

”Construction Regulations and Organizational Management” - A Case Study of a New Course Introduction to the Civil Engineering Curriculum

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“Construction Regulations and Organizational Management” – A Case Study of a New Course Introduction to the Civil Engineering Curriculum at Syracuse University

ABSTRACT

Through their careers, the Civil Engineering graduates may become project managers who will be leading the engineering teams. For such purpose, they will need the outlooks, perspectives, and ways of thinking, knowing, and doing appropriate for professional practice across economic sectors that are, in often cases, beyond the technical competencies that are taught in traditional classroom. These competencies include, but not limited to, engineering entrepreneurship and engineering enterprise management, ethical and professional considerations in engineering practice and decision making, critical thinking skills and engineering problem solving creativity, intercultural awareness in managing multinational and multi-background engineering teams as well as sustainability and environmental awareness. These competencies correspond to a number of ABET outcomes including to analyze social context in historical and contemporary settings; to communicate effectively in writing and visual presentation; to engage effectively in diverse teams; to reflect and act ethically; to engage in lifelong learning; and to design in context. However, there are few courses in engineering curricula that could encompass all these competencies in one single course. “Construction Regulations and Organizational Management” is a graduate/senior level course that is designed and introduced to the Civil Engineering curriculum with these objectives in mind. A Project-Based-Learning (*PBL*) course in nature, the first module of the course engages student teams to research on the engineering entrepreneurship and the required regulations for starting a design/construction firm either in the United States or internationally. As the course progresses, the students will make presentations on safety, environmental and risk management considerations for administration of a small engineering enterprise. The second module of the course focuses on the introduction of professionalism and Engineering Ethics to the students as well as theories of organizational behavior and employee motivation. Students are asked to research on ethical considerations and cultural aspects of engineering managing in another country and compare cases of successful project management and delivery due to such differences. Finally, in preparing the students for the professional job market, the third module of the course requires the students to choose a large global engineering / construction firm in which they will be interested for an internship or full-time employment and so conduct research on their operations, management processes, future growth opportunities and financial strengths and weaknesses.

INTRODUCTION

Construction industry is an important contributor to the national GDP for both developing and developed countries. According to the US Bureau of Economic Analysis (*BEA*), in 2007 alone, the construction industry was responsible for 4.1% of the United States GDP, down from a 4.8% contribution in 2006. Engineering News Record (*ENR*) and Oxford Economics in 2015 Global Construction Summit Report predicted a faster growth for the global construction market than world GDP over the next decade. This is mainly due to the fact that Asian economies continue to industrialize and the US recovers from the sharp downturn during the 2008 global financial

crisis. The construction industry in Asia and other emerging economies will experience a continuous faster growth over the next decade (2015 – 2025) because of rising populations, rapid urbanization and strong economic growths.

As a consequence, and due to the higher impact of construction activities on people, societies and the environment, it is a regulated industry. Construction engineers and hence, subsequently, civil engineering college students who strive to start their career paths as construction project engineers envisioning to become project managers must be aware of these existing regulations in federal, state/provincial and local levels. These regulations address a multitude of important and diverse matters ranging from enterprise management and business operations norms to societal, safety and environmental concerns in order to maximize the public welfare while minimizing potential harm and damages as a result of ongoing construction activities or the future planning.

Therefore, there exists a growing interest in incorporating a senior-level/graduate course that focuses on construction regulations and multiple aspects related to organizational management and organizational behavior issues within an engineering enterprise. Therefore, a new course entitled “Constructional Regulations and Organizational Management” is introduced into the Civil/Construction Engineering curriculum at Syracuse University in 2015 spring semester. The objective of this new course is to better prepare civil and construction engineering graduates towards their successful integration into the professional workplace through educating and raising student awareness on subjects that might often be overlooked in traditional civil engineering curricula across the nation.

This course is a Project-Based-Learning (*PBL*) course that also encompasses some of the lesser-addressed ABET outcomes such as analysis of social context in historical and contemporary settings; effective communication in writing and visual presentation; effective engagement in diverse teams; reflecting and acting ethically; engagement in lifelong learning; and in-context design. The first module of the course engages student teams to research on the engineering entrepreneurship and the required regulations for starting a design/construction firm either in the United States or internationally.

