbine installations was designed in a similar fashion and closely resembles each other. The Skystream turbine system is unique amongst the other systems due to its standard "grid-connect" configuration. The other three systems are designed for a battery charging system interface and are able to connect to the electric grid using alternative manufacturer/distributor supplied equipment. The configuration for these three turbine systems will be referred to as configuration A. The Skystream turbine system will be referred to as configuration B and will be described separately. All four turbine systems were configured using a four-battery 48V nominal battery pack constructed of deep cycle sealed Absorbent Glass Mat (AGM) 200-Ahr batteries. These batteries were chosen for their cost effective energy storage and low maintenance reliability. A 48V pack was chosen to fit the recommended voltage level compatible with all turbine systems. The capacity was chosen to satisfy the maximum recommended minimum Amp-hour rating provided by the manufacturers/distributors. The goal of the project does not include efficient usage of the stored energy from the turbines so the cost and reliability were the primary drivers in the choice of battery technology. All systems were installed on monopole towers at heights based on manufacturer standard design drawings and available tower hardware. The Skystream and ARE 110 turbines were supplied with 60 foot towers. The UGE 3kW was also supplied with a monopole tower but at the height of 18 feet. The Helixwind turbine was supplied without a tower but a 20 foot monopole tower was locally manufactured according to Helixwind specifications and used in the installation. All foundations were either installed (i.e. poured) as specified in manufacturer drawings or installed according to revised drawings contracted through a local engineering design firm. The nature of the project (State of Minnesota funding) required State registered engineering certification of all foundations. This was accomplished via local subcontract. In addition, all turbine system electrical installation was completed by licensed electricians. This work was accomplished by Minnesota State University electrician staff and via subcontract and included extensive cabling through conduits both external and internal to the turbine site building housing the power conversion and data measurement electronics. Each turbine system was earth grounded and interfaced via high voltage disconnects to the external conduit system. The disconnects are located at the base of each tower for easy access as necessary. The external (buried) conduits were routed from the disconnects to the rear of the turbine site building and up through the rear wall. Inside the turbine site building against the rear wall are an additional high voltage disconnect connecting each turbine power conversion equipment to the external conduit cabling. It is possible to isolate each turbine electrically using either in-line disconnect (one internal to the building and the other external to the building). In addition, each battery pack is isolated from each turbine system power conversion electronics through the use of a high voltage DC disconnect. All turbine systems are isolated from the grid and isolated from each other. The following two sections describe the A and B battery charging configurations.

Configuration A

The three turbines covered under this configuration generate three phase AC power. The AC voltage is rectified and bucked (i.e. voltage scaled) using custom, manufacturer provided, power converters rated for the peak turbine output. The three phase power is delivered over a range of voltages and currents to the power conversion boxes and the resulting output is regulated DC power. The output is routed to a battery charge controller which acts as a switch selectively routing power either to the 48V nominal battery pack or high power diversion load resistors if the battery capacity is near its peak. The battery charge controllers used in each system exceed the rated peak power capacity of each turbine. Each of the three systems has a dedicated diversion load capable of meeting or exceeding the capacity of the battery charge controller connected to it. See the figure below for additional detail.

