# AC 2010-2185: ENHANCING THE UNDERGRADUATE RESEARCH EXPERIENCE IN A SENIOR DESIGN CONTEXT

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# Enhancing the Undergraduate Research Experience in a Senior Design Context


## Abstract

The paper presents an instructional framework developed by the authors that engages senior students in a 5-credit Research and Development course incorporating project development, implementation, entrepreneurship, innovation, creativity, teamwork, and communication. The paper discusses the development and accomplishments of the course over the past four years in the context of the Quality Enhancement Plan (QEP) - an initiative at the University of Houston intended to encourage the development and enhancement of undergraduate research skills. The philosophy behind the course is to provide training and real world, small-scale project experience through the completion of a full-project lifecycle from conceptualization to prototype. Brief discussion of those projects that resulted in provisional patents, refereed journal publications, and conference presentations will be given. Some of the features of the course, such as University and industry guest speaker series and final project evaluation by the department's Industrial Advisory Board, leading professionals, faculty, technical staff and peers will be examined. The paper concludes by outlining a set of short term and long term goals for the future direction of the course.


## Introduction

Engineering and engineering technology disciplines consider senior project courses an important and even critical curricular component. In the past, many publications centered on general reporting regarding capstone course development, implementation and improvement[1, 2] and adding an industry collaboration component to the capstone courses[3, 4]. After the ABET 2K guidelines[5] were released, many established capstone courses added a systematic assessment component[6, 7, 8]. Recently, interest in the entrepreneurial and commercial dimensions of this work and inclusion of these concepts in capstone courses is on the rise[9, 10, 11, 12, 13, 14, 15, 16, 17].

The Senior Project course at the Computer Engineering Technology (CET) program, University of Houston is relatively young. As part of an effort to streamline the CET program in Engineering Technology (ET), the department decided to change the scope and redefine the course such that it was possible to measure student mastery of knowledge and skills in the CET program.

Prior to the changes, the course had consisted of three hours of lecture and a one hour laboratory. In this format, the course covered topics such as Op-Amps, ADC/DAC, interfacing, signal conditioning, microprocessor I/O, bus structure, and some machine language. The course was more hardware oriented with a very limited software component and did not have any laboratory assistant support.

During the revision phase, the authors recognized that most of these topics were covered earlier in the CET curriculum. The laboratory component consisted of several small

"cookbook" experiments during the first half of the semester while the second half of the semester was devoted to a term project (certainly not enough time for a meaningful team project experience). Students grouped in teams of two and proposed their idea to the laboratory instructor and the course instructor for approval. The students had to purchase their own parts and often worked outside the laboratory due to limited laboratory space availability. In addition, the course and laboratory instructors had very little interaction, leading to poor communication between these components. The authors attended several of the earlier lectures and observed student projects while noting the deficiencies and changes that had to be implemented in order to make improvements in the course a true measure of student mastery of the major.

The deficiencies observed in the courses were traced back to lower level classes that focused on fundamental concepts. This realization gave rise to the CLABS (read as C-LABS) Project[18] in summer 2004. The CLABS Project was made possible with a change in administration of the college and department, hiring a new generation of energetic faculty and strong desire to change at all levels. The rationale behind the CLABS Project is reported in several publications[19, 20, 21, 22]. Effective Fall 2004, the course was taught under *Senior Project* title in a modern laboratory space with a new scope and direction.

The rest of the paper will discuss various dimensions of the Senior Project course beginning with its relationship to the Quality Enhancement Plan for the University of Houston. The authors will also examine specific instructional components, aggregate student assessment data, course accomplishments in the past four years, and short-term and long-term goals.

**Quality Enhancement Plan (QEP)**

The University of Houston's focus on undergraduate research evolved from a collaborative effort to develop a Quality Enhancement Plan (QEP). The QEP is a major component of the reaffirmation process for the Southern Association of Colleges and Schools (SACS), a regional accreditation agency[23]. In September 2006, a QEP committee representing a cross-section of university stakeholders began meeting to brainstorm and discuss ideas that could potentially enhance student learning. After five months of investigative work, including gathering feedback from the wider university community, the QEP committee recommended an undergraduate research focus to the University of Houston (UH) SACS Leadership Team[24].