FIRST MODULE: ENGINEERING ENTREPRENEURSHIP AND OPERATIONAL REGULATIONS

I. REQUIREMENTS FOR STARTING A DESIGN OR CONSTRUCTION FIRM

The first module of the proposed course focuses on federal, state or local requirements, regulations and multiple steps in registering an architectural or design firm (*A/D*) or Construction firm in the US. Students are required to do a comprehensive research and presentation on their start-up company information, location, adopted organizational chart, the proper business establishment structure (proprietorship, partnership or corporation), obtaining an Employer Identification Number (*EIN*), tax requirements as well as the required business permits and operational licenses. Table 1 summarizes step-by-step guide of the general requirements for establishing a heavy civil firm in the New York State. Table 2 also illustrates on the Business Naming process for a heavy civil construction firm in New York State for one of the student projects.

Table 1: Proposed General Requirements for Business Establishment in New York State

Step 1	Select a Business Name
Step 2	Select an Attorney or Reliable Alternative
Step 3	Choose a Form of Business Ownership
Step 4	Obtain a Federal Employer Identification Number
Step 5	Obtain a Business Name Permit
Step 6	Register for Federal License and Permits

Table 2: Student Team Guidelines for Naming a Construction Engineering Firm in New York State

1.	Go to the United States Patent & Trademark (USPTO) website at uspto.gov. Enter name of your business and check to see if that name is already taken.
2.	Visit the Secretary of New York website to register business. Find the area dedicated to business services. Search the name of your business and check to see if that name is already taken.
3.	Check with municipal government's office or county clerk's office
4.	Perform searches on the web and domain registration names at website such as GoDaddy.com or Register.com

Figure 1 demonstrates a snapshot of the Application for Employer Identification Number (EIN) for one of the student team projects. In order to register a construction engineering firm in New York State, after filing for a Business Certificate, a proper business organization shall be adopted in compliance with the state laws and regulations. A Federal Employer Identification Number (EIN) must be obtained as well as a Sales Tax Number in order for the newly-established business to collect sales tax on behalf of and for the State.

Form SS-4 (Rev. January 2010) Department of the Treasury Internal Revenue Service	Application for Employer Identification Number (For use by employers, corporations, partnerships, trusts, estates, churches, government agencies, Indian tribal entities, certain individuals, and others.) ▶ See separate instructions for each line. ▶ Keep a copy for your records.	CMB No. 1545-0003 EIN
Type or print clearly.	1 Legal name of entity (or individual) for whom the EIN is being requested	
	2 Trade name of business (if different from name on line 1)	3 Executor, administrator, trustee, "care of" name
	4a Mailing address (room, apt., suite no. and street, or P.O. box)	5a Street address (if different) (Do not enter a P.O. box)
	4b City, state, and ZIP code (if foreign, see instructions)	5b City, state, and ZIP code (if foreign, see instructions)
	6 County and state where principal business is located	
	7a Name of responsible party	7b SSN, ITIN, or EIN

Figure 1: Snapshot of the IRS Form SS-4 (1/10) "Application for Employer Identification Number"

Figure 2 demonstrates a snapshot of the New York State Application for Registration as a Sales Tax Vendor.

