Opportunities for Synergistic Collaboration between U.S. and Asia in Construction Business, Research, and Education

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Abstract

"The world is flat" as the popular author Thomas L. Friedman declares in his best belling book about the progress of business globalization in the 21st century [3]. Construction projects and related businesses have been global since the 1800's, but it has never seen such rapid transformation in both scope and depth as in the past decade. Construction projects today often bring together international design talents, construction management firms, local and international labor forces, and global suppliers. On a visit to Dubai in the United Arab Emirates on the Persian Gulf, a person will experience the complexity of globalization of modern construction projects- with Arab owners, European engineering and design companies, American construction management teams, Korean general contractors, Jordanian subcontractors, and labor forces from Thailand, Indonesia, Turkey, and Sri Lanka. A count of material suppliers reveals over 60 countries involved, covering all continents. Indeed construction projects are getting more and more complex and competitive, as is the project execution. The trend toward globalization poses both challenges and opportunities to construction and engineering companies competing on a global scale. While global competition may be a threat to many companies, there are, however, many opportunities for synergistic collaborations that can create win-win scenarios for construction business, research, and education. This paper presents some of the opportunities between the U.S. and Asia in business integration, research collaboration on technologies, and educational development, which may mutually benefit countries on either side of the Pacific.

Introduction

Globalization has provided new opportunities to the construction industry in business practice, research and education. Many construction projects today involve owners, engineers, architects, project managers, contractors, subcontractors, suppliers, and labor forces from various parts of the world. Asia has undergone major economic developments in the past decades, with rapidly growing areas such as China and India. Several countries, such as Vietnam and Thailand [2], are now expediting the construction of their infrastructure systems. With the political relationship thawing with other countries, North Korea will likely become another booming region for engineering and construction fields when it rebuilds its infrastructures. Historically many U.S. engineering and construction companies have a strong presence in the Asian market. The recent boom in Asian economy has brought even more competitors

to the region. Although low-price competitive bidding has been the business model for international construction projects, many owners are exploring design-build and even design-build-operate-transfer projects with participants from multiple countries.

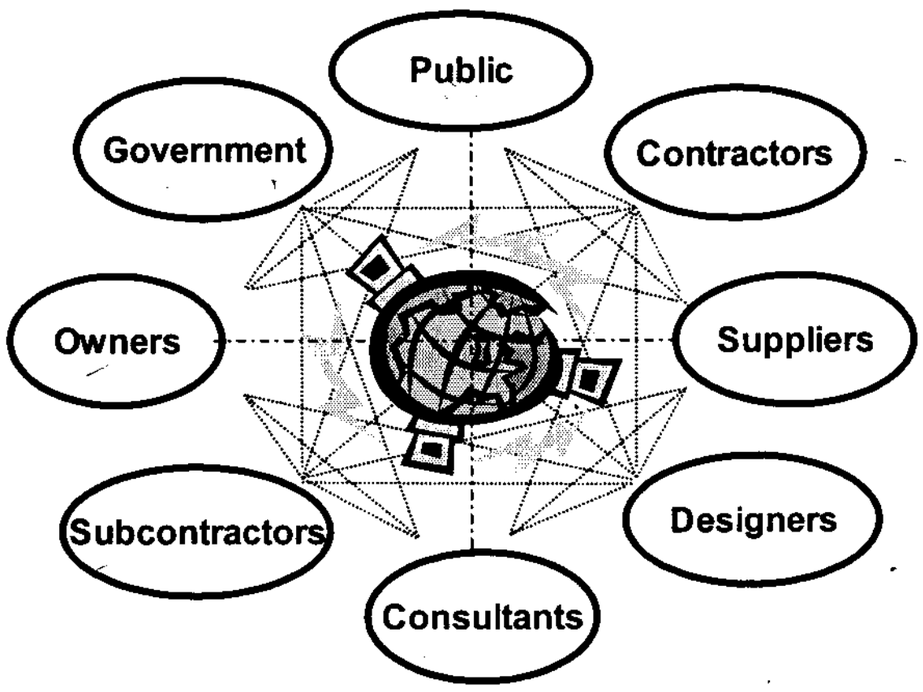

Figure 1. Technology-Based Global Project Management

As an example, a skyscraper project in China can easily find firms from 40-50 countries involved. The mega projects in Dubai contain products, services, and workers from all continents. It is important to recognize that construction companies today need to be able to compete globally. Inevitably when projects and businesses go global, there is an increasing need for information technologies to support global operations and collaboration among project participants. Technology-based global project management (Figure 1) will not succeed until the business processes from global participants are fully integrated. The change toward global project management also requires different approaches to education and research. Based on the author's over 22 years experience in engineering, construction, research, and education in both Asia and the U.S., this paper presents some synergistic opportunities that may benefit the global engineering and construction community. The following sections highlight (1) the need for full integration of business processes, technology, and education; (2) opportunities in research and development in the fields of sensor technologies, remote monitoring, 3D laser scanning, sustainability, and green building; and (3) global construction education.