Once the university SACS team accepted the recommendation of the QEP committee in January 2007, the leadership began the process of delineating the framework for undergraduate research at UH. The first step was to develop a common definition of research that would resonate with the entire UH community. Deliberations in the group led to the following statement:

> Research is a diligent and systematic inquiry or investigation into a subject in order to discover facts or principles, and increase the sum of knowledge, enhance design, or enrich artistic ability[24].

Fundamentally, the objective of the undergraduate research initiative or Discovery-Based Learning Initiative was to incorporate and/or emphasize research activities and skills in

the undergraduate curriculum. Figure 1 presents the specific goals delineated by the report[24].

- Undergraduate research should be a signature program from UH, one that makes the university more attractive to potential students with records of strong academic achievement.
- Undergraduate students at UH will participate in some level of research activity by the time they receive their bachelor's degrees.
- By the time they graduate, UH students will have a fundamental understanding of research and its importance to society.
- The number of students participating in research experiences who are selected for presentation will grow.
- Undergraduate student retention will improve.
- The six-year graduation rate of first-time in college students and the four-year graduation rate of transfers beginning with 60 or more credit hours will improve.
- External funding for undergraduate research will grow.

Figure 1. QEP Goals for Undergraduate Research.

In order to assess university progress toward the general undergraduate research goals, the QEP also identified several student learning goals. These include:

- Students will be able to formulate a research question or problem.
- Students will be able to identify basic principles and knowledge related to their research question or problem.
- Students will be able to develop a research plan to address or resolve a specific question or problem.
- Students will be able to collect and interpret data and information in an attempt to resolve the question or problem.
- Students will demonstrate awareness of the responsible conduct of research.
- Students will be able to articulate their research findings through written, performance and/or oral presentations.

Many of these goals have been a critical part of the undergraduate learning experience across a variety of disciplines. However, the intent of the QEP was to develop a systemic plan for making research activity and skill-building a core element of undergraduate education at the University of Houston. In addition to providing a common university framework for enhancing student learning, the undergraduate research initiative has also served to highlight instructional practices throughout the campus that have been incorporating elements of research-based education.

One of the most prominent examples of research-oriented education practice is exemplified by the Senior Project course in the Computer Engineering Technology (CET) program. In the following sections, details about the Senior Project course (ELET 4308/ELET 4208) components are given to show how the senior project course meets the requirements of the QEP.

## New Format for the Senior Project

In its new format, the Senior Project class can accommodate a maximum of 48 students and when possible, students work in teams of four students. Students are free to choose their team members. In a few instances, there have been three-person teams due to enrollment numbers. Two surveys are conducted during the first session. The first survey is a self-assessment of the student knowledge and information about their work schedule (most students work part time and few work full time). A follow-up survey is conducted at the end of the semester and the results are then compared. The purpose of the first survey is to assess student's knowledge and workload and provide guidance if an overloaded schedule is identified. Results of the most recent surveys are discussed later in this paper.

The second survey conducted during the first day of the class is to assess the desired time blocks that the teams will require to use the lab outside the normal class schedule. The purpose of this survey is to schedule laboratory hours of operation. The course has three graduate assistants and they are selected from a pool of 8-12 candidates. Assistants go through an exhaustive interview process before they are hired. Each semester, all laboratory assistants in the ET department go through a two-day training prior to the start of the classes. The specific policies and requirements for the senior project course are provided by the faculty in charge. Each graduate assistant (GA) normally spends between four to five semesters in the senior project class. Each GA works 20 hours a week for the course.

The laboratory hours span five days a week with time blocks assigned according to the student requests and graduate assistants' class schedule. Each team has a budget of $350 for their project. The funding for each project is provided by the ET department. The faculty has the freedom to increase the budget once a promising project is identified and the team makes significant progress. The course is somewhat unstructured and teams must identify their own projects. Each team identifies several potential projects and discusses them with the faculty members and the GAs.

## Senior Project Course Instructional Components

The following section describes the materials and instructional strategies that are key to the functioning of the course.

**Books**- Two books are assigned in the course. One on engineering design and the other covers creativity[25, 26]. Reading assignments are given routinely. These two books are used during the first course frequently during what we call the Proposal Phase. Another book[27] will be used, effective Fall 2010, during the second course, during the Implementation Phase.

