

## **2007: TEAM TEACHING CAPSTONE DESIGN**

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# **Team Teaching Capstone Design**

## **Abstract**

This paper describes a team taught capstone design course and outlines some of the logistical issues for the student (grades), faculty advisor (time), industry representative (standards), and coordinator (consistency). It describes a set of best practices that include consensus on course objectives, integration of an industry representative, checks and balances, clear expectations and roles, published grading rubric, assignment of advisor and industry representative by their choice, and strong communications. Since no two institutions are the same, these recommendations will require adaptation for successful implementation.

## **Introduction**

Many institutions offer a capstone design course to provide engineering students a culminating design experience. Of the many possible teaching paradigms, team teaching results in several advantages while it presents many challenges and opportunities. In this paper, we look at a specific team taught course, outline the logistical challenges, and provide a set of best practices and recommendations.

The reader should acquire a good understanding of the key issues and become aware of some techniques in practice today to resolve them. No one capstone design course will fit every institution's setting and environment, so the suggestions may or may not apply to your specific course. We assume the reader is familiar with the basics of team teachings and wish to implement it in a design course. Here, we focus on the logistical challenges and do not attempt to convince the reader that team teaching works or even makes sense.

In the next section, we describe a team taught course that has not experienced major changes since the fall of 2002. Then, we very briefly review the advantages to this approach. Following this, we discuss the logistical challenges in detail and what they mean to the student, faculty, industry representative, and the coordinator. And finally, the last section provides a set of best practices and recommendations for implementing a team taught capstone design course.

## **Description of a Team Taught Capstone Design Course**

In this part, we describe the structure of a specific team taught capstone design course. We roughly divide the overview into the areas addressed in the 2005 national capstone design survey<sup>1,2</sup>. Additional details may be found in an ASEE paper<sup>3</sup>.

We begin with a look at the institutional profile as outlined in Table 1. This sets the environment for the course and offers insight into key organizational selections. The University of Portland consists of a

small, private university with an emphasis on teaching. It is located in the Pacific Northwest and a region of the country often referred to as the *Silicon Forest*. As such, the university offers an

urban setting within the City of Portland, OR. Primarily, students live on campus with some upper class students living off-campus. The greater community includes a number of high-technology companies such as Intel, Tektronix, Hewlett Packard, Xerox, IBM, Sun, TriQuint, Lattice, Credence, Mentor Graphics, Mathstar, Yahoo, Hitachi, Sharp, and Pixelworks to name a few.

**Table 1. Institution Profile.**

Name	University of Portland
Type	Small, private, teaching
Region	Pacific Northwest
Location	Urban, City of Portland, OR
Campus	Resident
Community	Local high-technology

As listed in Table 2, the course information appears like many other institution's offering. Design teams consist of both department-only and interdepartmental teams. The later would include students from the computer science and electrical engineering

programs. Typically, there are 10 – 12 teams-per-year. The course contains both a lecture and a project component offered at the same time and it spans two semesters or one academic year. The first semester is always fall. In lecture, topics include both professional skills and project management subjects.

**Table 2. Course Information.**

Team type	Department, interdepartmental
Interdepartmental	Computer science and electrical engineering
Structure and sequence	Class and project in parallel
Duration	Two semesters, fall then spring
Topics	Professional skills and project management

All of the Electrical Engineering and Computer Science Department faculty participate in the project component of the course as shown in Table 3. Generally, this includes ten full-time faculty members but it may be less due to sabbaticals or when a new faculty member joins the department. Overall, the course includes a single

coordinator who also provides the formal lecture component. This role counts toward the coordinator's teaching load. The other faculty members each serve as an advisor to a team,

sometimes two, and mentor and, otherwise, teach the project component. This activity does not count toward their teaching load. Most teams consist of three students so this equates to a 3-to-

**Table 3. Faculty Involvement**

Project	100% of faculty
Instruction	One coordinator
Faculty Role	Advisor, manager
Students-to-faculty	Typically 3-to-1
Other: Industry Representative	Role model, technical resource

1 student-faculty member ratio. Each team also works with an industry representative from a local high-technology company. They function as active participants in the project component and offer the team a role model and a technical resource. Industry representatives do not sponsor nor do they fund a project. This is very different than other approaches<sup>4</sup>. Team interaction with the industry representative is on a monthly basis, or more often.

