Issues and Challenges for the Construction Community

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Abstract

There are significant industry trends in the Architecture, Engineering and Construction (AEC) industry today. The industry faces major changes in owner requirements and contractors' roles, globalization, skilled work force shortages, increased role of suppliers, reduced cycle time requirements, and increased capital effectiveness requirements. Construction industry today is moving to fully integrated/automated project processes. This has caused outsourcing, alliances, contractor consolidation, and experimentation. These events present both challenges and opportunities for the construction community. This article highlights the existing and future issues and challenges for the construction industry from the perspective of trends and new technology development. The authors have explained qualitatively what steps industry should take to minimize these future challenges. The paper describes the role of management, technology, clients, industry and academia to address the challenges. This paper also identifies the qualities or abilities construction students should achieve during their study time. And last, foci of potentially meaningful research are listed.

Key Words: Construction Industry, Academia, Issues, Challenges, Constructability, Partnering.

Introduction

The increasing scope and complexity of construction projects, along with a greater number of externally imposed requirements, has expanded the challenge to project managers for successful completion. Increased competition and changing client demands are requiring the construction industry to address a wider range of issues than ever before in areas such as strategic analysis, worker problems, knowledge management, and emerging technologies. At the beginning of the twenty-first century, many concerned persons are looking to the future of construction and, concurrently, to the future of construction education, in a concerted effort to determine how construction educators and industry can best meet the requirements of the next century.

The world economic big picture today is characterized by world population growth, a large number of underdeveloped countries, aging infrastructures, international competition, sophisticated approaches, and accelerating change. Key global issues include the opening of eastern European countries; the operation of the European Economic Community (EEC) and the Euro currency combine; the opening of the third world country economics such as China and
India; the more active role of World Trade Organization (WTO); creation of the North Atlantic Free Trade Association (NAFTA); and a shift of resources away from the military and environmental consciousness.

There are positive economic factors in the U.S. which include open and competitive markets, historical strengths in user industries, historical strengths in suppliers, strong engineering/technological universities, and an innovative industry (Yates, 1994). However, there are threats to the U.S. leadership, including low investment in U.S. construction research and development, weaknesses in assimilating new technologies, growing weaknesses in related industries, potential shortages of skilled workers and managers, and procurement based on cost rather than quality (Harris, 1992).

In our view, some of the most important challenges facing the construction industry that need to be understood more effectively are: How will university-level construction education programs in the United States respond to the importance of technology as an engine of change? Will developments such as object-oriented modeling or artificial intelligence impact construction? Will there be a shortage of skilled construction workers and managers and if so how severe? What potential measures can be taken to protect the national infrastructure from more terrorist acts? Should there be a change in the way of design and construction? Can new construction concepts and their implementation such as Partnering, Constructability, Total Quality Management (TQM), Best-Value Contracts and Value Engineering solve some of the major construction problems?

As a background for possible action, it is useful to review current features that characterize construction.

**Present Status of the Construction Industry**

The construction industry is the second largest industry in the United States in 2001 after that of computers. Construction had annual revenue of about $862 Billion in 2001 (US Census Bureau, 2001). The industry involves owners/developers (government, industry, private parties and investors), designers (architects/engineers), contractors, field managers (project managers/superintendents), suppliers and craftsmen. In addition, the outcome is usually "custom made" with almost every project a separate and unique entity, conceived, financed, designed, constructed, and operated separately.

Individuals, organizations, or associations with diverse and often fragmented interests represent each of the groups that contribute directly or indirectly to construction. There are about 1,000,000 contractors, competing for work either directly or indirectly (www.enr.com). The largest contractor has an annual construction revenue of about $15 Billion, while the smallest does only a few hundred thousand dollars worth of work annually and employs about four people (ENR, 2000). Medium and small companies employ an average of 10 employees. The ENR listed top 400 contractors carry out about one-third of the total construction work. There are at least twenty-five separate construction specialists, each addressing unique problems and requiring special education and experience. Roughly six million construction workers are represented by about fifteen national labor unions, and by approximately one hundred eighty
national trade associations. Other contributors such as planners, engineers, architects, lawyers, bankers, bonding companies, material/equipment suppliers and accountants are equally diverse in their talents, interests and ways of operating. But there is little general perspective on how all the separate entities fit together. There is no real central focus to integrate all the activities and entities, which usually can be achieved by efficient use of managers.

The structure of the industry is specialized and layered, with complex interlocking interests and traditions for which there is very slow response to any change such as automation, computer technology and/or mass production. This character makes it highly effective on practical or sub-project matters, yet often ineffective on general or program matters (Oglesby, 1990).

The construction project, itself, has its own set of complexities. It involves the entire life cycle of a physical facility beginning with a 'gleam in the eye' of an owner who is exploring the need for the facility to its completion. The normal steps in the project life cycle are: conception, planning, authorization and financing, design, procurement, construction, start-up, operation/maintenance and dismantling. Each has a peculiar set of problems, and each needs an appropriate strategy/management to move from one step to the next step.