**Lectures**- Nine lessons are presented in the first course. The lectures are synchronized with the two books and are supplemented with additional information. The lectures are more accurately described as discussions with the instructor serving as facilitator. This method encourages students to be active participants. This method was chosen because students suggested they can read the books and other text-based resources on their own

and use the classes to discuss problems and solutions in a more active learning environment. The following list briefly describes the focus of each lesson.

Lesson 0- This is an overview lesson and briefly reviews design, projects, teamwork, ethics and the four aspects of the creative process.

Lesson 1- This lesson covers the first of the four aspects of the creative process known as the *explorer*. Here, students learn how to look at things in a different dimension.

Lesson 2- Lesson 2 introduces students to the art of design, defining the problem, project management, communication, collaboration, and generating concepts.

Lesson 3- The discussion in this lesson concentrates on being an *artist*. Students learn how to take the raw material and make something new from it, experiment with variety of approaches, ask "what if" questions, and break the rules or create new ones when necessary. This lesson uses examples of innovative process and creativity.

Lesson 4- This lesson explains the design process, product life cycle, template for design, senior project design process, software process, modern design process, formulating solutions, decision making, and writing proposals.

Lesson 5- This lesson discusses the third role of the creative process referred to as a *judge*. The students are enabled to answer questions such as is this idea good? Is it worth pursuing, will it give me the return I want? And do I have the resources to make it happen?

Lesson 6- This lesson discusses developing models and prototypes, performing design analyses, testing the overall design, revising, refining and critiquing the design, and project and people skills.

Lesson 7- The final role of the, namely the *warrior*, is discussed in this lesson. Here, students learn the basic strategies of being a warrior and make their idea a reality and move from "what if" to "what is."

Lesson 8- In lesson 8, students learn about presenting and implementing the final design, writing the final design report, implementing production, and quality management.

**Homework**- Each semester, students are given four to five homework assignments. Each homework assignment has five to six questions and students work on the homework individually. The assignments are drawn from class discussions and reading assignments. In general, most questions do not have one unique answer, as it is the case with cooked book assignments. Students need to acquire a broader understanding of technical problems and offer their solutions. This encourages students do more in depth reading and review of the relevant literature and case histories leading to a more viable solution. This sort of assignment helps students learn more about an issue and prepare themselves for the sort of problems they may encounter in industry.

**Exams**- Closed book and notes midterm and final exams are given. Most questions are from the two books, lessons, guest speaker presentations, workshops, reading assignments, and class discussions. Embedded in the exams are several open-ended questions. The exams tend to test students' involvement in all phases of the project they are involved in, and the ways they approach the solution to the open-ended questions. Again, these types of questions train students to become life-long learners.

**Workshops**- Three workshops are conducted at the beginning of the semester. The first workshop is a three-hour, hands-on training on Microsoft Project. Microsoft Project is used to create Gantt charts to track team progress and is conducted by the Information Technology trainer at the University of Houston. In the second workshop, students are introduced to the UH policies regarding intellectual property and patents. The workshop is conducted by the office of Research and Intellectual Property Management. The third workshop is on research in technical and science libraries and is presented by the College of Technology Librarian.

**Guest Speakers**-The guest speaker series is designed to introduce students to real world challenges. Speakers are engaged in the cutting edge of their industry. They often bring a new perspective to the senior project. A few of the speakers are members of the ET industrial advisory board and are familiar with the curriculum and provide valuable feedback for the improvement of the senior project course. Others are entrepreneurs and CEOs that enlighten students by discussing the success of their companies and what is expected of the new graduates as they enter the workforce. Immediately following each presentation and workshop, a survey is administered. The purpose of the survey is to understand what students liked and disliked about the presentation or workshop. The summary of the surveys is relayed to the speaker.

**ET Faculty Speakers**- Volunteer faculty members who are interested in recruiting undergraduate students and engage them in their research often present their research topics. Students who would like to pursue specific research may join these efforts after exploring their options. In recent years, student teams have worked on projects such as sensor networks and biomedical devices as part of a faculty funded research. A separate policy governs ET faculty supervision of the undergraduate student teams. There is *no* separate grading standard for this group of students.