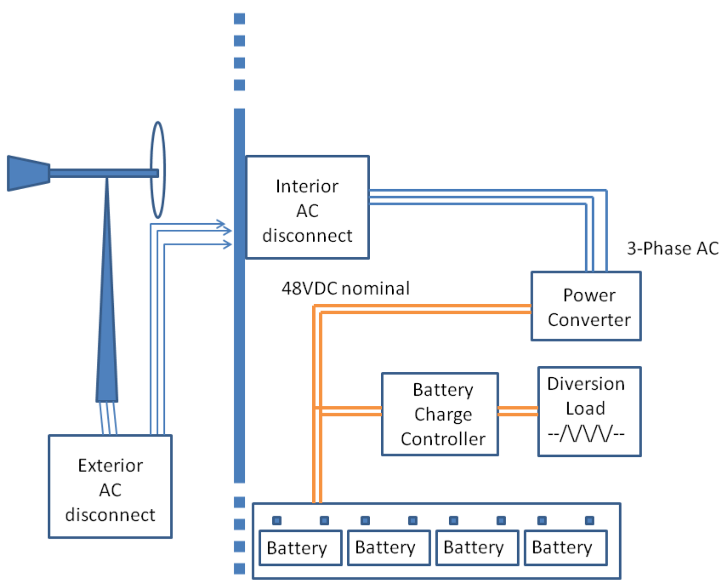

Figure 1: Configuration A Diagram

As mentioned previously, power from each turbine utilizing configuration A is delivered through two AC voltage/current disconnects prior to reaching the power converter. An additional DC voltage/current disconnect separates the battery pack from the rest of the system. In essence, each power source is connected to the system through a disconnect[2] since the battery pack can act as a power source or sink depending on the direction of the current flow. On the occurrence of battery pack failure, turbine failure or power conversion electronics failure, the failed system can be isolated from the rest of the system. In addition, each of these subsystems can be maintained (as necessary) under conditions of electrical isolation.

Configuration B

The Skystream turbine system is covered under this configuration. This configuration is unique to the project because of its grid-connect architecture. In essence, this configuration allows the Skystream system to see a virtual "grid" connection thus allowing the turbine to activate and generate power for the battery charging system. Similar to configuration A, this configuration includes disconnects at the base of the Skystream turbine tower and at the back of the site building interior wall where all conduits deliver power from the turbines. In contrast, the Skystream turbine delivers power as two $120V_{RMS}$ AC line-to-neutral lines with a shared neutral line similar to the $240V_{RMS}$ AC delivered to a typical household. The interior disconnect then delivers power to an autotransformer. The autotransformer takes the 240VAC input and delivers 120VAC to a combined inverter/charger from Outback Power Technologies, Inc. The autotransformer is necessary since if only one 120VAC line from the turbine is used, total power output from the turbine will be limited. The inverter/charger allows bi-directional power flow and is not being used according to its intended functionality. Its intended functionality is to act as an inverter for providing AC power from a 48V nominal DC source. However, the device is also designed to provide a power flow back to a battery system (DC source) at a power level less than the inverter function capacity. This limitation on the charging power flow required that a somewhat oversized device be used. This charging capability is intended, by the manufacturer, to be used under conditions where a temporary reversal of power flow is necessary. This involves the device being used in parallel with the "grid" as a standby power source. On the occasions that battery power is necessary due to the lack of "grid" power, the charger function would be used temporarily after the "grid" became available to recharge the battery pack. In summary, the inverter/charger is intended to be used primarily as an inverter but with limited charging capability to maintain the DC power source. For this configuration, we are using the inverter/charger primarily as a charger however the inverter functionality is crucial to its utility in the configuration. The Skystream turbine is designed for "grid" connect and expects to see $120V_{RMS}$ AC line-to-neutral on at least one of its lines before it will close its internal contacts. In other words, the Skystream will not deliver any power without a viable AC line connection. We provide a virtual "grid" through the inverter. Once the virtual "grid" is seen by the turbine and under wind speed conditions exceeding the cut-in speed, the turbine will begin to rotate and supply power through the

[2] National Electrical Code (NEC) 2008

inverter/charger to the battery system. As in configuration A, this configuration incorporates a battery charge controller in parallel with the battery pack and a diversion load exceeding the capability of the charge controller. Finally, this configuration includes a battery protection feature. A relay box is included between the autotransformer and the interior AC disconnect enabled over a limited range of battery pack voltage. If the battery pack voltage exceeds the upper voltage limit or falls below the lower voltage limit, the relay will open. Opening of the relay removes the $120V_{RMS}$ AC line-to-neutral signal to the turbine from the inverter/charger and effectively disables the turbine. See the diagram below for additional detail.

