

Teaching Globalization Issues to Civil Engineering Students – The International Collaborative Construction Management Course

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Abstract

Several construction companies have reported that their engineers and project managers are not prepared to deal with the requirements of the increasing globalization that is creating new opportunities with expanding markets all over the world. Construction companies, engineers, and project managers are realizing that their domain knowledge on materials, equipments, construction techniques, management techniques and methods, and social skills are local. Traditional construction management education does not prepare engineers for these challenges. This paper introduces and presents the lessons learned of a course titled "International Collaborative Construction Management" that has been developed and taught to fill this gap. The course exposes students to an international collaboration experience. Students in the US, Turkey, Brazil, and Israel are teamed with students from the other countries, and the teams are expected to present schedules, estimates, risk assessment plans, and process models of a facility to be built in one of the participating countries. Students learn not only how to develop construction estimates and schedules, but also, globalization issues, methods for working on multicultural teams, negotiation techniques, and methods to improve international collaboration enhanced by the use of information technology.

Keywords

Globalization in Engineering, International Collaboration, Multi Cultural Teams, Construction Management.

1. Introduction

Construction companies are increasingly involved in and dependent on international projects. Statistics reported by the Engineering News Record (ENR 2006) showed that the top 225 international contractors performed work valued at \$189 billion in 2005, and that the figure grew to \$224 billion in 2006. In terms

of volume of total business, international contracts accounted for 34% of these firms total revenue in 2005, but this rose to 40% in 2006.

Successful construction project management requires a combination of knowledge of construction methods, management techniques and social skills for communicating, negotiating and motivating co-workers. Project management is applied in all phases of the life-cycle of constructed facilities: planning, design, construction and operations. Each of these phases is performed by groups of people, often working for different organizations. It is the project managers' responsibility to achieve cooperation and coordination within and among these groups to produce and operate cost-effective and safe facilities. This is a challenging task when all the team members are domestic; but when projects teams collaborate across national and cultural boundaries, this requires unique skills. Some of the key reasons international projects fail are that: they are treated as regional projects would be; project managers lack sensitivity to local cultures; the teams overly depend on information technologies; and excessive senior management attention (Lientz and Rea 2003).

Many construction companies have reported that construction engineers and project managers who have recently graduated are not prepared to deal with the requirements of the increasing globalization that is creating new opportunities with expanding markets all over the world. Construction companies, engineers, and project managers are realizing that their domain knowledge of materials, equipment, construction methods, management techniques and social skills are local; when bidding for and planning international projects they have to learn to work and collaborate with, and acquire information from, local engineers and managers. However, traditional construction management education does not prepare engineers for these challenges (Charles et al. 2005).

To begin to meet the challenge of educating students of construction management in participating successfully in international projects, we have developed and run a course titled "International Collaboration in Construction Management" (the 'ICCM course'). The course itself is a collaborative effort between leading universities in the US (Carnegie-Mellon), Turkey (METU), Brazil (UFRGS), and Israel (Technion-IIT). Now in its third year, it comprises joint lectures, readings and group discussions and requires teams of students from each country to prepare a joint project. The teams are expected to present schedules, estimates, risk assessment plans, and 4D CAD simulation models of a facility to be built, with each team member taking on a professional role.

International collaboration is also common in the design of construction projects. Revenue for the top international design firms from international projects reached \$33 billion in 2006 (ENR 2006). A university course teaching the skills needed for designers and planners in such projects, called "Computer Integrated Architecture/Engineering/Construction Global Teamwork", has been run since 1993 (Fruchter 1998). Based at Stanford University, it currently has 19 participating universities (Fruchter 2008). The goals of this course are to teach architecture, engineering and construction (AEC) professionals to collaborate across disciplines, and in particular, how to use tailor made Internet collaboration tools to communicate (Fruchter 1999). The focus of the ICCM course, on the other hand, is on the cross-cultural interaction between construction managers only.

The following sections outline the ICCM course goals and content, the experience to date of administering the course, and the lessons learned.

2. Goals and Content

2.1 Goals

Effective collaboration among construction managers in international projects demands a broad and holistic understanding of the many distinct aspects that may affect a project's outcomes. As a consequence, the goals that guide the ICCM course cover a combination of technical, managerial and

social skills. The technical skills include production planning, cost estimating, risk analysis, cash flow forecast, and value engineering; managerial skills include preparing collaboration contracts, managing the work of their own multinational teams, setting up communications and maintaining project data stores, and making presentations; social skills include cross-cultural collaboration and team work.

