



Preparing Engineers for Global Challenges

Dr. Souhail Elhouar, Bradley University

Dr. Elhouar is an Associate Professor of Civil Engineering and Construction at Bradley University. He holds a M.Sc. and a Ph.D. in structural engineering from the University of Oklahoma in Norman, Oklahoma and a BSc in Building Engineering and Construction from the University Of Tunisia School Of Engineering in Tunis (ENIT). He specializes in the analysis and design of industrial and non-industrial steel buildings and has been teaching steel design and other related courses for many years. His research interests include the design and implementation of artificial intelligence applications in structural engineering, modeling the behavior of structural systems and components under typical and extreme loading conditions (including the effect of fire and collapse analysis), the study of connection design methodologies, and the analysis of the behavior of composite members. Dr. Elhouar has practiced structural engineering at the international level and has participated in his department's internationalization program numerous times by accompanying students and teaching overseas.

Dr. Amir W Al-Khafaji, Bradley University

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1. Introduction

When it comes to preparing engineering faculty and students to meet global engineering challenges and needs, nothing compares to bringing together business executives, government officials, and educators from around the world to explore uncommon solutions to common global problems. The competitive advantage belongs to graduates, companies, and institutions who understand the global context of their profession.

The world of the twenty first century faces many challenges that future engineers are expected to master. In fact, problems such as climate change and global warming, water shortages, depletion of energy resources, scarcity of materials, overpopulation, and poverty are no longer bounded by geographic and cultural divides. Consequently, engineering education must rise to the challenges of tomorrow and produce engineers and builders who possess the needed knowledge, skills, global perspective, and social awareness to succeed. This is a formidable challenge that educational institutions are unlikely to be able to meet alone as the task goes beyond ensuring student technical competency. It must involve collaboration with global business partners, international institutions, and employers seeking engineering graduates.

2. Civil Engineering and Construction Challenges of the Twenty First Century

Twenty five years ago, Endersbee⁴ identified ten challenges that civil engineers would face in a globally growing market. Endersbee⁴ maintains that civil engineering is an international profession that will have to deal with increasing world population, substantial advances in agricultural practices, urbanization, mobility in location of world manufacture, issues of transportation in cities, advances in computer and communication technologies, the increasing world demand for electricity, the impact of energy use on the climate, implications of possible climate change, and the different laws at the international level. These challenges are a reality today, and civil engineers and constructors entering the job market must be well prepared to meet them by educational programs that emphasize diversity and the role of leadership.

Bhattacharyya¹ proposes that civil engineers deal with the public and relate to people as a political body thus the use of the term civil. Bhattacharyya¹ states that civil engineers have developed the greatest cities in the world and that they must be aware of the different cultures. Bhattacharyya¹ also emphasizes the role of ethics as a means to promote public welfare.

The issue of ethics is of a great importance to engineers and constructors and it is even a bigger of a challenge to those who wish to be involved in international projects. This is because ethically acceptable behavior can mean different things in different cultures. Furthermore, even when people agree that a certain behavior may be construed as unethical, the way they deal with it when it takes place can vary from looking the other way to taking punitive and even legal actions. Carroll³ identifies ethics as one of four necessary ingredients to meet global environmental challenges; the other three being reorganization of technology, education, and merging fractioned engineering organizations into more sustaining partnerships and coalitions. Boeckmann² brings up bribery and corruption as age old issues that continue to present challenges to all those involved in the engineering and construction industries around the world. Boeckmann² describes an effort involving a worldwide team of educators, engineering

professionals, and communicators to develop what they called the Global Anti-Corruption Education and Training project. The product of this project is a film and an educational program that promotes ethical decision making among engineers and other professionals, portrays ways to avoid falling prey to corruption, and encourages those in the industry to have the moral courage to expose it.

The International Construction Innovations Conference (ICIC) described in this paper provides the perfect environment and a sustainable platform for addressing all these challenges. Its major strength is the innovative approach of enlisting educators, industry representatives, and government officials from a large number of countries and bringing them together in focused settings to find solutions to specific problems. Students who participated in the conference gained a unique experience that opened their eyes and minds to the world around them, and the faculty members who attended the event were able to gain tremendous insights that they could share with their own students.