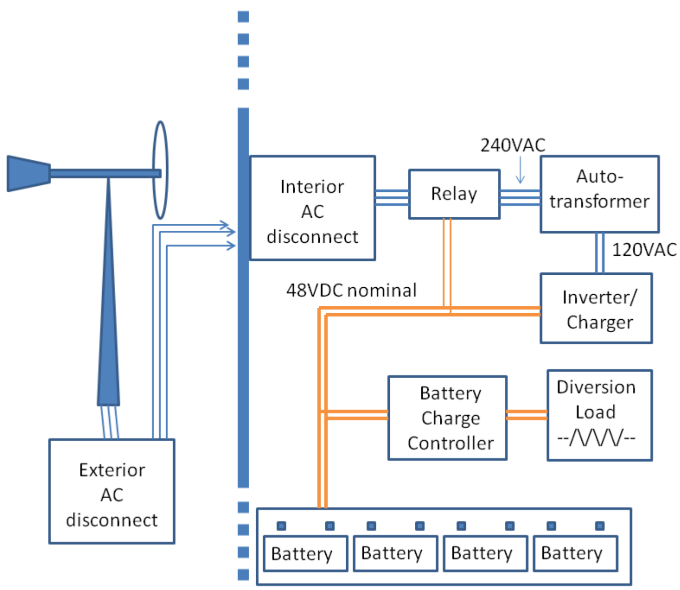

Figure 2: Configuration B Diagram

Data Collection

The data collected consists of weather related information including wind speed and direction at roughly 52 feet above ground level (AGL) and 20 feet AGL and outside temperature. This data is collected using two small wired weather stations interfaced to a computer within the turbine site building. The turbine output power measurements consist of output voltage and current or power. If power measurements are unavailable directly from the instrumentation, sampled voltage and current can be used to derive power factor corrected real power. Power factor corrected real power is available from two of the turbine system commercial instrumentation devices. The other two systems have yet to be instrumented although similar measurements are intended for these systems as well. The Skystream turbine system is instrumented with a T.E.D. (The Energy Detective) power meter which reports real power and RMS voltage through a USB link. The ARE 110 turbine system is instrumented with an Outback Power Technologies, Inc. charge controller with external MATE controller interface. The

MATE interface allows the measured power to be recorded via USB link to the data acquisition computer. Sampling rates for power measurements can be configured as high as one sample per second. Sampling rates for the wind and other weather data is as high as one sample per minute. Since we wish to correlate the power measurements with wind data the measurements are recorded at a sample rate of one sample per minute. This provides reasonable resolution for long term wind power data reporting. A sample of the Skystream data over the course of one day is shown below.

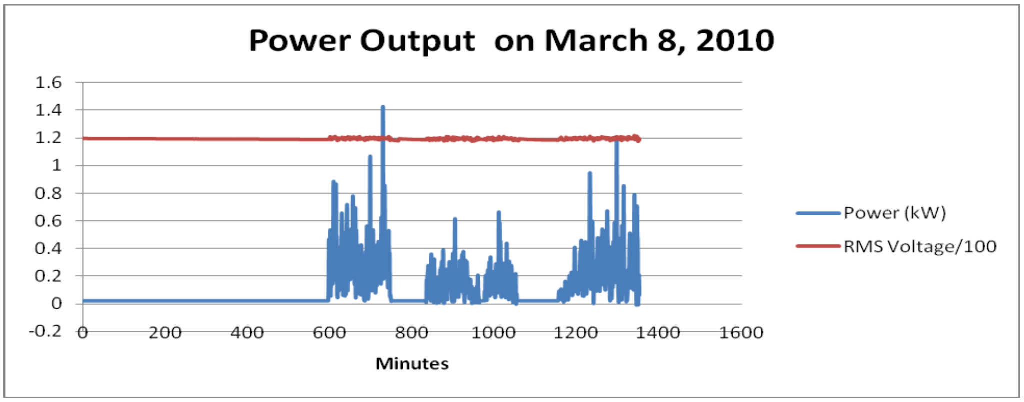

Figure 3: Power and voltage measurement data from the Skystream 3.7 turbine system.