Global Projects Need Integration of Business Process, Technology and Education

It is not difficult to imagine the challenges faced by a project management team with global participants. Language barriers, culture differences, varied engineering standards and codes, different construction means and methods, testing procedures, international suppliers, transport methods, insurance, floating currencies, and risks, just to name a few. These challenges could make or break a project and will ultimately define a construction company's future. Many U.S. and Asian engineering and construction companies are now relying over 50% of their annual revenues from overseas contracts and projects. These companies are often joint-venture partners with local and/or other international firms, as are evident in construction projects in China and other Asian countries. These international conglomerates from Asia, U.S., and

Europe all need to adopt a different business process in order to collaborate and compete at the global level. Managerial structure and organization will have to adapt to the dynamic relationships among project partners and participants. More importantly is how business process must be modified to ensure the integration of project data, information, and systems. Software, computer systems, databases, and the Internet provide the framework for data and information integration; however, many companies reported that the key ingredient for success lies in innovation in integrating business processes with technology. The following sections outline opportunities in several promising research areas and a new global construction education program that targets educating a new generation of global project managers.

Opportunities in Sensors, Remote Monitoring, and Sustainability Research

Among many areas of research that may benefit the global construction business, three areas of research in technology appear to be very promising because of their potential long-term impact. These technology areas include (1) sensors and remote monitoring, (2) 3D laser scanning and photogrammetry, and (3) sustainability and green building.

(1) *Sensors and Remote Monitoring*

Sensor technologies have dramatically changed the way we collect field data. These embedded sensors transmit data related to specific characteristics. Some sensors detect the existence of certain substances; others detect deformations, corrosion, cracks, and loss of cable tension. These embedded sensors provide data streams to offsite experts so that inspections can be conducted remotely (Figure 2).