3. The Global Engineer

The practice of civil engineering and construction on a global scale requires that engineering graduates be adequately prepared to deal with diverse issues that surpass their geographical boundaries and challenge their comfort zone. Parkinson⁷ presented a rationale for developing global competence. In his synthesis, he answered the question of why global competence is needed and provided concrete examples of globalization in four engineering disciplines: mechanical, electrical, civil, and chemical engineering. Parkinson⁷ then presented 13 different competences encompassing a broad set of attributes and skills that engineering graduates should have, namely, the appreciation of other cultures, communication, history, economics, technical abilities, and others. Hundley et al.⁶ conducted a survey among 563 respondents to identify the attributes of a global engineer. They probed survey participants on the level of importance and level of proficiency in a number of attributes at various stages of learning and development.

It is generally agreed upon that upon graduation, and to be able to be effective in a global economy, young civil engineers and constructors are expected to be aware and understanding of cultures that are different than their own. They need to understand that there can be legal and technical differences in the various parts of the world that will adversely affect their performance on a project if not taken into account. They need to be able to communicate with local businesses and understand the politics of the place including how to deal with political figures and government agencies in an effective way. Most importantly, they need to do all this with utmost integrity within a set of ethical standards that may be very different from those to which they are accustomed.

The skill sets needed by future graduates must include opportunities to practice these skills or at least observe them in action. This can be done in a variety of ways, the most obvious of which, is to introduce these skills in a classroom setting. This approach is effective in delivering materials to students but falls short on providing opportunities to the students to practice learned skills. Study abroad programs are an effective method of introducing students to new cultures and they are extremely effective when they include significant interaction with local businesses and government and other organizations at the countries being visited. However, these programs

usually only benefit the small number of students that gets an opportunity to participate. A third alternative is to create opportunities for students and faculty to interact with industry and government decision makers and educators from around the world and form sustainable partnerships that create new opportunities to interact with the global players of the civil engineering and construction industries at different levels. This is exactly what the ICIC was designed to do and the benefits from holding it are still being felt even after eight years.

4. The International Construction Innovations Conference (ICIC)

The International Construction Innovations Conference (ICIC) was created with a vision to develop a network of business executives, policymakers, and scholars from around the globe to promote business alliances and joint ventures between industry, government entities, and academia. The objective was to make it easier to pursue basic and applied research, align and leverage new partnerships, and secure new funding sources. At present, the world stands at a unique period in the history of exploration and discovery defined by high risk and great opportunities. The new global economy, outsourcing, and emerging technologies have significantly altered the working environment of the infrastructural industry. The challenges presented by the global economy will drive revolutionary business and research developments on a great scale. The ICIC had five specific objectives as listed below:

- to provide a forum to examine and seek answers to profound questions and challenges confronting executives in government, education, and business worldwide,
- to exchange information and research ideas relevant to the infrastructural industry and pursue business partnerships with executives from around the globe,
- to gain access to a cross-cultural institutional network of influential business executives, decision-makers and scholars with wide-ranging cultural traditions and expertise,
- to create mechanisms for alternative funding sources and means to influence policymakers on emerging legislations, fast changing markets, and technologies. This includes public policy recommendations to implement and sustain local and global business activities, and
- to explore innovations in infrastructure and gain strategic insights into current global business challenges, best business practices, emerging business trends, and development of new awareness to make informed decisions

The ICIC has a unique organization structure that motivated participants and created effective synergies between educators, professionals, elected officials, and government officials from around the world. Initially, areas of geographic proximity around the globe were defined and potential participants were identified to form local ICIC committees. A total number of 350 decision makers participated not only in the conference but also six executive summits involving global problems of common interest. Figure 1 shows a map of the world identifying the 33 countries that were represented at ICIC and the locations of the local committees.

