

ADDING CONSULTING ENGINEERING TO THE CURRICULUM

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Introduction

Many civil and environmental engineering students join consulting firms when they graduate or join later in their career. If they start their careers with a government agency or contractor they will undoubtedly work with consultants. Many students do not understand how a consulting firm operates but are attracted by the business aspects of consulting and management. In response to student requests and the opportunity to provide an introduction to consulting engineering, a three-credit elective course is offered at Michigan Tech University. It was developed for juniors, seniors, and graduate students and was originally planned for civil and environmental engineers, but engineering students from other disciplines have taken the course. The course has been offered in the spring semester (January – April) two times – 18 students enrolled in the first year and 30 students enrolled in the second year. The course has been team taught by two instructors who, between them, bring substantial consulting, government service, university teaching and research experience to the classroom. This paper describes the topics covered in the course, major projects and assignments, special features, and resources.

Course Topics

The primary objective for the course was to provide an introduction to consulting engineering for students. The course covers a variety of topics including:

- an introduction to the role of a consulting engineer within the engineering profession
- consulting firm business structure, organization, and ownership
- careers in consulting engineering
- accounting – introduction to basic accounting, how consultants set rate structures and get paid, overhead, profit, cash flow, and reading financial statements
- marketing – tracking projects, direct assignments, the proposal process, Qualification Based Selection (QBS) vs. bidding
- proposals – preparing Request for Proposals (RFP), responding to RFPs, parts of a proposal, organizing a team to prepare a proposal, developing a work plan and estimating time and budget requirements
- consultant selection – project interviews, presentation skills
- contracts and negotiations
- managing projects to achieve successful outcomes
- effective meetings
- working with clients as project partners
- ethical considerations related to consulting
- written communications – correspondence, reports, other documentation
- international consulting

Students are evaluated using a mid-semester test (25%), a take home final exam (25%), a major proposal project (20%), several small assignments (20%), and attendance and class participation (10%).

Major Projects and Assignments

Resumes

The first assignment for the students is to submit a resume for review and comments. This has provided an excellent chance for the instructors to gather information on the students experience and their career objectives. About one-third of the students in the class have worked for consulting firms primarily in an inspection, surveying, or testing role. Feedback is provided and discussion on careers options and additional resources are identified.

Presentations on Consulting Firms

One of the early assignments in the course provides an opportunity to learn more about several consulting firms. Each student will select a consulting firm by draw, prepare a one-page fact sheet on the firm, and make a 4-5 minute presentation. The list of firms is developed from the ENR (Engineering News Record) publication on engineering design and environmental firms. Copies of the fact sheet are distributed to everyone during or after the presentation, so everyone has a valuable resource document. Students are asked to summarize the background and history of the firm, areas of consulting expertise, size and type of organizational structure, offices, high profile projects, unique aspects of the firm, opportunities for entry-level engineers, and a web page address for more information. Many of the firms that are presented do not recruit on campus, so this assignment has provided excellent leads to firms that the students may not have known. For example, one student discovered a firm that fit her career objectives for work in developing countries, applied on-line, was invited for an interview in their head office, and is now working for that firm.

Major Proposal Project

The major proposal project is a two-part project in which students are divided into 3-4 person teams. Each team first develops a scope of work for a project and then responds to the RFP (Request for Proposal) by preparing a formal proposal and presenting it to the class and a selection committee. This approach was taken instead of assigning a specific RFP to the class to ensure that every team member would be comfortable with the project and could contribute. In addition to the experience of preparing a proposal, each team gets experience in preparing a RFP. The instructors worked with the teams to help identify projects and expand or narrow the scope of work to be a manageable and more realistic project. Samples of RFPs and proposals are helpful for students. The instructors' personal experiences have proven invaluable, and there usually are some good stories or dilemmas that help students remember key points.

The information requested for the proposal includes:

- consulting firm – name, logo, personnel, mission statement
 - o assume that your firm’s head office is in Houghton
- an introduction identifying the team’s approach to the assignment
- work plan with a detailed breakdown by phases or tasks
- identify project manager and other key personnel
- estimated length of time to complete the scope of work
 - o include start and expected completion times for each phase or task and show interrelationships
 - o include hours for each employee
- estimated cost to complete the study
 - o include separate cost estimates* for each phase or task
 - o identify all reimbursable expenses

Rates are provided for personnel:

Direct Labor:

Principal	\$75/hour
Project Manager	\$50/hour
Staff Engineer	\$25/hour
Technician	\$20/hour
Secretary	\$15/hour