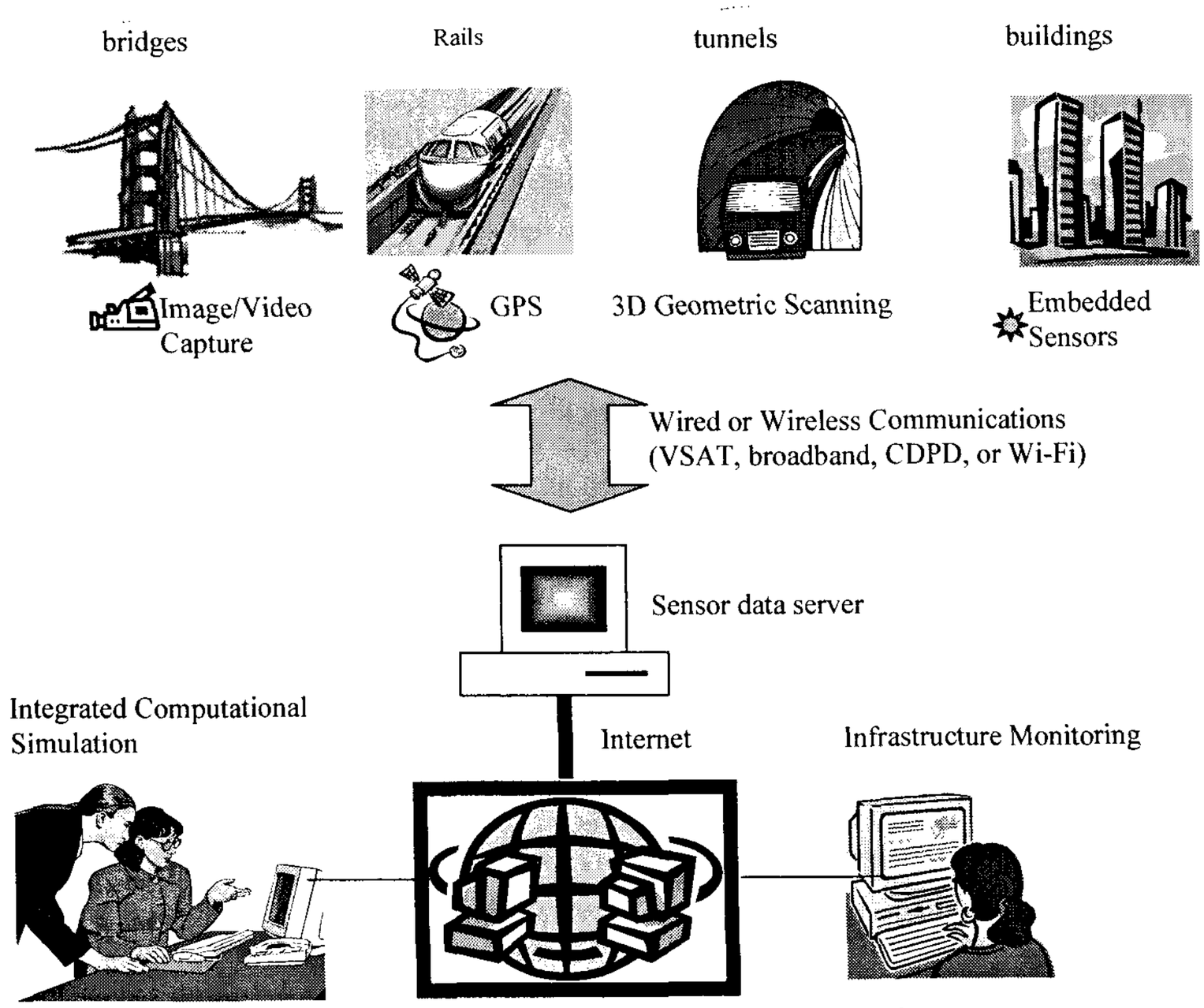

Figure 2. Sensing and Remote Monitoring

Taking advantage of the sensor and wireless technologies, researchers are working on a new approach to inspect infrastructure systems such as bridges, tunnels, locks, and dams. Using sensor technologies, including optic fibers, microelectromechanical (mems), and chemical and acoustic sensors, engineers can remotely monitor the condition of a building component, a main cable strength supporting a bridge, or the flow rate of water drainage in a tunnel. These sensor technologies provide a new approach to infrastructure health monitoring because it enables constant data collection so that engineers can set acceptable operating ranges of key parameters. Once the sensors detect out-of-range signals, a trigger is issued to alarm the infrastructure managers to conduct preventive maintenance, thereby cutting down costly and lengthy repair works. Global outreach using satellite, wireless technologies, and the Internet can also bring expertise from all around the world to remote bridge inspections, tunnel repairs, and other building problems.

(2) 3D Laser Scanning Technology & Digital Close Range Photogrammetry

Similar to RADAR, which utilizes sound echos to detect the distance of objects, 3D laser scanners utilize LiDAR, (LIght Detection and Ranging), which uses laser (light) to beam at objects and measures the time for laser to reach the object. From the angle of the beam and travel time, the device calculates the distance from a surface and generates 3D coordinates for points on the surface. Computer software then converts these points and generates 3D models from which volume and positions can be accurately obtained. The technology behind 3D laser scanning is a pulsed laser that utilizes the time-of-flight method to measure accurate ranges of each laser pulse. The laser detector measures to natural surfaces without the need of special reflectors with ¼" accuracy to a range of 50-100m. Figure 3 shows a laser scanner by Leica GeoSystems and a 3D model of an excavation site in Chicago.

Digital close range photogrammetry utilizes overlapping digital photos of an object taken from various angles to reconstruct 3D models. Software programs are available to process these photos and transfer the interpreted 3D images to CADD programs. Digital

Figure 3. 3D Laser Scanning for Constructing 3D As-built Data

close range photogrammetry provides an alternative means of collecting field as-built data for facilities or bridges. In contrast to traditional surveying, photogrammetry and 3D laser scanning allow the collection of data from a distance (non-contact), thereby providing a less labor-intensive way of collecting 3D field data. There are ample opportunities in using 3D laser scanning and digital close range photogrammetry to benefit international projects where high precision works are required. Furthermore, both technologies can be very effective in capturing accurate as-built construction site digital data for engineering analyses. For example, to retrofit a power plant, engineers often need very accurate 3D data of the existing facility. 3D laser scanning and digital close range photogrammetry can provide the needed data for finite element analysis and constructability reviews. Figure 4 shows another example of using 3D laser scanning technology to measure urban excavation sites to monitor excavation rates to prevent settlements and movements of the nearby structures.

