Increasing Student Engagement and Persistence in Adult Distance Education

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Introduction

Excelsior College, a leader in online and distance learning, provides global access to quality higher education for adult learners, helping them overcome barriers of time, distance, and cost. A world leader in the assessment of learning, Excelsior is naturally renowned for its facilitation of degree completion and its advocacy on behalf of adult learners. The School of Business and Technology provides a holistic approach to degree completion to serve adult learners in achieving their educational and career aspirations. The faculty and staff’s mission is to provide quality Business and Technology focused programs that use innovative academic approaches for adult learners from diverse backgrounds.

Retention and student success are strategic directions for both Excelsior College and the School of Business and Technology. The College fully embraces the need to be accountable to student and external stakeholders on the issues related to student success including: retention, graduation, and learning outcomes of our students. This is informed by the College’s philosophy of student-directed, highly flexible paths to degree completion. It is with this philosophy in mind that Excelsior College and the School of Business and Technology developed numerous interventions to engage our student body as they make their way towards their academic goals.

Comprehensive description of work

The first intervention looked directly at academically inactive students which were found after studying the graduation and retention rates of Excelsior College. It was determined that there was a large amount, nearly one-third, of the student population that was academically inactive. This became the focus of one of the first and largest interventions. An inactive student is defined as a student who has paid their annual fee, but it is not academically progressing towards their degree goals. A committee of representatives from each of Excelsior’s four schools came together to determine the factors that made a student academically inactive or ‘non-persisting’. The committee felt that retaining these students does not constitute real student success. They advocated a model of student success that emphasizes engaging students early and throughout their time at the College, with meaningful, intensive, targeted and coordinated interventions.

Moreover, it urged the Excelsior College community to start thinking about student persistence as a more accurate and meaningful indicator of student success than the retention metric that we have used in the past. That metric helped set the stage for retention by highlighting the importance of retention to our students and to the success of the College. Persistence—based on indicators of academic activity and progress—will better enable the school to focus efforts and initiatives to help our students succeed.

It was with that in mind, that the committee began to set the definition and parameters of what constitutes a persisting student. The student must have participated in one of the following during the previous six months:

- Attempted an Excelsior College course
• Attempted an Excelsior College exam
• Transferred in credit
• Participated in a online conference or Clinical Performance in Nursing Examination (CPNE) workshop
• Participated in preceptorship

The committee was eager to draw on the experience and strength of Excelsior College in a cost and time effective way, but without losing the personal touch that the school is known for. The initial contact made was a voicemail from an advisor:

*Hi. I’m an Excelsior College academic advisor. I am calling you because we have not heard from you in a while and we would like to support you in completing your requirements. We’ve developed many new courses and exams to assist you in earning your degree. You may view them online at Excelsior.edu. Please call us in the next two weeks to discuss your academic plans at 877-226-1013. Again the # is…”*

The automated voicemail was followed by a postcard sent to the students’ homes. The postcard used an eye catching photo from Excelsior College graduation with the tag line ‘Wish you were here!’ and also included a check list for the enrolled student to complete. Examples included ‘Call your advisor’, ‘Register for courses’ and ‘Earn credit with an Excelsior College Exam’.

After this initial contact, which went out to over 8,000 students, each month new non-persisting students would be contacted directly by their advisors. The results across the programs are still being evaluated, looking at the chart below and the data that has been collected so far for the Bachelor of Science in Electrical Engineering; the persistence rate is well above the College average.

![Graph showing persistence rate for Bachelor of Science in Electrical Engineering Technology]

Excelsior College Overall persistence rate of 67%
This college-wide effort to reach out to academically inactive students aligned directly with the retention initiatives that the School of Business and Technology had in place as part of its strategic plan. The school had been contacting students who had not been active for six months with targeted emails and phone calls, very similar to the persistence effort. Additionally, the school also sends a ‘Welcome Packet’ to all students whose initial evaluation has been completed. In addition to the student’s academic plan, there is a letter that introduces the student to the technology team members and a listing of all the business and tech courses available for registration in the current term and encourages the student to contact an advisor to get started. The level of contact continues throughout the student’s time enrolled in the School of Business and Technology, including advisors reaching out to each student who has failed, withdrawn, or received a grade of ‘Incomplete’ in their program’s capstone course to discuss options.

In addition to Excelsior College’s efforts reaching out to students, the college has made it a priority to provide students an array of tools that will help them satisfy their degree requirements. Smarthinking, a free online tutoring service, is offered to all Excelsior College students. Live tutoring services are available 24/7 in nearly a dozen subject areas. Over 1,200 hours of online tutoring were conducted from July 2010 to June 2011. Excelsior College also provides students with a free Online Writing Lab (OWL). OWL’s easily accessible and organized content went live on the College’s website in December 2011 and is expected to be an invaluable resource for students needing assistance with anything from basic grammar to complex research projects. Excelsior College Library is another free resource designed to help students with research and study needs. Besides having access to the Library’s collections, students have dedicated librarians to help them identify, use, and evaluate information resources.

Although not a free resource, Excelsior College offers Practice Exams as a useful tool for those students that intend to “test-out” of certain degree requirements instead of taking a course. Preparing test takers for success is achieved by offering them a “feel for the road” before taking the actual exam for credit. Exposing students to sample types of exam questions and providing the rationales for practice test answers helps to position students for success on an exam. Student feedback reveals Practice Exams increase test taker confidence and their ability to pass an exam.

In addition to the internal best practices used to address persistence and retention, Excelsior College investigated outside resources that might complement existing processes and procedures for enhancing the student experience. Committees were formed and in-depth discussions were held to determine how external resources could be leveraged to support retention and persistence. These discussions led to some outside resources being embraced.

Excelsior College has partnered with the organization Inside Track whom serves as a coaching agency for Excelsior College students. The goal of this partnership is to strengthen persistence, graduation, and student outcomes. The partnership program was piloted by Excelsior College’s School of Nursing with a specific focus on improving student outcomes, examination completion pace, satisfaction, and persistence. A controlled study testing the efficacy of coaching revealed it had positive results for students in the School of Nursing. In particular, students taking instructional courses at Excelsior College who received coaching improved the likelihood of the student continuing into subsequent Excelsior College courses. It was determined that the partnership with Inside Track enhanced the student experience and supported
Excelsior College’s efforts to achieve exceptional student success. As a result, full-implementation of this program was added to the School of Nursing and pilots were launched for the School of Liberal Arts and School of Business and Technology beginning July 2011.

To determine the success of the pilot program with the School of Business and Technology, various success measures have been put into place. The primary success measures include: completion of Excelsior College courses (excluding military withdrawals), credit accumulation within a year (to include Excelsior College courses or exams), and student persistence as defined by Excelsior College, and financial return on investment. Secondary measures were also put in place including: student satisfaction impact, completion of required orientation, sequencing of courses, submission of new student paperwork, and grades for Excelsior College courses. Two key areas that the School of Business and Technology are closely monitoring throughout the pilot program are whether coaching contributes to an increase in Business and Technology students continuing into subsequent courses, as well as if there is an improvement in course completion rates.

Initial student feedback from coaching sessions are being tracked and categorized into recurring themes. Inside track obtained feedback about what students like, did not like, and what areas they wished to received more in-depth coaching on. These insights enable the college to determine what seems to be working well and where there may be areas for improvement. The following is a breakdown of some key points students shared during their coaching.

**What students like:**
- Instructors who communicate and engage with students
- Learning about Excelsior College resources
- Getting a coach for their first online class

**What students do not like:**
- Not knowing where to find grades and comments
- Uncertainty about what to expect from faculty

**Students want further coaching on:**
- Using Excelsior College’s resources
- Managing their time and commitments

In the fall of 2011, Excelsior College began the implementation of *Starfish EARLY ALERT* system, an early warning and student tracking system. Excelsior College intends to enhance student success and persistence by adding Starfish to the College’s extensive list of tools used to identify at-risk students in time to make a difference. Excelsior College is tying Starfish in with its existing Learning Management System (LMS) which serves as a course management and delivery tool. Excelsior College’s LMS does not offer the same robust communication functions native to a program like Starfish. The Starfish program is designed for the purposes of promoting student engagement by using unique capabilities such as early alert triggers and monitoring/reporting student progress. The complex reports Starfish is capable of generating will help faculty and staff determine at-risk students in a course.
A unique feature of Starfish that Excelsior College has embraced pertains to positive reinforcement for those students who are performing well in a course. Students who hold a C grade or higher in a course will automatically receive positive messages and reporting from the Starfish system. Those students with grades below a C would receive warning messages and reporting to encourage them to improve their performance in the course. Starfish is a sophisticated program that will enable Excelsior College to send real-time messaging and reporting to those students whose academic standing in a course is below the threshold where the student could subsequently earn an acceptable course grade of C or higher by the end of the course. This special messaging would enable affected students to make an informed decision about their academic standing in a course (e.g., seek a withdrawal, seek an extension, or work harder). Such a feature will enable students to proactively make an educated decision, ultimately having a positive impact on their persistence through a degree program. Excelsior College has also setup the Starfish system to notify students and faculty of non-participation in a course. If students fail to post messages to the class discussion board and submit homework assignments, early alert messages and reporting will go out when student activity drops off. This safety net complements the efforts of the College’s Academic Advisors who will make ‘persist calls’, ‘probation calls’, and ‘second notice of non-participation calls’ which are made when a student has gone two weeks without participating in a course.

Results

While the majority of the efforts described in this paper are in their first year of implementation, Excelsior College has begun to see steady gains in persistence rates. When the persistence first began in July 2008, about sixty percent of students were persisting. As of January 2012, sixty-seven percent of students are persisting college-wide. As presented in the graph above, the persistence rate of the BS in Electrical Engineering is currently well above the college-average. The College and the School of Business and Technology will continue to monitor the persistence data as it continues to adjust and create new initiatives to keep our students engaged and persisting. The focus on student persistence will continue to increase the development of a comprehensive suite of valid student success measures, such as increased student satisfaction, increased student learning and increased graduation rates.

Conclusion

Excelsior College has spearheaded the challenges of student persistence and retention by strategically implementing an arsenal of best practices and providing an array of student resources to facilitate academic success. Despite the mix of longtime and new practices used to engage students, Excelsior College is dedicated to reviewing, modifying, and updating its strategies in hopes to maintain an effective, balanced, and manageable plan that encourages students to progress through their degree program with confidence and satisfaction.
Collaborative Learning Journal Clubs in Biomedical Engineering Education
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Abstract

A challenge of teaching undergraduate biomechanics is providing content depth to students from diverse academic backgrounds, including a mix of engineers and scientists. One collaborative learning activity that is accessible to students from diverse scientific backgrounds is a Journal Club. Journal Clubs are popular educational tools in medical education. In an extensive literature review, 80% of 101 studies reported that journal club discussions improved knowledge and critical appraisal skills. The present study examines results from a structured Journal Club that has been implemented for three years in a biomechanics course of approximately 31 students per year. Typically 36% were Chemical Engineering majors, 45% were Mechanical Engineering majors, and 19% were other engineering/science majors. On average, 6% were graduate students. Each group of students chose and read an article from the peer-reviewed biomechanics literature and evaluated its scientific merit and interpretation of results in a guided discussion. This process was repeated approximately weekly. Students consistently recognized Journal Club as a significant learning experience, with annual averages of 3.8, 3.3, and 3.7 on a 5-point Likert scale (with 5 = “strongly agree”) over a three year period. An additional survey of the third cohort of students showed that students increased their proficiency in reading scientific articles (4.0), found Journal Club helpful to the successful completion of their literature review assignment (4.2), and recommended that Journal Club be kept as a part of the course (3.7). Furthermore, topics taught in the course lecture were perceived as relevant to Journal Club discussions (3.5) and the discussions themselves were enjoyable to students (3.5). These results indicate that students perceived significant educational benefit from the collaborative learning experience in Journal Club.

Introduction

Courses in biomechanics appeal to students from diverse academic backgrounds, especially in engineering and science. As a professional elective, engineering students often expect a computationally-intensive, technically-oriented course, whereas other scientists may not have a strong background in engineering mechanics. It is challenging to design course activities that offer depth of education while allowing all students to succeed with even a basic mechanics background. One approach is to focus on the critical evaluation of published scientific studies and the research processes that led to their findings. An effective collaborative learning activity for this is a Journal Club, in which students read and discuss articles from scientific literature. Within the medical community, Journal Clubs have a longstanding tradition. They originated as a cost-saving measure in the face of rising periodical costs and have evolved as a means for medical professionals to learn about cutting edge research being performed around the world. More research on the optimal design of Journal Clubs is essential to improving their implementation. Journal Clubs in medical education have been highly successful. Participation in a Journal Club increases medical knowledge in 88% of medical residents and bridges the gap between research and clinical practice. A literature review reported that 80% of published reports claimed that Journal Club discussions improved knowledge and critical
appraisal skills.\textsuperscript{1} In a small subset of this literature review, there were 12 articles in the experimental/comparative paper category. Of these, 10 articles noted a significant impact of an outcome measure (from a Journal Club) compared to a control activity (such as a lecture).\textsuperscript{1} Journal Clubs allow participants to discuss a peer reviewed journal article in a friendly setting while educating one another on the techniques described in that article. The knowledge obtained from a Journal Club can be transferred to a variety of daily work and personal activities.