Future Steps

The project is in its final year and we expect all operating systems to be instrumented and providing data prior to the end of the project period. After the conclusion of the current project tasks, we plan to continue operating the turbine systems in an effort to collect long-term reliability data and to continue providing a testing facility for additional small wind turbine designs. We hope the turbine site can provide an opportunity for undergraduate and graduate student conducted research in areas related to the current project such as electric to heat energy conversion using the diversion load power or further developments in AC/DC power instrumentation.

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Biography

VINCENT WINSTEAD
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ONGOING DEVELOPMENT OF A MODERN RADIO-FREQUENCY (RF) AND MICROWAVE ENGINEERING LABORATORY

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INTRODUCTION AND HISTORY

At North Dakota State University the RF and Applied Electromagnetics Laboratory has been significantly upgraded in order to give undergraduate and graduate students the opportunity to work with new and up-to-date professional measurement equipment and software. Begun almost a half century ago, the laboratory capabilities and student experiments were originally based on measurement equipment in the VHF, UHF, and X-bands. In the early years core experiments were based on use of the slotted line and General Radio equipment at the lower frequencies and the slotted waveguide and Hewlett Packard equipment in the X-band. In time, computer analysis and design of microwave devices was added.

STUDENT EXPERIMENTS IN THE EARLY YEARS

The applied electromagnetics laboratory of the 1970's included labs such as the following: (1) measurement of transmission-line characteristics, (2) microwave power measurements, (3) modeling capacitor fields with teledeltos (conductive) paper, and (4) impedance matching using transmission line stubs. The transmission line experiments had as objectives the measurement of line attenuation, characteristic impedance, and reflection coefficient for practical transmission lines. The creation of distortionless lines with the use of periodic loading coils could also be studied. Teledeltos paper is a two-dimensional paper with an approximately uniform resistance per square. A conductor is established by painting appropriate regions with conductive paint. Then a voltmeter is used to establish the surfaces of equipotential. The method of curvilinear squares (Hayt & Buck, 2006) could then be used to calculate the capacitance. Similar experiments were done at some universities using water in a tray as a replacement for the teledeltos paper and aluminum forms as models of the conductors. Related class demonstrations were performed using rubber-sheet models and fluid maps of potential fields (Rogers, 1954). In the fourth experiment, single- and double-stub tuners were used to match a generator to an unknown impedance. Using the slotted-line, this facilitated the visualization of standing waves along a transmission line, the measurement of the source frequency, and the measurement of the complex value of the load impedance as a function of frequency (Hayt & Buck, 2006). This latter measurement is very accurate, but can be tedious.

METALLIC WAVEGUIDE EXPERIMENTS

The experiments mentioned so far would be relevant today if the curriculum and its objectives permitted. By the 1980's and beyond, engineering students needed to be prepared for their professional lives by going beyond experimental studies that dealt only with improving student understanding of the basic engineering science. At some universities basic electromagnetics experiments were introduced in prerequisite physics courses, and such experiments still exist today. To meet the demands of the engineering profession, the laboratory in engineering electromagnetics added basic transmission line experiments in the UHF and microwave frequency ranges (Laverghetta, 1981). Another approach was to add a cluster of metallic waveguide experiments in the X-band. These experiments included the use of slotted lines or slotted waveguides for standing-wave characterization or measurement of complex impedance values in these bands. Students would also experience direct frequency measurement, dielectric-filled waveguides, isolators, attenuation and power measurements, waveguide bends and "tees", directional couplers, and other waveguide hardware. The key manufacturers of the day were General Radio and Hewlett Packard.