**Laboratory Graduate Assistant Presentations**- All graduate assistants recruited for the course are formally introduced to the students. Each GA makes a short presentation and students get to know them and understand their areas of expertise.

**Guidelines and Policy Manual (GPM)**- The GPM provides senior project students with information on policies, detailed guidelines for the progress report, proposal report and final project, grading forms, evaluation forms, purchasing policy, and other items.

**Web Portal**- A secured access web portal where supporting course materials are stored is provided for the course. The web portal provides specific folders for ancillary documents, project teams, laboratory GAs and the faculty directing the senior project course. The ancillary documents folder houses the GPM, creativity and innovation papers, technical papers on sensors and stepper motors, microcontroller documentations, MicroC library

functions, parts list available in the lab, lecture presentation slides and past student projects. The laboratory GA folder archives of all progress reports, proposal reports, final reports, homework, midterm and final exams. This folder is also used for communications with the senior project faculty. The senior project faculty folder is used primarily for development purposes.

Formative assessment plays a key role in the structure of the course. What follows is a brief description of the tools used by the Senior Project instructor and graduate assistants to collect data on student progress. This data can then be used to provide feedback that supports student learning.

**Weekly Progress Reports**- Writing weekly progress reports is a common task being practiced in many companies, large or small. The Senior Project course is the only course in the CET program that requires these progress reports. The purpose of the WPR is two-fold. First, it is intended to require each team member to review at least his/her current personal progress related to the project, the project's recent accomplishments, its planned near-term activities, its resource utilization, and any outstanding problems. Second, it ensures that all members of the team, the client, the team's faculty advisor, and the graduate assistants are all aware of the same information.

Each team member has two roles associated with the progress report. The first is to provide his/her personal input for each major section of the report. The second is to be familiar with the contents of the most recent progress report. Specifically, the progress report addresses the following items:

- Is the project on schedule?
- Specifically, what problems have the team encountered?
- How have the team dealt with these problems? What solutions have been explored or adopted?
- Are there any areas in which the team would like feedback from the advisor and the graduate assistants?

Each team submits a weekly progress report. Specific guidelines and requirements are provided in the GPM. Two GAs and the faculty review all reports. The graded reports are returned and discussed with the students. A grading form is given in Appendix A.

**Project Proposal**- The project proposal consists of a presentation and report. Each team must clearly address the following items in their presentation and report:

- Benefits of the product or process to the end customer
- Project objectives tied to the project specifications
- Strategy for achieving project objectives
- Detail plan of action divided into a number of tasks to be performed by individual member of the project team to achieve the project objectives
- Time schedule depicting weekly progress and individual/team assignments
- Cost analysis
- Design verification procedures
- Procedures to quantify prototype performance

Two GAs and the faculty member grade the reports. See Appendix B for the proposal evaluation form. The form has scores from other evaluations such as confidential peers in team and peers in class. Students receive their own evaluation form.

**Final Project**- The final project consists of a presentation, report and prototype demonstration. This is the most exciting event for the students and the department. UH faculty, industry guests, staff and other students are present during the presentation and prototype demonstration. The report consists of Executive Summary, Newsletter, Product Requirements, Design Specifications and Description, Construction Details, Cost Analysis, User Instructions, etc. Multiple evaluation forms are used during this event. The final evaluation form is given in Appendix C.

**Weekly Meetings with Graduate Assistants**- The faculty meets weekly with the GAs to review the activities in the previous week. Major issues are discussed and decisions made. The meeting also discusses tasks in progress and the faculty provides direction for the current week.

**Weekly Progress Reports by the GAs**- Each GA is required to document the work performed during the week and the tasks performed. Each GA writes a weekly progress report and the summary report is written by the supervising GA. The reports are also discussed during the weekly meetings with the GAs. Included in the submission are updated attendance file, updated grades file, and updated parts inventory.

After a thorough review and revision, the new Senior Project course (ELET 4308/ELET 4208) was offered in updated form in Fall 2008. A key feature of the new course was that the proposal and project components would each now be a semester long activity reflecting a comprehensive capstone experience.

