Creating Corporate World Experience in Capstone Courses

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\textbf{Abstract} - Many engineering capstone courses require senior design projects involving teamwork. The curricula at the University of Arkansas at Little Rock Donaghey CyberCollege engages local industries in providing meaningful design projects for student teams in real world settings. Both St. Vincent Health System and Heifer International sponsored capstone design teams in yearlong projects. These projects resulted in the students gaining professional skills, the industries gaining products that saved money and won awards, and the CyberCollege faculty gaining understanding and experience for developing its engineering curricula. Engineering educators who want to provide real-world experience to graduating seniors may benefit from learning how we obtained corporate sponsors for the projects, created student-consulting teams, and developed a capstone course incorporating system design theory. They may also gain insight from discussions about our methods for student evaluations and about the lessons we learned from our experimental capstone course.

\textbf{Index Terms} - Capstone course, Corporate experience, Engineering curricula, Senior design projects.

\section{INTRODUCTION}

In many engineering programs, the term “Capstone Course” often replaces the term “Senior Design Project.” Though the names differ, most instructors agree that final projects for engineering or information science (IS) majors should stress professional skills as well as design education [1] – [4]. Often, instructors attempt to accomplish this goal in the classroom through a variety of teaching paradigms [5]. At the University of Arkansas at Little Rock (UALR), the faculty in the Donaghey College of Systems Engineering and Information Science (CyberCollege) has honed its students’ professional skills and sent them keenly into the “real world” with a unique curriculum for senior design projects. The capstone course, a collaboration with local industries, proved to benefit both students and community, while giving students the experiences needed for stepping into engineering and IS careers.

The UALR CyberCollege uses Industrial Advisory Committees, consisting of local industry leaders, to help design the curricula in its six departments. This allows students to learn the skills that industries need. A natural extension of these committee relationships helped faculty design senior project courses involving real-world problems for students to solve. In the Department of IS, two such industry partners, Heifer International (Heifer) and St. Vincent’s Health System (SVHS), asked capstone teams to work on-site completing senior design projects, and the results were a “win-win-win” situation for all:

- Students gained professional skills;
- Industries received useful products; and
- Faculty successfully engaged students in meaningful education that prepared them for mixing academic theory with industrial practice.

Though the projects were different, the final products and presentations were similar in scope and accountability. As with most “real-world” problems, our student consulting teams found they needed to adjust the “textbook” system-development theories as they applied them to specific tasks. Both teams showcased the skills our IS students have to offer to the community. The corporate sponsors reported that the student teams saved them over $150,000 in consulting services plus a projected savings of thousands annually in overhead and operation costs. Also, one project team helped its sponsor earn both state and national awards for interactive communications from the Public Relations Society of America.

Engineering educators who want to provide real-world experience to graduating seniors may benefit from learning how we obtained corporate sponsors for the projects, created student-consulting teams, and developed a capstone course incorporating system design theory. They may also gain insight from discussions about our methods for student evaluations and about the lessons we learned.

\section{OBTAINING CORPORATE SPONSORS}

This capstone course design aimed to give students real corporate world experiences, so we began planning months in advance for the senior projects [6]. The CyberCollege’s Assistant Dean of Corporate Relations contacted local knowledge-based companies in late spring before the course’s scheduled beginning in Fall. The Industrial Advisory Committees became the starting points for contacts, and members helped orchestrate senior design projects with the businesses they represented.

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Suitable projects for faculty consideration allowed students to use classroom skills learned in the first three years of the IS curriculum, especially in Internet and database technologies. Additionally, corporate sponsors had to provide project leaders who could mentor students and who could meet regularly with faculty and students.