Emphasis is placed on learning through doing. Teams of students from different countries work in virtual international joint ventures. Each team applies a set of project management techniques for assessing the feasibility of building a facility. While primary emphasis is on the planning phase, the techniques and perspectives adopted are useful also for other phases of the facility development process.

The goals of the course were established according to the following four topics. The detailed learning objectives that derive from them are listed in Figure 1.

(a) **Communication.** It is expected that the students will be aware of the importance of communication to the coordination process, being able to identify and describe differences in the preferred styles and methods of communication among team members from different cultural and disciplinary backgrounds, as well as to identify and evaluate the potential consequences (positive and negative) of those communication styles as they relate to the class projects.

(b) **Local Engineering Practice and Standards.** The course aims to provide the students with the ability to understand and to deal with the influences of geographic and social/cultural differences that are common in the context of international construction projects. This includes the ability to identify and describe differences in preferred (or required) building methods and material selection among team members from different cultures; to describe the social/cultural, geographic, legal, political and economic factors that contextualize the differences in preferences (or requirements) for building methods and materials; to develop risk assessment plans that consider regional factors; and to identify core operations management concepts and principles and how to adapt them to the construction environment, especially those that are necessary for value engineering. One of the objectives is to enable students to identify, compare and contrast the standards of work practice for each culture represented in their team.

(c) **Group Interaction and Management.** One of the most challenging aspects of international construction projects is that much of the managerial work is of collective nature, implying collaboration among people. The course was designed to include such social concerns, providing students the necessary experience to understand and positively influence the collaboration among participants, including: to document a process that outlines a method of communication and describes a decision-making strategy for resolving conflict; and to demonstrate openness to ideas, methods, approaches, processes, and standards that may not be consistent with the student's own cultural values or experiences; and to identify characteristics of multicultural negotiation processes.

(d) **Information technology.** IT plays a central role in the coordination of international construction projects. At the same time as IT provides the necessary infrastructure for communication, it also shapes new forms of collaboration among team members, thus making understanding of how protocols and collaborative tools affect the international project essential. Three learning goals are identified: to define the required protocols for the use and development of technologies for multi-disciplinary remote collaboration; to develop and utilize strategies, techniques, for evaluating collaborating tools; and to make recommendations for the development of improved software tools for collaborative, multicultural collaboration.

2.2. Teaching Methods and Course Structure

The course runs over sixteen weeks from January to May, with a two (academic) hour frontal meeting each week. The period is set according to CMU term time, which in fact requires the other universities to teach across their winter and spring semesters. For the Brazilian team, who are south of the equator,

coordination across semesters and with carnival break is a particular challenge – this is in itself an example of the kind of multicultural accommodations that must be made. The sessions have three distinct learning activity types:

(a) **Lectures** to the full course group, using videoconferencing. The lectures provide technical knowledge about important aspects of the management of international projects. Topics include global construction management, risk management, and production management. Four sessions are devoted to lectures.

<p>By the end of the semester, students will be able to...</p> <p>Communication</p> <ol style="list-style-type: none">1. Identify and describe differences in the preferred styles and methods of communication among team members from different cultural and disciplinary backgrounds.2. Identify and evaluate the potential consequences (positive and negative) of those communication styles as they relate to the class project. <p>Practice</p> <ol style="list-style-type: none">3. Identify and describe differences in preferred (or required) building methods and material selection among team members from different cultures.4. Describe the social/cultural, geographic, legal, political and economic factors that contextualize the differences in preferences (or requirements) for building methods and materials.5. To develop risk assessment plans.6. Identify core operations management concepts and principles and how to adapt them to the construction environment, especially those that are necessary for value engineering7. Identify, compare and contrast the standards of work practice for each culture represented on the team. <p>Group Interaction and Management</p> <ol style="list-style-type: none">8. Document a process that outlines a method of communication and describes a decision-making strategy for resolving group conflict.9. Demonstrate openness to ideas, methods, approaches, processes, and standards that may NOT be consistent with the student's own cultural values or experiences <p>Information Technology</p> <ol style="list-style-type: none">10. Define the required protocols for the use and development of technologies for multi-disciplinary remote collaboration;11. Develop and utilize strategies, techniques, for evaluating collaborating tools; and12. Make recommendations for the development of improved software tools for collaborative, multicultural collaboration.

Figure 1. Statement of ICCM Learning Objectives.

(b) **Class discussions:** most of the learning process is planned to be driven by the problems and questions that students face during the team work. Thus, a set of papers on project management techniques are provided, as well as others on issues related to collaboration in international projects. Discussions are held separately within each team, facilitated by one faculty member, to give students the opportunity to discuss application of the content to real situations, as well as for the exchange of impressions among the groups about their experiences on the topics.

