

THE MISSION OF THE CIVIL ENGINEER IN THE MOVEMENT OF GLOBALIZATION

Patricia D. Galloway¹

INTRODUCTION

What is the role of the Civil Engineer? Our role is to build the quality of life. But in building that quality of life, we as Civil Engineers must be the leaders in today's engineered and constructed Projects around the world. Globalization is a word that should be in our everyday language and a word which all engineers must not only understand, but learn how to incorporate in our everyday business and professional lives. Our Mission as Civil Engineers is to ensure that there are no boundaries in how we build the quality of life.

There is a new global business landscape. And that business landscape – worldwide – is what will determine how and where we as civil engineers will conduct our business in this third millennium. So we, as civil engineers better realize, understand and appreciate that we are now working in a borderless world where the borders that used to enclose our particular discipline or industry have been obliterated. Obliterated by the need for total delivery packages which includes the planning, the financing, bonding and insuring, the design and construction, the construction equipment, as well as the installed equipment, the operations and maintenance and the ultimate re-use or disposal of the built environment. Obliterated by the belated recognition for our need for sustainability and improvements to the way we treat the world we live in.²

There is not a construction project today that is truly domestic, even if constructed in our home country. Financing, materials, special pieces of equipment, and/or engineering

¹ Patricia D. Galloway is the President Elect of the American Society of Civil Engineers (ASCE) and the CEO and President of The Nielsen-Wurster Group, Inc., located at 345 Wall Street, Princeton, NJ 08540, USA, www.nielsen-wurster.com

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technology come from all over the world in any project constructed today. And for those of us that are involved on a global basis, we need to recognize that understanding the whole financial and commercial structure by which we get this kind of globalization to function is essential. We cannot sit inside a little engineering cocoon. Engineering excellence is merely a step. Engineering innovation and brilliance is merely a step. The true contribution of the Civil Engineer is that they know how to make all these concepts integrate and function together.

We are also living in a borderless world where the borders that still enclose our individual nations have been breeched. This borderless world is now recognized with the European Union on the other side of the Atlantic, as well as NAFTA's approach to an economic union, initially of Canada, USA and Mexico and hopefully eventually all of the Americas, trying to bring simplified procedures to all nations sharing the Andean mountain range – and finally, though still in its infancy, APEC, the Asia Pacific Economic Cooperation, which hopes to include all countries with a Pacific ocean coast line.

While all those ambitious unifying or border-eliminating approaches are creating new layers of bureaucracies and new volumes of regulations, the real leveler of the playing field, the real destroyer of the borders still confining our industries and our nations is a virus that we have introduced. It is an electronic virus that can cross any border that we can establish. It travels through space, is multi-disciplinary, is multi-national, is multi-lingual, is automatic. It is the worldwide web; it is the internet and the extranet. It is computer aided design and drafting (CADD) that is becoming CDD: computer design and drafting of equipments, of structures, of scheduling just-in-time deliveries, of how and when you rent equipment. It is e-commerce, it is the 24/7 office working 7 days a week, 24 hours a day.

That is the new business landscape. But there is more. Just because there are immense needs in all of the developing and underdeveloped countries, needs driven by previously unmet needs and rapidly growing populations, needs alone do not translate into programs and projects for our industry. Those of us who have been active participants in the global engineering and construction industry have learned a long time ago that to succeed in any exciting part of the world you have to develop and adhere to a long-term strategy. You cannot simply parachute into the region – do your thing and then disappear. You have to stay, to become familiar, and to learn. In underdeveloped countries, the economies have always been volatile. Civil Engineers must now not only understand the engineering concepts that are learned in our Universities, must also must understand the global economic and financial conditions and barriers before embarking on infrastructure projects. The Civil Engineer must understand Project Management and must recognize what risks face each and every project no matter where its location in the world.

This paper addresses the mission of Civil Engineers in globalization; what civil engineers need to be aware of with respect to 1) Potential Projects in a global world and

the requirements for sustainability in all future constructed projects, 2) the understanding of the risks that should be addressed in engineering and constructing projects around the world and 3) the necessity for Project Management in all aspects of the Civil Engineer's professional performance.

POTENTIAL PROJECTS AROUND THE WORLD

The world's population is increasing at the rate of 80 to 100 million a year, all of it outside the so-called developed world (Japan, China, Australia, Europe and North America). Where you have people, you have needs. So the needs certainly exist for huge investments in infrastructure and potential civil engineering projects. Another demographic change is the rapid urbanization of our globe.