After many on-site visits and interviews with several knowledge-based companies, the faculty chose St. Vincent Health System (SVHS), a statewide healthcare provider, and Heifer International, a worldwide non-profit organization headquartered locally, for sponsors of the senior projects. We chose two companies because seniors enrolled in the capstone course could be grouped into two teams of three to five students each. Both companies assigned mentors to the student-teams, and both had huge needs for improving intranet and database infrastructures. During summer, corporate and faculty leaders held meetings to discuss:

- Outline of project expectations and accountabilities
- Protocol for student conduct and accountability
- Student teamwork issues and expectations
- Student evaluation and grading policies
- Student confidentiality agreements
- Distribution of company material and websites for student review
- Semester schedule for on-site meetings with student teams, faculty members, and corporate project leaders

At the beginning of the Fall semester, the students, departmental faculty, Assistant Dean of Corporate Relations, and employees of Heifer International and SVHS met to cover these project topics and answer student questions. Students were assigned team members and were introduced to the corporate project leaders of their capstone projects. Students were not given a choice about the teams or companies with which they would work, since balancing personalities and group chemistry was an experience we wanted to incorporate into the course’s design. All subsequent meetings between student teams and corporate leaders were held on-site at the companies’ offices.

Creating Student Teams

Two criteria we expected from the course were: 1) that students would receive “real life” experiences working in the corporate world, and 2) that students would use the classroom knowledge and skills from their first three years of IS coursework. To accomplish these goals, we asked students to create “mock” consulting companies for working with corporate sponsors. Students selected names for their companies, NeXus Technology Consultant Group for the SVHS project and Merito Consulting for the Heifer project, and they elected presidents to whom team workers reported.

Although collaborative groups took different shapes and functioned in different ways, faculty members lectured on guidelines to help the students create “mock” consulting companies. The following guidelines helped them set up and maintain their “businesses” [7]:

- Choose a team leader or management team
- Define tasks for team members
- Establish working procedures & work schedules
- Create evaluation materials
- Involve outsiders

Team leaders were responsible for keeping the teams on track, leading team meetings, and coordinating communication among members. Team members and leaders also determined job titles, depending on each student’s specific area of expertise, and the project’s division-of-labor plan as well as each member’s responsibilities.

To prevent problems during the two-semester long course, team members developed work procedures to cover meetings, communications, and conflict resolution. Faculty and business project leaders helped greatly in establishing working procedures. Questions that team members addressed at the start of the capstone course were:

- When and where do we meet?
- What procedures will we follow in the meetings?
- How do we communicate with other team members?
- What access do we have to people in business and faculty outside the department?
- What procedures will we follow to resolve conflict among team members?

A large part of the project was to create the actual products that corporate clients could use, called “deliverables.” The consultant companies kept logs of each student’s weekly accomplishments (papers, forms, etc.) in order for the team to reach its final goal. Team leaders tracked attendance at team meetings and required weekly reports from team members showing their assigned accomplishments and “billable hours.” Each student was required to put ten hours a week into the project.

Faculty and business project leaders set evaluation and grading procedures, but students had a large voice in the evaluations, as grades for the capstone course were a composite of evaluations from faculty members, corporate project leaders, and student team members.

In addition to working with corporate and faculty advisors, students were also instructed to ask other professionals for help [8]. Since these projects involved areas such as management, accounting, or industrial psychology, students needed to meet people who had experience in these areas. The CyberCollege’s Industrial Advisory Committees were invaluable for giving this support as were faculty members in other departments.

Throughout the two semesters, each student team met bi-weekly with respective corporate sponsors and faculty.

Designing the Capstone Curriculum

Course Methodology

In the past, many senior design project courses were one-semester long. Standard practice involved a typical classroom lecture format [9]. Usually, instructors handed projects to...
student teams for solutions, and students often did not experience all typical stages for solving “real-world” projects. We saw that a standard lecture format was ineffective for giving students corporate-world experiences. Students did not always remain attentive during lectures, and they did not grasp the associated skills in design stages when these were not relevant to classroom projects. So, we completely revamped our course design. If students were to gain corporate-world experiences and understand all design stages, then the capstone course needed two semesters.

Shelly, Cashman, and Quasney [10] and Satzinger and Orvik [11] suggest six phases of a System Development Lifecycle (See Figure 1), which allow for some variations, depending on the specific problems to be solved. The first semester consisted primarily of the first three phases of the Lifecycle—analyzing requirements, designing a solution, and validating the design. The second semester focused on the last three phases—implementing the design, testing the solution, and documenting the solution. Each project phase included specific tasks that the teams followed, and each task, usually resulted in a completed “deliverable.”