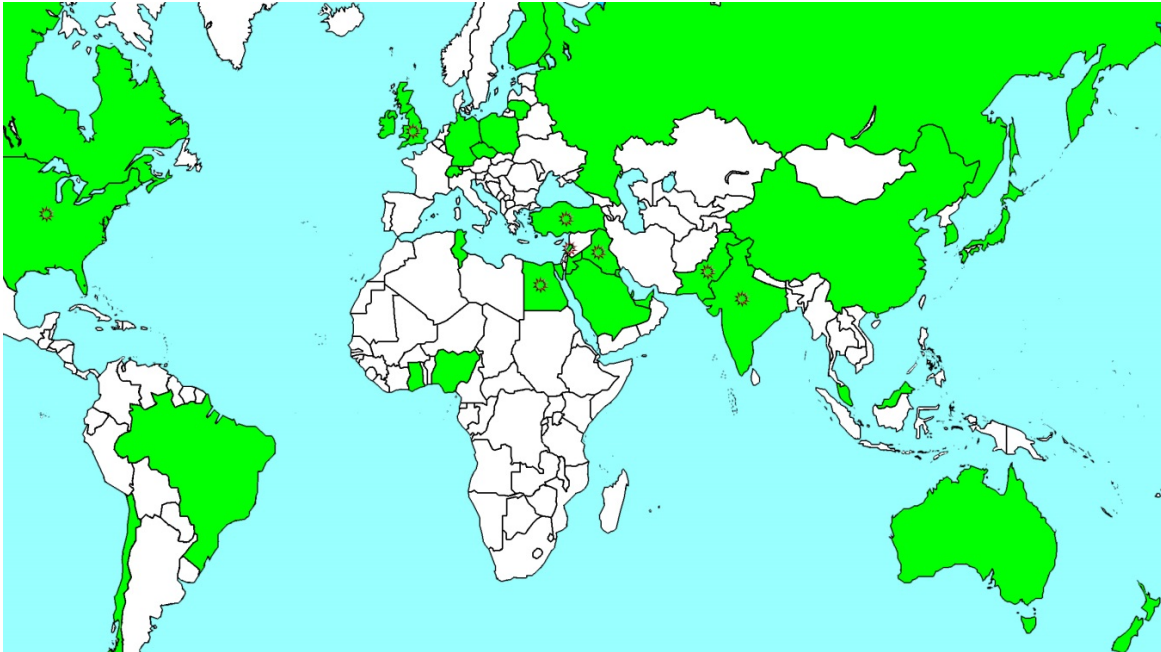



Figure 1. ICIC Countries and Local Committees ()

This arrangement provided numerous settings that linked diverse groups before, during and after the conference. The local planning committees then merged for a big planning meeting in Chicago, IL to work out the final details of the conference. This event in itself is of great importance as it created unparalleled opportunities for participants, most of whom are decision makers, to network and discuss important issues. Throughout history, business, educational, and cultural exchanges have helped create enduring bonds and relationships to build bridges of understanding between organizations and peoples. The ICIC network provides a firm foundation for effective international cooperation and an enriching environment for the development of new joint business enterprises, and it did produce partnerships to build a better world and turn risk into opportunity.

5. ICIC Focus Groups

In addition to the more than forty speakers and panelists involved in the conference, six focus groups were organized to address issues such as rebuilding Iraq, rebuilding Lebanon, on-line construction management, housing projects in Egypt and Turkey, the potentials for creating wealth in developing countries, and innovations book in construction. These focus groups were by invitation only and involved ten participants each. The members of each group were selected based on their knowledge of the problems being discussed, their expertise in the field, and their ability to effect the implementation of proposed solutions.

One of the focus groups dealt with the effort of rebuilding Iraq after the 2003 war. This group included Mr. Samir Sumaida'ie, Iraq's Ambassador to the United States, Mr. Qubad Talabani, representative of the Kurdistan Regional Government, Dr. Abid Theyab Al-Ajeeli, Iraq's Minister of Higher Education and Scientific Research, Dr. Hadi Al Khalili, Iraq's Cultural Attaché, and Dr. Beriwan Muslih Khailany, Iraq's Deputy Minister of Higher Education and Scientific Research as well as well-known academics, high-ranking government officials, and

leading business people from around the world. Because of the large number of projects that the country was planning to undertake in the following few years, online project management, which was one of the innovations discussed at the conference, was of particular interest to the Iraqi delegation. Dr. Mirosław Skibniewski, the A. James Clark Chair Professor of Construction Engineering and Project Management at the University of Maryland, connected with the delegation during the conference and then stayed in touch with them to discuss the training needs of the engineers and project managers working to rebuild Iraq. Dr. Skibniewski has helped Dr. Al-Ajeeli explore options for the online delivery of such training through the University of Maryland's project management program.