As an educational tool for undergraduates, students can improve individual reading and synthesis skills. The format of Journal Club is flexible and no strong preference in structure has emerged in the literature. The success of the Journal Club does depend on the goals set prior to the discussion.\textsuperscript{2} An avenue yet to be quantified is the longevity of evidence uptake or application of Journal Clubs.\textsuperscript{1} The student requirements to effectively participate in a Journal Club discussion include basic reading skills, discussion skills, and knowledge of the scientific method, but do not rely on depth of technical knowledge. The student must be able to read an article and think critically about its methods, results, and conclusions. In discussion, different perspectives (i.e. engineer vs. biologist) are appreciated. The present work describes a structured Journal Club that has been implemented in a biomechanics course for three years and presents results from student surveys.

\textbf{Comprehensive Description of Work}

The course described in this study was a biomechanics course at a primarily undergraduate private university. The average enrollment was 31 students per year. Graduate students could complete additional work to earn graduate credit. On average, 6\% were graduate students and 38\% were women. By discipline, students were typically 45\% Mechanical Engineering majors, 36\% Chemical Engineering majors, and 19\% other Engineering/Science majors. This diversity was mirrored in the students’ self-selected discussion groups: in the third cohort, 80\% of the student groups contained students from at least two different majors. Throughout the semester, students worked in self-selected groups of 3-4 for the guided Journal Club discussions. Approximately weekly, each group was tasked to choose and read an article from the peer-reviewed biomechanics literature, discuss its scientific merit, and evaluate the interpretation of its results. This process was repeated on Fridays throughout the semester.

The overall learning objective for the Journal Club was for students to demonstrate proficiency in locating, reading, analyzing, and discussing current biomechanics research literature. Proficiency in these skills is critical to student success in the literature review, which is the capstone assignment of the course. This is a skill that students who continue on to graduate school will be expected to perform. The structure of the Journal Club discussions and evaluation has evolved over the three-year period to promote active student discussions and accurate assessment.

To ensure students were prepared to effectively participate in Journal Club, the university’s Reference Librarian gave a guest lecture within the first week of class and demonstrated how to search for articles and access them via local resources or Interlibrary Loan. An associated homework assignment required students to find articles both in hardcopy and electronic format using the resources described by the Reference Librarian. To help students evaluate research
studies within the context of the scientific research process, the course instructor gave a brief primer on the peer-reviewed publication process early in the semester. This included a discussion of authorship standards within the field of biomechanics.

**Student Roles**

To ensure active participation and student preparation, each student was assigned a role. Students rotated among the roles approximately equally throughout the semester in a self-selected order. To promote effective preparation, an article had to be chosen each week and students needed to read the article prior to the in-class discussion.

The *Gatherer* student chose the article and posted it to Moodle (course management software) by the established deadline of 3 days prior to the in-class discussion. S/he also posted an 8-12 sentence summary of the article prior to the in-class discussion. The choice of the article was left solely up to the student, so long as it came from a peer-reviewed journal and was relevant to biomechanics. Students were especially encouraged to choose articles on topics of personal interest or on their chosen topic for the literature review assignment. The *Questioner* posted at least two questions about the article to Moodle prior to the in-class discussion. These were to be used as a starting point for the group’s discussion. The *Answerer* posted answers to these questions following the in-class discussion. For groups with 4 students, the *Historian* investigated the authors of the article with a focus on their collaboration and publishing history and posted a summary of relevant information prior to the in-class discussion. This formal preparation structure allowed for individual assessment, and helped foster a starting point for the in-class discussions. If the *Gatherer* failed to post the article by the deadline, the teaching assistant assigned an article to the group. If the *Questioner* failed to post questions, the group was tasked with identifying both questions and answers during their in-class discussion. Posts to Moodle were accessible to all students in the course.

**In-Class Discussions**

During the in-class discussions, 20-25 minutes were devoted to Journal Club. Students were each required have either a hard- or electronic-copy of their group’s article present during the discussion. An instructor (professor or teaching assistant) also read each article in advance and joined each group for 4-5 minutes during the discussion time period. During this time, students were encouraged to ask clarifying questions of the instructor related to the article, especially regarding technical details that were unclear. The instructors qualitatively assessed student preparation by asking targeted questions to the students, such as asking students to define scientific terms used in the article that may be new to the students. To give the students a sense of the breadth of biomechanics research being conducted, at the conclusion of the discussion time one student from each group was randomly selected to provide a brief (30-second) summary of their article.

**Student Assessment**

Students were assessed individually via posts to Moodle and documented participation in each group discussion. Table 1 below summarizes the point-accruing scheme based on student
role. A student earned two additional points each time s/he was randomly selected to summarize the group’s article for the class. In the third year, Journal Club performance was worth 15% of the course grade, with 12 points earned per week over the 8-weeks of Journal Club. All students had this opportunity at least twice to ensure that each student could earn up to 100 points total.

Research Data Collected

Student perceptions about Journal Club were surveyed as part of the normal course evaluation process. An additional voluntary survey of the third cohort of students was conducted. All questions asked students to answer on a 5-point Likert Scale (with 5 = “strongly agree”).

Table 1: Journal Club Student Roles and Point Values

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<th>Gatherer (weekly task)</th>
<th>Questioner (weekly task)</th>
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<tbody>
<tr>
<td>• Article less than 10 years old (3 points)</td>
<td>• Post questions to Moodle before discussion (6 points)</td>
</tr>
<tr>
<td>• Article posted to Moodle on time (3 points)</td>
<td>• Attend discussion with a copy of the article (6 points)</td>
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<tr>
<td>• Summary posted to Moodle before discussion (3 points)</td>
<td></td>
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<tr>
<td>• Attend discussion with a copy of the article (3 points)</td>
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<td></td>
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<tr>
<td>Answerer (weekly task)</td>
<td>Historian (weekly task)</td>
</tr>
<tr>
<td>• Post answers to Moodle after class discussion (6 points)</td>
<td>• Post historian summary to Moodle before discussion (6 points)</td>
</tr>
<tr>
<td>• Attend discussion with a copy of the article (6 points)</td>
<td>• Attend discussion with a copy of the article (6 points)</td>
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<tr>
<td>All Students – End of discussion summary to class (2 points) (twice per semester per student)</td>
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Results and Conclusions

Over three years, students consistently identified Journal Club as a significant learning experience. Sixty nine percent of the students in the third cohort volunteered to complete the additional survey. These students reported markedly increased proficiency in reading scientific articles and found Journal Club helpful in the completion of their literature review assignment. Furthermore, topics taught in the course lecture were perceived as relevant to Journal Club discussions. The discussions themselves were enjoyable to students and most students recommended that Journal Club be kept as a part of the biomechanics course. A summary of the Likert scale ratings is in Table 2. Overall, these results indicate that students perceived significant educational benefit from the collaborative learning experience in Journal Club.
Table 2: Journal Club Survey Likert Ratings

<table>
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<th>Journal Club Trait</th>
<th>Likert Rating</th>
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<tr>
<td>Significant Learning Experience</td>
<td>3.8, 3.3, 3.7 (over a three year period)</td>
</tr>
<tr>
<td>Proficiency in reading scientific articles</td>
<td>4.0</td>
</tr>
<tr>
<td>Completion of their literature review</td>
<td>4.2</td>
</tr>
<tr>
<td>To keep Journal Club as part of the course</td>
<td>3.7</td>
</tr>
<tr>
<td>Course topics relevant to Journal Club</td>
<td>3.5</td>
</tr>
<tr>
<td>Enjoyable Discussions</td>
<td>3.5</td>
</tr>
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Key educational benefits to this collaborative learning exercise include increased content depth compared to a traditional lecture - in a traditional lecture, the technical depth would be limited to ensure the success of students from different technical backgrounds. With the team-centered approach, students work collaboratively to self-educate on the relevant principles. It is interesting to note that throughout the course, 79% of articles chosen for Journal Club were directly related to the course topics (Figure 1). This suggests that students actively sought out relevant scientific studies to gain deeper knowledge of lecture topics. Interestingly, the proportions of student-selected articles were not the same as the proportions of topics lectured (Figure 1 compared to Figure 2). Furthermore, a semester-long literature review assignment, as previously mentioned, also required synthesis of scientific literature. The data suggest that most students used the Journal Club discussions to discuss articles relevant to their self-chosen literature review topic: in the third cohort, 22 out of 35 students did this. Interestingly, 42% of students in the third cohort reported discussing topics they learned about in Journal Club with their peers outside of the classroom, indicating good student engagement both in and outside of the classroom.

![Figure 1: Topics of Student-Selected Articles.](image)
Figure 2: Course Lecture Topics.

Instructors can also benefit from structured Journal Club discussions. Participating in the discussions gives regular feedback regarding student interest, which can influence the future selection of topics covered in the course. Journal Club also offers a unique opportunity to engage in discussions with students and share content knowledge with students who are most interested, and at a level appropriate to the student’s background. Furthermore, faculty members may reap the same benefits that health care professionals experience from Journal Club: namely, increased knowledge of contemporary scientific literature.\(^1\)

Future work will include objective assessments of learning as a result of the Journal Club discussions. This technique could be applied to other technical elective courses. Additional extensions of this work may include surveys of course alumni to assess the relevance of the skills developed in Journal Club to their careers and lives.

In summary, Journal Club discussions are an effective way to engage students in biomechanics. Students gain an introduction to scientific literature and the research process, and learn customized content in what would otherwise be an introductory course. Anecdotally, students have reported using their literature search skills to research topics of personal interest, particularly with regard to health. Students generally enjoyed the activity: as one student said: “… Journal Club broke things up and was a lot of fun…”
References


Aquarium Fires - Why Water and Electricity Do Not Mix
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Abstract
Large aquariums (25 gallons or more) offer an amazing way to teach electrical safety insofar as the prevention of electric fires is concerned. We report on 4 aquarium fires and their origin. All were started due to the presence of a large amount of water vapor in the air. All were caused by short circuits, which were never truly short circuits in the conventional sense – had they been true short circuits, no fire would have started. All of the fires were put out by the water in the aquarium, though not without terrible consequences. All of these fires could have been prevented if the owners had shown greater care of their aquariums. We cite examples of what such care entails in light of present day electric standards.

Keywords: aquarium fire, electrical safety, water and electricity, electric safety teaching

Introduction

Water and electricity do not mix. To teach this in a course about electrical safety, case studies are important. This paper will introduce four case studies that almost every student can relate to.

Many people have possessed an aquarium at some time in their lives. Most of these are no more than fish bowls with most holding under a gallon of water. However, there are some people who may have a large aquarium in their home or place of business. For simplicity, we define a large aquarium as one holding 25 gallons of water or more.

Surprisingly, aquariums are one of the greatest reasons for the cause of electric fires. The problem is water vapor. Accidentally spilling water on an electric appliance (for example, a heater) may prove dramatic, but there is generally no long lasting damage. In fact, the manufacturers of aquarium equipment are very focused on the issues of electric fires as well as electric shocks. Their insulation of the appliances that must contact water is extremely strong. Recall that a filter, heater, submerged light, as well as other gadgets must actually be in contact with water in order to work properly. The cords and plugs used on these appliances are extra thick and extra strong. We have had no personal experience of these ever causing a fire, and we are not even aware of any reports of such fires in the literature on this subject.

But even though the manufacturers of aquarium goods have done their due diligence, there is still a great deal of room for fires to occur.

The most common cause of an aquarium fire involves light fixtures outside of the aquarium. Water vapor can come off the top of the water and seep into the light fixture. Check the specifications, but there are only a few light fixtures (generally with fluorescent bulbs 4 feet long) that can work in a vapor rich environment without causing some sort of current leakage. Light fixtures that can be used as ceiling lights or overhead lights for aquariums will mention this fact, both on the fixture itself and on the bulb used in the fixture. These bulbs/fixtures have extra...
insulation to make them water-proof in a damp environment. Most pet stores/aquarium supply houses will supply you with the equipment to set up the aquarium, but they will neglect to supply the parts or even the advice pertaining to electric fires and light fixtures.

For an electric fire caused by an aquarium, there are 2 causes – a high density of water vapor and a low leakage current. Suppose that a test is made to determine the insulating properties of a light fixture. The resistance between line and ground is infinite (theoretically) or at least 30 million ohms (realistically). Suppose that a short develops – the resistance drops to zero, or realistically it drops to some value just under an ohm. With 120 volts (RMS AC) being the American standard, this would draw a current of over 120 amps. Most fuses are rated at 15 or 20 amps for normal home or business use. With a draw of 120 amps, the fuse (or circuit breaker) would open and the circuit would become “dead” before any real trouble occurred.

To put this another way, a short circuit (less than one ohm in resistance) would be a good thing to prevent an electric fire. It would indicate a problem immediately. It would call for someone to fix the problem. And there would be no damage.

But a conventional short circuit is NOT common with aquarium fires. What is much more common is to develop leakages between line and ground that are small – of the order of milliamps to start with and gradually increasing to as much as 7 amps. Since the smallest fuse or circuit breaker generally trips at 15 amps, the proper fusing of an aquarium will be of no use in preventing an electric fire. The process for the ignition of an aquarium fire happens according to the following sequence of events. (1) Water vapor condenses between line and ground, forming a thin film. A small current flows (maybe milliamps) through this film. This is hardly noticeable since the average large aquarium may draw 10 or more amps safely. (2) The water film will dry up but leave behind salts and dirt that can conduct. (3) New water droplets will condense on in the same spot between the ground and line voltages. The leakage can now be increased, with this new layer. (4) This process repeats itself, as the leakage gets larger and larger. This process has been known to take up to a month to occur, but it has occurred in as little as a few hours. (5) Ignition of fuel takes place at various temperatures. Paper and wood ignite at 451 degrees Fahrenheit. Most plastics ignite at over 700 degrees F. See [1] and [2]. Over time, the heat from leakage can cause the local temperature to increase to equal or come close to the ignition value. In addition there is a chemical process involved in the ignition of burning called pyrolysis. See [3]. This can lower the ignition temperature. Over time the application of a continuous source of heat can cause a fundamental breakdown in the structure of the plastic or wood or fuel so that its ignition temperature itself is lowered.