THE FREIRE-DINIZ MODEL OF THE APPLIED ELECTROMAGNETICS LABORATORY.

Almost 40 years ago, Frieire and Diniz (1973) published a textbook in Portuguese that was very significant for its intended audience (engineering students in Brazil) and for its time. The last chapter of the book dealt with suggested experiments for the electromagnetics course that could be found in American or European universities. The authors skillfully used their knowledge of electromagnetic theory to construct a set of experiments that required only a modest investment in laboratory equipment. This led to the following experiments:

1. Measurement of transmission line parameters
2. Use of the slotted transmission line to measure impedances
3. Impedance matching techniques
4. Study of the cutoff frequency of rectangular waveguides
5. Waveguide measurements using a slotted waveguide
6. Waveguides filled with dielectric material
7. Antenna pattern of the half-wave dipole.

Even today these experiments have continued usefulness. However, the pressures on the curriculum and the need to keep pace with current professional practice make it difficult to implement more than a few of the above experiments in a contemporary course. As attractive as it is, even the slotted transmission line or the slotted waveguide must be left for, perhaps, a classroom demonstration. Furthermore, the student will have to be content with a theoretical understanding of transmission line parameters. Antenna patterns remain of vital interest, so hopefully room for such a study will be made in the laboratory curriculum.

POZAR'S LABORATORY AS A MODEL

David Pozar's laboratory at the University of Massachusetts Amherst is a model microwave engineering laboratory. It combines significant theoretical and practical elements to improve student understanding as well as important experiences in professional development for students. Pozar and Knapp (2004) present the following set of experiments in an on-line manual:

1. The slotted line *(waveguide hardware, measurement of SWR, guide wavelength, impedance)*
2. The vector network analyzer *(one- and two-port network analysis, frequency response)*
3. Active devices *(the spectrum analyzer, power meter, mixers)*
4. Impedance matching and tuning *(stub tuner, quarter-wavelength transformer, network analyzer)*
5. Cavity resonators *(resonant frequency, bandwidth, frequency counter)*
6. Directional couplers *(insertion loss, coupling, directivity).*

This laboratory is usually associated with a second course for which the traditional undergraduate electromagnetics course is a prerequisite. However, some interesting features are present. In Pozar's first experiment, SWR and guide wavelength are considered in a waveguide context. This could also be done using traditional transmission lines and microstrip lines (Giarola & Rogers, 1978). Three experiments involve student use of network analyzers and the spectrum analyzer. Two experiments deal with impedance matching and insertion loss. These concepts and instruments should be included at least in introductory form in the first electromagnetics course.

BUDGET-PRICED INSTRUMENTS

The RF and microwave lab requires very expensive equipment and software. In situations where there are significant budgetary constraints, our students can benefit from new budget-priced RF and microwave measurement equipment and from instrumentation developed as part of senior projects. Related to this also are student-developed RF and microwave software packages for analysis and design (Fernandes, Giarola, & Rogers, 1983; Nelson & Islam, 2006; Bais & Rogers, 2008).

One example of a budget-priced instrument is the MJF Enterprises antenna analyzer (Hallas, 2005). This is not a precision instrument. However, it is priced under $500 and easily demonstrates for the student the frequency dependent character of transmission-line circuits and basic circuit components. It gives reasonable estimates of voltage standing-wave ratio.

A PC-based RF spectrum analyzer (Tracy, 2005) and a PC-based RF network analyzer (Tracy, 2006) are also available. They are low-cost instruments (under about $1,000). Their frequency ranges are limited (under 100 MHz and 260 MHz, respectively), but their accuracy is reasonable. Where only limited financial resources are available, instruments such as these could be the basis for a useful engineering lab experience.

