Using Webpages to Document and Assess Student Capstone Project Work

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Abstract

A Capstone course is a requirement for all Engineering Technology programs, under ABET-TAC standards. In the South Dakota State University Electronics Engineering Technology Capstone course, many of the ABET-TAC Program Outcomes are assessed using the direct evidence of student's work. The Capstone course has, for several years, required the use of group project webpages, which the students create and maintain during the course of the project, in order to help the student groups collaborate and to document their project. As the university changed its course management system, software to implement the webpages was not available for one year. Ironically, this provided an opportunity to measure, using rubrics, the positive impact the use of project webpages have on the quality of final project reports and in assessment of some of the program outcomes, which are detailed in this paper.

Capstone Course and Outcome Assessment

The 2010-11 ABET-TAC Criterion 4. Curriculum section states that "Capstone or other integrating experiences must draw together diverse elements of the curriculum and develop student competence in focusing both technical and non-technical skills in solving problems"[1]. A short search of ASEE Conference papers variously defines the goal of the Capstone experience is "to integrate the engineering and management disciplines into a single comprehensive educational experience"[2] ,"to provide a bridge for the students to cross between the academic world on one side and the technical professional world on the other"[3] , to "provide an extensive platform to practice engineering design and to facilitate the integration of what students have learned throughout their curriculum"[4] ,"to better prepare graduates for engineering practice"[5], and "to demonstrate their abilities to potential employers."[6] All of these statements are valid. Using the measured outcomes of a Capstone course to assess how well students are prepared for engineering practice makes up an important and growing task for engineering and engineering technology programs.

McKenzie[7] reported in 2004 the results of their survey of all ABET-accredited engineering programs, where they asked about the characteristics of capstone projects, including its duration, importance in the undergraduate curriculum, and practices using the capstone design projects to fulfill EC 2000 Criterion 3 and Criterion 4 requirements. They reported that 80% of the respondents said that each of Criterion 3 outcomes can be assessed within the capstone experience, with the most commonly assessed Program Outcomes being: Communicate effectively, Solve engineering problems and Use engineering tools. They further reported 91% required a final written report. Respondents also reported evaluating many other items for assessment including student surveys during and at the end of the course, self-reflection entries in journals, self-reflection papers, alumni surveys, notebooks, log books, student written user's manuals, exit surveys, and assessments by a consortium of faculty.

Gloria Rogers, ABET's Managing Director of Professional Services, writes extensively on the topic of assessment. In an article entitled "When is Enough Enough?"[8], she says that data collection activities must be examined in light of good program assessment practice, efficiency, and reasonableness. She says several questions need to be asked, such as, "Is there a clear vision of why specific data are being collected?" She answers, "Without clearly defined outcomes, there can never be enough data because there is no focus." The National Academy of Engineering[9] in 2009 issued a report called "Developing Metrics for Assessing Engineering Instruction: What Gets Measured is What Gets Improved". In that report they reinforced the idea that a sustainable evaluation system must not require implementation that is burdensome to faculty or administrators.

In the SDSU EET program, we are constantly re-evaluating the program outcomes and how they are measured by the assessment process. We believe that we have a good balance of data collection practices. The SDSU EET program has defined, with the approval of alumni and its industrial advisory board, sixteen Program Outcomes labeled (a) - (p). These begin with the ABET Criterion 3 Program Outcomes (a) - (k), and then add the Criterion 9, EET program specific requirements, and some SDSU required program outcomes, which are labeled (l) - (p). The EET program assesses student progress on the outcomes all through the curriculum, generally gathering data on no more than three or four outcomes per course, in order to concentrate on the outcomes important for that course, as Rogers [8] recommends. But in the Capstone course, twelve of the outcomes are assessed every year (see details later in paper). This is consistent with what McKenzie [7] saw in their review of Capstone courses. However, it does place a heavy burden of assessment data gathering on that specific course.

Capstone Project Webpages

One of the ways of reducing the assessment load in the SDSU EET Capstone course that we considered was to use student project group webpages to document the project design. We began requiring the use of project webpages in 2005, based in part on some of the research detailed below. For this paper, the author has looked at more examples of how some engineering schools, as reported mainly at ASEE Conferences, are using webpages in Capstone courses.