**Analyzing Requirements:** The consultant teams worked closely with sponsors to determine the projects’ specific needs. They first analyzed needs by interviewing actual employees who used the companies’ information systems. Students then defined a new system and determined their intended goals in order to organize the projects. They verified that company requirements were complete and that teams had all information to solve the problems. Then, they decided the system definition and scope and documented a purpose that was understandable for the company and feasible for the consulting team, thus giving a starting point for development [12].

**Designing the Solution:** Once the project’s requirements were known, the students began to design a solution. The second phase of the course involved investigating and documenting the project plans in detail in order to accomplish the intentions. Team members tracked their accomplishments and reported these to project and team leaders weekly. Students tracked their “billable hours” by recording their hours and specific tasks in typical “work weeks,” which often involved working eight hours “on site” at the company and two hours at the university. At the end of the Design Solution phase, teams had detailed records about the projects’ goals and accomplishments.

**Validating the Design:** Each team looked closely at its methodologies and kept a log of what it was doing and who was doing what. These weekly logs showed the deliverables set for each team member and tracked students’ accomplishments and attendance at required team meetings. These weekly deliverables helped validate the team’s project design. The design validation made certain that all necessary requirements were included in the initial document. Once the requirements were known and agreed upon, the teams began to specify how to implement a technological solution. The teams stepped through the solution design with test data. Both the team members and companies had to agree that the design solved the problem put forth in the requirements.

**Implementing the Design and Testing the Solution:** These two phases describe the process of creating the system and putting it into actual use. As shown in Figure 1, some System Development Lifecycles separate these into two phases, but both phases verify that the project’s requirements are met. The end result of implementation included documentation of any problems with the application or team project. So, for the practical purposes of these projects, both phases were simultaneously accomplished.

**Documenting the Solution:** The final stage documented the completed project, including requirements, design documents, cost and billable hours, computer code, and written proof of successfully completed test cases.

**Evaluating and Grading Students**

During the first semester, students focused on the first three phases of the System Development Lifecycle. These phases could be described as the “discovery” stage of the project. The purposes during these phases were to work closely with the company in the assessment of the project and define the full project scope. Students chose a project and defined its goals, objectives, and deliverables with emphasis on “real world” tracking and performance. Thus, a large percentage of the first semester grade was based on how well the scope of the project was defined, using the following three criteria:

- Assessment and determination of project scope  
  40%  
- Fall Semester deliverables  
  30%  
- Fall Semester exam and final report  
  30%

Each semester grade was a composite evaluation from the business project leader (40%), the faculty (40%), and other team members (20%). A report and presentation, which contributed heavily to the grade, were given on-site to the business and faculty project leaders.

In the second semester, students moved into the final three stages of the System Development Lifecycle. So, grading was based on the deliverables that teams produced.
and how well each was documented. Second semester grades were based on the following:

- Second semester deliverables 50%
- Documentation of project and final presentation 50%

**Documenting and Presenting Project Reports**

Since these capstone courses involved real businesses making real decisions, good project reporting was essential for the companies to make sound judgments. The faculty gained students' details (Table I) for documenting their research [7, 13]. The teams' analytical reports answered:

- What are the facts, and how do you know?
- What do you conclude from these facts?
- What do you recommend that the business do?