The normal progression of human habitation is from communities to towns to cities. About one half of the world's people now live in urban areas, up from one third in 1960. The needs in urban areas are obvious. In order for humans to live in urban areas, there needs to be basic infrastructure: water, food, shelter, sanitation; and then if you are going to develop the urban area, you need to have power, transportation and communications. Ultimately the need is to provide the ability to earn a living which is industrial infrastructure.

Improved infrastructure systems within the urban centers and improved infrastructure systems in the peripheral areas are necessary to support the unstoppable urbanization. Where does the Civil Engineer fit into all of these basic needs?

The world is divided into three primary sectors: developed countries, developing countries, and underdeveloped countries. The needs in each one are quite different and the Civil Engineer must understand what those differences are and how best to address them when planning infrastructure projects. All of this must be overlaid with the concept of sustainability. Sustainability and these infrastructure needs vary depending on the type of country and what the needs are and where the projects are located in the country.

Obviously, in the case of a developed country-increasing urbanization is a real issue. For instance, nearly 80% of the population in all three North American countries lives in urban areas despite the vast land available to support the population. Similarly numbers are true in Asia, Europe and Australia. Within all this, in a developed country, sustainability means cleaning up our abuses of the past as we continue to improve the efficient and quality of life in urban areas.

In the developed countries, the civil engineer will be concentrating on the need to address aging infrastructure, and repair and rehabilitation of an already constructed infrastructure. This aged infrastructure was constructed during times when little consideration was given to sustainable development. Consequently, our major urban areas face problems with air pollution, traffic congestion, obliteration of natural

resources such as trees, and contamination of drinking water sources. Thus, with any new constructed projects in a developed country, thought and consideration must be given as to how to resurrect the need for clean air, clean water, and efficient methods for moving people. For instance, scrubbers are being added to power plants and industrial process plants, underground tunnels for subways and people movers are replacing cars and allowing more people to be moved at a faster rate while at the same time reducing the pollutants that emerge in the air from car exhausts. New construction is being built around trees and/or replanting is being done as well as managed forests to assure renewable energy sources. Innovation and new technologies are critical for saving our current urban areas and the quality of life for its inhabitants.

Developing countries pose a different need. In a developing country, the need is to continue to improve infrastructure to support rapidly growing urban populations in meeting all the basic needs in an efficient manner without the environmental abuses and non-sustainable abuses in which the developed countries engaged in the past. Basic needs are there, however, more advanced needs in power, transportation and communications are necessary to advance the way in which its populations live and work. Lessons learned from engineering and construction in the urban areas of the past must be reviewed and conscious efforts made not to repeat the mistakes of the past. The American Society of Civil Engineers Canon of Ethics for Sustainability is a guide that can be employed in executing any constructed project. For example, power plants are again being constructed around the world to meet the increasing demands of increasing populations. However, consideration must be given as to what is the most appropriate type of power for a given country balanced with the consequences of that decision. For instance, hydro power is not available in all parts of the world. It mostly has been developed in North America. However, other parts of the world still offer an enormous resource for hydro power. Again, however, one must balance the effects of creating dams and what impact that dam may have to populations living in the area to be flooded. The same is true for transportation systems. Advanced intelligent transportations now exist, however, what is the balance with the knowledge of the population that is to operate and maintain the system? Is the current population able to use and maintain employed technologies and does the population have the ability to deal with the required computer and hardware upgrades that must be performed? These questions must be asked by the Civil Engineer before embarking on any project in a developing country.

Underdeveloped countries would first appear to be the biggest challenge, however, the infrastructure requirements in an underdeveloped country are quite basic-meet the basic needs of human life: water, food and sanitation. The ability to move the agricultural products to market for food and to have reliable and healthy water and sanitation systems that enable both to support life is first and foremost. Fresh, reliable potable water is a must and simple processes exist that can still be employed today in most remote regions, once a water supply is found. Food is critical and how that food will be processed and transported to the populations needing the food must be addressed. Civil

Engineers play an important role in assuring what types of food processing plants are required and what means of transport and road/rail/or water systems will be most efficient in delivering that food to the population. Sanitation is the key to preventing disease amongst the population. Again, however, consideration must be given to the level of sophistication of the sanitation plant and/or process proposed. Advanced waste water treatment plants may appear at first to be a simple solution, however, if the country location is so remote so as to make spare parts delivery difficult, or if the educational level of the population such that maintenance cannot be carried out, then the advanced waste water treatment plant may not be the answer. Maybe a simple gravity-fed sewer system to a lake with genetically grown plants and fish that can feed upon the sewage is the most practical. However, in all these situations, the Civil Engineer must be at the forefront to recognize these potential problems and to arrive at the most practical solutions.