Stahl [10] in 1999 reported an early implementation of the use of webpages by the Architectural Engineering and Building Construction Department of the Milwaukee School of Engineering. The department set up project specific websites as a clearinghouse for project data, including text, graphical, and video data, with the data including everything from contracts and meeting minutes to final drawings and construction images. Faculty and students used these websites to communicate regarding course and assignment requirements, but more importantly as the mode for students to organize, archive, and display their work. At that long-ago (in web-years) time, they reported struggling with the set-up of the websites.

Course Management software, such as Blackboard, from Blackboard Inc., Washington, DC, was used by the Mechanical Engineering program at Ohio University [11]. Faculty members and the student design teams used Blackboard to establish and maintain a communications channel with each other and with external industrial experts and referees. They reported, without further detail, that many student design teams established their own web pages. In 2008 Brodie [12] reported that at the University of Queensland, a Learning Management system (not named) was used for on-line project-based courses. There, 70% of respondents either agreed or strongly agreed that the course structure, entirely done through webpages, had enhanced problem-solving skills and made effective use of prior knowledge.

The Electrical Engineering and Computer Science program at the University of Portland [3] required each student project team to maintain a project web site, which contained an up-to-date repository for all project information. It included pages for documents, meeting minutes, presentations, schedule, and other data such as critical design files. The instructor provided a "starter" web that used a standard theme and page hierarchy. Teams were encouraged not to customize the web, which can be a time sink, or use it for other purposes. It contained a home parent-page and child-pages for documents, meeting minutes, presentations, schedule, and other information. Each team could only publish their own web pages, while the instructor had full access rights to all student web folders, which provided evidence for outcome assessment.

At Carnegie Mellon [13] in 2009, proprietary software called DesignWebs was used to provide a method for students to organize, navigate and synthesize the documents and conversations that occur while designing an engineering artifact in a project-based course. This software provided a bird's eye-view that is otherwise not possible due to information scattered in design discussions and documents.

At Washington State University [14], the focus was on the development of group artifacts, the first of which was developing a collaborative website called WSU Wiki. Students actively develop the wiki with the intent that it will be used as a community resource, for self and group assessment, improvement of the course, and the benefit of future students. At Grand Valley State University [15] in 2009, Google on-line applications – Group, Chat, Sites, Mail, Docs, and Calendar – were used for their senior project management course. They reported many successes and few difficulties using these free software tools.

Rubrics

Rogers [16] says that a rubric is "an authentic assessment tool used to measure student's work". This paper is not about the value of using rubrics, but rather showing the use of rubrics in a specific Capstone course. Furtner [6] talked about the use of detailed rubrics for Senior Design proposals in the Purdue Electrical and Computer Engineering Technology program. The program faculty developed rubrics, that the students had access to, that were very specific about what needed to be in the proposals. They concluded that a detailed grading rubric can be used to help convey the engineering professors' grading expectations for technical reports and proposals. They also concluded that just handing the rubric out was not enough. They recommended going over writing samples and using the rubric to grade those samples, in order to help translate the "theory" of rubrics into applied knowledge, which can help students perceive that a detailed rubric can be used as a clear outline of grading criteria.

At Iowa State [4], the Industrial and Manufacturing Systems Engineering Department reported using rubrics in their Capstone course. They believed that the Capstone course should address as many of the department learning outcomes as possible. One of their main concerns was that all project groups show ongoing evidence of design progress, with the intent of simulating working for an engineering manager in industry as a newly-hired engineer. They used their webpage setup and rubrics to monitor the design process. They also reported that they had to develop and change their rubrics over time, as experience showed that new considerations arose over time.

Sealy [17] published examples of the rubrics they used for assessment of ABET Program Outcomes (a) and (b). His department spent a great deal of time talking about the workload necessary to properly implement the assessment process. They, as are most programs, were concerned that an assessment method which causes an undue burden on faculty would not be successful in the long run. They felt the use of standardized rubrics across the program helped lessen the faculty workload.