(c) **Project presentations:** two presentations are required for each team, an interim and a final one. The presentations provide for evaluation and comparison of the teams' progress.

Beyond the lecture hours, students meet with their teams at least once more each week, to coordinate their **project tasks**. Together with the personal reading requirements, the project tasks demand the majority of the students' time on the course. Through the course, the students are required to prepare individual and team submissions. The personal deliverables are a **weekly journal** (with three sections: a summary of the weekly readings and their feedback and opinion about the issues introduced by the authors; a report on their individual weekly activities toward the project goals; and a discussion on collaborations issues that emerged during the week from their team's work) and a **final individual paper** (which reviews their journal entries through the semester and summarizes their conclusions, perceptions and understanding of the process they have completed). The team submissions are:

(a) a **collaboration contract** including a formal organization structure, definitions of individuals' responsibilities, how their joint venture will be organized, etc. They must carefully define their commitments to one another vis-à-vis when they will meet (how often?, what time?, how long?, where?), how absences will be dealt with, procedures for making decisions, resolving conflicts and for communicating with one another, how they will behave when someone is not participating, dominates, or distracts the group from its task, etc.

(b and c) interim and final project presentations, which are presented to the whole course.

2.3 Content

As can be seen from Figure 2, the course content includes two types of readings and lectures: a) the core topics of international construction projects, globalization issues and cross culture collaboration; and b) the topics needed to support the technical aspects of the project tasks, and are greatly tailored by the project deliverables and kind of team organization. In the first year that the course was given, additional topics that were pertinent to the specific project types were included, such as risk management, Build-Operate-Transfer projects, and design of production systems. These were removed in the second year as the project tasks were simplified, as will be explained in the following section.

2.4 Technology

The ICCM course relied primarily on common and widely used commercial or open source collaborative tools and protocols such as email, chat clients and videoconferencing programs/protocols. However, the two exceptions are the The Kiva group collaboration tool (www.thekiva.com) and the PolyCOM videoconferencing facility. The videoconferencing facility was adopted to provide many-to-many videoconferencing over the Internet, which is poorly supported by the free services. In the case of The Kiva, it was used to provide appropriate support for team collaboration through discussion threads and as an information repository where teams could store project files and other data.

3. Experience to Date

In the first year that the course was given, each of the teams was composed of students from two countries only. Bilateral teams were set up between CMU & METU, CMU & Technion, and CMU & UFRGS. Each team was given the task of preconstruction planning for a real project in Turkey (light-rail), Israel (highway tunnels) and Brazil (low-cost housing project), respectively. The project type, the project delivery system and the contract type were all different for each group. All teams were required to prepare cost estimates and master construction schedules, but there were also project-specific requirements: Team 1 (Turkey-USA) prepared a detailed risk management plan, Team 2 (Israel-USA) developed a technical proposal for toll collection, and Team 3 (Brazil-USA) designed a production system. The students in the local project countries were expected to provide the local knowledge, while the CMU students were

expected to play the role of providing construction expert knowledge; this was the premise for the international collaboration. A local mentor from the industry, who had actually worked on the given project, was assigned to assist each group; the mentors gave feedback about the suitability of the project deliverables that the teams prepared.

<p>International construction projects:</p> <ul style="list-style-type: none"> • Lientz B.P. and Rea, K.P, "International Project Management" Elsevier Science, 2003. Chapters 1, 8 and 9. • Crosthwaite, D., Connaughton, J., "World Construction 2005-2006", Davis Langdon Management Consulting, London, 2006. • Grogan, T. (2007). Inflation Bows To Sub-Prime Crisis. ENR: 26-32. • Tulacz, G. and P. Reina (2007). Firms Are Now More Selective. ENR: 10-16. <p>Globalization issues and cross cultural collaboration:</p> <ul style="list-style-type: none"> • Hooker, J., "Working Across Cultures". University Press, 2003. • Friedman, T.L. "The World is Flat – A Brief History of Twenty-First Century", Farrar, Straus and Giroux, 2005. • Stiglitz J.E., "Globalization and Its Discontents", W.W.Norton and Company, 2003. <p>Value management and target costing:</p> <ul style="list-style-type: none"> • Kelly, J., Morledge, J., and Wilkinson, S., "Best Value in Construction", Blackwell Publishing (2002). • Kelly, J, and Male, S., "Value Management". • Ballard, G.; Reiser, P. (2004) "The St. Olaf College Fieldhouse Project: a case study in designing to target cost". Proceedings of the 12th Annual Conference on Lean Construction, Denmark. • Cooper, R.; Slagmulder, R. (1997) Target costing and value engineering. Productivity Press, Portland, Oregon, 379 p. • Kato, Yutaka (1993) "Target costing support systems: lessons from the leading Japanese companies". Management Accounting Research, 4, 33-47. <p>Risk management:</p> <ul style="list-style-type: none"> • Smith, N., "Risk Management". <p>Production systems design:</p> <ul style="list-style-type: none"> • Arditi, D.; Tokdemir, O. B. and Suh, K. et al. (2002) "Challenges in Line-of-Balance Scheduling." ASCE, Journal of Construction Engineering and Management, Vol. 128 (6): pp. 545-556, December. • Koskela, L. (1992) Application of the new production philosophy to construction. Stanford, EUA, CIFE, August 1992. Technical Report No 72.
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Figure 2 – ICCM Readings (2008 edition)