DTF-17 (8/04) New York State Department of Taxation and Finance

Application for Registration as a Sales Tax Vendor

Department use only

Please print or type

1 Type of certificate you are applying for (You must check one box ; see instructions): Regular <input type="checkbox"/> Temporary <input type="checkbox"/> Show <input type="checkbox"/> Entertainment <input type="checkbox"/>					
2 Legal name of vendor					
3 Trade name or DBA (if different from item 2)				4 Federal employer identification number	
5 Address of business location (show/entertainment or temporary vendors use home address)					
Number and street		City	County	State	ZIP code
6 Business telephone number (include area code)		7 Date you will begin business in New York State (see instructions)		8 Temporary vendors: Enter the date you will end business in New York	
9 Mailing address, if different from business address on line 5					
c/o name		Number and street	City	State	ZIP code
10 Type of organization: Individual (sole proprietor) <input type="checkbox"/> Partnership <input type="checkbox"/> Trust <input type="checkbox"/> Governmental <input type="checkbox"/> Exempt organization <input type="checkbox"/> Corporation <input type="checkbox"/> Limited Liability Partnership <input type="checkbox"/> Limited Liability Company <input type="checkbox"/> Other (specify) <input type="checkbox"/>					
11 Reason for applying: Started new business <input type="checkbox"/> Purchased existing business <input type="checkbox"/> Adding a new location <input type="checkbox"/> Change in organization <input type="checkbox"/> Other (specify) <input type="checkbox"/>					
12 Regular vendors: Will you operate more than one place of business? <input type="checkbox"/> Yes (check appropriate box below) <input type="checkbox"/> No <input type="checkbox"/> A Separate sales tax return will be filed for each business location. <input type="checkbox"/> B One sales tax return will be filed for all business locations (complete Form DTF-17-ATT and attach it to this application).					

**Figure 2: Snapshot of the New York State Department of Taxation and Finance Form DTF-17 (8/04)
“Application for Registration as a Sales Tax Vendor”**

II. CONSTRUCTION HEALTH AND SAFETY REGULATIONS

Personal injuries, accidents and loss of lives are relevant in construction industry. According to the *Bureau of Labor Statistics 2014 workplace fatality preliminary data*, 4,679 workers were killed on the job in 2014 in the United States. This corresponds to 3.3 per 100,000 full-time equivalent workers which, on average, is almost 90 a week or more than 13 deaths every day. Fatal work injuries involving contractors accounted for 17 percent of all fatal work injuries in 2014. Occupational Health & Safety Administration lists the leading causes of worker deaths on construction sites as falls (39.9%); electrocutions (8.5%); being struck by an object (8.4%), and getting caught-in-between (1.4%). According to the Bureau of Labor Statistics, these "Fatal Four" were responsible for more than half (58.1%) of the total construction death toll in 2014, (*BLS reports, construction worker deaths in 2014*).

Health and safety aspects on a construction site are vital for the successful delivery of a project. Comprehensive planning and careful implementation will provide for the best project outcome while protecting the public, workers, equipment, environment, and the company from injuries, damages and legal pursuits. Developing a safety management program that includes safety planning, safety plan execution, and maintaining records will ensure proper safety performance.

According to the Project Management Body of Knowledge (*PMBOK Guide*), safety management includes the processes required to assure that the construction project is executed with appropriate care to prevent accidents that cause or have the potential to cause personal injury or property damage. Tasks associated with safety management include: safety planning, safety plan execution, and administration and reporting. Each of these tasks carry their own unique aspect to safety management. Safety planning involves developing an approach to manage the various project hazards. Safety plan execution is the successful implementation of a safety plan by performing a carefully crafted list of activities, often monitored onsite by a safety officer or

manager. The third, administration and reporting, is the maintenance of safety records and reporting safety activities (PMBOK Guide).

For a construction project, Safety Planning involves a job site analysis of potential hazards inherent in the relative work and requires making decisions on how to best deal with these hazards effectively. This analysis includes a review of the normal hazards associated with the type of construction anticipated, and a survey of the geographical and physical hazards of the site. Other important considerations for developing the project safety plan include contract and owner requirements, government laws and regulations, safety policies, site location, and management commitment (PMBOK Guide). Depending on the geographical location of the construction project, there may exist different safety laws and regulations, both on a local, state, and federal level, during construction that must be considered. Another important consideration are contract requirements. The major contracts that cover the project construction may also have specific owner requirements for safe practices.

Students will research on required tools and techniques for successful Safety Plan Execution for their established firms. The Occupational Safety and Health Administration (OSHA) is the main federal agency charged with the enforcement of safety and health legislation. OSHA's mission is to assure safe and healthful workplaces by setting and enforcing standards, and by providing training, outreach, education, and assistance. Employers must comply with all applicable OSHA standards. All engineering firms required to comply with the General Duty Clause of the OSHA Act, which requires employers to keep their workplace free of serious recognized hazards.