<table>
<thead>
<tr>
<th>Guideline</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Be specific in describing the problem</td>
<td>Tell the methods you used to solve the problem, providing specific evidence. The best evidence includes costs &amp; savings. Also cite examples of increased productivity.</td>
</tr>
<tr>
<td>Use the same strategy to research the different methods for solving a problem.</td>
<td>If one method saves the business 5% and another saves it 10%, the business will better understand which to choose if you use the same strategy to research both methods.</td>
</tr>
<tr>
<td>Describe the methods in detail.</td>
<td>Businesses need details to better compare your methods for reaching a solution. Present all the facts for each method.</td>
</tr>
<tr>
<td>Describe your findings in accordance with the business’s needs.</td>
<td>If the business understands your subject sufficiently and wants more in-depth results, provide them.</td>
</tr>
<tr>
<td>After writing the report, have someone review it.</td>
<td>Give the report to an unbiased reader outside the field, who should be able to read it and understand.</td>
</tr>
</tbody>
</table>

**TABLE I**

**GUIDELINES FOR PROVIDING FINAL PROJECT DOCUMENTATION [13]**

The reports also needed evidence of trustworthy information and accuracy. Problems may become compounded with collaborative reports--several persons contribute text, different people do graphics, and still others review it for technical accuracy. The teams’ weekly logs and records proved valuable for reporting and for proving that teams used reliable methods to convince sponsors that the projects could help them improve their information systems. In addition to final reports, 45-minute oral presentations were also required. Instructors lectured on analyzing audiences, practicing speeches, and using effective graphics [7], [14] -- [17]. Final presentations included audiences from Industrial Advisory Committees, CyberCollege faculty and students, and employees from sponsoring companies. Presentations highlighted the teams’ accomplishments and the students’ assessments of the experience.

**RESULTS**

In addition to gaining valuable corporate-world experience, both teams provided improvements to the companies’ information systems while learning system development. They also made career connections for employment opportunities after graduation.

Both teams followed the System Development Lifecycle in theory, but as in the real world, adjustments were made to fit specific problems and corporate situations. Table II shows how teams moved through the Lifecycle during the two-semester course, modifying it to circumstance.

**St. Vincent Health System Capstone Project**

The NeXus consulting team at SVHS had the primary objective of providing the company with a seamless upgrade from paper forms to an automated system with paperless web-format. After interviewing employees in the Information Services Administrators group, NeXus consultants identified a major problem associated with using multiple paper forms and calculated the cost savings if SVHS implemented automated forms via the intranet. The team developed a plan that addressed this, gave methods for solutions, and mapped details of goals and strategies.

The Nexus team created software using ASP.NET and successfully integrated it with the SVHS intranet. It was able to create a paperless workplace, calling its database driven web application “FormCenter.” Students worked closely with SVHS to create a user-friendly interface for people lacking computer skills. The FormCenter has universal platform accessibility, so employees with badge identification numbers and intranet access can use it.

The organizational benefits to SVHS were enormous—hospital officials say it will save them $100,000 in consulting services and several thousand dollars annually in overhead and operations. The company also reported the new system will eliminate the hospital’s triple carbon copy paper forms that require large rooms filled with file cabinets. Because it uses the .NET technology, the company can easily add additional modules to FormCenter when needed.

**Heifer International Capstone Project**

The Merito Consulting team working with Heifer International began design of an Automated Request Management System (ARMS) for the Information Services Technical Support Department. To ensure that the department could provide the services necessary to support the overall organization, it needed tools and processes in place to support its employees and to provide a comprehensive, integrated service desk that would allow it to automate processes, accelerate incident resolution, and provide real-time visibility of infrastructure assets.

The majority of the first semester focused on analyzing and documenting criteria that justified the company’s purchase of the ARMS solution software. The second semester focused on selecting and evaluating the proper software, according to the previously developed criteria. The
the project was necessary, albeit challenging. However, Merito Consulting was not able to fully install and test its solution due to purchasing delays and end-of-semester time constraints. Thus, its final report could not analyze how well the ARMS solution software fulfilled the organization’s needs. The project nevertheless was a success in that the organization received well-researched criteria and advice on which to base its software decision. Heifer estimated a savings of over $80,000 in consulting fees. It expects to reap even more benefit from the hours that employees will save by using the new ARM System.

**DISCUSSION**

At a time when universities have limited resources for corporate internships and cooperative education programs, students are often not exposed to corporate cultures until getting their first jobs. The positives become apparent for creating a capstone course where students get corporate real-world experience: Students learn industry standards and professional skills that use cutting edge technologies; faculty gains insight into teaching strategies that provide students with skills that industries truly need; and corporate sponsors save money, receive well-researched solutions to business problems, and have the opportunity to train potential employees who are the university’s brightest.