Analysis

In three of the fires that we studied, the ignition point was in a light fixture. The light fixture was NOT rated for use in a damp environment. Burning is evident throughout the fixture. A typical fixture for aquarium use is shown in Figures 1 and 2. Another light fixture, not rated for use with an aquarium, is shown in Figure 3, following a fire that started in the fixture from water condensation. In Figure 4, we show a different kind of ignition, the ignition of a power strip. Power strips were bought by a homeowner at the local store (like Radio Shack or Lowes or Home Depot). These are great for use with computers and televisions, so long as you draw a
current for which the power strip is rated. However, they are NOT designed for use in damp environments. In fact, some manufacturers of power strips now list the following warning: “NOT for use in a damp environment – NOT for use with an aquarium”. The reason for this warning is simple. Aquarium fires are a very common form of fires, and the manufacturers of these power strips have been sued for their role in said fires.

Figure 1 and 2. Typical light fixture for aquarium use
Figure 3. Light fixture following a fire that started in the fixture from water condensation.

Figure 4. Two power strips – The left one is completely burned; the right one is not changed.

In Figure 4, two power strips are shown. These ran the filters, lights, and heaters for a large aquarium. The power strip on the left is completely burned; it vaporized. No melt was found near the strip. Only by luck, the second strip did not ignite.

What is also common in the fires that we investigated is the fact that damage to the home from fire is almost nonexistent. Also, death or damage to the human is almost nonexistent. Simply put, the water in the aquarium inserts itself into the accident such that it puts the fire out. This does not mean that the accident is trivial. In one case, a man had spent $10,000 for rare tropical fish. The fire caused the water in the tank to heat up and explode the glass. The flooding caused major water damage in the house. Also, the explosion tossed fish up to 20 feet. Some were found embedded in window screens. In addition to the $10,000 loss of fish, the homeowner paid $80,000 to fix flooding damage and smoke damage.

To sum up our observations of these 4 fires:

Electric shock or death – not likely, but it can happen.

Fire damage – can happen but not likely.

Flooding damage – very likely and very serious

Smoke damage—very likely and serious.

One other thing should be mentioned here. In two of the accidents, the homeowner/business-owner noted a “smell” for several weeks before the fire. The smell was of something burning. In one case, he called in an “expert” who checked all currents and voltages and gave his aquarium-system a clean bill of health. In these cases, the sense of smell trumped electrical knowledge.
**Conclusion**

We note that aquarium fires are a very common form of electric fires. We note that their prevention is quite simple – use only appliances specifically made for use in a damp environment. Trust your sense of smell over your meter readings. Know that fusing the aquarium and buying quality appliances are a good start, but they are no protection against these fires if you have any light fixture or power strip in the vicinity that is not made for use in a damp environment. Further specifications about the use of items in or near an aquarium can be found in the National Electric Code\(^4\).

**References**


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Redmine in an Academic Setting
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Abstract
A web-based collaboration system called Redmine was introduced for use in our capstone design program. Many project teams effectively used both the project's wiki, discussion forums, and a repository tool for recording and communicating their design work. The students also learned to use the discussion forums and the issue tool to manage their projects. On the other hand, various user statistics obtained from the system allowed the faculty advisors to monitor the frequency of each student's contributions and to quickly review the content and quality. The system made a significant impact on the outcome of the project results. This paper will present issues in deploying the tools and the best practices for using these tools in capstone design courses.

Introduction
To become successful engineers, students must learn technical knowledge, good communication, skills, and teamwork skills. Traditional lecture-based coursework focuses on providing a solid theoretical foundation and analytical skills for each of the various disciplines. On the other hand, laboratory courses and engineering design courses are often used to teach communication and teamwork skills. Typical communication skills include, but are not limited to, maintaining lab/design notebooks, writing technical reports, and oral presentations. A project-based course may also include writing a proposal.

On-line collaboration tools, also known as groupware, are widely used in many organizations to improve their productivity and the quality of their products. Currently, Wikipedia includes over 95 software tools. Types of collaboration tools include bulletin (discussion) boards for threaded discussions, public folders for sharing documents, and version control systems for concurrent editing software source codes or CAD files. Therefore, it is beneficial for students to learn skills to use such tools in engineering projects.

In our capstone design program, students work with their academic advisors as well as industry sponsors, who are typically out of town, toward a common project objective. An open source web-based bulletin board system was introduced for enhancing the design program in the spring of 2005 and made significant impact on the outcome of the project results. Although the system provided many benefits to our program, better collaboration tools have been developed. Hence, we migrated from the bulletin board system to an open source bug tracking system called Redmine in the fall of 2010.

Learning to use the system and manage a design project effectively also contributes to the following ABET student outcomes:

1. (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
2. (g) an ability to communicate effectively
3. (d) an ability to function on multidisciplinary teams
In the following sections, we will present issues in deploying the system and the best practices for using these tools in capstone design courses.

Selecting a System

A variety of collaboration tools are widely available. Functions useful in engineering design courses include:

1. Record keeping, such as Wiki and discussion board supporting attachments
2. Technical discussions and design reviews, such as discussion board
3. Revision control of design documents, such as a version control system
4. Project/Task management, such a Gantt chart tool
5. User statistics (log capability) useful in evaluating student’s performance

Since each university has a unique set of computer/network policies and support capabilities, there is no readymade recommendation that fits every school’s needs. Key IT issues in selecting a system are as follows.

1. Technical supports available on campus: IT groups are typically comfortable with either Microsoft or Unix/Linux technologies. Successful deployment of a system often depends on the availability of technical support.
2. Budget: A total cost for deploying a system includes hardware, software licenses, and ongoing support efforts.
3. User Account Management: It is easier for both students and a system administrator to use/manage tools that are accessible by a single account. If a project involves external users, such as sponsor mentors, allowing them to access the system might be an issue.
4. Back Up and Availability: Once students start using the system, it must be available until the end of a semester and the information must be protected via backed ups.

Our experience with these issues in setting up our first bulletin board based collaboration system was reported in the 2008 ASEE Zone 1 Conference. The following sections will describe some of these issues addressed in the migration process.

Redmine in the Design Lab at Rensselaer

The bulletin board system allowed students to learn and practice electronic record keeping, ongoing design review, and revision control. However, it did not provide any project management functions. Therefore, we looked for another system that also provides project management related functions.

Our first installation of Redmine (version 0.8.x in the summer of 2009) was used for our initial prototyping and experimentation. The Redmine package is extremely powerful and very configurable. As a result, it took a yearlong pilot project to find the best way for setting up the system to meet our needs. Some of these decisions resulted in specific Redmine configuration while other settings were addressed by establishing conventions for system usage.
Basic Workflow Settings and Security Policies

Our operation of Redmine is intended to serve as the project's design notebook, in a manner similar to traditional paper log books. The students record design documentation in the 'issues’ and ‘forums’. Our security settings allow the students to use most of the capabilities except for deleting material - just as one typically would not erase or delete material from a paper design notebook. This is supported for software, CAD files and other documentation by using Subversion or a similar change control tool. While students can mark things as deleted in the repository, the change control software does not actually delete things. Material can be readily retrieved whether accidentally or intentionally marked for deletion. By maintaining the integrity of the design data students learn the importance of complete and accurate record keeping.

Features Enabled for Users

Redmine's security model also supports the concept of 'roles' and 'responsibilities'. Each defined role has an associated set of responsibilities for each project. These responsibilities translate to the workflow and security settings of Redmine. For our students, we have created the role of 'Team Member'. Team Members can add or edit wiki pages, create and update issues, add threads in the forums and reply to the posts of their team mates and can work with the files in the change control repository.

To acknowledge and help identify our sponsors, they are assigned the role of 'Sponsor'. Our faculty participate in the program as evaluators with the role of 'Chief Engineer' while our staff members who provide the day to day project management are assigned the 'Project Engineer' role. For our purposes, these roles have very similar security settings with slightly more control going to the Project Engineers. Our Project Engineers have the additional capabilities necessary for managing their projects such as configuring and maintaining the project's wiki and other Redmine details.

Features Enabled for Administrators

A number of features and functions are reserved for our system administrators. These include the typical security and system wide configuration management utilities and the ability to add and delete projects.

Our approach is to create a separate project in Redmine for each student team. This allows for the segregation of intellectual property and a coherent organization of project information. For projects that continue across multiple semesters, students continue to work within the same project space. This allows the teams to access the design artifacts left by the previous teams.

Each project has a dedicated repository managed by the change control software (Subversion). Within each project we create a standard set of forums (bulletin boards) for the student to collaborate. Our identification and usage of the boards has evolved over the years and includes our experiences prior to utilizing Redmine. The boards are currently named for the course deliverables our students are expected to produce. They are Background Information, Project Management, Statement of Work, Design, Midterm, and Final Deliverables.
A degree of automation has been developed to facilitate the creation of the projects at the start of each semester, the addition and assignment of students to the projects and, at semester’s end, the removal of each students ‘active status’. This was done by creating our own Redmine plugin.

Results

In this section, we shall share some best practices and observations from our application of the Redmine package. It is the authors' hope that these will be helpful to those looking to implement their own collaboration systems using Redmine or similar tools.

Using a Virtual Machine

We recommend taking advantage of Virtual Machine technology to allow for experimentation prior to a production installation. Using the VirtualBox technology provided by Oracle allows one to create a virtual machine, install the operating system and then take a ‘snapshot’. The user may then add more software and configuration data and if that iteration is deemed incorrect, the system can be reverted back to that snapshot and the process repeated as needed until a suitable implementation is found. Moreover, this approach allows us to quickly recover the system in case of a server hardware failure.

We also suggest that Virtual Machines be used when upgrading. To ensure the safety of each upgrade, our approach has been to create a virtual machine with the same version of operating system as our production machine. By then installing the running version of Redmine, a copy of our production database and a small set of uploaded files one can create a mini-clone of the production system. A snapshot of the virtual machine in this state can be used to ‘roll back’ the changes if needed or to allow the upgrade to be repeated for practice. When testing a new version, one must be sure to verify both Redmine itself as well as all plug-ins currently in use.

Issues and Project Management

We observed that teams making use of the Redmine Issues functionality are better organized and yield a stronger team output. Based on our project management experience, we coach our students to put in a meaningful set of issues with reasonable start and end dates and to ensure that each issue has an owner. This allows the team to use the automatically generated Gantt Chart to track their project's progress and to make progress reports to the faculty advisors.

By adjusting the configured workflow or by establishing a simple set of conventions, it can be enforced that the owner of an issue is not allowed or able to close it - that either the Project Engineer or a designated team member must confirm that the issue is actually complete before it is closed. This reduces ‘issues churn’ where minimally useful issues are opened and closed so that a team ‘looks busy’. Validating the issue's actual completeness also provides a level of quality assurance.

Wikis

Wikis can be used for a variety of academic purposes. We have found that two general uses are most helpful in our program. Because all team members can make edits to wiki pages, it can be
useful for collaboratively writing reports. A drawback to this is the challenge of obtaining the desired formatting within the wiki. A plug-in called ‘DocPu’ is available for document publishing from one or more wiki pages, apply formatting commands and product one of multiple outputs.

The second usage, and most common usage in our program, is for ‘how-to’ or knowledge base creation. As all team members are able to modify the pages, students are encouraged to add information as they discover it. A wiki page containing development or documentation standards helps the entire team utilize a common approach. While the technology of a project may be familiar to the students, the application domain may not be. A project glossary of terms and abbreviations help the team with the commonly used ‘lingo’.

Forums

The students have been very successful using the forums for both technical discussions and design reviews. Students are able to collaborate with faculty staff and sponsors following the industry model of multiple contributors who access the discussions from multiple locations and at various times.

The forums are represented in Redmine in a typical bulletin board fashion using the 'threads' model. This maintains the integrity of a discussion by interweaving posts from each participant it can make it harder to know where to find information. The wiki can provide a solution for this by having students create a cross reference or index to the forum postings in the wiki. This is, unfortunately a manual process.

Version Control - Repository and SVN

Subversion was selected as the tool for change management. Although Subversion can be a standalone tool, students can use their Redmine account to access it and monitor activates using the Repository tool. Each project in Redmine has a separate Subversion repository automatically created by Redmine when the project is first defined. Figure 1 shows a sample repository structure that meets the multidisciplinary needs of our projects. The Tags folder would include a copy of the working folder made at the end of each semester as a snapshot of the project as left by each project team.

Maintaining separate repositories allows us to secure and isolate the intellectual property of each sponsor. This also eliminates having one team accidentally or intentionally modifying the repository of another project team.

Inventory Management Support

As part of our continuous improvement efforts, we periodically review the available plugins for Redmine. Prior to the Fall 2011 semester, we added the ‘Booty Bay’ plugin that allows us to manage our loaner equipment and textbook library. Each record consists of the name and description of an item and the current holder. We also created ‘phantom’ users bearing descriptive location names, such as 'Storage.Cabinet.2', so that it can be used to indicate the item's location when it is not borrowed.
By replacing our previous paper based sign-out log with ‘Booty Bay’, students are able to locate any books/equipments they need. Using the recorded user names and email addresses, an academic advisor can quickly collect these items back to the Lab and may facilitate sharing/scheduling books/equipments as needed. These records have proven to be extremely effective as all items borrowed during the Fall 2011 semester were returned by the borrower.