CAD IN THE MICROWAVE ENGINEERING LABORATORY

In the 1970's and 1980's it was common in the microwave laboratory to introduce computer-aided design (CAD) and analysis, often using locally produced software such as PACMO (Fernandes, Giarola, & Rogers, 1983). These and similar packages could be used today, but they have often been replaced by student or trial versions of commercial software. Another package that was used at the time was MECAP, developed at the University of Maine Orono under the leadership of Dr. John C. Field (Field & Herrick, 1974). This package allowed the modeling of a wide range of transmission-line and microwave devices. A slightly more versatile package was MCAP (Gupta, Garg, & Chadha, 1981). The computer language used in PACMO, MECAP, and MCAP was FORTRAN. These were primarily analysis packages. MECAP could be driven by an optimization program that gave it a design capability. More recently, Nelson and Islam (2006) introduced MES, a Web-based package consisting of tools for analog filter design, impedance matching, and microwave network analysis. A related MATLAB-based package, CAMDS, incorporates microstrip design and analysis, waveguide analysis, impedance matching, microwave filter design, and microwave network analysis (Bais & Rogers, 2008).

In the modern lab the packages mentioned above are useful in providing an analytical solution for comparison with data taken in the lab and offer the user full access to the computer code. However, a commercial package like Agilent's Advanced Design System (ADS) is extremely useful especially since it offers the student design tools that weren't even dreamed of a few decades ago (Agilent Technologies, 2009).

A MODERN MICROWAVE LABORATORY

Recently the NDSU ECE Department made a commitment to significantly upgrade its RF and Applied Electromagnetics Laboratory. Today it consists of several design and measurement stations, each equipped with a computer and appropriate software. Four specialized stations provide the capability for making RF and microwave measurements of the following types: scattering parameters, time-domain reflectometry, spectral analysis, component characterization in the frequency domain, and electromagnetic interference. Currently, experiments dealing with some of these topics are integrated into the course in applied electromagnetics that is required for all undergraduate majors in Electrical Engineering or Computer Engineering. The lab is also used in the graduate courses in microwave engineering where, for example, students apply microstrip design concepts to practical devices using ADS software. Interest in the lab is further enhanced by use of the facility by senior design students. The RF and Applied Electromagnetics Laboratory is stimulating interest in a subject that is often challenging to students.

AN OUTLINE OF FOUR CURRENT MAJOR EXPERIMENTS

For the introductory undergraduate applied electromagnetics course, four major experiments are currently used at NDSU. A brief description of each is presented below, along with comments on the relationships that exist to the early experiments described above.

The **first experiment** (Fig. 1) is a coupled transmission lines or cross-talk experiment. This is an experiment that breaks away significantly from the experiments that were done earlier in the lab.

The content reflects interests in the department in signal transmission and electromagnetic compatibility. This experiment also reflects the general philosophy in use in the lab: the experiments are extensions of the course. The principal focus is not only to reinforce and explain theoretical concepts, but also to extend student learning beyond the lecture hall. Several types of coupled lines are studied: coupled open-wire lines, twisted pair, and coaxial lines, along with various types of grounding. The student experiences firsthand the transmission of signals through space and the potential problems this creates.

In a **second experiment** (Fig. 2) a study of discrete components is made. An impedance analyzer (Agilent 4395A) is employed to measure the impedance over a wide frequency range for several types of resistors, inductors, and capacitors. The student sees that one component can look like the other at different frequencies. This lab is also a departure from the experiments in use in the initial decades of the lab. On the surface it would seems that the measurements made would reinforce the theoretical studies done in the lecture hall of resistance, conductance, inductance, and capacitance. However, the student quickly learns that the mathematical models experienced in the textbook have severe limitations.

The **third experiment** (Fig. 3) employs a high-quality modern microwave network analyzer (Agilent E5071C) to study impedance matching using a double-stub tuner. This lab is closely linked to the experiments done by students in the lab three decades ago. The design and measurement goals are the same, but the instrumentation is radically different. The modern network analyzer produces very speedy results when compared to the earlier slotted-line approach. However, the student misses directly experiencing the standing wave on the slotted line. The students also use the network analyzer to measure the scattering parameters of microstrip devices (Giarola & Rogers, 1978). They thus experience a technology that has, for the most part, replaced the older metallic waveguide technology of the past.