Overhead: 150% of direct costs

Profit: each team can select

Subconsultants: Cost plus 10%

The objective is to provide experience in the process of developing a work plan and preparing a schedule and budget. The evaluation for the project is based on how well the team has presented the process and not on how accurate or correct are the schedule and budget that is presented. The challenge for students is to develop a plan on how to do the work and not actually perform the study or project itself. Many students have no prior coursework experience with this process, but they plan their daily and semester activities all of the time to be successful at university. They just don’t think about the process as part of engineering

Local planning projects have been popular ones for this assignment. Planning projects tend to have characteristics that can respond to several interests and they get students thinking of the future as well as alternatives with no one right answer. Local projects have been good because students can visit the location as you would often do in the proposal process. A sample list of past projects includes:

- Feasibility Study of an Automated People Mover for the Michigan Tech University Campus
- Feasibility Study of a Boat House and Dock Facility for Michigan Tech University

- Route Location/Preliminary Design of Sharon Avenue Extension, Houghton, Michigan
- Feasibility Study of Two-Way Street Operations in Downtown Houghton
- Design of a Community Septic System for Lake Gogebic, Michigan
- Development of a Multi-Purpose Stadium Complex for Outdoor Events in the Copper Country
- Development of a Non-Motorized Recreational Route on the Portage Lake Shoreline
- Feasibility Study of a Copper County Vintage Trolley
- Preparation of a Best Practice Manual for Runoff Sediment Ponds for Highway Projects in Wisconsin
- A Program for Small Community Water Distribution Needs in Guatemala

Other Assignments

Among the other assignments include interpretation of financial statements and other accounting reports, determination of billable rates, and several readings that require critical thinking.

Special Features

Career Fair

Michigan Tech hosts Career Fairs during the fall and winter semesters in which companies and government agencies are on campus to meet students in an open house format. The Career Fair for the spring semester occurs in Week 6. The Fair has provided an excellent opportunity to generate interest in consulting firms, link material from the course, and arrange for guest speakers for the class.

Guest Speakers

This course has provided an excellent opportunity for guest speakers. In a larger urban area it may be easier to recruit speakers for a class, but because of Tech's location it does present a few challenges so we often piggyback a guest presentation with a campus visit on other business such as recruiting, a meeting of the Department's Advisory Committee, or Winter Carnival. Our alumni have been very supportive and are extremely pleased to participate in this course where typically they speak on their experiences in consulting or working with consultants. Among the speakers have included;

- principals/owners of small local consulting firms
- recent graduates that have joined consulting firms in entry-level positions
- alumni with a range of experience in consulting and working with consultants

Etiquette Dinner

Since consulting will involve client meetings and conducting business during meals, an evening dinner was planned to introduce and practice etiquette tips for these types of

events. Dress was business casual. Arrangements were made with Michigan Tech Dining Services. Prior to dinner, a presentation was made on dining etiquette by the Director of Dining Services, and then following dinner, a presentation was made by the Director of Career Services on tips for business etiquette. Students were assessed a fee of \$15 for the dinner.

Resources

There are several resources that have been used for the course. A textbook has not been required. Among the resources used have been:

American Council of Engineering Companies (www.acec.org)

American Society of Civil Engineers (www.asce.org)

“Standards of Professional Conduct”

“How to Work Effectively with Consulting Engineers”, ASCE Manual No. 45, 2003

“Engineering Your Future”, Stuart G. Walesh, ASCE Press, 2000

Ethics case studies taken from ASCE News and other sources

Institute of Transportation Engineers (www.ite.org)

“Practice Management for Design Professionals”, John P. Bachner, Wiley, 1991.

“Stuff You Don’t Learn in Engineering School”, Carl Selinger, Wiley/IEEE Press, 2004

“Wisconsin QBS Manual”, American Council of Engineering Companies of Wisconsin, (www.qbswi.org/docs/A-EQBS.pdf)

SunCam, Inc. (www.SunCam.com) – DVDs of consultant presentations for projects in Florida

Engineering firm financial statements and sample accounting reports with substitute firm names

Sample Request for Proposals and Proposals.

Student Evaluation and Comments

The feedback from the students has indicated that this course has been invaluable in helping them understand consulting engineering. The course has become a very popular and top-rated elective. The students have identified a few topics that they would like expanded or added in the future and among the topics include more on meetings, international consulting, and how to negotiate, and a session on golf etiquette.

Conclusion

As engineering departments look to introduce leadership and business principles into their curriculums to meet new ABET objectives, a course in consulting engineering may be an attractive option to consider. The topics and content are evolving but the feedback from two years of offering this elective at Michigan Tech has been extremely positive.

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