An examination of the course components reveals that the curriculum and instruction also incorporated most of the general research-based learning activities later described by the University Quality Enhancement Plan. Figure 2 provides a map of course learning activities against the student learning goals proposed by the UH QEP. As suggested earlier in this section, assessment and evaluation play a key role in the Senior Project course. Each learning activity is accompanied by a rubric-based performance assessment usually taking into account multiple perspectives including the instructor, graduate assistants, industry representatives (during the final project presentation), members of the department's Industry Advisory Board, faculty and university guests. In addition to performance assessments, student surveys are also implemented to gauge perceptions of course effectiveness.

Results from these assessments are used to make pedagogical and curricular decisions regarding the direction of the course[8, 28, 29, 30]. The assessment tools themselves are consistently evaluated for their effectiveness and relevance to the instructional process. The next section discusses some recent assessment results.

| | | ELET Course Components | | | | |
|---|---|---|---|---|---|---|
| | | **Final Project** | **Project Proposal** | **Progress Reports** | **Workshops** | **Guest Speakers** |
| **UH QEP Student Learning Goals** | Formulate a research question or problem | ✓ | ✓ | | | |
| | Identify basic principles and knowledge related to their research question or problem | ✓ | ✓ | | ✓ | |
| | Collect and interpret data and information in an attempt to resolve the question or problem | ✓ | ✓ | ✓ | | |
| | Demonstrate awareness of the responsible conduct of research | ✓ | ✓ | ✓ | | ✓ |
| | Articulate research findings through written, performance, and/or oral presentations | ✓ | ✓ | ✓ | | |

Figure 2. QEP Learning Goals vs. ELET 4308 Course Activities.

**Assessment Results**

Assessment plays a vital role in evaluating both student performance and overall program progress. As described earlier, the senior project instructor administers a self-assessment survey to students to gauge their perceived level of learning over the length of the course. As part of a demographic survey at the beginning of the course, students are presented with an item which states the following: *For the senior design project, team members will need skills in several areas. Please rate yourself on a scale of 1 to 10 (10 being best) on each of the skills listed below*. A list of relevant skills is then provided and students must indicate their self-rating in the appropriate space. These skills are:

- Real project experience
- Customer interaction
- Research skills
- Writing skills
- Presentation skills
- Software skills
- Hardware skills
- Website creation
- Leadership
- Team player

- Professional ethics

A similar item is presented to students at the end of the course providing a "before and after" picture of self-ratings.

It must be noted that self-assessments can be a somewhat crude measure due to students' tendency to overestimate their competence in the beginning but the data are still useful as a point of reference for instructors when making decisions about various aspects of the course.

Table 1 presents mean results of student survey responses in the Spring 2009 project class.

Table 1. ELET 4308 Self-Assessment Results Spring 2009

| **Spring 2009 Skill Self-Assessment** | **Start of Semester** | **End of Semester** | **Δ** |
|---|---|---|---|
| Real Project Experience | 5.69 | 7.77 | 2.08 |
| Customer Interaction | 8.18 | 7.73 | -0.45 |
| Research Skills | 7.69 | 8.54 | 0.85 |
| Writing Skills | 7.37 | 8.00 | 0.63 |
| Presentation Skills | 7.24 | 7.56 | 0.32 |
| Software Skills | 6.43 | 7.05 | 0.62 |
| Hardware Skills | 7.88 | 8.12 | 0.24 |
| Website Creation | 6.12 | 5.55 | -0.57 |
| Leadership | 7.92 | 8.29 | 0.37 |
| Team Player | 9.04 | 9.50 | 0.46 |
| Professional Ethics | 9.06 | 9.25 | 0.19 |

Student responses suggest an increase in self-reported skill level overall. This was especially true with regard to *real project experience* which saw a mean change of over two points, the largest reported increase by far. This change is encouraging since the intent of the course was to provide students with more hands-on experiences and expectations similar to what they would find in industry.

The next largest reported increases were in research, writing, and software skills. These changes are consistent with the focus of the course i.e. investigating a problem through research, documenting and reporting ongoing progress via written reports, and developing a technical solution that often involves making effective use of appropriate software packages.

The reported declines customer interaction and website creation indicate a need for greater course scrutiny. Although these are listed in the survey as necessary skills, these areas are not emphasized in the course. There is no real website development component to the senior project and while the presentation must address some broad marketing themes (i.e. identifying potential users) there is no overt customer-oriented focus. The Instructor must therefore evaluate the course strategy to either increase the emphasis on these skill sets or remove them as metrics for programmatic assessment.