Assessment, Webpage and Rubric Usage in the SDSU EET Capstone Course

At SDSU, the EET 470/471 Project Management/Capstone sequence (two semesters) is a hybrid course, which in this context means the course uses two means of instruction: face-to-face class meetings for interaction and lectures and also uses D2L course management software, from Desire2Learn, Inc., Kitchener, Ontario. The Capstone course instructor is in charge of teaching project management tools and techniques during the first semester, and also acting as an overall Project Director, organizing project teams and assessing the groups' work against the standards that projects are expected to meet. In the first semester project teams define and begin their technical projects and in the second semester they do the majority of work and complete the projects. The position of technical advisor for each of the project groups is split among the EET faculty, based on the faculty member's area of expertise.

In the outcomes assessment process, the faculty teaching each course records how well the students do as a whole on the assessment, with a typical goal being "80% of the students achieve a score of 8 out of 10, based on the rubric used." In most courses, the outcomes are assessed individually, but in the Capstone course, with its emphasis on teamwork, some of the outcomes are assessed for the project team as a whole. At the end of each semester, the assessment information from all courses is tabulated by the program coordinator, and the EET faculty meets early the next semester to review the results. Of the outcomes that do not reach their goals, the faculty as a whole choose ones for closer study, and the faculty person teaching that course decides on corrective action to take the next time the course is taught. Such a feedback loop is our way of ensuring continuous improvement in the EET program.

The twelve Program Outcomes assessed in the Capstone course are: (EET graduates have …)

(b) an ability to plan, carry out, and evaluate a group project to solve a technical problem.

(d) an ability to apply creativity in the design of systems, components or processes appropriate to program objectives

(e) the ability to function effectively in teams both as a member and as a leader
(g) an ability to communicate effectively
(h) a recognition of the need for, and an ability to engage in lifelong learning
(j) a respect for diversity and a knowledge of contemporary professional, societal, and global issues
(k) a commitment to quality, timeliness, and continuous improvement
(l) the knowledge to manage change and improve productivity
(m) an ability to use the concepts learned in fundamental communication courses and posses more developed skills in research and writing in a discipline specific context.
(n) the ability to apply project management techniques
(o) the ability to use appropriate engineering tools in the building, testing, operation, and maintenance of electronic systems
(p) the ability to analyze, design, and implement industrial control systems, computer network systems, or electronic systems

Figure 1 shows the rubric used to assess a portion of Outcomes (m) and (p), which uses the final written report of the project team. The rubric assesses for Outcome (m) the ability to write in a discipline specific context, in this case writing a final report on the project. The rubric is also used as a part of the assessment for Outcome (p), the ability to analyze, design, and implement systems. The report's description of the team's design process, and inclusion of design process evidence, is a measure of how well the students understand the design process.

Outcome	Tool	Rubric	Superior	Excellent	Good	Fair	Poor
		A7	10	9	8	7-6	5-0
(m) … writing in a discipline specific context. and (p) … ability to analyze, design, and implement systems	Final Report	Document the Design Process	Design process completely detailed All appropriate supporting documents present in written report Clear understanding of design process demonstrated	Mostly detailed Most Mostly clear	Basically detailed Some Some-what clear	Sketchily detailed Few Little	Not detailed No Poor

Figure 1. Combined Rubric used to assess a portion of Program Outcomes (m) and (p) in the Capstone course

The entire assessment of Outcome (m) in the Capstone course also includes assessing the project proposal, status reports, technical information updates, and the Senior Design Conference PowerPoint presentation. Outcome (p) for each of the project groups is also assessed further by the course instructor and the project's technical advisor. These assessments are done using other rubrics not shown in this paper.

After the spring semester of 2009, the Capstone course assessment results showed that two of the program outcomes stood out as missing their goals by a large margin. Outcomes (m) and (p), with the seven project teams scoring an average of only 5.5 out of 10 on the rubric (Figure 1), were well below the goal of an 8 out of 10. The Capstone course instructor looked for reasons why these outcomes were so poor that year, and decided that what had changed in the course process was that a project webpage was not used by the project teams that year, as had been required in the past.