For companies registered in New York State, in conjunction with the OSHA, the NYS Department of Labor approved and established the New York Public Employee Safety and Health Bureau (*PESH*). Created in 1980 that enforces safety and health standards promulgated under the OSHA Act and the New York State Division of Safety and Health standards (*NYS DOSH*). NYS DOSH oversees safety regulations, training and consultation as well as the evaluations and enforcement. While OSHA maintains jurisdiction over all private sector workplaces, NYS PESH monitors the public sector employers in the state of New York, including: state, county, town, and village governments, as well as public authorities, school districts, and paid and volunteer fire departments. PESH also inspects public employer work site and gives technical assistance during statewide emergencies (NYS DOSH). Overall PESH and OSHA combine to create a powerful tool/program that businesses and organizations can use to establish best business practices. Both provide a number of offices throughout the country and state respectively and give various forms aid including: training, technical tips, answering questions, written program developments, and presentations.

The NYS DOSH umbrella of protection includes 10 programs and a Licensing and Certification Unit, to offer safety and health information and assistance to employers and employees. These programs related to heavy civil construction include the Public Employee Safety and Health (*PESH*) Bureau, the Industry Inspection unit, the License and Certification unit (*L&C*), the Radiological Health unit (*RHU*), the Asbestos Control Bureau, the Boiler Safety, the Mine Safety Training Program (*MSHA*), the Workplace Safety and Loss Prevention Program (also referred to as Industrial Code Rule 59), the Hazard Abatement Board (*HAB*), the On-Site Consultation Services unit (*21D*), and the Engineering Services unit (*ESU*). Each of these

programs provided public and private employers with the scope of health and safety protection through regulations, training and consulting, and evaluations and enforcement (NYS DOSH).

III. ENVIRONMENTAL REGULATIONS IN CONSTRUCTION ENGINEERING

The third student project and presentation within the first module focuses on raising awareness on the federal, state/provincial and local laws and regulations regarding the environmental protection for construction firms that the students established in their first project.

The basic approach to environmental management starts with environmental planning, followed by environmental assurance and environmental control. During the environmental planning process, the environmental characteristics of the construction site and the relevant environmental standards are identified, the environmental impact of the project is determined, and the processes are selected to guarantee compliance with environmental standards. The environmental assurance, involves the constant evaluation of results by environmental management to satisfy relevant environmental standards. The third and final process, environmental control, requires monitoring specific project results to ensure compliance with environmental standards and identifying better ways to address performance (PMBOK Guide). Inputs to environmental planning include a scope statement, contract environmental provisions, standards and regulations, permits, environmental policy, site and neighborhood environmental characteristics, project execution characteristics, historical information, and other process outputs. All governmental standards and regulations relevant to the project must be considered by the project management team. For example, an Environmental Impact (PMBOK). Several types of tools and techniques may be required during the Environmental Planning process to produce an integrated environmental management plan. These include risk planning processes, alternatives selection, benchmarking, flowcharting, and stakeholder analysis. Risk planning processes involve identifying and categorizing all environmental risks.

On the federal level, the main regulatory body responsible for environmental protection and enforcement is the Environmental Protection Agency (*EPA*). The EPA establishes laws, regulations, and mandates that assist contractors throughout the design, planning, and construction of a given project. The EPA defines the construction sector as being primarily engaged with building projects, engineering projects, and land development projects. The EPA details topics such as asbestos, ozone layer protection, federal environmental requirements for construction, lead, construction and demolition materials, storm water discharges from construction activities, and effluent limitation guidelines. The EPA can greatly improve the contractor's project outcomes through collaborative planning and information sharing. On the other hand, the New York State may also establish its own specific laws and regulations while adhering to federal mandates. The New York State Department of Health (*DOH*) and The New York State Department of Environmental Conservation (*DEC*) are the main regulatory bodies within the state of New York that are responsible for implementing and enforcing legislative mandates related to the environment. Areas within each department often overlap and contractors can acquire information related to their project. The DEC provides detailed information in a variety of categories including: energy and climate, land and waters, education, outdoor activities, and several others. While the extent of each department is vast, the DEC gives specific attention to the construction industry. Contractors may collaborate with DEC employees on