**Monitoring Project Progress**

Based on the authors' many years working with or within industry, the value of using the Redmine Issues and Gantt charting feature has been clear from the start. Information gathered for creating and updating Gantt Charts is automatically gathered as Issues are updated. We have found it necessary to clarify to students that Redmine's terminology is not identical to those traditionally used in project management as seen in Table 1. Students are better able to benefit from the tools once they have a clear understanding of the traditional terms and methods and how these are represented by Redmine.

![Figure 1 Sample Subversion Folder Structure](image)

<table>
<thead>
<tr>
<th>Traditional Terms</th>
<th>Redmine Terms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tasks</td>
<td>Issues</td>
</tr>
<tr>
<td>Milestones</td>
<td>Versions</td>
</tr>
</tbody>
</table>

To ensure that demonstrable progress is being made, we coach our students to include mention of the work completed when the percent complete number is adjusted. Such a note may include a link to a forum posting, a link to a wiki page that has been updated or a link to a revision in Subversion where the issue has been addressed. As part of quality control feedback, the percent completed may be reduced if a team member or coach does not agree as to the effectiveness of the previous update. This may lead to improved or repeated testing, additional analysis or other appropriate work.

We have built a small number of standard queries to help teams manage their issue lists. Typically, issues not having a responsible owner do not see much progress. As a result, we have
created a search for issues without an assigned owner. To help students cut through a long list of issues, another query selects those issues assigned to 'me', thus providing the student with their personal to-do list. Redmine includes two charts related to issues - one to show how the quantity of issues is changing over time and another that indicates how long issues are remaining open. The first graph typically shows a slow rise in the number of issues as the students 'ramp up' in the project. As the students come to understand the problem and generate solution concepts, the number of issues will rise. A plateau may occur as the students become involved in bringing their concepts into practice. When the students have selected a concept to follow, the number of issues will steadily rise again as they record and resolve implementation problems and refinements.

We have found that students and coaches can better track progress when well defined milestones, or 'versions' as they are called in Redmine, are used in the project plan. When new issues are created, they may be tied to a version. Redmine can then list the issues that must be achieved to reach a version, providing a 'to-do' list for the team. Issues may be prioritized and, as needed, reassigned from one version to another. This overall list of the versions and their related issues provides the team with a project road map. Our experience confirms that teams who pay appropriate attention to this project management yield stronger project outcomes.

While the typical industry practice is to use Gantt charts to visualize project schedules, student may be more comfortable with a calendar based view. Redmine makes this alternate view readily available. By simply viewing the calendar, students can see which issues are currently active.

Redmine offers an additional variation on standard project management by making a ‘Roadmap’ available. Here one can see the Versions (milestones) that have been identified for the project as well as a list of the issues needed to accomplish each Version. Issues that have been completed are marked by a line drawn through them much as one would strike out completed items on paper. When a system is divided into subsystems, a version can be used to manage a subsystem development also.

**Monitoring Student Progress**

One of our initial criteria for selecting Redmine was the ability to monitor and observe student usage, participation and progress. Redmine has been very helpful in accomplishing this through our use of its built-in capabilities and our creation of a supporting plug-in.

Redmine includes the ability to display the last date that a user signed into the system. In a typical semester, students would be expected to use the system every day or two. Students who have not recently accessed the system can be encouraged to increase their online participation, both for a technical contribution and as part of the course communications requirements.

Redmine facilitates reviewing activity by a user. Faculty and staff can quickly evaluate both the timing and substance of the activity. The system can display all activity or only specific types, such as wiki edits or issue related updates. We point out to the students these features are also available to their team mates, suggesting that activity or inactivity are both visible throughout the team, not just to the project coaches.

When evaluating these contributions, we look for timeliness of replies and origination of new
material by the student. The system has proved effective for student coaching by reminding students that signs of continuous participation would include their posting of original content as well as thoughtful analysis and feedback on the contributions of others. It is important that monitoring of postings not simply be a numbers game. The content and regularity of postings are more important than sheer volume.

Overall volume of postings is, however, loosely related to a project's overall activity level. While a high number posts by a student is not a singular indicator of success, a low number of posts generally is an indicator of a problem. Using a plug-in developed by our Lab, we can extract activity counts by activity type for all of the students in the program. Those with substantially lower activity levels can be reminded of the importance being actively involved in their project. This coaching opportunity itself affords the opportunity to have one-on-one involvement which may be more important for some students.

Conclusions

The authors’ experience working outside the traditional academic settings has clarified the importance of utilizing collaboration tools for our project based capstone program. By following the design process, we gathered our requirements, benchmarked the available packages and selected an appropriate solution. Through experimentation we identified configuration settings and operational procedures that would allow us to provide a solid academic experience for our students while minimizing the support needed to keep the system operational.

Our use of Redmine has proven to be very productive and powerful for both students and academic advisors. Moreover, this experience helps students transition to the business world after graduation. Our students who are continuing their studies learn the importance of collaboration and gain exposure to the tools that can facilitate this.

Bibliography

Teaching decision problem formulating and solving skills using spreadsheets
R. John Milne
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Abstract

This paper describes a variety of communication media and tactics used in teaching Engineering and Management students to formulate and solve management decision problems using spreadsheets. Many of these problems are framed as optimization models—where students specify decision variables and objectives and constraints as a function of these decision variables. Other problems are solved with simulation models in which some spreadsheet input cells have probability distribution functions and consequently key output cells are described and interpreted statistically. The conceptual modeling/formulation of optimization and simulation decision models is done primarily via thinking and handwritten notes. The data and variable relationships are input by students into an Excel spreadsheet where canned solvers are used as computer subroutines according to parameters set by the students. The author (instructor) uses a variety of communication media (Excel, writing notes on the board, talking, PowerPoint, video) in facilitating students learning to formulate and solve decision problems. The core of this paper explains when to use each media—blending active and passive learning depending upon the item being learned and the context. The principles apply to instruction when software is used to implement problem solving concepts and to other learning contexts where software is integrated with offline learning. Practical considerations are discussed such as how the author deals with different software versions and monitor/font sizes varying among student laptops, his office computer, and the computers used in the teaching lab. The paper concludes with a remaining challenge for which the author has not yet found a good approach.

Introduction

During their junior or senior year, Clarkson University students majoring in Engineering and Management take a course in operations research. In this course, students learn to formulate and solve management decision problems using Microsoft-Excel spreadsheets. Many of these problems are framed and solved as optimization models. In an optimization model, decision possibilities are expressed as variables, and objectives and constraints (equations) are expressed as a function of these decision variables. For example, an investment problem may involve decisions on which stocks to select to maximize total return subject to constraints ensuring that downside risk is limited. In another example, the decisions may be where to insert radiation needles to destroy cancerous cells while minimizing the number of healthy cells destroyed. Other decision problems are analyzed with simulation models in which some spreadsheet input cells have probability distribution functions and consequently key output cells are described and interpreted statistically. For example, given probability distributions of customer arrival rates and service times, simulation models can be used to calculate statistics such as average customer waiting time and the probability that a customer waits more than a specified number of minutes. The primary course objective (as reflected in homework and exam problems) is for the students to be able to take a word description of a decision problem, formulate a mathematical description of the problem in spreadsheet (Excel) format, set the appropriate parameters for solving the problem, and apply canned software (Risk Solver Platform for Education) to solve the problem.
To facilitate the attainment of this course objective, the author (instructor) uses a variety of communication media (writing notes on the board, spreadsheets, PowerPoint slides, and video). The remainder of this paper is organized by communication media and how and when the instructor uses each communication media. In addition to using the best media for a given learning context, by using multiple media in a given class session, student boredom is reduced and different student learning styles are accommodated.

Classroom Communication Media

Writing on the Board

I write on the board most core concepts that the students need to know. Note taking ensures the information enters the students’ brains and “we write on the board at about the same speed with which we comprehend information.”

A key aspect of decision modeling is framing the problem. After introducing a problem, I may ask the students what additional information they need to know to formulate the model, or I may ask them questions like, “What are the constraints?” Writing on the board facilitates these interactions since I can write the students’ answers (sometimes “tweaked” by me) onto the board in any sequence they respond.

Another reason for writing on the board is that I can refer to these notes later during the process of entering the decision model into the spreadsheet. It is possible to do the same with slides but difficult because of only a single projector screen.

Sometimes using the spreadsheet graphical user interface (GUI) is straightforward. Other times the student must execute a series of non-obvious steps in order to accomplish a single task. Writing notes on the board is helpful for these situations. For instance, I may write on the board the following steps to conduct a (single) sensitivity analysis immediately prior to using the spreadsheet GUI:

**Parametric Sensitivity Analysis**
1. Click New Cell to vary Parameter
3. Link Old Cell to Varying Cell
4. Click on Output Cell

Although the students enter their model into spreadsheets, often the problems are too difficult for them to proceed from word problem statement to spreadsheet model without writing anything down. In these cases, it is better for them to write out their solution on paper. Suppose, for instance, they are asked to add a constraint which models the situation that chairs must comprise at least 10% of the total production of chairs, desks, and tables. I would ask them to try modeling the constraint on their own. Many of them would just stare at their spreadsheets. After
a couple minutes, I would write on the board the following steps and pause after writing each step to ask a student to suggest how the step applies to the example.

Process for Modeling Challenging Constraints
Step 1. Write constraint on paper in your own words.
   e.g. chairs must be at least 10% of total production
Step 2. Alter your word description to contain decision variables
   e.g. C / (C + D + T) >= 10%
Step 3. Convert into a linear form.
   e.g. C >= 0.1 (C + D + T)
   e.g. 0.9 C - 0.1 D - 0.1 T >= 0
Step 5. Enter the constraint into your spreadsheet.
Step 6. Generalize the constraint to be parameter driven
   e.g. (1 - %) C - % D - % T >= 0

By writing these steps on the board (on their paper), the students develop the habit of executing multiple steps on paper which is easier than trying to do one multi-step process in their heads.

Modeling formulation skills can be developed through a series of building block exercises. As an example building block, I may write on the board the following question and give the students a few minutes to work out the answer on their own before we discuss together as a class:

Question: a port can load either 10 shiploads of [type] X or 15 units of [type] Y or 20 units of [type] Z each week. What combinations of X, Y, and Z can be loaded in 12 weeks?
Answer: (1/10) X + (1/15) Y + (1/20) Z <= 12

Spreadsheets

Over half the time of most classes, the students are using spreadsheets. Sometimes the students learn by watching me play the decision modeler role while they type along in their own spreadsheets. At other times, the students are given time in class to work on the problems on their own after we first discuss them; every few minutes, I will interrupt their exercises to do the next couple steps myself before they continue again on their own. A key aspect is to ensure that the spreadsheet models are well organized and properly documented and highlighted.

Sometimes there are multiple ways to accomplish a task in Excel. Typically, I will begin showing them the most intuitive way to do something (based on the GUI) even if it involves more clicks and takes longer to do and only later show them the less intuitive short cuts. Occasionally, I will make mistakes on purpose since students need to know how to identify and recover from such mistakes.

Spreadsheets are posted on moodle from where students can download them. Before class, I will post spreadsheets that students can use in class to reduce their typing (e.g. data already loaded or model partially built). Sometimes these pre-loaded spreadsheets will contain “poor choices” for
the parameter settings so that students get in the habit of reviewing and adjusting the parameter settings. After class, I post the spreadsheets we developed in class with post-class annotations inserted as comments to highlight aspects of how we developed the model or observations we noted vocally in class.

Although the Risk Solver software should perform the same under different software versions, in practice different versions of Excel (2007 vs 2010) and different operating systems (32 vs 64 bit) yield different results on occasion. Consequently, it is important for the instructor to use the same software and operating system in class which is used by the majority of the students. Ideally, the instructor will test the classroom exercises on all common software platforms prior to entering the classroom. More commonly, when students encounter failures using different software platforms, I will test the exercises myself on that platform to see if there are types of exercises which should be avoided in future class sessions.

I adjust the font size of each worksheet used in class. Typically, I prefer 130% magnification (for easy viewing from the back of the classroom), but if that setting does not show enough of the screen content for a particular worksheet, I may zoom to only 120% or even smaller magnification. It is helpful to practice/rehearse with these font sizes and simulate a smaller monitor size on my personal computer (outside the classroom) so that the experience matches closely with what I will be showing the students in class.

**Slides**

PowerPoint slides are used less often than spreadsheets and writing on the board. Slides are good for showing graphics (e.g. to visualize the hill climbing algorithm), for items which the students need to be able to reference (but not really learn/memorize), and to convey the gist of some ideas without the students mastering the details. Before an exam, I will use slides to review material the students should have learned earlier but may have temporarily forgotten. (Also I insert some new material into these review sessions and sometimes review the prior material from a different angle or using additional words). Slides are good for covering material quickly. Powell and Felder suggest that the active learning methods of developing spreadsheet models or at least taking written notes is preferred for most learning activities in this type of course. Nevertheless, I try to show at least a few slides every other class session so that the resulting variety of media stimulates student interest.

**Videos**

Videos are great for showing moving items (e.g. showing a graphical simulation of an automated warehouse). They are good for showing testimonials of executives boasting of the specific value of the operations research methods the students are learning. Finally, videos are good for showing practicing operations research engineers describing their best work.

**Conclusion and Remaining Challenge**

This paper summarizes communication media and tactics used in educating students to model and solve decision problems using spreadsheets.
A decision model will work only if it is completely correct. If any spreadsheet cell or parameter setting is incorrect, the student will get different results than his classmates and sometimes no usable results at all. This challenge is exacerbated by varying levels of spreadsheet competence among the students. A student who has developed spreadsheets during a co-op assignment tends to be considerably faster at spreadsheet typing and navigation than a student who has rarely (and for some students never) used spreadsheets prior to the course. The challenge is controlling the speed of the course delivery so that the slower students can keep up without boring the faster students. When the faster students get bored, they may daydream or multi-task and thus miss a step which results in their models failing as well. When I act as a role model developing a spreadsheet in class, I try to proceed at a pace which can be comprehended by about 90% of the students. Is there a better way to address this challenge of accommodating different student capabilities while retaining the advantages of an interactive instructor-facilitated learning experience?