UNDERSTANDING GLOBAL INFRASTRUCTURE RISKS³

Civil Engineers have not typically been seen as understanding the financial aspects of projects. However, in today's global projects, understanding the financing aspect is fundamental tool in being the Leader of the project team. Investment and financing decisions regarding potential projects around the world are often made on limited analysis of the project execution and its future use or operation. Then financial viability is assessed assuming little risk to achieving scope, function, timing, and cost goals based on these limited analyses. Such an approach leads to highly inefficient use of capital. The potential for such inefficiency is increasing. For example, there is still limited recovery from the Asian downturn that began in 1996. That downturn led to regional political crises, instability and financial retrenchment in many geographical areas, especially in Asia and the Western Pacific – easy financing in this geographical area is a thing of the past. Similarly, the cooling and now recovery (albeit in its infancy) of the U.S. economy leads to more thorough potential project Risk review globally before project financing. The War on Terrorism reprioritizes near and medium term project requirements and a shifting of public sector project spending focuses world wide. All business sectors and their capital project needs are forced to adjust to this different commercial reality.

Nonetheless, global needs continue to rise dramatically. Available capital has shrunk with only recent minimal movement to a growth trend. There now is significant competition for available financing reminiscent of the tight markets of the nineteen eighties. Project Risk is a necessary focus that is driving global and regional project financing decisions and a concept that must be understood by today's global Civil Engineer. Significantly, medium and long term market demand for the products/commodities in the process industries and resource production sectors indeed are shifting from yesterday's models. Unlike conventional wisdom, public project

³ Portions of this Section have been extracted from a paper entitled : "International Project Risk Ratings and Emerging Trends in Project Management", Kris R. Nielsen, PMP, BSME, JD, and Harold Dorbin, BSChE, JD

spending will not lead directly and near term to industrial demand. For example, public spending on security is expensive. Public spending for political stability is expensive. Both goals often require infrastructure development and evolution. Such infrastructure does not improve productive efficiency – merely provides a safer and stable environment in which to live and work. In the past, airport capital projects would expand capacity, use efficiency, and transportation timeliness. All are results that translate into immediate business expansion. Conversely, today's plant and transportation infrastructure security will not translate into immediate business benefit, but will provide longer term business environment risk reduction.

In light of the needs of the populations around the world, the Civil Engineer must recognize that these projects will be constructed in the midst of various risks. As the leader of the civil engineered project, the Civil Engineer must not only recognize what these risks are, but how to identify, address and provide the framework for solutions to best manage these risks. Risks in global projects, especially in developing and underdeveloped countries are not easily identified or even recognized at first glance.

What is risk in this context? It is not typical catastrophic risk that can be insured. Risk in this context is simply those issues, conditions, actions that cause a project or a participant therein not to meet its goals, e.g., goals of scope, quality, function, delivery time, and cost. Addressing Risk and its potential manifestation, its probable impact, its management prospects, now are fundamental to meeting this milieu. The global public financing agencies, private banking and financing corporations, and government and corporate senior management now demand greater Risk consideration. Projects do not move from feasibility to a financed or funded project without broader risk evaluation. Capital wasting projects are being eliminated or properly focused to reduce risks prior to spending on often self-fulfilling feasibility studies. Then, the resultant feasibility studies employing risk evaluations are focused and are used to reduce and eliminate risk prior to seeking financing or funding. The financing community or management / Board of Directors approving committees are requiring risk evaluations by those seeking the financing and those internally considering the financing. The goal: improved and practical efficiency in using capital and in executing and operating Projects with reduced Risk.

Today, complex proprietary risk rating models are part of the solicitation process or the evaluation process required for project financing or funding. These models and the input upon which they operate assure consistency between project evaluations, provide relative comparison with similar or competing capital uses, and tie to the financing or funding uses. Merchant and investment banks, public finance agencies and affiliates, and executive managements are requiring assessments, evaluations and ratings as part of proposals and applications.

Ultimately, good intentions, good planning, worthy ideas do not become projects without funding or financing. Risk must be addressed. To get projects financed or funded, risks must be evaluated and rated in categories of Project Specific Risks and

Context Specific Risks. Such Risk Categories focus on both initial project execution and ultimate project operations. These Risk Categories are then modeled to produce ratings that are consistent and comparable. In turn, the ratings underpin decisions on corporate funding decisions versus other uses of its capital. For financed projects, the ratings underpin project financing decisions and the cost thereof to the party seeking it. Generally as an example, the use of capital that meets a government's agenda the most effectively or provides the corporate owner/operator the better return has the higher rating as risks are less. This means a less probable manifestation of risks that erode the goals planned. Capital funding or financing rates are less risky and thus lower.