When the Capstone course instructor first began requiring project webpages for Capstone projects in the spring semester of 2005, the university used the WebCT course management system, which is now a part of Blackboard. At that time, WebCT's Student Presentation feature allowed the course instructor to set up teams within the software, and the teams could set up their own html-based Homepage and links to other information needed. The final written reports done by the students for 04/05 projects showed a marked increase in quality, especially with regards to documenting their design process. However, the Capstone course instructor did not gather specific evidence at that time to prove this assertion.

In the fall of 2008, the university switched from WebCT to the D2L course management system. The Capstone course instructor did not find any function within D2L that was equivalent to the WebCT Student Presentation feature. (D2L has a separate software package called ePortfolio, which would probably suit the purposes of a project webpage, but the university did not purchase that software option.) D2L does include a "Group Locker" function that stores files in a common location accessible only by the group and by the class instructor. Any member of the project group can upload files to the locker. For the Capstone projects 08/09, the course instructor decided that the group locker function would be sufficient for the function of saving and sharing project information, and required its use. The course instructor checked periodically during the year to make sure groups were using the lockers to store information needed by the project. However, in the locker there is no organizing structure available, as there is when a webpage and links must be maintained during the course of the project execution. So the group locker acted as a big box to throw papers in, where they were confused and then ignored. The final written reports for 08/09 were assessed as much poorer than the past years, in such areas as how well the design process was documented. Many of the final written reports did not even include documentation that was present as files in the group locker.

In the summer of 2009, with the poor results of the final written reports of 08/09 in hand, the Capstone course instructor searched for a way to reinstate the project webpages requirement. There are many types of software available for writing and maintaining webpages, and many commercial sites, that for free or a low cost, will host web sites. The course instructor did not like any of the options he investigated, due to the fact that commercial ads are present on most sites, that a true homepage/supporting links structure were often not clearly apparent, and that these webpages would have no real protection from harmful software attack.

Further research into D2L revealed the little-used (at least at this university) software feature called “User Homepages”. This feature is meant to be used as a Facebook-type self-introduction page by each student individually. It allows a homepage with links to supporting documents, with folders for those documents provided within D2L. But with some prior setup and organization by the course instructor, the User Homepage can be used as a group project webpage. In 09/10, a project webpage was again required for the Capstone course.

A rubric was developed to evaluate the project webpage use during the course of the project. This rubric was changed and updated as the year progressed, and no consistent data was gathered on group scores as the project progressed. That data will be gathered next year. The format of the rubric, as can be seen in Figure 2, is such that the course instructor puts in a checkmark to indicate the level of achievement of that particular item. This is done in order to reduce the instructor’s workload. Addition comments can be added at the end. The project group gets this filled-out rubric returned and they can see specifically what items are missing, or are insufficient, and can correct those problems.

EET 470/471 Capstone WebPage Rubric				
Project Name			Date Assessed	
These items are evaluated in the Formal Project Proposal – just need to be present				
	Present - 1	Not Present - 0		
Title Block (Names, etc.)				
Abstract				
Charter				
Formal Project Proposal				
PowerPoint from Conf.				
Need to be updated during project. If an item is not needed for this project, or is not required to be done yet, do not score it				
Reports	Excellent – 3 Updated on schedule	Good – 2 Missed 1 update	Fair – 1 Missed 2 or more updates	Not Present - 0
Gantt Chart				
Customer Reviews				
Status Reports				
Deliverables Table				
Justification Statement				
Technical Information	Excellent - 3 Up to date – matches project status	Good - 2 Behind by 1 date/revision	Fair - 1 Behind by 2 or more	Not Present - 0
System Diagram				
Links to similar projects				
Research List of webpages				
Other pictures/drawings				
Circuit schematic				
Links to spec sheets				
Enclosure drawings				
Parts list w/ Costs				
Software listings				
User’s Manual				
Total - % of possible points				

Figure 2. Project Webpage Rubric used in Capstone course

The requirements of webpage use are clearly defined for the project groups in documents available to them in the D2L page for the course. Appendix 1 shows a summary of the details of how the webpage process is used currently in the EET Capstone course. Appendix 2 shows an example of a final group project homepage from 09/10.