Table 4 identifies the characteristics of a typical project. Here, a student team proposes the project and each works on its own project. A specific project spans an entire year and a team completes only one

**Table 4. Project Information.**

Source	Student
Number of projects	One-per-year
Number of teams	One-per-project
Students-per-team	Typically 3
Hours-per-week	Ranges from 10 – 12

project-per-year. Generally, teams consist of 3 students and the hours-per-week allocated to the project range from 10 – 12. Regardless of the time required, students are expected to complete the project. The faculty must approve each project to avoid overly aggressive and technically unsound projects. A critical expectation for each team is to design, build, debug, and demonstrate a working prototype.

Table 5 lists the source of funding for each project. The institution budgets at least \$200 for each project. Once all teams submit their budget, any funds left unallocated are distributed to teams that request additional funds. Projects funded by the institution become university property. As a result, some students elect to fund their own project so as to keep it. Typically, some teams choose to solicit donations from local industry. They are not required to do so.

**Table 5. Funding Information.**

Institution	Budget of \$200 (or more)
Students	Varies widely
Other	Some industry donations, MOSIS

In addition, some teams decide to implement their design in a custom integrated circuit and these chips are fabricated under the MOSIS Educational Program<sup>5</sup>.

Each student and team must complete a number of deliverables as outlined in Table 6. A student prepares a weekly email status reports identifying individual accomplishments, plans, and issues. Monthly, each

team, but one presenter on a rotating basis, offers a program review consisting of an oral presentation. Here, the subjects include project-wide status of accomplishments, plans, and issues. Each semester, the team prepares two documents. In the fall, they publish a *Functional Specifications* and *Project Plan*. Then, in the spring

they prepare a *Theory of Operations* and a *Final Report*. Each team schedules three approval meetings-per-semester (6 during the year) with their advisor and industry representative. These formal meetings approve the documents and place them under change control. In addition, the fall semester includes a design release approval meeting and the spring semester includes a prototype release approval meeting. Each team maintains a web site that holds all of their documentation, presentations, design data, and computer files. Other deliverables include peer evaluations used for grading plus a course and a senior exit survey used to assess the design class and degree program, respectively. Late in the spring semester, each student team presents the findings of their project at a campus-wide Founders Day celebration in a technical conference format.

**Table 6. Course Deliverables.**

Status reports	Weekly, email
Program reviews	Monthly, oral presentation
Documents	Fall Functional Specifications Project Plan Spring Theory of Operations Final Report
Approval meetings	Three fall, three spring
Web site	Contains all project information
Evaluations	Peer, course, exit
Formal presentation	Founders Day, spring

The formal instruction component focuses on both professional and project management topics as described in Table 7. The professional topics include technical writing, oral presentation, ethics, leadership, conflict resolution team skills, and life-long learning. For project

management, the students study and apply scheduling, milestones, design constraints, budgets, risk assessment and contingencies, change control, testing and debug skills. All of these subjects are introduced in lecture and practiced throughout the year in their projects.

**Table 7. Sample Course Topics.**

Professional	Project management
Technical writing	Schedules, milestones
Oral presentations	Design constraints
Ethics	Budgets
Leadership	Risk assessment
Conflict resolution	Contingencies
Team skills	Change control
Life-long learning	Testing, debug

### Team Teaching Advantages

The advantages to team teaching are well documented as are the challenges<sup>6,7</sup>. Table 8 provides a summary of the advantages for the course just described. We have elected to be brief in this section because the focus of this paper is on issues and recommendations.