However, despite its close parallel of real international project collaboration scenarios, this arrangement proved to have numerous problems from a learning perspective. As the groups were composed of students from only two countries (one country being USA in each group), the local group carried out most of the work as they were closer to the data sources, mentor and had more experience of the local conditions. This significantly decreased the level of multicultural collaboration and limited the understanding of foreign students about local conditions. Also, as the project requirements were clearly set, there was limited room for innovative solutions and value engineering.

To improve the multicultural collaboration learning experience, the teams' structure and their tasks were changed in the second year. Each team was now composed of students from at least three countries, and each student in the team was given a different professional role (project manager, estimator, scheduler, risk assessor, etc.) They had the joint task of pre-construction planning for provision of a standard 15,000 m² office building in a city of their choice: Ankara, Haifa, Porto Alegre or Santa Clara. A preliminary design model of a real office building project, constructed in Pittsburgh, was provided to serve as a baseline to define the design intent for the project. All teams were required to prepare cost estimates,

master schedules, risk assessments and to perform value engineering. One course instructor mentored each group, representing the owner. In weekly meetings, mentors gave some information about how to develop the project deliverables, provided construction market conditions in their country, and facilitated group discussions about the assigned course readings. The major differences between the first and second years are highlighted in Table 1.

Table 1. Comparison of Two Sessions

Characteristic	1 st year	2 nd year
Project	Different projects in each country: <ul style="list-style-type: none"> - Urban transportation and mass transit project in Turkey, - Low-cost housing project in Brazil, - BOT transportation project in Israel 	Same project in each country: A mid-size commercial building project
Team composition	1: Turkey-USA 2: Israel-USA 3: Brazil-USA	1: Brazil-Israel-USA 2: Israel-Turkey-USA 3: Brazil-Turkey-USA 4: Brazil-Turkey-USA
Project deliverables	Project specific deliverables	Same project deliverables for all teams
Mentors	From industry, project focus	Instructors, collaboration focus

The impact of these changes on the success of the course can be summarized as follows:

1. In the second year, students learned more about how people from different cultures communicate (the so-called “cultural fluency”) due to the higher level of multiculturalism within each team. Students from culturally diverse backgrounds had to develop a shared perception of the project and use a similar lens through which they had to understand the requirements of the project. This ability to develop a shared perception is actually in and of itself an expected outcome of the course. However, the increased level of multicultural communication also resulted in greater challenges due to greater “differences” among a higher number of students from diverse cultures. Technical differences such as units, currencies, calculation methods as well as different time zones, languages and working days resulted in communication problems. It was more difficult to organize group meetings due to time differences, to understand the “meaning of numbers” provided by each group member using a different unit/scale, and there was a higher risk of technology failure due to connections from more than two locations. Cultural fluency increased, but at a cost of increased complexity in communications.
2. In the second year, each individual student played a greater role and better balance was achieved between team members from different countries. Each team member brought his/her own specific expertise to the team, together with information about local conditions.
3. In the second year, contributions were more innovative. Assigning an essentially open-ended project – to prepare a cost, time, risk assessment and value management plan for a typical office building, to be built in four different locations considering local market conditions – gave students more scope to apply their knowledge. Findings regarding each country were compared and differences were revealed. Moreover, the findings of each group about the same country were compared and the validity of different approaches/solutions was discussed.
4. In the second year, team sessions included discussion of assigned readings with participation of the mentor. These discussions helped the team members understand their project tasks better, provided an opportunity to talk about their cultural identities and increased the level of involvement of the mentors (instructors) with the teams.

As a result, the second year was more successful in terms of increasing the students' awareness of collaboration in multicultural environments and enhancing their knowledge on differences between construction technologies in different parts of the world.