Finally, in the **fourth experiment** (Fig. 4) a commercial spectrum analyzer (Agilent E4402B) is used along with wide bandwidth active antennas to explore the frequency spectrum experienced in the laboratory location. The students measure the radio frequency of several local broadcast stations. The analyzer also allows listening to individual stations after they are located in the ambient spectrum. This experiment introduces the students to antennas (Freire & Diniz, 1973) and to the spectrum analyzer (Pozar & Knapp, 2004). However, the primary objective is to help the students see the connection of the course material to the real world in which they live and work.

Fig. 1. First experiment station.

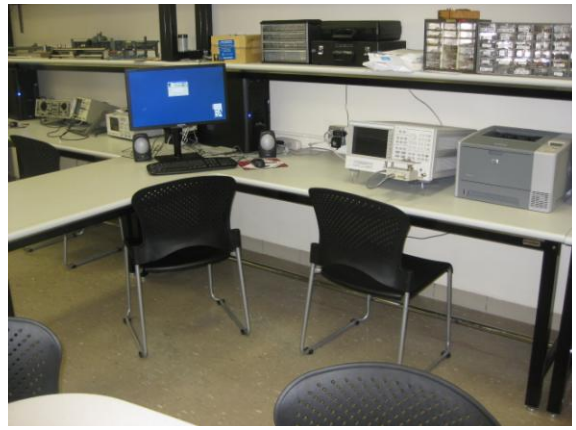

Fig. 2. Second experiment station.

Fig. 3. Third experiment station.

Fig. 4. Fourth experiment station.

Two other stations were also added at the back of the lab (Fig. 5). These stations are multi-functional areas. The equipment at these stations can be used for circuit board manufacturing, experiments and simulations. At this point these stations have been very helpful for groups of undergraduate students in Electrical and Computer Engineering who are completing required senior design projects (i.e., capstone projects). This space has also been used for graduate and undergraduate research in applied electromagnetics. In particular, software programs on the computers have been used to simulate the radiation from printed antennas, and the test equipment at these stations has been used to develop and test various flexible sensor networks being applied to phased-array antennas.

Fig. 5 also shows a very useful table located in the center of the south end of the lab. This table has been used for meetings between advisors and undergraduate and graduate students. This area has provided a nice forum for sharing ideas about projects openly and conveniently.

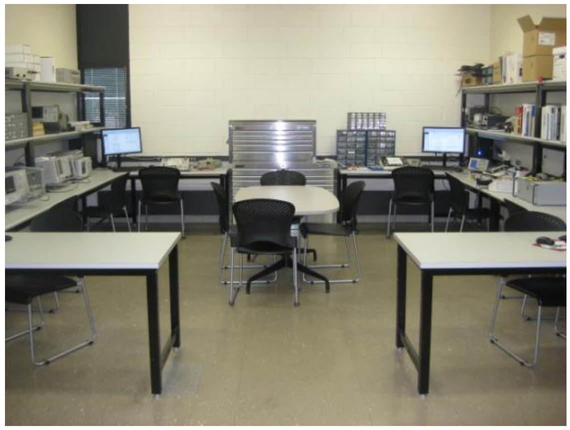

Fig. 5. Multi-functional stations.

CONCLUSION

The experience students have today in the RF and applied electromagnetics laboratory is the result of decades of development by many educators and researchers. The goal has always been to enhance student learning and to adequately prepare future engineers. The challenge has been and still is to choose those laboratory experiments that will be most helpful in the long-term. Some personal experience with electromagnetic waves and quality professional measurement equipment is a step in the right direction for today's students. This combined with the creativity and energy of students and instructors alike should produce the desired results.

ACKNOWLEDGMENTS

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BIOGRAPHICAL INFORMATION

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