many areas to inquire information concerning locations of construction and demolition debris facilities, instructions on hazardous waste disposal, and air quality standards for NYS (DEC). Additionally, contractors are required to obtain detailed permits for a given project that directly relate to environmental protection. A few of the permits include: Protection of Waters Permit, Freshwater Wetland Permit, Coastal Erosion Permit, Wild Scenic and Recreation River Permit, Mined Land Reclamation Permit, and various permits related to air pollution. The DEC is a fundamental part of environmental protection in the state of New York and assists the EPA on a state level. The EPA, DEC and DOH are essential for contractors and their efforts to keep the environmental healthy.

IV. RISK MANAGEMENT REGULATIONS IN CONSTRUCTION ENGINEERING

As the last component of the first module, students will learn about different aspects of the operational and project risk management for their established engineering enterprises. Students will learn about the critical role that risk identification, analysis, and risk response strategies play in engineering enterprise management. The PMBOK Guide provides essential information for construction firms in establishing best business and project management practices in risk management planning, risk identification, qualitative risk analysis, quantitative risk analysis, risk response planning, and risk monitoring control with required inputs, tools & techniques, and outputs for each process.

For a selected student project that involves establishing a heavy civil construction firm in NY state, the proposed risk mitigation strategies included (but not limited to) purchasing insurance, obtaining performance bonds, warranties, guarantees, and hiring an expert witness, among others. Purchasing insurance is a way to reduce the financial impact of a business interruption, loss or damage to a facility or equipment. It serves as a risk management tool for construction companies that can provide coverage for losses related to materials, risks, natural disasters, employees, and even the business. Common forms of insurance in the construction industry include property insurance, business interruption insurance, liability insurance, professional liability insurance, builder's risk insurance, and flood insurance, among others. In New York State, a number of insurances are strongly recommended, including: unemployment insurance, workers' compensation and employers' liability insurance, and disability benefits coverage. It should be noted that all three types of insurance can be obtained via private insurance carrier, and the New York State Insurance Fund. Students identified that in order to successfully manage their operations, the risk management must be addressed throughout the lifetime of each project. The critical processes related to risk management (risk management planning, risk identification, qualitative risk analysis, quantitative risk analysis, risk response planning, and risk monitoring control) are important to consider in developing a risk management plan that will ensure successful construction of high-risk projects. Strict compliance with regulations and laws will keep a project on or under budget and will help mitigate potential future liabilities.

SECOND MODULE: ENGINEERING PROFESSIONALISM, ETHICS AND ORGANIZATIONAL BEHAVIOR

The second module of the course focuses on the introduction of Professionalism and Engineering Ethics to the students as well as an introduction to the organizational behavior theories and the employee motivation. Engineering social responsibility is an organizational matter and society is best served by pursuing joint-interests of the stakeholders and economic symbiosis. It is important for the students to realize that an established engineering firm is not an instrument of the partners or shareholders, but rather, a coalition between various resource suppliers, with the intention of increasing their common wealth. Therefore, an ethically-sustainable enterprise is the one that finds and maintains a balance between economic consequences, legal considerations and moral obligations in business decision makings. This Balanced Approach and the Stakeholder Model Framework in ethical business decision making is further illustrated in Figure 3 for student engineering firms that were established and studied in Module I of the course.