4. Lessons Learned and Conclusions

The most prevalent common thread in the students' overall evaluations, taken over both years, was that the course had succeeded in providing a valuable learning experience by virtue of their participation in a real-life international collaboration. A majority noted that the course provided them with a real multicultural collaborative construction management experience, which they think will be a competitive advantage in their professional life. Their more detailed assessments showed various levels of success in each of the course's primary goal areas – cross-cultural communication, construction management practice, group interaction, and information technologies. The following paragraphs discuss these issues in the light of both faculty and student evaluations collected over two years. Where relevant, the impact of differences in the way the course was structured over the first and second years are highlighted.

Cross-cultural communication. As expected, students reported the negative impact of cultural differences in their final individual reports. It became apparent that students from different countries with different cultures have different mental models of the way in which collaborative groups should be structured, how they should function, how roles should be assigned within the group, and who should be responsible for ensuring that tasks are completed with the expected quality and on time. We observed strong correlation between student teams that did not invest sufficient time to design a reasonable organization structure and to explicitly formulate how teamwork should be structured, on the one hand, and the incidence of problems in the collaboration. This was heightened during the second year, where teams comprised participants from three countries, as opposed to two during the first year. During the first year, for example, the Brazilian-American team had a hard time trying to organize their work because the American students wanted to have a power structure with a boss and workers, whereas the Brazilian students wanted to have a horizontal structure with work division and shared responsibilities. The American students wanted to have a contract clause with sanctions for individuals unable to complete their work; the Brazilian students preferred to spread responsibilities across all team members.

An issue that arose in both years concerned different perceptions of time, punctuality and tardiness across cultures. Coordination of holidays proved to be difficult. American students were upset with the low level of output delivered by the Brazilian students during the Carnival break in Brazil, but presented exactly the same behavior during the spring break in the US. Americans had a hard time understanding that for Brazilians and Israelis, some tardiness in delivering work was permissible. American and Turkish students clashed because of different understanding of the importance of being punctual for meetings.

All communication and coursework was conducted in English, which required all of the other students to collaborate in their second language, and also required them to translate all of the technical material into English for the benefit of their American colleagues. Several documents, such as project documents and local publications of cost and productivity data, had to be translated. This double burden – of functioning in a foreign language, and the work of translation – was largely taken for granted by the American participants.

The class clearly demonstrated several issues related to cross-cultural collaborations. Students differed in the way that they organized themselves, working processes, time management, social conventions, and the distribution of knowledge and expertise. However, to provide perspective, it is important to mention our observation that conflict doesn't arise just because of cultural differences. Personality is also a key factor. In the few cases where individual students were unable or unwilling to fulfill their tasks, the resulting tensions caused the team more problems than the cultural differences did.

Construction management practice. Students became acutely aware of the differences in engineering practice and construction methods between the countries. Not only did they share fairly detailed information about how different building parts would be built in each country – such as the prevalence of reinforced concrete construction in Turkey and Israel, versus the use of steel in the US or other materials in Brazil – but they also saw the differences in professional roles. The differences in perception of risk across countries, both economic and safety risks, were also apparent. The use of different systems of measurement, different methods for quantity take-off, cost estimation, contract procurement and scheduling, were all encountered and had to be dealt with by the teams.

Group interaction was an important part of the course because teamwork was seen as key to achieving collaboration across the countries. A particular problem arose in the course in terms of the degree of professional construction training and education of the students. The Brazilian, Israeli and Turkish students were all Master's level students, many of whom had already worked as engineers and architects. The US students, on the other hand, were undergraduate students, some of whom had not studied entry level construction management courses. This too led to frustration in terms of the expectations of the different students concerning the degree of detail needed in their submittals.

The **information technology** adequately supported giving lectures to four locations simultaneously, and team presentations were made to the full class live with video feeds. It was possible for students in any country to ask questions, and the ability to remotely control cameras made it easier to focus in on individual speakers in the room each country. During the first year the students faced some technical problems with voice over IP connections (using Skype) in their team meetings because of dropped connections. This problem was partially solved by the investment in the Polycom system that was utilized during the second year, but even Polycom technology could not avoid dropped calls when students used poor internet connections. Nevertheless, the most common communication problems were not due to technology issues, but due to the different accents and the cultural differences described above.

Students preferred to use Skype and e-mail for communication rather than more advanced tools such as video-conferencing (Polycom) or intranet sites (Kiva - www.thekiva.com). They preferred to keep Internet communication simple and effective: little desktop sharing, no video and rare use of “information centric” alternatives (such as Kiva). Technology is an enabler of collaboration but advanced technology does not guarantee effective collaboration in multicultural environments.

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