Bibliography

Abstract
Reducing the environmental impact of civil aircraft involves a number of problems that require a careful balancing of a number of often-conflicting considerations. The field is therefore one that can be used to expose engineering students to complex real-world environmental problems that involve making difficult decisions in arriving at an acceptable solution. In this paper such a course that is intended to introduce students from all engineering disciplines to multi-faceted environmental problems is described. This course involves student discussions and student reports and examples of the type of topics that are considered for these purposes are described.

Introduction

In the delivery of engineering programs environmental problems are often treated too simplistically. In reality the solutions to such problems frequently involve choosing between options that all have their own unique advantages, drawbacks, and limitations and involve dealing with complex and often contradictory ethical considerations. It seems important, therefore, to expose engineering students to complex real-world environmental problems which involve making difficult decisions about which solution to adopt. The environmental problems that are associated with civil aviation are almost all of a complex nature whose solution involves complex and difficult choices. The study of the environmental impact of civil aviation and of the reduction of this impact appears to be a good way of introducing students to the complexities of many real-world environmental problems. It is the development of such a course that is the topic of this paper. The course is not intended just for students in Aerospace Engineering programs but is rather intended to provide students in any engineering program with an introduction to the complexity of the environmental problems that an engineer may face.

Civil aviation, while not a major contributor to the world’s environmental problems, is taking steps to reduce its environmental impact\(^1\). The industry is also dealing with limitations based on environmental considerations imposed by various governmental organizations. The major environmental effects of civil aviation are related mainly to:

1. The generation of noise particularly near airports: The type of noise produced by an aircraft can be aerodynamic noise arising from the flow over and near the aircraft or noise arising from the engines and other mechanical devices. Both the noise level produced and the distribution of the noise over the ground (the noise footprint) are important considerations.\(^5\)

2. Local air and ground pollution around and downwind of airports: Such pollution arises mainly as the result of emissions from aircraft during take-off and landing and while taxiing, emissions from private automobiles, taxis, limousines, buses, etc. arriving at or leaving the airport or parked with engines running on airport property, trucks delivering cargo, mail, etc. to the airport, airport service vehicles of various types, emissions from
aircraft Auxiliary Power Units (APU’s), maintenance and construction operations, and aircraft de-icing operations.

3. Effect of engine emissions during cruise: During flight, aircraft engines emit carbon dioxide, oxides of nitrogen, oxides of sulphur, water vapor, hydrocarbons and particles which consist mainly of sulphate from sulphur oxides, and soot. These emissions alter the chemical composition of the atmosphere in a variety of ways, both directly and indirectly. The unique feature of the emissions during flight is that the majority of them occur far above the earth’s surface. Subsonic aircraft generally cruise at an altitude in the range of 9 to 13 km, i.e., close to the tropopause, the sharp transition between the troposphere and the stratosphere. The troposphere is the region in which the turbulent motions and precipitation related to weather occur. In contrast the stratosphere is relatively stable and the vertical motions in it are generally sufficiently small compared with the horizontal motions with the result that the air travels almost horizontally in this atmospheric layer.

4. The effect of contrails (condensation trails): Contrails are line-shaped clouds sometimes produced by aircraft engine exhausts typically at aircraft cruise altitudes. The combination of water vapor in the aircraft engine exhaust and the low ambient temperatures that exists at these high altitudes allows the formation of contrails. Contrails are composed primarily of water (in the form of ice crystals) and do not, in themselves, pose health risks to humans. They do, however, affect the cloudiness of the earth’s atmosphere and therefore might affect atmospheric temperature and climate. Depending on the temperature and the amount of moisture in the air at the aircraft altitude, contrails may evaporate relatively quickly (if the humidity is low) or they may persist and grow (if the humidity is high). The jet engine exhaust provides only a small portion of the water that forms ice in persistent contrails but it does provide the particles on which the precipitation occurs. Persistent contrails are mainly composed of water naturally present along the aircraft flight path.

The first two of these environmental effects, i.e., noise and regional air pollution, have been subject to regulation for about three decades. Concern about the impact of aviation on climate change is more recent and, as yet, no complete framework for its regulation has been agreed upon. However, climate change is considered by most to be the more serious long-term challenge of the four environmental impact areas mentioned.

Many papers concerned with various aspects of the teaching of environmental engineering and of the use of the study of environmental engineering to expose students to other more general aspects of engineering are available. These papers are typical of those in this area and are given here purely as examples of papers in what is now quite a well-visited field. However, none of the available papers appears to deal with the use of studies of the environmental impact of civil aviation.

Course Content and Organization

A course entitled **Environmental Effects of Civil Aviation** has recently been developed. This course mainly consists of sections on: (i) an introduction to the subject, (ii) some background information, (iii) aircraft noise, (iv) local and regional environmental effects, (v) impact of civil aviation on global warming, (vi) aircraft contrails, (vii) design of civil aircraft for the future,
(viii) engine design changes to reduce environmental impact, (ix) reducing environment effects of civil aircraft by changes in operational and traffic management procedures.\textsuperscript{11}

The course in its initial implementation has consisted of fairly conventional lectures and relatively free format classroom discussions of specific topics. The evaluation of student performance is based on assignments on specific basic subjects, on several small projects where the students are given a particular topic and have to write a three to four page report on the topic, and two major projects where the students are given a broad, multi-faceted subject and must produce a report in which all aspects of the topic are discussed and the conflicting aspects of solutions to the problem are considered.

**Typical Problem Areas Considered**

In the classroom discussions, in the shorter reports, and in the longer reports the topics considered involve conflicting considerations that come into play when deciding on a solution or combination of solutions to adopt. A brief discussion of some typical problem areas considered in these activities is given below. The first two of these areas are discussed in more detail in order to give a better idea of the type of considerations that enter into the discussions and reports.

**Best Fuel Use Range:** It can be shown using a fairly basic analysis that for a given basic design of an aircraft there is a range that gives the lowest fuel consumption per passenger mile flown. A typical variation of fuel use with range that illustrates this point is shown in Fig. 1. Therefore, in order to reduce the fuel burn and therefore to reduce the emissions produced on long distance flights it has been suggested that aircraft should break long distance flights into a series of shorter flights, the aircraft being refueled at each intermediate stop. However, this procedure does have drawbacks, among these being:

1. The intermediate stops can add appreciably to the overall flight time and lead to passenger dissatisfaction.
2. The costs associated with the airport use for the intermediate stops can be appreciable adding significantly to the total cost of the flight.
3. The local noise and atmospheric pollution associated with landing and take-off from the intermediate stops and with the vehicles associated with the refueling of the aircraft can be quite significant. Also depending on the time of year of the flight and the flight route it may be necessary to de-ice the aircraft at the intermediate stops which can have its own environmental consequences.
4. Depending on the flight destination the intermediate stops may have to be at airports that are not on the direct flight route which means that the overall distance flown is greater than flown on a direct non-stop flight which adds to the actual fuel burnt.
All of these considerations must be taken into account when deciding whether or not it is wise to break the flight down into a series of shorter flights. Several methods for accomplishing the reduced fuel use associated with breaking the flight into a series of shorter flight have been suggested without actually landing and taking off at a series of intermediate stops have been suggested. Perhaps the most widely discussed of these suggestions is that of using air-to-air refueling\textsuperscript{12, 13}. This would involve having a tanker aircraft meet the aircraft at or near cruise altitude and in order to transfer fuel to the airliner thus avoiding the necessity for it to land and take-off. Safety concerns are usually advanced as the reason not to implement this approach but the fuel usage associated with the tanker aircraft taking-off, climbing to near cruise altitude as well as the regional pollution associated with the use of the tanker have also to be taken into account.

**Improving Engine Efficiency:** Reducing the production of CO2 by aircraft can be accomplished by improving the efficiency of the engines which reduces the amount of fuel burned during cruise. The most direct way of improving the efficiency of an aircraft engine is to use higher pressures and maximum temperatures in the engine. Unfortunately, the use of these higher pressures and temperatures will usually increase the amount of NOX produced by the engine. All too often in the past the environmental effects of NOX production have been downplayed and the emphasis has been on reducing CO2 production. However, NOX formation in aircraft engines at cruise altitudes is now seen by many as area of increased concern possibly having environmental consequences that are greater than those associated with CO2 production. A number of possible means of producing an increase in engine efficiency without increasing the NOX production substantially have been proposed. For example, studies of a double annular engine configuration to deliver staged combustion, which accommodates the conflicting requirements of both high power and low power operation by using two separate combustors, have been undertaken. However, the extra cooling air required by this system and need to make other compromises have meant that the theoretical benefits of the system have not been fully realized in practice. Other approaches are possible and the relative advantages of these systems
taking into account the environmental effects of CO2 and NOX production need to be considered.

**De-icing:** Conventional deicing in which the aircraft is sprayed with the deicing liquid is carried out for safety reasons. However, the liquid used can have environmental consequences such as contaminating ground water flows. Other deicing methods have been considered but all have both advantages and disadvantages. Further discussion of the balancing of safety considerations and environmental effects needs to take place.

**Aircraft Design:** The design of aircraft that have lower drag than conventional aircraft and which therefore reduce fuel usage and therefore reduce environmental effects has received much attention. The design that has received the most attention is the so-called blended wing-body (BWB) design. The design concept evolved from earlier flying-wing and delta-wing aircraft designs and basically involves a combination of a moderately swept outer wing, similar to that on present day commercial aircraft design, with a central wing cum fuselage capable of housing a large number of passengers, typically in two decks with 24 or 26 abreast seated at the widest part of the cabin. While the design does produce a drag reduction, the passenger reaction to the very wide rows of seats and the difficulty of handling the boarding and de-boarding of passengers are problems of considerable concern. Further investigation needs to be undertaken of aircraft designs that reduce the drag on the aircraft while being more passenger friendly.

A number of other problems that arise in trying to reduce the environmental effects of civil aircraft are suitable as topics for discussions and student reports.

**Conclusions**

Experience with the delivery of a course on the Environmental Impact of Civil Aviation indicates that it is a suitable topic for introducing engineering students to the complexities of many environmental problems. The civil aviation field provides a number of areas that illustrate such complexities. Such areas that can be used in classroom discussions and as topics for student reports have been considered.

Among the main educational outcomes arising from the course are:

1. The student is more aware of the ways in which civil aviation impacts the environment and of the difficulties encountered in attempting to predict the magnitude of some of these impacts.

2. The student has an increased awareness of the complex and often conflicting nature of some of the proposals for reducing the environmental impact of complex engineering systems.

3. The student has an increased awareness of the complex and often conflicting engineering and non-engineering aspects of many environmental problems.

4. The student is more aware of the complex and often contradictory ethical aspects involved in dealing with the environmental impacts of complex engineering systems.
Bibliography

Using ABET Outcomes to Assess Information Literacy in Mechanical Engineering: Early Results and Applications for other Programs

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United States Coast Guard Academy, New London, CT

Abstract:

Technological advancement has led to significant changes in how information is collected, synthesized and disseminated. It is essential that educators help undergraduate engineering students develop and improve their informational literacy skills in the context of the current and emerging information infrastructure. Although information literacy is not specifically mentioned in the ABET outcomes, the development of these skills is essential to the achievement of several outcomes. Mechanical Engineering and Civil Engineering faculty at the United States Coast Guard Academy (USCGA) have been working together to develop performance indicators and assessment tools under existing ABET outcomes designed to develop and improve student information literacy skills. The link to ABET-student outcomes (g, i, and j) enables students to see the connection between information literacy and their ability to communicate, to engage in lifelong learning, and their knowledge of contemporary issues. The authors discuss steps taken at the USCGA to evaluate aspects of information literacy within the current assessment process in the Department of Mechanical Engineering. The progressive infusion of information literacy skills in the curriculum, the development of relevant performance indicators, and steps taken to collect and analyze this assessment data are presented. Analysis of student performance to date based on assessment rubrics is also presented.

Introduction

According to the Final Report of the American Library Association Presidential Committee on Information Literacy\(^1\), Information Literacy (IL) is defined as “an individual’s ability to know when there is a need for information, to be able to identify, locate, synthesize, evaluate, and effectively use that information for the issue or problem at hand.” IL knowledge and skill have been identified as critical components to gathering and using information. For the past decade, librarians have aggregated large amounts of research on the topic of IL and made it readily accessible online\(^2\). However, engineers, as a whole, lag behind librarians in regards to the knowledge and skills related to IL. With the tremendous amount of information available at the click of a mouse in today’s electronic age, knowing how to find, organize, and evaluate this information is the challenge\(^3\). Engineering students must be encouraged to develop the skill required to evaluate the credibility and validity of this information, for proper use in technical reports or presentations. It has been challenging for most engineering faculty to find a place to infuse and integrate IL into an already demanding curricula\(^4\). However, engineering faculty need to address this topic of IL in order to meet ABET-student outcomes especially those related to communication and life-long learning. Research has shown that IL is most successful when it is associated with an existing assignment within a course\(^3\). It is with this in mind that the authors embarked on this assessment process. This paper outlines the recent steps taken by the Mechanical Engineering (ME) department at the United States Coast Guard Academy (USCGA) to infuse IL into the existing curriculum and presents the preliminary results.
Overview of Assessment Process

The curricular ABET outcomes for the ME department are generic to the four engineering majors at the United States Coast Guard Academy and correspond to ABET-student outcomes a-k. In years past, the ME faculty embarked on the use of Barometric Assignments (BAs) as a means to assess student outcomes (Appendix A shows the process). The relevant BAs used to assess the outcomes related to IL are listed in Table 1. These BAs were selected “near the end” of the program of study and therefore each BA focused on a single outcome. The Outcome Achievement Levels (OALs) are deliberately considered to be summaries of the effectiveness of the program as a whole (and not as a report card for the effectiveness of a single course in which the BA is used).