**Table 8. Advantages to Team Teaching Design.**

Greater technical expertise	Faculty advisor, industry representative
Student-to-faculty ratio	Low 3-1, personalized learning
Supportive teaching environment	Resolve common issues
Professionalism	Industry representative
Better emulation of industry	Teams, managers, schedules, deliverables

First, several teachers (faculty advisors and industry representatives) can increased the overall technical base. This allows a program to cover the technical requirements across a very wide range and with great depth. Because each team includes their own

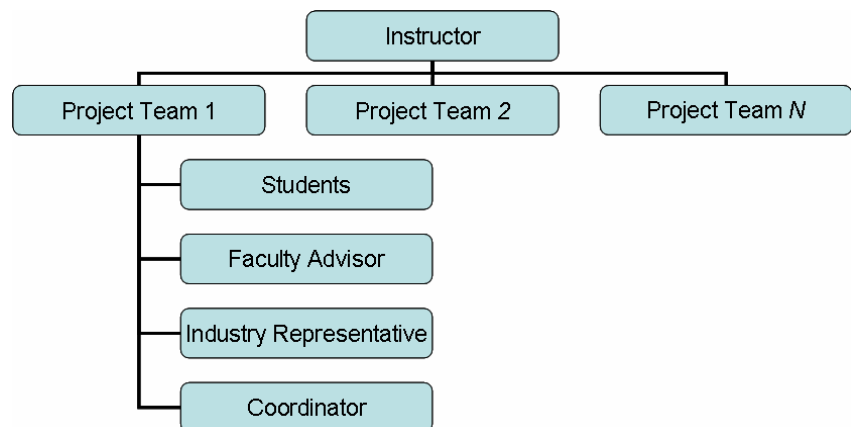
faculty advisor, the student-to-teacher ratio is very low at 3-to-1. At times, the ratio drops to 1-to-1 or individual instruction. With a traditionally-taught course, a single teacher often faces challenges alone. Conversely, the team teaching approach provides a natural environment to resolve common issues. This can be considered a teaching support group. Since the greater team includes a working engineer, students can observe, first hand, just how a professional in their discipline practices. Such interaction supports the professional objective for the course. Lastly, the team environment with multiple managers, a schedule to meet, and deliverables to complete, greatly parallels the product development cycle of many companies. It provides for a good introduction to many of the subtle issues prevalent in industry.

**Team Teaching Challenges and Opportunities**

In this section, we discuss the reporting organization of the capstone design course and the membership of a typical team. Additionally, we look at how the team taught instruction creates a number of interesting challenges and opportunities. We note that in the next few tables, the topics are discussed in a more-or-less random order. Do not assign any priorities.

Teaching Team. The organizational chart of the capstone course is illustrated in Figure 1. It illustrates a management hierarchy where each project team reports to the Instructor

(coordinator). This organization reflects the overall responsibility of the instructor. Each team includes students, a faculty advisor, an industry representative, and the coordinator as an *ex-officio* member.



**Figure 1. Management of the capstone design course.**

Because much of the instruction occurs outside of the formal lecture, we consider this a team taught course. In fact, during the spring semester, the time allocated to lecture is reallocated to project time. This provides

students additional time to meet as a team on a regular basis. The faculty advisor meets weekly

with their team to review documents, critique oral presentations, resolve technical design issues, assist with debugging, and, otherwise, manage the team. But the nature of the team taught structure poses some important logistical issues.

**Student Challenges.** Students are not familiar with team taught courses and face several issues as describe in Table 9. First, they report having too many bosses: instructor, advisor, and industry representative. At

times, students indicate that the three bosses ask them to do three different things. Students naturally discuss their classes and report that some advisors hold a team to one academic standard while

another advisor requires a different standard. Some students feel very uncomfortable with the grading of a project-oriented class because it appears very different then a traditional lecture, homework, and exam type of class. Because the grading rubric is unfamiliar, they claim arbitrary and subjective assessment of points. Lastly, few students appreciate the importance of documentation to the design process and soon discover that it requires significant time. Often, they view this activity as tangential to their design tasks and claim it is busywork. All of these challenges provide fuel for student unrest in the design course.