Another focus group dealt with the effort of rebuilding the infrastructure of Lebanon. It is rebuilding the roads, bridges, airports, schools, and utilities that ultimately helps a country get back on its feet after an armed conflict of any kind. The conflict between Israel and Hezbollah that took place in Lebanon in 2005 caused incredible damage to the country's infrastructure with estimates ranging from \$2.5 billion to \$5 billion or more. The rapid construction of roads and bridges was at the forefront of discussions on rebuilding Lebanon that took place at the ICIC. The participants in this special focus group discussing such efforts included: Congressman Ray LaHood (R-Illinois), Dr. Amr Salama, HBRC chairman, Ministry of Housing, Utilities and Urban Communities (Cairo, Egypt), Mr. Ibrahim Mahlab, president and chief executive officer of The Arab Contractors (Cairo, Egypt), Mr. Hussein Chaer, president of Cedar Hills Company (Beirut, Lebanon), Mr. Haytham Haidar, managing director of Otak International (Abu Dhabi, UAE), Mr. Doug Oberhelman, group president of Caterpillar Inc. (Peoria, Illinois), Mr. Benjamin Tang, principal bridge engineer with the Federal Highway Administration (Washington, DC), Mr. Sergio "Satch" Pecori, president and chief executive officer of Hanson Professional Services (Springfield, Illinois), and Ms. Rosie Andolino, executive director of the O'Hare Modernization Program (Chicago, Illinois). While the engineering and construction community in Lebanon has some of the resources needed for the reconstruction efforts, the sheer scope and volume of projects was so overwhelming that outside assistance was needed and being sought. Innovations presented at the conference such as the ability to replace bridges in less than 48 hours were of great interest to members of the focus group

The states of housing construction in Egypt and Turkey were also topics addressed by one of the focus groups. In particular, the construction industry in Egypt is using innovative solutions to meet the country's need for affordable housing and address the impact of population growth. Egypt was seeing an over-concentration of its population in just five percent of the country's total area. This concentration, centered mostly in Cairo and the Alexandria region, has resulted in a shortage of low-income housing, the "deterioration of the built environment," and threats to historical sites due to the encroachment of developments. In response to these issues, the Housing and Building National Research Center established an administrative system for utilizing the building material waste generated by the building material industries. The program was intended to reduce building materials waste by reusing it and preserve the environment.

6. The Caterpillar Ideation Sessions

As part of the ICIC, Caterpillar Inc. invited 22 distinguished professionals, lawmakers, and scholars from around the globe to its "Think Tank" facility in Peoria, Illinois, to participate in

round-table ideation sessions. Ideation is a creative brainstorming process that helps companies like Caterpillar Inc. identify where to allocate future research dollars and to identify potential acquisitions in order to effectively meet current and future customer needs.

Overall, Caterpillar Inc. conducted two ideation sessions as part of the ICIC. The first one focused on the heavy construction business (road construction, civil works, site development, and underground utilities). The second ideation session focused on the general construction business (commercial and residential building construction, specialty trades, and landscaping). During the ideation sessions, stakeholders had an opportunity to address future trends, current challenges facing customers and government agencies, and their "wish lists" for future products and services. In addition, attendees had a chance to evaluate a select number of concepts Caterpillar was working on to better serve its customers in the construction industry.

In order to ensure ideation sessions were valuable for both the participants and the company, individuals selected to participate had extensive experience in the industry, an in-depth understanding of the business, knowledge of the issues facing customers, and a vision of the industry's future. Four Caterpillar Inc. employees also participated in each session and served as experts in the areas of industry, product knowledge, technology, and support.

Holding these ideation sessions in conjunction with the ICIC provided a number of benefits to Caterpillar and the participants. From the company's standpoint, it was an excellent opportunity to bring some of the best minds from around the world together to focus on the future of the construction industry. The company also benefited from the exchange of ideas that can help Caterpillar, in turn, better focus its future product and service offerings. The sessions gave everyone involved an excellent opportunity to further develop business relationships with key players in the industry. Business leaders, policymakers, and scholars also had an opportunity to have their voices heard by the world's leading manufacturer of construction and mining equipment. Some of the most interesting topics that were discussed included underwater construction, making high end construction equipment affordable for developing countries, using automation and precast products to build hundreds of thousands of housing units in the Middle East, and the future of emissions standards in the US and around the world.