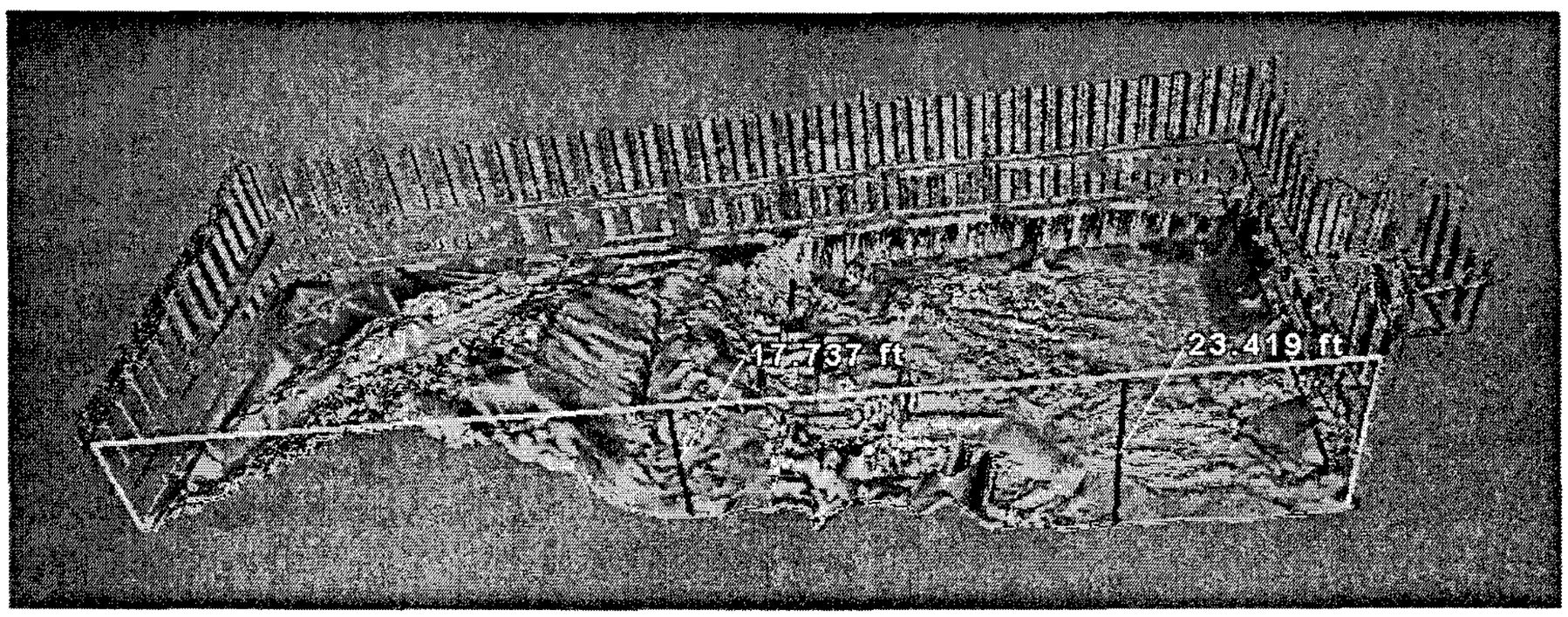

Figure 4. 3D Laser Scanning Application in Monitoring Urban Excavation

(3) Sustainability and Green Building

Undoubtedly the global A/E/C (architecture/engineering/construction) industry is going green. With global warming now a generally accepted threat to human existence, countries are looking into alternatives to traditional construction materials and design that may contribute to long-term sustainability of our society. LEED (Leadership in Energy and Environmental Design) certification for buildings is common in the U.S. and in the world. More owners, architects, engineers, contractors, and suppliers are all looking into ways to support a sustainable life style by cutting waste and carbon dioxide emission, using alternative energies, and reserve water resources. Many proven technologies developed in U.S. and Asian developed countries may have immediate impact on developing countries such as China, India, and other rapidly growing countries throughout the world. These technology areas include building wind turbines, solar power panels, wave generators, waste treatment technologies, micro-organisms for environmental cleanup, drainable surface pavement, and active/passive solar building designs.

Opportunities in Global Construction Education

Global construction projects need well-trained project managers. At the Department of Civil and Environmental Engineering of the University of Illinois at Urbana-Champaign (UIUC), the faculty of the Construction and Engineering and Management Program are striving to improve the construction education by infusing the global view into their undergraduate and graduate curriculum. This global vision has been confirmed by ABET (Accreditation Board for Engineering and Technology) and ASCE (American Society of Civil Engineers) Civil Engineering Body of Knowledge for the 21st Century [1]. At UIUC, a new 5-year dual (bachelor-master) degree program, named the Global Leaders Program in Construction Management, was created in 2004 to specifically educate the global project managers in the future. The program has been very successful with international construction companies serving on the industry advisory board and actively recruiting students from the program.

Conclusions

The world is indeed getting flat and projects are becoming inevitably global. In a global economy when businesses compete without borders, construction companies must take a brand new approach to (1) better integrate international business process into technologies, (2) research and develop new technologies to support remote engineering and construction project management, and (3) invest in education that prepares the work force to successfully carry out international projects. Both Asian and the U.S. construction industry can benefit from collaborations in business process integration, technology developments, and global education. As a construction consultant, researcher, and educator, I'm extremely optimistic about the future success of international collaboration on construction projects. It is important to recognize that global construction projects need global partners. Global partnership requires the support of the information technologies with integrated business processes. And, last, but not least, we need to train construction students and personnel to be effective members of the global workforce who are culturally diverse, technology savvy, and passionate about playing an active role in the global construction community.

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