Table 1: Mechanical Engineering Program Barometric Assignments

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Course, Barometric Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>g: an ability to communicate effectively</td>
<td>Mechanical Engineering Design, Final Presentation Documentation (video, evaluation and report)</td>
</tr>
<tr>
<td>i: a recognition of the need for, and an ability to engage in life-long learning</td>
<td>Mechanical Engineering Design, Extensions and Applications Report</td>
</tr>
<tr>
<td>j: a knowledge of contemporary issues</td>
<td>Mechanisms, Paper on Contemporary Mechanism Design</td>
</tr>
</tbody>
</table>

A full set of BA’s was collected for analysis by Spring 2008. Results relevant for this discussion are listed in Table 2. The desired achievement threshold was set by faculty at 100%, so an outcome in which student achievement was less than 100% is considered as not having attained.

Table 2: Summary of 2008 ME Program Outcome Assessment Results

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Percent of Students Meeting Outcome Achievement Threshold</th>
<th>100% Outcome Attainment?</th>
</tr>
</thead>
<tbody>
<tr>
<td>g: an ability to communicate effectively</td>
<td>100%</td>
<td>YES</td>
</tr>
<tr>
<td>i: a recognition of the need for, and an ability to engage in life-long learning</td>
<td>95%</td>
<td>NO</td>
</tr>
<tr>
<td>j: a knowledge of contemporary issues</td>
<td>95%</td>
<td>NO</td>
</tr>
</tbody>
</table>

After executing the BA process for one Academic Year, the faculty began to notice significant drawbacks to using such a system for outcome achievement assessment. The most significant of these is that the BAs are selected from among existing assignments, and therefore are limited in scope to the existing content of the program’s courses. The problem here is that this existing content is necessarily restricted by the program's limitations (facilities, budget, personnel, etc). Hence, the BAs do NOT measure student achievement relative to what the students "should" be learning, but rather only relative to what they "are" being taught. Furthermore, the BA data itself cannot be applied to answer questions such as "what new courses should the program offer?" or "What specialty should our next faculty member bring to the program?" Also, using BAs as a sole assessment tool does not easily allow the use of
"triangulation" (cross-checking internal results with those of outside assessors) to validate its results.

The faculty concluded that the assessment process based on BAs was in need of improvement before it could be used to provide meaningful data for program improvement. To this end, the ME faculty decided to migrate the program's outcome assessment system to a "rubric-based" assessment system as modeled at ABET's IDEAL training institute. In 2008 the ME faculty embarked on a five-year schedule for developing rubrics and implementing the modified assessment system. During the development of the three student outcomes under consideration herein, the ME faculty noted that the USCGA Civil Engineering (CE) program evaluation provided a model from which ME could launch its own assessment.

Program Outcomes and Information Literacy

Following the lead of the CE department at USCGA, the ME faculty observed that IL was not specifically addressed in the current curriculum. This sparked the ME faculty to reevaluate the current program outcomes and make several modifications. The process developed by the CE faculty was used to identify IL-related student outcomes, link them to current courses and develop assessment tools. This process is shown in Figure 1.

It was identified that IL was captured in the following ABET-student outcomes: g (ability to communicate effectively, i (ability to engage in life-long learning), and j (knowledge of contemporary issues.) Once this was established, performance indicators were developed to capture IL skills, knowledge, and ability. The performance indicators related to student outcomes were then mapped to current courses in the ME curriculum as shown in Table 3.

<table>
<thead>
<tr>
<th>ABET-Student Outcome</th>
<th>Related Performance Indicator</th>
<th>Courses that Contribute</th>
</tr>
</thead>
<tbody>
<tr>
<td>g: Ability to communicate effectively</td>
<td>Research information from a variety of sources, use information to make engineering decisions/judgment and produce a technically sound report.</td>
<td>Mechanics of Materials, Mechanisms, Engineering Experimentation, Mechanical Engineering Design, Design Project Management</td>
</tr>
<tr>
<td>i: Recognition for need and ability to engage in life-long learning</td>
<td>Use a variety of tools such as professional journals, books, codes, and standards as sources of industry information</td>
<td>Engineering Experimentation, Mechanisms, Machine Design, Mechanical Engineering Design, Design Project Management</td>
</tr>
<tr>
<td>j: Knowledge of contemporary issues</td>
<td>Investigate, gather and analyze information related to contemporary issues</td>
<td>Intro to Mechanical Engineering Design, Mechanisms, Thermal Systems Design, Mechanical Engineering Design, Design Project Management</td>
</tr>
</tbody>
</table>
The performance indicators developed in Table 3 were further examined and an evaluation process and plan was constructed. This included identifying which classes would be the primary source of assessment data, the assessment tools to be used, the collection cycle, the assessment coordinator, and the evaluation of results. This plan is shown in Table 4.

**Table 4. Performance Indicators Related to IL Assessment Map**

<table>
<thead>
<tr>
<th>Performance Indicators</th>
<th>Primary Source of Assessment Data</th>
<th>Assessment Tools (Instruments)</th>
<th>Data Collection Cycle</th>
<th>Assessment Coordinator</th>
<th>Evaluation of Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research information from a variety of sources, use information to make engineering</td>
<td>Machine Design</td>
<td>Research paper/source assignment (grading rubric)</td>
<td>Fall 2011, Spring 2012</td>
<td>Dr. Egelhoff</td>
<td>End of Course Review, Program Review, Department Review</td>
</tr>
<tr>
<td>decisions/judgment and produce a technically sound report</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use a variety of tools such as professional journals, books, codes and standards</td>
<td>Mechanisms, Design Project</td>
<td>Class of ’59 Paper (grading rubric), Research paper</td>
<td>Spring 2008, Fall 2011</td>
<td>LCDR Rozzi-Ochs</td>
<td>End of Course Review, Program Review, Department Review</td>
</tr>
<tr>
<td>as sources of industry information</td>
<td>Management</td>
<td>or report</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investigate, gather and analyze information related to contemporary issues</td>
<td>Mechanisms</td>
<td>Research paper or report (overall score)</td>
<td>Spring 2008, Spring 2012</td>
<td>Dr. Egelhoff</td>
<td>End of Course Review, Program Review, Department Review</td>
</tr>
</tbody>
</table>

**Assessment Tools**

As per Table 4, a variety of tools can be used to assess student performance, to include research papers, technical papers, journals, capstone project reports, laboratory reports and oral presentations. Grading criteria were developed to reflect the infusion of IL in related performance indicators. The IL components of the grading performance criteria (PC) evaluated students’ ability to: (1) write a well organized paper, (2) develop a clear and concise theme, (3) identify the type and importance of information related to theme, (4) use of technical writing skills and (5) incorporate a variety of high quality references. Once the assessment was conducted, the student performance results were divided into three categories: (1) exceeds, (2) meets, and (3) below expectations.

**Results**

Examples of student performance in two courses, Mechanisms and Machine Design, are presented in this section. In Mechanisms, a junior level spring semester course, students were required to write a paper, and they were prompted on topics of contemporary issues including
engineering failure cases. The targeted audience was specified as a “reasonably well-educated adult.” The sample size used was 18.

In Machine Design, a senior level fall semester course, students were required to write a technical research paper and were prompted to consider topics that would contribute to their senior capstone project. The objective of the paper was to research a specific component, problem, or technology related to that topic. Although each senior capstone design project consisted of four to five students, each individual student was required to submit a separate and unique paper. The sample size used was 29.

The students assessed in the Mechanisms course and Machine Design course were not the same group of students, nor was the assessment completed in chronological order. Both samples were of different student groups at different levels of education. The results of the student performance assessment, based on the IL-related components of the writing assignment, are shown in Figures 2 and 3.

![Figure 2. IL Components in Mechanisms Paper](image1)

![Figure 3. IL Components in Machine Design Paper](image2)
In both figures, “exceed” corresponds to a score of 90-100%, “meet” corresponds to a score of 70-89%, and “below” corresponds to a score less than 70%. Figure 2 shows that overall student performance well exceeded minimum (70%) expectations. The only exception is in the technical writing skill category where 10% of the students fell below the minimum (70%).

One might expect the performance in Machine Design to show performance at a higher level since it is a senior level course. Figure 3 shows us that overall student performance again met or exceeded expectations. The most striking observation is in the category of variety and quality of sources. Over 40% of the students fell below minimum (70%) in this category.

Conclusion

It is essential that educators help undergraduate engineering students develop and improve their informational literacy (IL) skills in the context of the current and emerging information infrastructure. We have described how a previous assessment process using so-called Barometric Assignments failed to indicate student skill levels with regards to IL. As a result of applying the continuous-improvement program assessment cycle, the Mechanical Engineering faculty have developed performance indicators and assessment tools under existing ABET outcomes to investigate the current state of engineering student IL skills by exploiting existing grading rubrics for classroom assignments that students are already doing. Preliminary results show that some cohorts of students are functioning at high levels of IL while other cohorts demonstrate a wide array of skills in the IL domain. This work marks a “stepping off point” for future refinement of methods to assess and improve the information literacy skills of undergraduate engineering students.

References


5. ABET, Institute for the Development of Excellence in Assessment Leadership (IDEAL), information available online at http://www.abet.org/ideal/.

Appendix A: Engineering Department Barometric Assignment Assessment Process

Each outcome is assessed in one or more courses.

Evaluate each student’s performance on one or more Barometric Assignments (BAs).

Calculate each student’s Outcome Score using student performance on Barometric Assignments (BAs).

Determine if each student’s Outcome Score exceeds the predetermined Outcome Score Threshold of 70%.

Calculate the student Outcome Achievement Level (OAL) for the course (i.e., the percentage of students with Outcome Scores above the predetermined Outcome Score Threshold).

Determine whether or not students in this course have successfully demonstrated outcome achievement (i.e., compare the Outcome Achievement Level (OAL) to the predetermined Achievement Threshold of 75%).

Information feeds into End of Course Review (EOCR) process.
CAN WE AFFORD THE WOW FACTOR?
A MECHATRONICS EXAMPLE

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Abstract
A course in Mechatronics Engineering is used to provide an example of a course with the “wow factor”. These are the courses that are oversubscribed and sustain their popularity from year to year through word of mouth. As with most “wow factor” examples, the course is hands-on and project based. A commonly held view is that the excitement and enthusiasm demonstrated by the students in such courses should be duplicated throughout an engineering curriculum. However, a decade of experience with the mechatronics course has left the instructors with one oft repeated question: “can we continue to afford such courses, given that they are expensive in terms of both time and money?” This paper reviews the offering of the course in Mechatronics and discusses the underlying resource issues and future implications.

Introduction

A recent article in ASEE Prism extolled the virtues of courses with the “wow factor”\(^1\). These are the courses that are oversubscribed and sustain their popularity from year to year through word of mouth. It’s no surprise that the majority of such courses are hands-on and project based. The ASEE Prism article wasn’t the first appearance of the phrase. For example, Simcock talked about the need to reintroduce the “wow factor” to revitalize interest in electrical engineering\(^2\). He did so through the phased introduction of industry based projects from year 1 to year 4, with projects that involved design and build. An elective course in Mechatronics Engineering at Queen’s University is put forward as an example of an elective course with the “wow factor”.

The course is laboratory-based and technology-oriented course in Mechatronics Engineering, where mechatronics is the subject that combines elements of computer, electrical and mechanical engineering. The course presentation covers all the keywords that one hears in discussions on what is needed for the next generation of engineering students. The list of keywords include: active learning, integrated learning, just in time instruction, theory versus practice, written and oral communication, multidisciplinary and interdisciplinary teams, lectures, tutorials, laboratories, workshops and design projects. It is possible to find at least one course of this nature in most engineering schools. These courses are able to promote the excitement and enthusiasm among the students in a manner that should be present in all engineering courses. However, a decade of experience with the mechatronics course has left the instructors with one common question; “Can we continue to afford such a course, given that it is so expensive in terms of both time and money?” This paper reviews the organization of the course and discusses the underlying resource issues. But a reminder will first be given of the key role that active learning plays as the underlying pedagogical concept behind all such courses.
Active Learning

Active Learning is said to be the key to truly effective education. Goff paraphrased Piaget and said “… in order for a student to understand something, she must construct it herself, she must re-invent it.” He went on to observe that students who are engaged in the learning process master the material. Students who are not engaged generally do not succeed. The best way to engage students is to create an exciting active learning environment. Active learning is a key element in the conceive, design, implement and operate approach of CDIO to engineering education. CDIO stands for Conceive Design Implement Operate, an international initiative supported by a leading universities that seeks to develop the framework for producing the next generation of engineers.

In engineering, it has long been recognized that a hands-on project-based or laboratory-based course lends itself naturally to the creation of an active learning environment, be it at the undergraduate or graduate level. Over a period of 10 years, an elective course in mechatronics engineering has been developed that is believed to provide students with a rewarding and stimulating experience in engineering problem solving, within a process of active learning. It does so through a combination of lectures, tutorials and laboratories that culminates in a team project which requires the students to assemble and program a team of robots to perform a given cooperative task.