7. Presented Topics and Impact on students and the industry

The ICIC was covered by ENR⁵, which published an article about it in its November 2006 issue. The conference had a tremendous impact on the Peoria community and the construction industry at the local, national and international levels. It also created a unique venue for Bradley University Civil Engineering and Construction students to network with and learn from professionals, scholars, and high level decision makers from around the world. Figure 2 shows examples of a number of innovative construction projects from around the world that were presented at the conference and that students got a chance to learn about first hand from the people who were involved in them.



Figure 2. Sample of the construction projects highlighted at ICIC 2006. (a) Japan's Kansai International Airport; (b) the new San Francisco-Oakland Bay Bridge East Span; (c) Burj Al Arab in the United Arab Emirates

The conference program also included such topics as current issues affecting the construction industry, global construction insights, risk management and sustainability of global business partnerships, accelerated bridge construction technologies in the US, the construction industry in Egypt, Business opportunities in Iraq, the Czech Republic construction market, the China construction market, the Brazil construction market, sustainable building systems for the future, the asphalt revolution and world-wide innovations in materials, latest developments in construction automation technologies, and many other interesting topics. The conference also included two panel discussions; one panel discussion was to investigate and identify new world markets and the second was to discuss the world of ethics and on-line reverse auction bidding. The variety and wealth of topics in subject and source provided an unmatched opportunity for participating students and faculty to be more aware of what is going on in the world around them. It may be fairly easy to invite a speaker to class to talk about construction efforts in China, or in the Czech Republic, or in Japan, or in the United Arab Emirates, or anywhere else in the world. But to have decision makers from all those places available at once to talk about their particular regions is something that is quite unique and that was only possible because of the way ICIC was organized, planned, and executed.

The remarkable network of more than 350 professionals and high level executives including twelve ministers, 97 CEO's and company presidents, and 49 scholars is in fact a tremendous asset to have available to students and faculty at a conference of less than 500 participants. The connections that were created helped build lasting relationships that the Bradley University Department of Civil Engineering and Construction took advantage of to enhance its study abroad program and grow its pool of invited speakers. It is having these connections that caused an accrediting agency to declare that the Study Abroad program of the department is unique in the nation. As a matter of fact, and because of the relationships that were created because of ICIC, Bradley University Civil Engineering and Construction students have high level government officials, such as an advisor to the king of Jordan or a minister, and executives from the largest civil engineering and construction companies in the countries being visited visit with them and make presentations at their classes. The impact of such an exposure on students lasts a lifetime.

Jim Owens, one of three Honorary ICIC Chairs and the then Chairman and Chief Executive Officer of Caterpillar said in his conference opening remarks: “according to the World Bank, free trade and open markets have lifted 200 million people out of poverty in the last decade—the largest and fastest reduction ever recorded in human history. We all, regardless of where we live or where our businesses are headquartered, operate within a global economy. In the construction industry in particular, we have a real opportunity to improve quality of life for people around the globe.” Caterpillar, Inc., which is headquartered in Peoria, IL, is a big player in the global construction market. Caterpillar was one of the main supporters of the conference and conference attendees had an opportunity to visit Caterpillar's Edwards Demonstration Center, just west of Peoria, for a machine demonstration on the first evening of the conference. The demonstration center consists of both indoor and outdoor facilities where heavy equipment operators come to learn how to safely operate a variety of Caterpillar products.

Following the successful ICIC events, representatives from Bradley University were invited to visit with business and government leaders in the Gulf region. The delegation met with business executives and government officials in the United Arab Emirates, Jordan, Egypt, and Qatar. The trips led to the creation of business partnerships including one of the companies creating an office in the Gulf. The ICIC continues to pay dividends including continuing partnerships between American companies and foreign firms, the Civil Engineering and Construction department at Bradley University with international institutions, and joint ventures in the Middle East. In fact, two subsequent business delegations were arranged through the ICIC Network that resulted in the establishment of new business offices by Clark Construction in several countries.

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