In conjunction with student self-assessment, the CET program uses student performance as a metric for program evaluation. For several years, the CET program has focused on three general learning outcomes. These are:

- Students will demonstrate an ability to identify, analyze, and solve a technical problem.
- Students will demonstrate an ability to communicate effectively.
- Students will demonstrate an ability to function in teams.

Since students must necessarily demonstrate each of these characteristics to successfully complete the senior project, it was decided that the senior capstone course would provide the best opportunity to assess these skills. Using a set of comprehensive rubric-based tools, students are assessed on various dimensions of their performance including the areas described by the general learning outcomes. These in turn reflect the majority of skills listed in the self-assessment survey. Figure 3 illustrates the basic links between the learning outcomes and skills in the self-assessment.

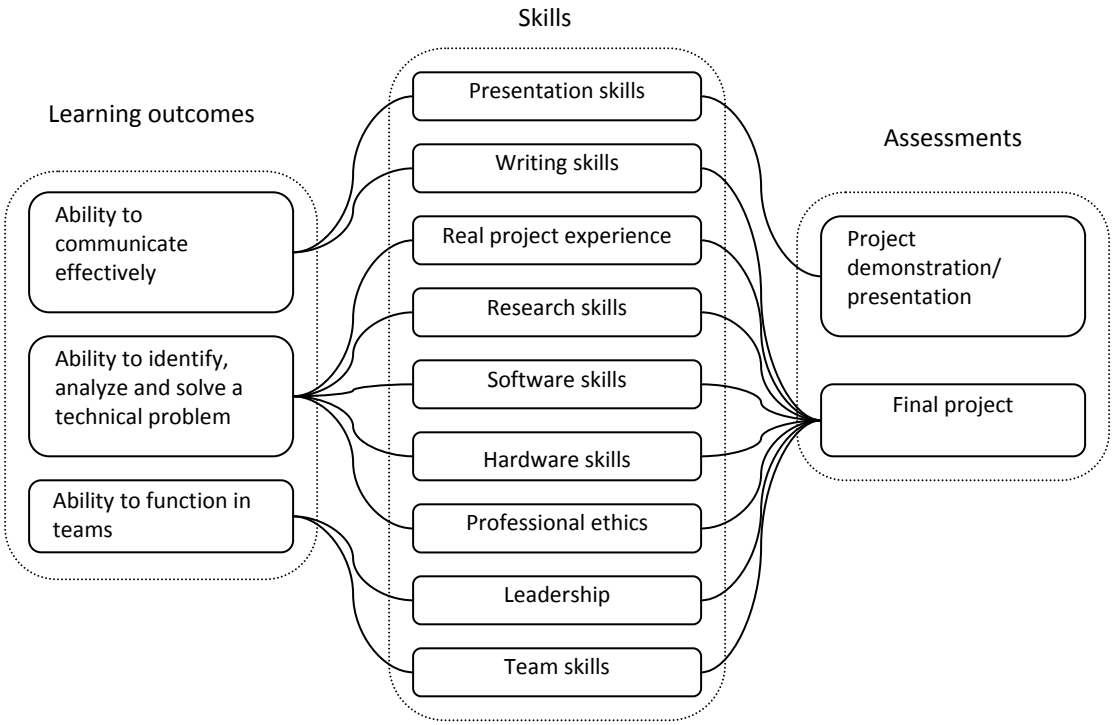


Figure 3. Link between learning outcomes, skills and assessments.

In Spring 2009, the minimum competency benchmarks for the project demonstration and final project report were 17.5 out of 25 points and 245 out of 250 points respectively. In essence, outcomes on each of these assessments constitute a broad a metric of how students perform relative to the self-assessment skills and in turn the overall learning outcomes.

A review of actual performance outcomes revealed that 88% of the students met at least the minimum competency standard for the overall project. However, only 56% met the minimum performance standard for the presentation. The latter result suggests a need to provide more guidance to students on how to develop and deliver and effective technical presentation.