**Table 9. Student Challenges and Opportunities.**

Too many bosses	Sometimes conflicting
Standards, expectations	Inconsistent across teams
Grading	Unfamiliar rubric, subjective
Documentation	Busy work

**Faculty Challenges.** Like students, faculty advisors are initially unfamiliar with team teaching and Table 10 provides a summary of these issues. It is the norm that each advisor presents a different style of interaction with a team. Some take a

completely hands-off approach while others adopt a totally hands-on style. Generally, the overall learning experience of the student team heavily depends on this interaction.

One reason for the variation is that some faculty members are motivated, intrinsically, to commit time to their team while others just simply can not justify the time. To be a good advisor does require significant time and it is, largely, not included as part of their teaching load. Instead, team teaching becomes more of a service-like component. Technical alignment of an advisor and a team may not always be in synchrony. In one example, a computer science faculty member advised a team working on a commercial lighting design. Another major challenge lies in the fact that differences exist in the support for process in the design course. Some faculty members are comfortable with a more formal approach while others prefer a much less formal, almost research-like, design process. Finally, some faculty members are just hard graders and demand more from their teams then others. This creates an inconsistency in grade equity between the entire set of teams. These challenges for the faculty continue to arouse lively discussions and debates.

**Table 10. Faculty Advisor Challenges and Opportunities.**

Role	Different interactions with team
Motivation	Time commitment
Technical expertise	Possible miss-match
Support for process	Formal, informal (research)
Grading	Consistency

Industry representative challenges. The industry representative perhaps feels more comfortable in the team setting than the other members. After all, they work in teams every day. Table 11 list the challenges presented to the industry representative.

**Table 11. Industry Representative Challenges and Opportunities.**

Standards	Not industry, what is minimum
Role	Unclear, agreement with advisor
Involvement	Level, intrinsic reward

It is always clear what the standards are on the job, but often the industry representative is not clear of how hard to push the students. Their role is less well defined so they can adapt it to the time they have available. At times, they may find themselves in disagreement with the faculty advisor. Some industry representatives wish to become fully involved with the team while others only peripherally engaged. Usually, the level of involvement is in proportion to the time they can commit. Again, it is a strictly intrinsic reward that motivates the industry representative. Some report they participate because they feel a responsibility to give back to their profession.

Instructor challenges. The instructor or coordinator faces a number of challenges as outlined in Table 12. A major obstacle lies in the fact that advisors hold teams to different standards. Another area concerns recruiting and retaining industry representatives. If you ask them to do too much, they simply do not have the time. If you ask them to do too little, they will feel they are not needed. The goal should always be to find the balance point for an industry representative to volunteer year after year. Grading is a major responsibility for the coordinator. This challenge

**Table 12. Coordinator Challenges and Opportunities.**

Inconsistent advisors	Different expectations
Recruiting industry reps	Balancing act
Assigning advisors	More than technical match
Grading	Consistency across class
Student professionalism	Representing the university
Course evaluation	Effect of advisor, unfamiliar rubric

involves providing consistency and equity across a widely varying set of students and teams. Since the student teams directly interact with the professional community, they represent the university. Sometimes, students are less than professional and yet the university must always shine in the best light possible. Finally, student evaluations for the course count toward the instructor. Two factors are at odds with obtaining a fair assessment: advisor, and grading rubric. The advisor can significantly influence, positively or negatively, the perception of the student toward the course. Similarly, the unfamiliar grading rubric is often considered a negative because it is different. Together, these challenges can be a great impediment for faculty member to agree to serve as the capstone design instructor.

## Team Teaching Best Practices

This part presents a set of recommendations or best practices that result in addressing many of the challenges to team teaching capstone design. Rather than looking at each issue individually, the best practices integrate the specific suggestions into a set of guidelines that, in our experience, give rise to fewer problems and less unforeseen complications. Table 13 depicts the recommendations and best practices.