After completing these courses, students reported feeling prepared for transition from college to careers. They made important professional contacts, and both sponsors asked students about employment at these companies upon graduation. Students were also able to put this “working” experience on resumes, using project leaders as references.

Though our students admit they underestimated how much work the projects involved, they believe the experience was invaluable. They learned how to work as a team to accomplish tasks, a skill that gives an added edge with employers. Many say this course was one of the most important components of the CyberCollege’s curriculum.

As with any newly designed course, insight comes after the first year in terms of the course’s functioning. Students could not always easily work ten hours a week off-campus, and both students and faculty often found the physical logistics taxing with busy class schedules. Since most seniors in our program have Fridays free from course work, most of the off-campus work was scheduled then. This solution, however, was not always convenient for business leaders. So, working out a nine-month meeting schedule for the full-length of the project is necessary, albeit challenging.

<table>
<thead>
<tr>
<th>TABLE II</th>
<th>PROJECT DEVELOPMENT FOR CAPSTONE TEAMS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>St. Vincent Health System</strong></td>
<td><strong>Heifer International</strong></td>
</tr>
<tr>
<td><strong>First Semester:</strong></td>
<td><strong>First Semester:</strong></td>
</tr>
<tr>
<td><strong>Analyze Requirements</strong></td>
<td><strong>Analyze Requirements</strong></td>
</tr>
<tr>
<td>• Determine project scope</td>
<td>• Determine project scope</td>
</tr>
<tr>
<td>• Analyze available resources</td>
<td>• Create work plan</td>
</tr>
<tr>
<td><strong>Design Solution</strong></td>
<td>• Create communications strategy</td>
</tr>
<tr>
<td>• Define project</td>
<td>• Assess needs through interviews</td>
</tr>
<tr>
<td>• Identify SVHS users’ rights</td>
<td>• Establish advisory board</td>
</tr>
<tr>
<td>• Select calendar control interface</td>
<td>• Determine implementation budget</td>
</tr>
<tr>
<td>• Verify users’ badge numbers</td>
<td>• Develop potential ARMS vendor list</td>
</tr>
<tr>
<td>• Develop software for paperless form center</td>
<td></td>
</tr>
<tr>
<td><strong>Validate Design</strong></td>
<td><strong>Validate Design</strong></td>
</tr>
<tr>
<td>• Meet with SVHS group to validate solution</td>
<td>• Match potential solutions with ARMS vendors</td>
</tr>
<tr>
<td>• Validate use of badge numbers</td>
<td>• Create “Request for Proposal” for ARMS vendors to submit</td>
</tr>
<tr>
<td>• database verification process for each user</td>
<td>• ARMS vendors demonstrate the product and solution</td>
</tr>
<tr>
<td>• Create database-driven web application</td>
<td>• Use “Decision Analysis” form for discussing selection of vendor</td>
</tr>
<tr>
<td>• Compile software code</td>
<td>• Give recommendation of selected ARMS vendor to Heifer</td>
</tr>
<tr>
<td><strong>Second Semester:</strong></td>
<td><strong>Second Semester:</strong></td>
</tr>
<tr>
<td><strong>Implement Design and Test Solution</strong></td>
<td><strong>Design Solution and Validate Design</strong></td>
</tr>
<tr>
<td>• Install hardware and software</td>
<td>• Identify appropriate staff to evaluate ARMS vendors</td>
</tr>
<tr>
<td>• Test software</td>
<td>• Research and price solutions with ARMS vendors</td>
</tr>
<tr>
<td>• Test interfaces and integrate with other applications</td>
<td>• Match potential solutions with documented requirements</td>
</tr>
<tr>
<td>• Develop custom paperless forms</td>
<td>• Create “Request for Proposal” for ARMS vendors to submit</td>
</tr>
<tr>
<td>• Complete pilot testing</td>
<td>• ARMS vendors demonstrate the product and solution</td>
</tr>
<tr>
<td><strong>Documentation and Project Closure</strong></td>
<td>• Use “Decision Analysis” form for discussing selection of vendor</td>
</tr>
<tr>
<td>• Finalize policies and procedures</td>
<td>• Give recommendation of selected ARMS vendor to Heifer</td>
</tr>
<tr>
<td>• Activate production system</td>
<td>• Negotiate and approve contract</td>
</tr>
<tr>
<td>• Complete two trial runs</td>
<td><strong>Implement Design</strong></td>
</tr>
<tr>
<td>• Final report and presentation</td>
<td>• Develop detailed implementation plan and budget for selected ARMS solution</td>
</tr>
<tr>
<td><strong>Second Semester:</strong></td>
<td><strong>Implement ARMS solution</strong></td>
</tr>
<tr>
<td><strong>Design</strong></td>
<td><strong>Test ARMS solution</strong></td>
</tr>
<tr>
<td>• Identify appropriate staff to evaluate ARMS vendors</td>
<td><strong>Train staff to use ARMS</strong></td>
</tr>
<tr>
<td>• Research and price solutions with ARMS vendors</td>
<td><strong>Documentation and Project Closure</strong></td>
</tr>
<tr>
<td>• Match potential solutions with documented requirements</td>
<td>• Develop evaluation criteria</td>
</tr>
<tr>
<td>• Create “Request for Proposal” for ARMS vendors to submit</td>
<td>• Complete project documentation</td>
</tr>
<tr>
<td>• ARMS vendors demonstrate the product and solution</td>
<td>• Final report and presentation</td>
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Another problem that many group projects experience is that some students work harder than others. In most circumstances, the course’s corporate nature helped motivate team members who did not accomplish a weekly work assignment. Team leaders and corporate mentors became quite stern in making sure that all students did their assigned tasks to keep the project running smoothly. If students fell short of producing a “deliverable,” an individual meeting was immediately scheduled to correct the problem. With the team members monitoring themselves, a corporate mentor monitoring the team, and a faculty member monitoring the
team and process, students had many “bosses” to whom they answered. They were more inclined to complete their assigned tasks in order to reach a common goal.