While no definitive causal link can be made between instructional pedagogy and outcomes, overall project performance is consistent with the student self-reported increases in various skills. As indicated previously, the final project rubric represents a wide stroke of assessment. Future analyses would benefit from more precise metrics of some less technical skill areas such as professional ethics and team skills. Currently these skills are assessed within the scope of the larger project rubric. However, a more detailed and accurate picture of the impact and effectiveness of the course rests on our ability to precisely measure core skills.

**Short Term Goals**

The short term goals are those goals that can be accomplished in the next 2-4 years and are summarized below.

- Capitalize on the accomplishments of the past four years.
- Monitor the progress of the students as they go through the revised laboratories in the CET program under the guidance of the CLABS Project initiative.
- Encourage more faculty to take part in mentoring the students.
- Improve the assessment instruments.
- Encourage senior project students participation in department's sponsored tournaments such as Botball[31], and FLL (First LEGO© League)[32], and Houston Robotics[33].
- Pilot test senior project teams' participation in mentoring at least one group from the K-12 involved in various robotics activities. This goal raises students' social awareness and responsibilities. Additionally, it may lead to K12 students interest in STEM (Science, Technology, Engineering, and Mathematic) education.
- Require senior project students to spend six hours in the lower-level laboratories and mentor freshman and sophomore laboratory teams. Currently, senior project students participate and act as judges in at least one final project presentations by freshman, sophomore or junior students and submit a short report of their experience. The combined reports are shared with the CET faculty.

**Long Term Goals**

The long-term goals for the senior project course face several challenges including time. Some efforts along these lines are currently underway and require additional resources. These are the goals that require four years or more to be accomplished. The long-term goals are summarized below.

- Increased industry participation in mentoring and sponsoring student projects.
- Facilitate industry internship for the students.
- Increase joint projects with other departments within ET.

- Increase joint projects with other schools at UH.
- Increase participation in regional and national competitions.
- Increase Conference presentations by students.
- Produce more patentable projects.
- Produce more journal publications.
- Increase student sense of community responsibilities.

**Accomplishments**

In the past four years, the senior project students were able to secure four provisional patents and published their work in various refereed journals[34, 35, 36, 37]. Students also attended regional conferences and two teams were awarded first and second places in undergraduate research competition at the 2008 ASEE-GSW annual conference[38, 39]. Other papers presented or scheduled to be presented are given in[40, 41, 42]. Few projects have been routinely showcased since 2006 at the Research and Scholarship Day at the University of Houston. Other student projects for the past few years are archived at[43].

The projects completed by the students have received wide acceptance by the Industrial Advisory Board members and industry guests who frequently visit and evaluate the final projects. The projects also have been very instrumental in placing students in local companies.

**Conclusion**

Internal support such as adequate laboratory space, tools and modern equipment conducive to innovation and creativity; graduate assistants support to monitor and assist the students on their projects, extended lab hours, incentive for students to do outstanding work and faculty with keen interest in continuously updating the teaching materials are part of the successful operation of a senior project course. Leveraging the service organizations of the institution to take part in the student training is highly desirable. A faculty who has been in the industry and is current with state of the art practices can contribute immensely to the nurturing of the students. External support is essential including industry participation in variety of forms such as sponsoring student projects, donations of parts, mentoring of the project teams, and active involvement during the final project presentations and evaluations. Finally, a supportive administration and faculty is a must.

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## Appendix A

**Department of Engineering Technology**
**Computer Engineering Technology**
**Senior Project**
**ELET 4308/ELET 4208**
**Evaluation Form for Weekly Progress Report**

Progress Report No.:

Team No.:

Team Members :_____

Project Title : _____

Date Progress Report Submitted :_____

Time Period Covered in the Report: _____To _____

| WPR Sections | Max Possible Points | Points Assigned | Comments |
|---|---|---|---|
| 1. Project and Purpose | **2** | | |
| 2. Accomplishments from the previous week | **5** | | |
| 3. Planned activities for the current week | **5** | | |
| 4. Resources utilized<br>4.1 Labor usage<br>4.2 Financial resource usage<br>4.3 Project schedule Status | **5** | | |
| 5. Current or continuing problems | - | - | |
| 6. Comments and suggestions | - | - | |
| 7. Supporting Documents | **3** | | |
| **Total Points** | **20** | | |