Course Objectives. The foundation for any course rests on the objectives. It is important that all of the faculty involved in teaching the course participate in setting the objectives. Objectives fall into two categories: technical, and non-technical.

**Table 13. Recommendations and Best Practices.**

Course objectives	Participant consensus
Industry representatives	Technical expertise, enforce minimum standards
Checks-and-balances	Off campus approvals, advisor decision maker, change control
Clear expectations	All participants except industry representative
Grading	Rubric, coordinator ensure consistency
Advisor assignment	Choice, rotate with industry representatives
Communications	Many, varied

Any discussion of the technical component typically involves project expectations. In the course described, the expectation includes that of a working prototype. A paper design or simulation alone does not meet this expectation. In traditional classes, instructors focus so much on the ideal that a working prototype drives home the point that the real world differs from the classroom with its own set of opportunities.

But perhaps the greatest obstacle to consensus involves the non-technical (professional and project management) component. The key issues generally focus on the role of process in the course<sup>8</sup>. This really means how much emphasis should be placed on documentation? A practicing engineer absolutely must document their work. This requires significant student time and, perhaps, takes time away from their design. So, where is the balance?

In the course described, the minimum required documentation consists of the following. Note that none of the documents require a minimum page count.

- Functional Specifications: describes *what* the project does.
- Project Plan: defines the *methods* the team will follow.
- Theory of Operations: explains, technically, *how* the design works.
- Final Report: provides an integrative *summary* of the project.

Documents considered but ruled out include a market analysis, design analysis, testing plan, and manufacturing plan. All of these are important steps in product development but were considered outside of the minimum set.

Summarizing, consensus on course objectives requires faculty agreement on the technical and non-technical components. You can expect more discussion on the non-technical side.

Industry Representatives. The most obvious reason for integrating an industry representative into the design team is the added or missing technical expertise. Yes, it requires some time to recruit, retain, and manage them, but there are many other reasons to include the industry representative.

First, they serve as a role model to the team and they show the student how a professional practices engineering in their discipline. In addition, the industry representative reinforces and validates many of the subjects introduced in the lecture component. During approval meetings, it is common for the industry representative to cite an example from their company to illustrate a key point.

A more subtle reason for including an industry representative on the team is that they help to assure minimum academic standards. Most faculty advisors pay more attention to the work of the student team when their name appears on the design. Anytime something leaves the institution, most faculty members take pride in the item. This advantage roughly parallels the peer review of manuscripts and proposals.

Summarizing, including an industry representative as an active participant of the design team increases the technical expertise and helps assure minimum academic standards.

Checks and Balances. Most processes benefit from checks and balances and these can be inserted in several places. These include time management, interaction with the industry representative, and staying focused.

For most students, this will be the first time they have been involved in a significant design project. In most courses, the instructor places boundaries around a problem and provides the students a method to follow and completion dates. This is not the case with a capstone design and a team taught course. This situation can be improved with a set of deliverables spread out across the semester. It is far easier to detect when a team is slipping their schedule if they miss a milestone. These hurdles help the student team manage their time.

Students learn from their mistakes, yet the university must present a good impression to the local technical community and the industry representative. What sort of mistakes do students make? They are notorious for last-minute requests to review a document or to participate in an approval meeting. Or, the quality of a document or design does not meet minimum standards. These types of problems can be minimized if all interaction with the industry representative is first reviewed by the faculty advisor. The advisor conducts a sanity check before the student contacts the industry representative.

Students typically struggle to stay focused. To avoid wandering problems such as “feature creep”, a change control board can rule on proposed changes to a document, plan, or design change. In the course described, the change board consists of two students on a rotating basis and the course coordinator. Once requested, a major change must pass through the board, gain approval, and be communicated to those involved. It may sound slow and tedious, but most change requests are processed using email and require only one day.

Summarizing, checks and balances assist students with time management, representing the university, and staying focused across a yearlong project.

Clear Expectations. In a team setting, everyone must understand their own role as well as all other roles. Nothing does this better than to write it down and this involves clarifying who is responsible for what.