What are Project Specific Risk categories? Project Specific Risk categories are those that are driven by the specific project form, scope, etc. These categories include⁴: delivery and operational risks, technology risks, financial risks, political/contracting risks, political risks, environmental risks, social and economic risks. Definition of these risks includes:

Project Specific

Delivery/Operations. This risk factor involves those issues or concerns associated with engineering, procurement, construction (EPC) execution and operation of the project.

Technology. This risk factor involves those issues or concerns associated with the technologies involved in the EPC methods and operation technology of the project.

Financial. This risk factor involves those issues or concerns associated with the financing of the project, including the EPC period and operations or equity financing.

Procurement-Contractual. This risk factor involves those issues or concerns associated with the contractual and procurement approaches/systems/processes used for both EPC and operation of the project.

Project Context

Political. This risk factor involves those issues or concerns associated with the local, regional and national political situation confronting the project.

Environmental. This risk factor involves those issues or concerns associated with the environmental problems, concerns and activities confronting the project during the EPC execution and the project operation.

Social. This risk factor involves those issues or concerns associated with the social and cultural impacts of the project to the community and region within which it is to be located.

Economic. This risk factor involves those issues or concerns associated with the

⁴ These Project Specific Risk and Context Specific Risk categories are those analyzed and modeled by Pegasus Consulting, Inc., a subsidiary of Pegasus Global, Inc., that is wholly owned by the Nielsen-Wurster Group, Inc. These categories are those modeled to produce the Pegasus RatingTM used to address project risk pre-financing.

macro economic impact of the project to the community and region within which it is to be located.

In addressing any needs of the population for any civil engineering constructed project, risk assessment is a critical function of the Civil Engineer.

THE NECESSITY FOR PROJECT MANAGEMENT

How do you begin to satisfy the infrastructure needs of the world's population and the risks that may emerge in the constructed projects? The Civil Engineer must again address all issues involved with going forward with a project, including financing, risk assessment and Project Management.

With an annual per-capita income level of less than \$3800⁵ in most developing countries, there are definite limits on how to finance all those needs out of the public purse. But some of those needs can be met by more creative approaches to financing of well-planned and well thought out projects. That will require enlightened political leadership and cooperative financier investors to make it happen. It will require true public-private partnerships, where the principal role of the public sector is to make a project bankable. This can be accomplished through enabling legislation, through permitting, or at times through subsidies or guarantees and other supporting actions. The private sector will then be able to finance, design, build, operate and maintain many of those needed infrastructure systems improvements. We as Civil Engineers cannot impose all of our approaches onto developing countries without an understanding that you must create the proper balances. As leaders, Civil Engineers must play a larger role in political structure since infrastructure is politically based whether that means that the ultimate employer is government quasi government or the government overseeing the privatization.

Civil engineers are really the focal the point for both leading the planning and execution of engineering and construction. It is not just engineering and planning, but also the political and private sector. Civil Engineers must become involved at the decision making level, including high government and private sector company positions. In addition, in order to make wise and well reasoned decisions, Civil Engineers, as the primary engineering discipline, must be involved in project management when executing a civil engineered project. It is also critical for Civil Engineers to recognize that civil engineering involves construction-engineers cannot think that they are just a bunch of engineers and planners, but that we are the discipline that leads construction.

Civil Engineers must recognize the totality of what they do-it is not simply the design and engineering and then the actual construction, but the execution of the entire process. This entire execution process includes the decisions to allow the project to go forward, the analysis of risks that may emerge in their planning and the financing of those

⁵ As of 28 October, 2002, \$3800 US is equivalent to 490,680 Japanese Yen or 4,046. European Euros

projects. Then the Civil Engineer must understand the contracting framework in which a project will be executed.

Today's global civil engineering projects are primarily constructed under the parameters of Engineer/Procure/Construct (EPC) contracts. This means that the party or typically the consortium of parties that are comprised of multinational firms, bond together to design and engineer a project, procure its material and equipment, construct the project and then commission and start up the project. Global mega projects have typically been constructed in the past using what is termed a cost-reimbursable contract, meaning the consortium is paid for every dollar spent in executing the project.

In the mid-1980s, the Business Round Table⁶ commissioned its Construction sub-committee to evaluate if a premium was being paid to Engineer-Construct (E&C) contractors for capital projects. Then, if such a situation existed, what was the premium? In 1988, the Business Round Table commissioned the prestigious Construction Industry Institute (CII)⁷ to identify the cause and recommend alternatives to correct the situation.