An Approach to Mechatronics

The Queen’s approach to mechatronics is to focus on the application of electronics and microcontrollers to mechanical systems. The course is designed around a series of tasks that involve a prototyping board with a microcontroller and a mobile robot that uses the same microcontroller, as illustrated in Figure 1 and Figure 2, respectively. The “MechBOT” mobile robot has a flexible platform on which sensors, actuators and supporting electronic circuits are mounted, as illustrated in Figure 3. The chassis is a commercial R/C controlled four wheel drive ATV mobile robot. It was chosen in part due to the large deck space available to accommodate all of the sensors, actuators and supporting electronic circuits used in the course.

A series of eight laboratories is used to introduce the students to the technology, alternating between the application of the technology to the prototyping board in one week, and then the application to the mobile robot in the following week:

- Lab #1 (Introduction to the Stamp microcontroller and the protoboard) and Lab #2 (Introduction to the PBASIC language)
- Lab #3 (Introduction to Sensors, photoresistor mounted on a servomotor) and Lab #4 (Introduction to the Robot, with navigation by contact sensing or limit switches, as illustrated in Figure 2)
- Lab #5 and #6, navigation by ranging (infrared sensor), with Lab #5 as the protoboard based laboratory illustrated in Figure 1, and Lab #6 as the robot based laboratory
- Lab #7 and Lab #8, navigation by colour (CMUcam camera for colour tracking)

The laboratories are conventional in that they are structured. A handout details the procedure and every group deals with the same hardware. Variation between groups comes about due to
the software programming and differences in the placement of the sensors and actuators. The laboratories could be viewed as one part applied electronics, and one part introductory microcontrollers, with a mobile robot as the application. The majority of students are from mechanical engineering. In many cases, this is their first experience with microcontrollers. For the laboratories, students work in pairs and this occupies the first eight weeks of the course. In the final four weeks of the course, the experience and knowledge gained in the laboratories is applied to a team design project. The current version of the project, as illustrated in Figure 4, is posed as a problem that mimics the task of autonomous vehicle navigation, with two robots per team traversing the test arena in a cooperative fashion. The test arena has a raised bridge that requires the robots to climb on to and drive off of, in a controlled fashion. Each team of 2 robots (4 students) is tasked to travel around the loop without hitting any walls (or each other). Red and green LED panels mimic traffic signals. A colour camera on each robot is used to determine whether the signal is red or green. A discussion of the past projects as they relate to their competitive aspects can be found in Surgenor, Firth and Daoust.

The active learning component attracts a group of students that is enthusiastic about the hands-on nature of the course. However, this enthusiasm can become a problem when the hours spent testing and troubleshooting begin to use up time required for other courses. Students have 24 hour access to the laboratory so they can work on their projects at any time. This can be a drawback for those students who get too engaged by their project, at the expense of time spent on their other courses. The assigned tasks and deliverables are structured to help limit the hours spent on the course.

**Value of the Course**

Student comments about the course have been universally positive, a selection of which are given below:

- "it's the best class I've ever taken, I like the practical application of things"
- "this course is awesome, I (think) everyone loves it"
- "I liked the hands-on experience, it made learning material easier and more fun"
- "good setup learning how to use components first (alone) and then on the robot"

For the past six years, the course has been consistently ranked 1st out of the 12 technical electives offered by the Department, as measured by the University Survey of Student Assessment of Teaching, a formal course evaluation that is conducted for all courses by the university. The course consistently scores 4.8 or higher on a scale of 5 in response to the question "overall, this is an excellent course", with the Department mean at 3.7 (standard deviation of 0.36), where 5 = "strongly agree". This is not to say that students are uniformly happy with the nature of the course. The fact that assessment is based to a degree on the performance of a robot (that the students have admittedly configured and programmed) leads to inevitable “real-world” frustration, when what worked perfectly in pre-testing, fails in final testing due to unanticipated hardware failures or software bugs. “Real-world” assessment in an academic environment can be problematic.
In recent years, at the end of the course the students are asked: “Name three positive things that you’ve learned in the class that you think will be of value to you in your future career as an engineer.” The results have been positive, but rarely mechatronics specific. Students offered comments such as “Teamwork is more important than technical ability” and “You need to be methodical in the problem solving process”. The fact that the feedback was positive was not surprising given course surveys from previous years. But the “non-mechatronics” feedback originally caught the attention of the instructors. On reflection, the exercise highlighted to the instructors that they had designed the course around the process of engineering problem solving, and this has become one of the dominant features of the course.

Experience has shown that problems must be presented such that the students are “forced” to be methodical. The team project problem is broken into 3 parts, roughly 1 part per week. Each part is in turn is broken into 3 manageable tasks: 1) Demo (basic elements of the overall task, 2) Basic (contains all but one of the elements of the final task, three trials) and 3) final (same as basic with one additional element, and only one trial. This approach was found necessary to “force” students to break the task into manageable parts, as well as to find a compromise between the academic nature of the exercise and the real world nature of the task, where the mark was based directly upon the performance of a machine, and only indirectly on the performance of the student.

Cost of the Course

Experience with the Queen’s course in mechatronics demonstrates the well-known drawback to the laboratory or project-based approach to engineering education, that is the problem of resources, both time and money. Such courses need specialized physical resources, extra teaching assistant (TA) time and can consume excessive amounts of both student and instructor time. It’s possible to cut back on the time demands (ie. reduce the number of labs), but with an obvious negative impact on the scope of what is learned. It’s also possible to reduce the time required by providing a less open ended project. But this has a significant pedagogical impact, as discussed in detail in the paper appropriately titled “What did I really learn in my mechatronics class? The challenge line problem revisited”, a paper that reviews the balance between the extremes of a highly constrained problem with a well defined answer versus the open ended problem with multiple, or perhaps nonexistent, solutions.

It’s a given that laboratory and project based courses cost more money to deliver than lecture based courses. Ignoring the cost of contact time, the direct cost (instructor plus TA time) is estimated as 4 times that of a conventional course. Specific to mechatronics, the equipment cost is on the order of $5,000 per year, for parts replacement and the inevitable upgrades driven by changing technology. The option of charging students a course fee to cover these costs is not an option in the publically funded Canadian university system, which views such charges as hidden tuition fees. So what to do? The only answer to be put forward at this point is to continue to lobby one’s administration that the added cost is worth it, and to ensure that the students are the ones that deliver the message. A motion to drop the course in 2010 for reasons of “we can’t afford it” was stopped by a petition signed by 80 students. One outcome of that result is illustrated in Figure 5.
Conclusions

A course in Mechatronics Engineering was used to provide an example of a course with the “wow factor”. A commonly held view is that the excitement and enthusiasm demonstrated by the students in such courses should be duplicated throughout an engineering curriculum. However, a decade of experience with the mechatronics course has left the instructors with a common question: “can we afford such courses, given that they are expensive in terms of both time and money?” This paper reviewed the offering of the course in Mechatronics and discussed the underlying resource issues. The only recommendation is that both students (and instructors) need to continue to lobby on behalf of such courses. The effort is worth it.

References

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Figure 1. Navigation by range, protoboard based laboratory.
Figure 2. Navigation by range, robot based laboratory.

Figure 3. Typical robot configuration for the team project.

Figure 4. Test arena for the team project in 2011.
Figure 5. Outcome of the wow factor, the (partial) class photo.
An Automatically Adjustable Walker for Elderly People

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Abstract
In this paper, we present an improved approach to design a four-legged walker. A walker is a walking tool that helps to support elderly people to move smoother. Currently, most walkers are fixed structure. It’s uneasy to adjust and only suitable for walking on flat ground, not for stairs or inclined ground. In our design, the front legs of a walker can be automatically adjusted according to the measurement of two inclinometers installed on two sides of the walker. When the walker is used to climb stairs, the inclinometers will indicate a positive angle. A microcontroller installed in the front frame will drive two stepper motors to retract the front legs until the angle equals zero. Similarly, if the walker is placed on a descent stair, the measured negative angle makes the microcontroller drive stepper motors to extend the front legs so that the angle is eliminated. A prototype of the design is being examined and simulated. It is expected that the automatically adjustable four-legged walker can provide flexible and independent mobility to the elderly users which will reduce the level of assistance needed.

Introduction
The size of the population of the elderly is increasing at a fast rate, and a great part of that population is limited by disabilities. According to the population statistics\(^1\), the number of senior citizens will increase from 13% to 20% in 2050 and many of the old people will be at great disadvantage where the mobility is concerned.

Mobility plays an important part physically and psychologically. Since a large percentage of elderly people can’t retain proper mobility, the motion aids, such as adult walkers, become popular tools for the elderly or disabled persons to use. An investigation in the United States showed that people using walking aids had increased by 96% from 1980 to 1990. Due to the increase of the use of walkers, there have been many developments to improve their functionalities, for example, developing intelligent walkers\(^2\), adding an easy-used basket and embedding a braking device in a walker\(^3,4\) and controlling the level of a four-legged walker using hand-controlled levers\(^5\). As a result, these improvements have enhanced the safety and independent life style of elderly persons.

In this paper, we will present an approach to design an adjustable four-legged walker. The essential idea of the design is to install two inclinometers along the level bars on two sides of the walker (see Fig.1 for detail). When the walker is placed in ascending/descending stair or uneven walking ground, the sensors, i.e. inclinometers, will send a measured angle signal to the microcontroller which is installed at the front frame of the walker. The microcontroller will control two stepper motors to retract or extend the front legs to accommodate uneven surface so that the user can move comfortably with the assistance of the walking aid apparatus.
The paper will be organized in the following sections. A detailed design will be explained in section 2. Then, the simulation result will be discussed and the conclusion will be provided in the final section.

**Design of the Four-legged Walker**

Fig.1 shows the basic structure of the four-legged walker aid apparatus. From the figure, we can see that the walker contains four parts: (1) the mechanical part, which contains an inverse U-shaped front frame with a reinforcement bar and two P-shaped rear frames. (2) two inclinometers; (3) two stepper motors; (4) a microcontroller with a stepper motor driver.

(1) Mechanical Frame

With four legs, the walker can stably stand on the ground. The two front legs are made up of three concentric metal tubes which are shown in Fig. 2 (a). The outer tube holds the middle tube which compresses the spring coil surrounding the inner tube. A single aperture is drilled into the
(2) Inclinometer

The working principle of a gravity inclinometer is shown in Fig. 3. When the surface of an object is not perpendicular to the line through the earth’s center of gravity, the angle will be measured and indicated. Most inclinometers can provide the measured angles in pitch and roll directions, respectively. For the application in this paper, considering the price and the quality, the single axis inclinometer, SCA61T-FAH1 FA1H1G family, is chosen.

The inclinometer can measure the angle with the range of ± 90 degree. The resolution is 0.0025º with 10 Hz bandwidth. Besides, the product is robust and has high shock durability (20000g) and excellent stability over temperature and time. Besides, it can communicate with a microcontroller in SPI series communication approach.

(3) Stepper Motor

A stepper motor can drive one step ahead when an electric pulse signal is provided. There are basically two types of stepper motors in terms of winding arrangements for the electro-magnetic coils: bipolar and uni-polar. For the uni-polar stepper motors, it has one winding with center tap per phase. Each section of windings is switched on for each direction of magnetic field. Since in this arrangement a magnetic pole can be reversed without switching the direction of current, the commutation circuit can be made very simple.

For the stepper motor in use, we mainly consider the price, the step angle and the provided torque and the power consumption so that it can serve the design well.

(4) Microcontroller

The microcontroller is used to communicate with the inclinometers and motors. Considering the application environment, the cheap price and robust property will be the primary factors to choose the microcontroller. In addition, since the computational amount is small, an 18-bit microcontroller from Microchip Company is sufficient for the design.

The microcontroller will interchange information with inclinometers through SPI series communication and the stepper motors through a stepper motor driver.

The working principle of the four-legged walker is as follows: When confronted with an inclined ground or going up stairs, as shown in Fig. 5 (a), the inclinometer will send the angle \( \theta \) to the microcontroller. The microcontroller will control the stepper motor to pull the cable so that the spring-loaded button will be out of the aperture which will make the middle tube free. By the gravity and the push force added by the user, the outer tube will move down so that the front leg will retract. When the front leg becomes shorter, the angle \( \theta \) will decrease. When the angle \( \theta \) tends to zero, the microcontroller will send a signal to the stepper motor so that the cable will be released and the spring-loaded button will lock the middle tube in place. Similarly, when
confronted with a declined or going down stairs, the inclinometer will send a negative angle signal to the microcontroller. The microcontroller will control the stepper motor to pull the spring-loaded button out of the aperture again. The coil spring attached to the middle tube will cause the extension of the front legs until the rear frame reaches the horizontal level. Once the angle $\theta$ reaches zero, the microcontroller will send a signal to the stepper motors so that the cable will be released and the spring-loaded button relock the middle tube.

Fig. 5. Side view of the walker in ascending position and descending position

Simulation

The design is being evaluated and simulated in the MATLAB/Simulink environment. The results are satisfactory. Further studies about parameter selections, such as the necessary torque provided by the stepper motors, a suitable coil spring so that it can provide a proper force for the walker effectively to travel most walkable uneven surfaces, are still under investigation.