Data on the assessment of the final written reports were gathered at the end of the year 09/10, and compared to the past three year's performance, as seen in Figure 3. The data shows a clear drop in student performance on the portion of Outcomes (m) and (p) assessed by final written report Rubric A7 (Figure 1), for the year when a project webpage was not required, and a return to much better results when the project webpage requirement was reinstated. With only five to seven project groups each year, there is not a large enough data set to analyze and call this a statistically significant result, but common sense says it is a significant result.

Year	# of project groups	Project Webpage?	Assessment results from Outcomes (m) & (p), using Rubric A7. (average on a 10 pt scale)
06/07	6	WebCT Student Presentation webpage	8.2
07/08	6	WebCT Student Presentation webpage	7.8
08/09	7	D2L – Group locker use only	5.5
09/10	5	D2L User Homepage webpage	9.4

Figure 3. Four years of assessment data of a portion of Program Outcomes (m) and (p) from the Capstone course

The 09/10 results were also higher than in 06/07 and 07/08, but the capstone course instructor attributes that to a specific effort by the instructor that is probably not repeatable on a consistent basis. Because the final reports were so bad in 08/09, the capstone course instructor spent the year constantly reminding the groups to update their webpages and the importance of the final written report, to the point of "nagging" the students. Because a good process is back in place; a required project webpage, the nagging should not be required in future years. The results of assessment will be examined closely after the 10/11 year to ensure this is true.

In addition to the web page and final written report data assessment detailed above, the use of project webpages in Capstone student projects has had a few pitfalls, and many successes, which can be detailed as:

Pitfalls:

- The D2L User Homepage feature is an awkward system, being used in a way for which it is not intended. Students require extensive help from the course instructor when starting to use the webpages and creating links.
- If a student uses the D2L User Homepage function for this course, he/she can't use it for another course.
- In this 2-semester sequence course, the group locker files in D2L will not transfer automatically to the new semester. However, the students and/or instructor can make a

Zip file of the files in the group locker, download, and then upload the files to the new course.
- The project group member delegated the task to keep the webpage updated must be chosen carefully. Even if all the other team members are updating the group locker on a timely basis, none of that is apparent if the project webpage isn't updated.

Successes:
- Groups do not need to wait for a missing member of team, and any data that only he/she has, to continue work on the project.
- Students keep track of their researched technical information more readily when they have a place to save it to right away.
- Students will save more technical information when they can just save a file or a link to the project group locker, rather than having to print and save pieces of paper.
- Status reports are submitted and Gantt Charts must be updated on a regular basis, so students realize their progress or lack of progress.
- Tracking student progress is less time consuming for class instructor. The instructor checks webpages on Fridays every two weeks, and assesses them quickly using the rubric, which is much less time consuming than sorting through piles of paper submitted or following up on papers not submitted.
- The instructor can see if groups actually have the technical details that the Status Reports say they have.
- Although this is not assessed in a formal way, the course instructor believes that because all students in the Capstone course can see other groups' webpages, this produces positive peer pressure that improves the webpages overall.

Conclusion

Requiring a project webpage is an important tool for successful Capstone projects, as documented by improvement in assessment of specific Program Outcomes. The SDSU EET program is convinced that the use of project webpages is a good communication, project management, and project design tool, and will continue to require its use in the Capstone course.

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Appendix 1. SDSU EET Capstone Webpage Process Detailed

Because of the software structure of the D2L User Homepage function, only one student in each group can make changes to the project homepage, but all members of the group can upload to the group locker. From there, it is one of the assigned roles of the project group to update files from the group locker, and to maintain the group webpage. The course instructor gets the specific URL address of the User Homepage from the project team member, and posts that address in D2L so all students in the Capstone course, including students on other project teams, can see the resulting webpage and follow the links.

The linked files can be in many of the software formats that are useful for the project, although D2L does not accept some kinds of files, such as Microsoft Project *.mpp files. The course instructor provides workarounds for the students, such as instruction in how to make a screen-capture snapshot of the MS Project Gantt Chart, and then insert the picture on the homepage, instead of linking to a file. D2L accepts:

- Word for proposals and status reports
- Excel for data collection and presentation
- PowerPoint for the team's Senior Design Conference presentation
- MS Project Gantt Chart screen snapshots (jpg) for project tracking
- HTML for the project homepage and for links detailing technical information
- JPG scans of technical catalog figures or pages
- PDF for all other types of files, including CAD files;

whatever is needed to detail the technical project.