As this was the first graduating class from our newly formed Department of IS, this first-year experience with two senior project groups was small and involved only seven students. While groups of three and four students were manageable for mentoring and monitoring, we realize that future changes may be needed as our program grows. A program with 50 or more seniors could easily become overwhelming for faculty to direct and monitor. We intend to limit the number of students to three to five per group. With more than five students per group, faculty would have a difficult time coordinating schedules for meetings. With less than three, the faculty could not create a meaningful “group” project experience with a feel for teamwork.

Even though business project leaders devoted extra time to manage the course, the benefits to the company were great. The teams successfully saved both companies thousands in consulting fees and delivered products which will enhance efficiency for years to come. Also, the companies were able to “test” serious job-seeking candidates. The project resulted in jobs and future employment opportunities for many of the students.

Faculty also benefited from watching the seeds of three-years’ classroom instruction grow into fruitful and successful products in the “real world.” It also made business contacts for future research opportunities, and the publicity surrounding SVHS’s state and national awards for its paperless system has been a boon to our program.

The corporate capstone project also raised the IS curriculum. In order to make its students more employable, the department will add more team projects in lower-level courses. Also, with the wide use of .NET technology in industry, faculty members intend to emphasize this more, giving students more marketable skills. The department will add more business management essentials to all IS courses and a project management course to the curriculum.

With this capstone course design, we are convinced that no classroom activity can substitute for our students’ “real world” working experiences. The students learned and retained more skills in corporate environments than we could teach in the classroom, and all parties—students, faculty members, and sponsors—were winners.

ACKNOWLEDGMENT

We would like to thank St. Vincent Health System and Heifer International for hosting the capstone courses, the success of which rested on the project leaders: Shawn Shuffield, Dan McFadden, and Douglas Smith of SVHS; and Bradley Clayton at Heifer. We also thank the talented students for their hard work and help with this effort.

REFERENCES