Conclusions

In this paper, the design of an automatic adjustable four-legged walker has been presented. Unlike most four-legged walkers currently in the market, the four-legged walker utilizes the inclinometers to measure the inclined or declined angle of the rear frame of the walker and automatically retract and extend the front legs through stepper motors controlled by an embedded microcontroller. Since the electrical devices, such as a small microcontroller, inclinometers and stepper motors, are cheap components, the design essentially doesn’t increase the price of a walker. Furthermore, it brings a number of advantages. For example, the users don’t need to control the level of the walker using hand-controlled levers, which may be uncomfortable or impossible if the users are only standing while holding walker handles for support. Moreover, introducing small microcontrollers to control the walker may also provide some pleasure functionalities, such as displaying time, reminding the elderly about some appointments and so on.
Bibliography


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Syracuse University Internship Program

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Abstract

Dubai Contracting Company (DCC), in collaboration with the Department of Civil and Environmental Engineering (CIE) at Syracuse University, offers a unique real-world experience for up to six (6) CIE students preferably in their Junior or Senior year of study to participate in a multi-week summer internship program in Dubai, United Arab Emirates (UAE). The James A. Mandel and Samuel P. Clemence DCC SU Internship Program (DSIP) brings together six students, competitively chosen from Syracuse University and six students from Lebanese American University, to work collaboratively for one of the leading construction firms in the UAE. Created by Mr. Abdallah Yabroudi, CEO of DCC and mentor to the summer interns, the program consists of classroom lectures, construction site visits and cultural experiences. The in-office lectures cover a variety of topics including but not limited to: reading and understanding construction drawings, planning and scheduling, cost estimation and pricing, and bidding and tendering processes. Each lecture is presented by an experienced DCC staff member covering the topic of their respective field. Numerous site visits to current and completed DCC construction projects provide hands-on field experience by allowing students to meet with project and construction managers on each site to better understand project details, quality control measures and construction techniques. Students selected for this program will also have the opportunity to learn about business practices, history and culture of the Middle East, creating an environment for professional and personal development. In addition to midterm and final examinations, students are required to produce a comprehensive technical report detailing each construction site visit and construction associates visits, reflecting their individual knowledge. The DSIP program provides a rare and unique opportunity for students to learn about global construction contracting through invaluable site visits, professional lectures and cultural experiences.
Introduction

Dubai Contracting Company (DCC), in collaboration with the Department of Civil and Environmental Engineering (CIE) and the Syracuse University (SU) Abroad Program, aims to provide a real-world experience for up to six (6) CIE students preferably in their Junior or Senior year of study to participate in a multi-week summer internship program in Dubai, United Arab Emirates. This internship program is designed to expose students to the operations and physical realities of one of the leading construction firms in the United Arab Emirates (UAE). Students selected for this program will also have the opportunity to learn about business practices, history and culture of the Middle East, creating an environment for professional and personal development.

Dubai Contracting Company is a leading construction company in the United Arab Emirates and the Gulf Cooperation Council. Established in 1962 and headquartered in Dubai, DCC is recognized worldwide for its commitment to quality. This reputation for quality has allowed DCC to gain clients’ trust based on a high level of professionalism used to complete projects on time and cost efficient. DCC’s entire organization is committed to the achievement of quality which the firm believes differentiates it from its competitors. By using previous projects as benchmarks as well as various internal control systems, DCC ensures that it always abides by its founding principle of achieving the best quality in construction possible. Currently DCC is involved in many projects in Dubai, including the Burj Al Salam Tower, the Conrad Hotel and the Kingdom of Sheba. Current landmark structures such as the Rolex Tower and Tower 014 represent DCC’s influence as a leading contracting company in Dubai.

DCC Chief Executive Officer and Syracuse University alumnus, Mr. Abdallah H. Yabroudi initiated this collaborative internship program. Throughout this program, students are exposed to all aspects of the construction management industry through project site visits, lectures and cultural experiences. Students have the opportunity to meet with project and construction managers on site to better understand project details. Through a combination of learning and discussion sessions at corporate headquarters and on actual project sites, students learn the detailed inner workings of the contracting and construction industry.
History of the Program

The internship commenced in the summer of 2008 and consisted of twelve students total; two women and four men from Syracuse University CIE department and two women and four men from the American University of Dubai (AUD). This internship lasted for five weeks, from May to June. The 2008 curriculum was developed by Mr. Abdallah Yabroudi and key professors from Syracuse University. Lectures were provided by both SU and AUD faculty members. Students spent extensive time on construction sites. A three day trip to Amman, Jordan allowed the students to better understand the Middle Eastern culture. Students had the opportunity to visit Mount Nebo, the Dead Sea and the Jordan River. In addition to the three day cultural excursion to Jordan, students also visited the Musandam Peninsula in Oman for one day.

The second internship consisted of thirteen students total and ran from May to June 2009. Six students, two women and four men, were competitively chosen from Syracuse University CIE Department. Additionally, four male students were chosen from Lebanese American University (LAU) and one male student from the American University of Sharjah. The most notable change from the first internship was the addition of two students from the 2008 DSIP internship who served as teaching assistants. The addition of two teaching assistants from Syracuse University served to enhance the overall learning experience for the 2009 interns. The 2009 curriculum was revised extensively. All lectures were provided from DCC staff members. Lecture topics in contracts and change orders, mechanical, electrical and plumbing management, and finance were added to the curriculum. Construction visits to neighboring emirate, Abu Dhabi were added to the construction visit schedule. Additional site visits allowed students more time to experience the physical demanding roles of project and construction managers. Students also developed their skills in creating and giving oral presentations and technical writing. Cultural experiences consisted of a three day trip to Istanbul, Turkey where students visited the Hagis Sophia, Blue Mosque and Topkapi Palace. In addition to the three day cultural excursion to Jordan, students also visited the Musandam Peninsula in Oman for one day.

The third internship which spanned May to June 2010, consisted of fourteen students. Six students, three women and three men, were competitively chosen from Syracuse University CIE Department. Additionally, six male students were chosen from Lebanese American University and one male student from the University of Colorado. One student from DSIP 2009 served as the teaching assistant. Once again, the curriculum for the 2010 internship was revised extensively based on feedback from the prior year’s interns. A lecture given by an architect on the design of structures completed by DCC was added to the curriculum. The construction site visits and lectures were reorganized to follow a more logical sequence. In addition, a visit to a local pre-cast concrete plant and sewage treatment plant was added to the site visit schedule. A
A three day cultural experience to Amman, Jordan provided students with insight to cultural practices through visits to Petra, Jerash Mount Nebo, the Dead Sea and the Jordan River. In addition to the three day cultural excursion to Jordan, students also visited the Musandam Peninsula in Oman for one day.

This report presents a thorough description of the 2011 DSIP experience which included visits to both completed and under construction projects, class lectures and cultural experiences. The 2011 internship consisted of fourteen total students. Six students, two women and four men (one Environmental Engineer), were chosen from the Syracuse University CIE Department. Six students, two women and four men, were also chosen from the Lebanese American University. Two students from the 2010 internship served as the teaching assistants. The curriculum was revised extensively with an added lecture on Information Technology and the lecture schedule was revised to provide students with more information before the construction site visits began.

Program Description

This highly competitive program consists primarily of classroom lectures, construction site visits and cultural experiences. Students selected for this internship are automatically enrolled in CIE 470: Global Engineering Internship. Students receive three credits as well as a grade that counts towards their overall grade point average. For the duration of the internship, transportation, lodging, and office space is provided by DCC for all students and faculty advisors. Each student is provided with Personal Protection Equipment which includes a hardhat, construction gloves, safety glasses, safety vest and steel toed boots. In addition to the safety equipment, each student receives a laptop computer and mobile telephone courtesy of DCC for the extent of the internship. Finally, each student receives a thousand dollar stipend at the start of the internship for everyday expenses.

Prior to the summer internship, each student chosen from Syracuse University must attend a one credit seminar class, titled CIE 400 in the spring semester. This weekly seminar class brings in Professors from various departments in Syracuse University to discuss relevant issues about the Middle East and Dubai. Students are assigned readings revolving around the culture, geography, history, language, politics and government and customs of the Middle East. This informative lecture series helps the future interns to adjust to the culture of the Middle East before arrival. Each student is then required to submit a comprehensive report detailing what they have learned regarding the culture and customs of the Middle East.

The in-office lectures cover a variety of construction management related topics including: safety during construction site visits, reading and understanding construction drawings, planning and scheduling, cost estimation and pricing, bidding and tendering processes, legal aspects, contract formation, and disputes, delays and arbitration. Each lecture is provided by an experienced DCC staff member covering the topic of their respective field.

Figure 2: Interns learn how to read and interpret construction drawings
Daily quizzes, in addition to a comprehensive midterm and final examination allow the instructors to monitor the student’s progress. Students are required to take detailed notes on the lecture material in preparation for the examinations.

Construction site visits to current and completed DCC construction projects are integral to the internship. Students have the opportunity to work on multimillion dollar contract value projects such as the Burj Al Salam Tower, Conrad Hotel, Abu Dhabi National Exhibition Center Tower, Kingdom of Sheba [Phase 1], Fairmont Palm Hotel and Resort, Rolex Tower, 014 Tower, and Guardian Towers. Each construction site visit is initiated by meeting with project and construction managers to better understand project details, quality control measures and construction techniques. Following a thorough safety induction, students are guided through the construction site by project managers who provide detailed information about the project. During every site visit, each student is responsible for documenting the observed construction techniques and practices.

In addition to examining the construction work, students are given the chance to perform actual block work on at least one of the many construction site visits. In the 2011 internship, students performed block work construction for interior walls in the Burj Al Salam Tower. The Burj Al Salam tower is a fifty-four story multi-use tower currently under construction in Dubai. In preparation for laying the concrete blocks, students work with a DCC surveyor to specify the approximate grid locations on the concrete level. These approximations are needed to determine the block work outline which shall be traced on the slab using measurements in accordance with construction plans. The student outlines are then checked using 90 degree angles by either the Quality Assurance Quality Control (QAQC) engineer or the site engineer. Upon determining the

Figure 3: Students observe reinforced steel bar size, formation and spacing on the Burj Al Salam Tower in Dubai
exact placement of the blocks, the site must be cleaned using water in order for the students to start block work. Each student laid block wall using appropriate mortar material by hand as specified by technical drawings, the Quality Assurance/Quality Control engineer and site surveyor. Upon completion of the block wall, each student then checked the placement accuracy of the blocks using different methods as taught by the site foreman. Hands on activities such as laying block wall provide each student with a better insight into the physical realities of construction.

DCC maintains close working relationships with several local construction associates in order to provide quality service in all aspects of a project. The interns visit several construction associates such as Elie and Randa Gebrayel Architects Progress Engineering Consultants (ERGA) and Albonian International, a leading electromechanical contracting company. Currently ERGA Progress is collaborating with DCC on an exceptionally ambitious project, Mina Al Fajer, in the emirate of Fujairah, UAE. Mina Al Fajer is a luxurious development complex directly next to the Hajar Mountains and overlooking the sea. Students learn about the challenges faced when coordinating with subcontractors especially in the design, procurement and build of all MEP building services. Informational site visits to Ready Mix Beton (RMB), a concrete batch plant in Dubai showed the interns how concrete is produced and distributed to site. RMB continues to push the limit of concrete strength standards and is the main concrete supplier to DCC. A visit to United Precast Concrete Dubai (UPC) informed the interns of the design, production and erection of precast concrete elements for construction projects. With more than 25 years of experience in Bahrain, UPC Dubai is a leading specialist of concrete development and production. In addition to the construction site visits, by meeting with construction associates, students gain an appreciation of the amount of collaboration needed to construct a project successfully with quality as the main objective.
In addition to midterm and final examinations, students are required to prepare an extensive and comprehensive technical report detailing each construction site visit and construction associates visit, based on information received from project and construction managers on site. Technical writing guidelines are provided to each student in order to ensure quality writing. Instructors and teaching assistants provide reviews of writing drafts.

The 2011 internship provided the students with enveloping cultural experiences with trips to Fujeirah, India and Oman. A three day cultural excursion to India provided the students with a deep understanding of Indian customs and practices with trips to the legendary Taj Mahal in Agra, as well as Humayun’s Tomb, Qutub Minar, Jama Mosque, Rajghat, Hindu Temple, and Red Fort in Delhi. Experiences such as riding through the streets of Delhi on a cycle rickshaw and being able to walk through the Taj Mahal portrayed a contrast to the relatively newly constructed towers of Dubai.

![Figure 5: Students visit the famous Taj Mahal in Agra, India as part of a cultural learning experience](image)

Personally, as a student who has experienced this once in a lifetime opportunity, the lessons I leaned at DCC reflected a culmination of my established commitment to the field of Civil Engineering, my personal moral objectives set for my future, and the need to give back to my community at the highest level of quality I can provide. Experiencing engineering on a global scale allowed me the opportunity to simultaneously acknowledge the limits of my past understanding of engineering and to seize the opportunity to complicate and enrich my education. Construction visits to multi-million dollar contract projects helped me gain experience that I believe is impossible to attain through lecture based teachings alone. I have come to appreciate the true diversity of the world surrounding me as a crucial instrument in gaining cultural self
awareness and reaching a higher level of intellectual aptitude. Working with diverse interns and extremely capable DCC staff members, allowed me to gain as much knowledge concerning both practical and theoretical aspects of Civil Engineering, to network both socially and professionally and build upon my strengths while allowing myself to recognize my weaknesses. This program taught me the necessary skills of effective construction management and helped me apply my proficiency and flexibility of skill to the professional engineering world.

Conclusion

Dubai Contracting Company is a leading construction company in Dubai recognized for its worldwide commitment to quality. The DSIP program has provided a rare opportunity for university students to experience construction contracting through the DCC perspective. The high quality standards set for every project DCC constructs will indubitably permeate with each student throughout the entire length of their professional career. Over 50 students from the USA and Middle East have now experienced this unique and life enriching internship program. This internship program is an invaluable opportunity for students to experience engineering practiced on a global scale.
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