The milestones that must be met for the two-semester Capstone project can be detailed as (with items marked with a (*) required to be on, or linked from, the project homepage):

- Choose team and project
- Write a *charter, and get the project approved
- Write a *formal proposal with specific project goals and deadlines
- Develop and update a *system diagram with *technical details proposed
- Maintain a *Gantt Chart that is updated as the project progresses
- Write *status reports and *customer reviews on the project's progress
- Produce a *PowerPoint and present at the Senior Design Conference at the end of the first semester
- Build and test a prototype of project/ *technical details updated
- Complete a *project review early in the second semester
- Build and test the final project / *technical details completed
- Present project at the Engineering Exposition at end of second semester
- Produce a *final written report

The course instructor provides in D2L an example project homepage for groups to see and/or emulate. This example page demonstrates minimum requirements; the students may do more. The instructor also posts the workarounds and specific software instructions needed to make the D2L User Homepage work for this purpose. The Capstone course instructor is not satisfied with the D2L User Homepage structure and workarounds required, and so is continuing to search for a better place to host the project webpages.

Appendix 2. **Example of a Project Group Homepage with Links to Subpages**

This homepage has been slightly reformatted to fit this portrait-orientation paper. The links, marked by an underline, are not active in the electronic form of this paper.

RFID Drink Dispenser

Project Team Members: XXX, YYY, ZZZ
Technical Advisor: XXX
Customer: XXX
Last Updated: 4/27/10

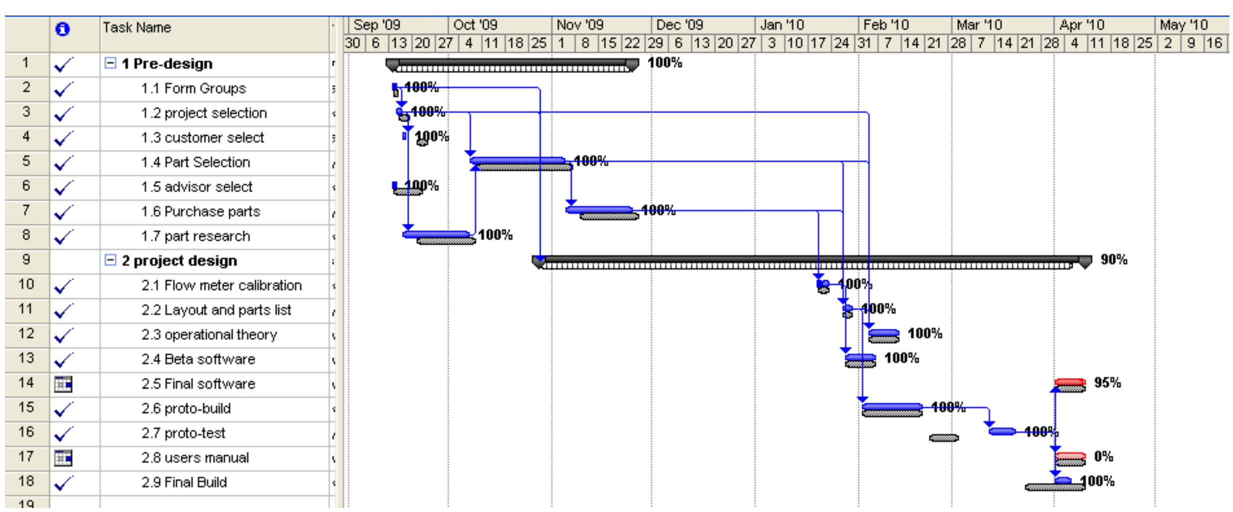
Abstract/Summary

Our project team designed and built a beverage dispenser capable of tracking quantities dispensed per individual using RFID tag identifiers assigned to them. This system will allow our customer to proportionally distribute costs to the individual users when they choose to settle their tab. We completed this project by April 10, 2010 for a cost of $240.00.