The student team owns the success or failure of the project and must determine who will do what and when. Each semester, the team designates a team lead that serves as project head and sees that the team is making progress. They call and chair meetings, interface with the industry representative, and resolve issues as they occur.

Each team meets weekly with their faculty advisor to review progress and resolve any problems. Also, the advisor assists with document preparation, program reviews, and meeting coordination. They serve as the primary technical resource for the team and are the decision maker for approvals.

The coordinator administers the class, delivers lectures, prepares students for milestones, assigns advisors and industry representatives to teams, and resolves any student-advisor-industry representative issues. Overall, the instructor manages the collective design teams for success.

The industry representatives include seasoned engineers who work with the team to resolve issues, provide technical guidance, and participate in all approval meetings. Conversely, their role is not well defined so that they can shape their own role in proportion to the time they can commit.

Summarizing, expectations must be written down and the role for the student, faculty advisor, industry representative and coordinator must be well defined.

Grading. Students generate great anxiety for a team taught course because the grading process is different. Instead of homework, projects, and exams with numeric values, they are presented with a grading rubric that appears subjective. It is important to provide the rubric the first day, discuss it, and explain that it is similar to evaluation of a practicing engineer.

In industry, companies place a very high value on an engineer meeting their schedule. The other key component would be the engineer's technical contribution. A rubric that emphasizes these points is as follows.

- Schedule (60%): milestones, documents, program reviews, team skills, etc.
- Technical (40%): depth and breadth of the contribution.

The first rubric element, schedule, evaluates the non-technical objectives and focuses on the process component. Then, the second element, technical, evaluates the depth and breadth of an individual's contribution toward the project. This emphasis parallels the annual review criterion of many companies.

To document the grade for a student, the coordinator can prepare a written evaluation that assigns points to each component of the rubric. In addition, the evaluation can discuss the student's contribution to the project, highlight their strengths, and offer some areas for improvement including suggestions. In essence, this is an annual review for each student for each semester. We suggest that a short version of the evaluation be presented to each team at the mid-semester point.

The student evaluation includes performance information collected from the student's peer team members, advisor, and, informally, the industry representative. A student's grade begins with a recommendation by the advisor since they work most closely with each member of the team. To provide equity across the class, the coordinator looks at all of the students and decides to either agree or not agree with the advisor's recommendation. In cases of disagreement, which are few, either the advisor or coordinator typically possesses some additional information. The two can discuss the differences and come to consensus on a student's final grade.

Summarizing, the coordinator must stick to a published rubric, acquire as much feedback about a student as possible, and review the entire class to assure equity in grading.

Advisor Assignment. The coordinator must assign a faculty advisor and an industry representative to a student team. One would think that a simple alignment of technical expertise would make the process easy. But, when students select their own team, they tend to cluster by grade point average or ethnicity. So, you end up with strong and weak teams. Similarly, you have strong and weak advisors and industry representatives. So how should you match these characteristics? Another question is should you allow student teams to request a faculty advisor?

Worrying about weak and strong has not yielded any positive or negative results. Similarly, allowing student teams to request a faculty advisor is, basically, a popularity contest and serves no purpose. One successful approach allows a faculty advisor to request their top three teams in order. The coordinator can use this information to match the advisor to a team and, generally, it rarely results in a third choice.

Some industry representatives work better with some advisors and the opposite also holds true. A coordinator should avoid these mismatches at all times. Instead, once the advisors have been assigned, ask the industry representatives to select their top three projects/advisors in order. This usually results in assigning industry representatives to either their first or second choice. Generally, they will tend to select projects they have some technical feel for and interest in. If possible, it is a good idea to rotate advisors and industry representatives if the pools do not change over time.

Summarizing, it is not necessary for a student team to request an advisor, and the coordinator can assign advisors and industry representatives by asking them to request their top three projects in order. Remember to assign the advisors first and then the industry representatives.