*Please complete the top portion of this evaluation form in Word and turn it in with every weekly progress report.*

Faculty Advisor (signature) _____ Date : / /2010
Dr. Farrokh Attarzadeh

## Appendix B

ELET 4308/ELET 4208
Proposal Evaluation Form

**Team no.:**
**Project Proposal Title:**
**Team members**
**Instructor: Dr. Farrokh Attarzadeh**

| Criteria | Possible Points | Points Earned | Comments |
|---|---|---|---|
| ▪ **Peer evaluation-**Peers in other teams | 10 | | |
| ▪ **Peer evaluation-**Peers in your team | 10 | | |
| ▪ **Faculty evaluation of the presentation**<br>▪ | 10 | | |
| ▪ **Proposal Document:**<br>▪ Logical format<br>▪ Media<br>▪ Typographical errors<br>▪ Neatness<br>▪ Consistency<br>▪ Accuracy of information presented<br>▪ Completeness | 12 | | |
| ▪ **Introduction** | 4 | | |
| ▪ ***Project Objectives*** | 4 | | |
| ▪ ***Project Description*** | 25 | | |
| ▪ **Plan of Action** | 5 | | |
| ▪ **Verification** | 3 | | |
| ▪ **Cost Analysis** | 5 | | |
| ▪ **Project Schedule** | 4 | | |
| ▪ **References** | 3 | | |
| ▪ **Senior Project Questions** | 5 | | |
| **Points Possible** | 100 | | |

## Appendix C

# *Senior Project*

### *ELET 4308/ELET 4208*

### *Final Project Evaluation Form*

**Team no.:**
**Project Title:**
**Team members:**
**Instructor: Dr. Farrokh Attarzadeh**
**Date:**

| Criteria | Possible Points | Points Earned R1( ) | Points Earned R2( ) | Points Earned R3( ) | Comments |
|---|---|---|---|---|---|
| • **Peer evaluation-**Peers in other teams | 20 | | | | |
| ▪ **Peer evaluation-**Peers in your team | 20 | | | | |
| ▪ **Faculty & TAs evaluations of the presentation** | 20 | | | | |
| ▪ **Project Document:**<br>▪ Logical format<br>▪ Media<br>▪ Typographical errors<br>▪ Neatness<br>▪ Consistency<br>▪ Accuracy of information presented<br>▪ Completeness | 20 | | | | |
| ▪ **Executive Summary** | 10 | | | | |
| ▪ **Newsletter** | 20 | | | | |
| ▪ **Introduction** | 5 | | | | |
| ▪ **Background** | 5 | | | | |
| ▪ **Product Requirement** | 10 | | | | |
| ▪ **Design Alternatives** | 10 | | | | |
| ▪ **Design Specifications** | 20 | | | | |
| ▪ ***Design Description*** | 40 | | | | |
| ▪ ***Construction Details*** | 25 | | | | |
| ▪ **Costs** | 10 | | | | |
| ▪ **Conclusions** | 10 | | | | |
| ▪ **User Instructions** | 20 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| ▪ **Project Schedule** | 10 | | | | |
| ▪ **References** | 5 | | | | |
| ▪ **Components of the Project Binder:**<br>▪ A binder cover<br>▪ A cover sheet for the documents inside the folder<br>▪ Table of contents (for the documents inside the binder)<br>▪ Senior Project Presentation Slides<br>▪ Senior Project Report (refer to the guidelines specified in the document in this folder under the title "Senior Project Report)<br>▪ Senior Project Proposal Presentation Slides<br>▪ Senior Project Proposal Document<br>▪ Progress Reports (organize them as 1, 2, 3, etc.)<br>▪ Minutes of the meetings (organize them from the first to the last minutes of the meetings)<br>▪ **Copy** of all the invoices from all the sources<br>▪ **A CD containing**:<br>(a) All of the above items with proper folder names,<br>(b) All digital pictures with appropriate labels, chronicling the progress from the beginning to the end,<br>(c) Any digital movie of your project, and<br>(d) Any other useful information pertinent to your project | <br>3<br>3<br>4<br>10<br>--<br>5<br>5<br>5<br>10<br>5<br><br>10<br>10<br>-<br>- | | | | |
| **Points Possible** | 350 | | | | |