CII determined that the primary cause was the cost reimbursable contractual format and recommended a shift to Lump Sum Turnkey (LSTK) contracting in appropriate situations. Appropriate, however, was not adequately defined. Nonetheless, a wholesale shift to LSTK contracting began in the 1990 to 1995 period globally. The Owner/Employers' Project Management was not prepared for the shift. Neither was the E&C Contractors' Project Management.

The result was a 180-degree swing in the pendulum through the end of the 1990s. E&C Contractors were now faced with no "brand loyalty" and stiff competition. Operations at best could generate mere "super market" margins. Failure of multi-national and regional E&C Contractors was increased, reducing the competition sought by the Business Round Table.

For both parties, project management was in chaos. This was not a surprising reaction considering Project Management was not treated as a profession. One was forced to learn project management skills in an apprentice format. As a "young pup", you were assigned to a project team where you learned through "on the job training". If you had a good master in an appropriate context, you learned good project management, otherwise you did not!

A paradigm shift is now underway to achieve a more balanced business equilibrium between Owners/Employers and E&C contractors. Attention is directed at what is the "appropriate" context for LSTK contracts or other formats.

⁶ The Business Round Table was composed of senior executives from Fortune 500 companies

⁷ CII is funded by industry subscription and is managed by the University of Texas, in Austin, Texas, USA.

Civil Engineers often focus on design and engineering concepts and not sufficiently on Project Management concepts, yet Civil Engineers comprise the largest source of project managers. Project Management is rapidly becoming a recognized profession, like engineering with its own required professional certification. Project Management, like the use of Capital, requires focus and efficiency. There is a two-path trend underway to achieve this result. For example, the Project Management Institute (PMI) developed and maintains a globally recognized set of standards for project management. With standards, university program accreditation, training and certification examinations can be undertaken. PMI developed the “Project Management Body of Knowledge” or “PMBOK,” which describes generally accepted practices with respect to Project Management (there are both printed and interactive versions of the PMBOK: issued by the Project Management Institute Standards Committee: A Guide to the Project Management Body of Knowledge, Project Management Institute, Upper Darby, PA, USA 1996, and PMI Interactive PMBOK, Project Management, Institute, Upper Darby, PA, USA 1998). The typical bodies of knowledge included as part of the PMBOK are project integration management, scope management, cost management, time management, risk management, procurement management, quality management, communications management and human resource management. The standards cover planning, monitoring, and execution processes.

PMI undertook examination for “Project Management Professionals” (PMP) beginning in 1984 to provide professional certification. By 1997, there was nearly 8,000 PMP’s world wide. Given the trend toward Owner-Contractor business equilibrium, the need for professional project management development has exploded. As of September 2002, PMI has certified over nearly 50,000 PMP’s, and the most rapid increase has been in the Asia-Australia-Pacific region. Additionally, all PMP’s must re-certify with professional development and continuing education every 24 months, thus assuring currency in knowledge and its usage.

Disproportionate to and totally party oriented project management is disappearing. Project Management is focusing on the project first and party requirements second. Such a trend reinforces and supports the developing commercial equilibrium between the parties. Thus, Project Management is enjoying the “mega trend” toward efficiency and effectiveness:

It no longer is merely a trade learned through apprenticeship.

Professional standards are available and being required.

Risk Management, a key element of the PMBOK is focusing specific Project application of these standards (a topic beyond this paper) in a professional manner.

Projects are executed with lessened Risk manifestations for all parties.

The necessary move to commercial equilibrium between parties is being implemented.

CONCLUSION

In conclusion, Civil Engineers today have been focusing on matters such as International Competitiveness; Educational requirements and International standards to practice civil engineering, and transnational issues, as appropriate (e.g. certification with specific attention has been paid to the practice of civil engineering in border countries, states, provinces and communities) and; Uniform systems of units, codes of design, and standards of practice. However, the Civil Engineer as the leader, must broaden his/her horizon to not only these issues centered more around the design aspect of civil engineering, but to that of how, where and under what context civil engineering projects are constructed in today's global environment. Civil Engineers must understand the entire context of how a project is conceived, financed, managed, designed, constructed and operated. The Civil Engineer in its mission of globalization must recognize the needs of the population and that the needs are different for developed, developing and underdeveloped countries. In doing so, the Civil Engineer must undertake these projects within the mindset of sustainability while keeping a balance with the needs of the population and the survival of our planet. The Civil Engineer must take an active role in the political and private sectors so as to maintain its position as the decision maker and the leader of the project. As that leader, the undertaking of any project must consider the risks associated in going forward with a project and that may emerge during the project. And finally, in order to have a successful project, the Civil Engineer must execute the project under the guidelines of good Project Management. In this manner, Civil Engineers will emerge as the leaders of the global infrastructure projects and will continue to build the quality of life in this millennium and millenniums to come.