Communications. In a team setting, communications is of paramount importance<sup>9</sup>. Here, we are referring to communication between the students, faculty advisor, industry representative, and the coordinator. Below we offer some example tools to improve communications.

- Weekly Status: student email with accomplishments, plans, and issues.
- Weekly Team Meetings: students and advisor.
- Monthly Program Reviews: student oral presentation of team accomplishments, plans, and issues.
- Project Web Site: centralized repository for documents, meeting minutes, presentations, schedule, and design data.
- Change Control Board: approval notice sent to team and board members.
- Faculty Meetings: resolve common advisor issues.
- Approval Meetings: milestones reviewed and approved.

Each student prepares a short email each week that discussed their own accomplishments, plans, and issues. It is sent to other team members, faculty advisor, coordinator, and optionally to the industry representative. The advisor and coordinator can zero in on the issues section where students will often list a problem they feel uncomfortable discussing in person.

The weekly team meeting provides a great forum to build a strong bond between the student members and the faculty advisor. This is where the majority of team teaching occurs. It is important to set a specific day and time and to avoid missing the meeting if at all possible.

Each team maintains a project web site that contains all of the information for the project in one, easily accessible, location. It provides a good mechanism for posting documents and design data that the off-campus industry representative can access. Generally, it works better than emails due to filters common in many mail servers. At the end of an academic year, the web sites can be moved to an archive web site<sup>10</sup> for assessment data and for use as a recruiting tool.

As discussed earlier, a change control board reviews and approves request for changes to any controlled document (e.g., Functional Specifications). All requests and actions are documented with an email trail and this includes notifying the project team of the impact of a change. For example, a team may wish to drop a key feature of the design. If approved, the board sends a notice to the team indicating approval, the document to change, and the new revision number. The team then modifies the document, updates the history page, and posts the new revision on their web site.

The faculty meets periodically to resolve some common issues as they arise. For example, at the beginning of the fall semester, the faculty reviews the project proposals for degree of difficulty and technical soundness. Thus, if there is consensus among the faculty, the project is approved. Other issues that may result in a faculty meeting include grading, use of facilities, or the team budgets. But anything that needs resolution should be discussed.

An approval meeting consists of a good communication tool because the entire team can get together, it marks the completion of a key milestone, and it allows review of future plans. The final approval meeting in the fall semester is the design review. This involves a technical

analysis of the design and it provides a go-ahead for detailed implementation. In the spring semester, the last approval meeting is to review the final report. Here, the student team prepares an integrative document that describes their yearlong capstone design experience. In the discussion, the advisor and industry representative often ask the students what they learned.

Summarizing, success in a team setting requires strong communications. Use as many and as varied tools as necessary to keep the lines open between the students, faculty advisor, industry representative, and coordinator.

## Conclusions

Team teaching capstone design results in many logistical challenges revolving around the student, faculty advisor, industry representative, and coordinator. Using a specific course as an example, we presented a list of recommendations and best practices that in our experience resulted in fewer issues and less unforeseen difficulties. These include the following.

- Gain consensus on course objectives, particularly documentation.
- Integrate an industry representative into the student design team.
- Institute numerous checks and balances for focused student teams.
- Establish clear expectations and roles.
- Published the grading rubric and assure course-wide equity.
- Map an advisor and industry representative to a team by asking for their top three projects.
- Maintain strong communications using as many and as varied tools as possible.

By using these guidelines and suggestions, you can develop a framework and infrastructure for your team taught capstone design course. This will require some adaptation because there is no ideal model and no two institutions are exactly the same.

Reflecting, we wonder how well these recommendations would work in a large, public, state-supported, and research-oriented institution. We expect that the large number of students might result in equally large teams and this may create a high student-to-faculty ratio. In addition, if the local community did not include several high-technology companies, then would it be practical to integrate the critical industry representative? Another issue to consider is the course evaluation. How do you structure an assessment tool for a team taught course? In closing, we suspect that different institutions will face different obstacles and this will require the faculty to solve new, interesting, and unique challenges.

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