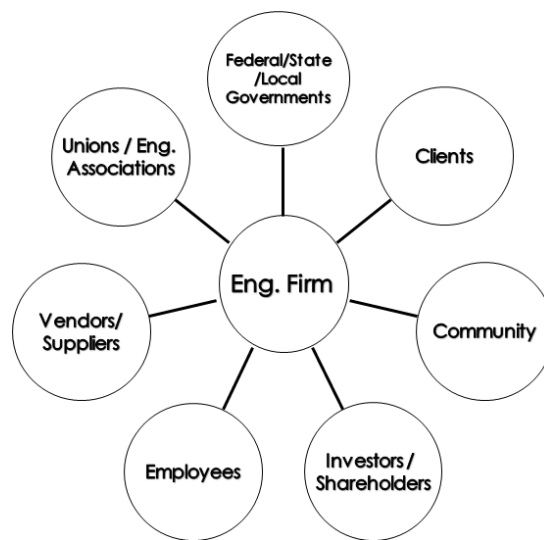


Figure 3: The Stakeholder Model for Engineering Ethics Analysis and Business Decision Making

Moreover, according to the National Society of Professional Engineers (*NSPE*) Code of Ethics for Engineers, engineering is a respected profession that has an important impact on the well-being of the society and the quality of life for all people. Engineering students, as tomorrow's engineers and industry leaders, must be equipped with honesty, impartiality, fairness and equity to provide public safety and health in accordance to the highest ethical standards.

In this module of the course, students are asked to perform a comprehensive research on the existing or potential ethical considerations/constraints in expanding their initially-registered engineering firm into another country as part of their fifth student project. Issues of organizational or systematic corruption in business practices in different jurisdictions are addressed and presented here as well as cultural awareness and cross-cultural issues in business negotiations and performing projects abroad. Their sixth project involves data gathering, researching and presenting a case study of two similar infrastructure projects that are currently being built or have been completed in two different countries. The students are asked to identify elements of success or failure in project delivery methods for the two investigated projects and then to analyze and comment on the causes, reasons and the application of better engineering/organizational practices towards successful completion of the selected infrastructure projects.

THIRD MODULE: RECAP OF THE PRINCIPLES AND MANAGERIAL ANALYSIS OF AN EXISTING LARGE CORPORATION

The third and last module of the course focuses on preparing the students for undertaking career paths in civil / construction engineering in professional job market. In this module, for their last project and presentation, students are required to select a large global Engineering / Construction (EC) publicly-traded corporation in which they will be interested for an internship or full-time employment. Students are asked to consult the company annual reports and research the public information to investigate the financial statements of the company (mainly the balance sheets and income statements) for three to five past consecutive years. This will enable the student groups to apply the in-class learnings of the Construction Accounting principles to analyze and comment on the financial soundness of the company in current or future operations. Furthermore, students will be able to comment on the effectiveness of the current managerial processes as well as identify future growth opportunities and business threats considering the current financial strengths and weaknesses of the selected public corporation.

SUMMARY

The objective of this course, through its three modules in performing these seven stand-alone yet completely intertwined projects, is for the students to accumulate as much as possible real-world engineering management insights and expertise which will not only help them in developing managerial vision for their engineering projects but also towards learning as much as possible about the laws and regulations; business norms and organizational management principles for successful establishing an engineering enterprise. Through its first introduction to the Civil & Construction Engineering curriculum at Syracuse University and its first offering in spring 2015 semester, the course has been very well received and attended by the entrepreneurial students who were/are interested in applying the learnings of this course and starting their own engineering firms. Below are few excerpts from the students' feedback that is collected at the end of the semester for improvement and planning purposes:

- *One of the best courses I have taken over my college career. Really helped me develop skills that I can use out in the real world.*
- *This course was very helpful for both junior and seniors who are intern/job hunting.*
- *Really enjoyed the project based learning for this class, the content really helped me to understand the industry as well as conduct of myself in my past interviews.*
- *I enjoyed the material that we learned about. It opened me up to a part of engineering I haven't seen before. I feel like this will help me in my future career.*
- *The instructor challenges us to think outside of problem solving but to also look in our ethical and moral foundations. Engineers are leaders and we were challenged to create and research about starting our own companies and the responsibilities (ethics, environmental, legal, etc.) that we would face.*
- *The work load is time consuming but extremely rewarding.*
- *Project based learning approach. Class was relevant to my goals of starting a business.*

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