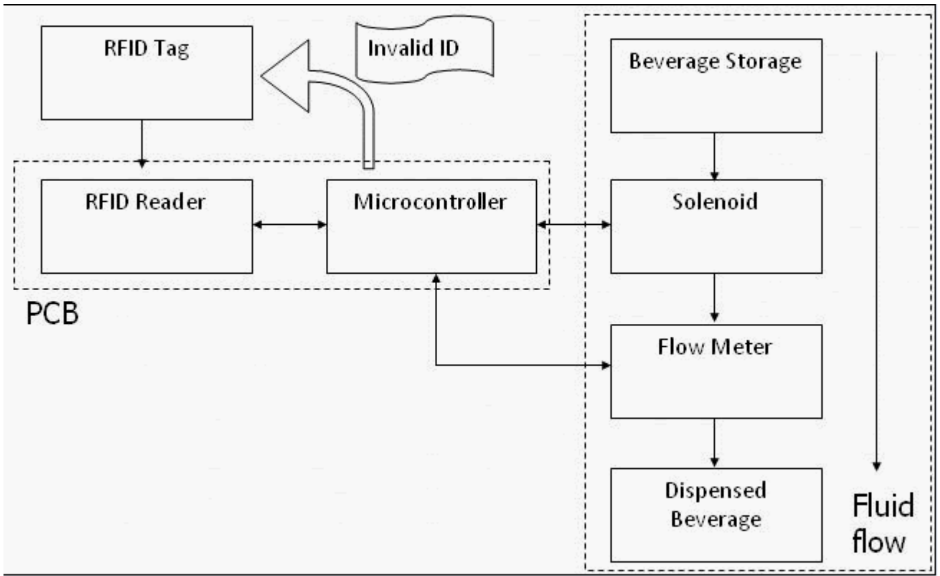
If this project was to be done in industry each of our 3 team members would be paid an hourly rate of $19.23 /hr. With each of the team members working 3 hours each week for the 27 weeks until completion the labor costs would reach $4672, for a total of about $5500.

Our system works by running the main software on a Basic STAMP microcontroller. A RFID reader will identify the individual using the system, and then allow that individual to dispense the beverage. The quantity dispensed will be tracked by a digital flow meter connected to the microcontroller. The microcontroller will have an array of the accepted RFID tags, when the tag is verified by the RFID reader; the microcontroller will output who used the system, what time they used it, and the quantity dispensed.

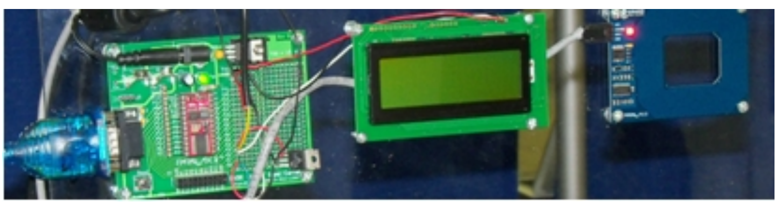
Gantt Chart



System Diagram

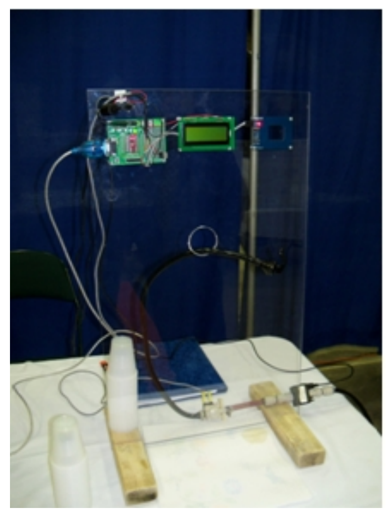


Final Project Pictures



BASIC Stamp module LCD Display RFID module

System mounted for display



Formal Documents	**Data Sheets**	**Other**	**Report/Review**
Formal Proposal	Super Carrier Board	Deliverables	Status Reports
Powerpoint	BS2e MODULE	Software Flowchart	Customer Reviews
Charter	RFID Reader	Parts List	
Final Report	Flow Meter	Schematic	
	Solenoid	User Manual	
	TIP29	Final Code	
	LCD		