Challenges in Construction’s Future

The most profound recent developments in construction are seen as: the increasing complexity of many of its projects and organizations, the increasing technological complexity of projects, more complex interdependencies and variations in the relationships between its organizations and institutions, and proliferating regulations from government. At the project level, management has just begun to integrate design, procurement, and construction into one total process through total quality management (TQM), value engineering and constructability analysis. Based on previous and existing industry conditions, the authors foresee that the following issues and challenges will dominate the near future:

- There are now and will continue to be shortages of resources, including skilled workers, and technical and supervisory staff.
- There will be more and more stringent governmental regulations relating to matters such as safety in design and construction methods, the environmental consequences of projects and human resource policies at all levels (EEO).
- Progressively the regional building and fire codes will be standardized in the international format and will be enforced more rigorously, especially due to recent terrorists attack.
- Global construction will increase due to an international strengthening of world economies.
- Innovative project delivery systems such as design-build, performance specifications and warranties, and best value contracts will become more popular and change how contractors do business. Contractors will be selected based on performance, quality, safety, reliability, and other factors rather than only costs.
- The Internet will minimize the necessity for the design team to be in the same locality. Design coordination by electronic means can lead to fewer design errors and omissions. Fewer complete designs will take place before construction starts; instead some version of fast-track design will evolve into the normal design process.
• Advanced technology and composite materials will be used for fast, cost effective and safe construction. High strength concrete, ceramics, composites, and fiber-reinforced polymers will be in common use. Wood products will be largely high performance, pre-assembled units. Construction materials will be increasingly recyclable and recycled.

• The use of preassembly, modular and standardized construction systems will expand to reduce cost, accidents and time of construction.

• Industry will look for more new concepts such as constructability, life cycle cost analysis, partnering and total quality management, and these will be implemented more frequently.

• User-friendly project management, estimating and scheduling software will be offered as a means to minimize construction time, risk, and improve project control. Even small contractors will try to use them.

• The price of construction will be based on its value to the customer, and the quality of the work, rather than the cost to the builder and a mark-up.

• There will be less new construction, and more and more repair and rehabilitation of existing infrastructure.

• Restructuring, owner reorganizations and internal company changes will be widespread. This will cause more outsourcing, alliances, contractor consolidation, and experimentation.

• Failure of the contractors in their first year of business will continue to be significant due to inadequate knowledge about the industry and widespread risks.

• The image problems of the construction industry will be an ongoing issue. Construction still is not recognized as a profession due to poor impressions about the integrity of contractors, and the nature, safety and quality of work. High school graduates and university students are not generally motivated to enter the construction industry for work. Many people, who are at the forefront of the industry, don't even encourage their children to enter the construction business.

Possible Actions can be Taken

Industry will need to cope with new political, economic and cultural realities resulting from the terrorists acts, the mergers and acquisitions, the slowing economy, the energy crisis, changing world development patterns, and new societal standards. These trends have been accelerating and will most probably continue into the future. Despite recent economic problems, there will be an ongoing need for the construction industry to expand and improve its capabilities and its scope of operation to meet the changing and, in the long run, growing demands for its services. Solution for the future of the construction industry can be structured around five themes: technology, owner, management, the role of industry and the role of academia.

Technology: Collaboration, rather than competition, is necessary to replace linear patterns of working. It is important to reduce the barriers of implementing total quality management (TQM), constructability and partnership. Advanced information and communications technologies must be developed and applied to construction organizations to facilitate information processing and flow, and collaborative working on construction projects. Innovative construction technologies developed using advanced analysis and design techniques will be needed to produce new construction materials and novel technologies. Other technology trends, which will have a major
impact, include the need for adaptable buildings that can provide productive working environments for changing occupants and businesses. Occupant turn-over will increase and companies will increasingly move to having buildings that provide flexibility while reducing capital investment and maintenance risks. Related to this will be continued growth in the move towards standardization of components and assemblies, together with increasing interest in design for re-use.

Continuing environmental pressures and political demands for increased sustainability in the AEC industries will drive both of the last trends. Associated construction methods will also change as off-site, factory-based manufacture will take an increasing role, as will automation of the erection on site.

**Owner:** Owners and all construction stakeholders will have an important role to play in reducing some of the challenges. They are also key drivers of safety, sustainability and re-use, along with governments and society. We envision that the natural culmination of the integration of supply chains is the marketing of 'branded' building types where the buyer chooses, according to their needs and budget. Those at the cheaper end will have more standardization, while the expensive brands will offer greater customization. Clients will buy more on reputation and proven performance of components, systems and buildings/constructions. There are clearly strong links here with the pre-assembly, modularization and automation themes.

**Management:** There will be a continued emphasis on the integration of people, process and product. This is being improved vertically (i.e. through the process), but in the future this must be complemented by greater horizontal integration across disciplines and organizations that acknowledge the vital contributions of planning and design. This will require a new breed of multi-disciplinary, multi-skilled professionals who can provide a holistic approach to design, procurement and construction. While retraining can service this need to some extent, we believe the long-term solution will require the education of new types of AEC graduates and researchers. The separation of design from the rest of the project process is a fundamental weakness in the construction industry: significant re-balancing is required to integrate design with construction and performance to ensure that issues such as flexibility of use, operating and maintenance costs and sustainability are considered in the design and planning stages of a project. There is considerable scope for the introduction of tools and techniques to facilitate this integration. The changes in client needs and associated methods of designing and procuring buildings and structures will result in a different blend of construction organization. The continuing development of information technology will enable truly virtual teams and environments that come together for specific projects or as part of permanent supply chains.

These new ways of working will have a major impact on organizations and appropriate working environments and cultures (Lih, 1997). The related sociological issues will require attention within education, industry and research institutions. New, flexible protocols will be necessary to facilitate these changes. These may necessitate changes in project management to meet the changing needs of the design and construction process.

**Role of Industry:** Over-arching many of the changes we foresee are opportunities and responsibilities for the industry at large. Professional institutions must break down their barriers...
and vested interests in order to recruit and support new workers with different skills who can help deliver the changes in work practices and attitudes. Industry needs to come forward to solve the image problems by insuring the people and society that construction is one of the safest and integrity based industries, and that it is not always profit driven instead of people driven. These changes will impact educational needs and the providers of education and training.

**Role of Academia:** What is the Role of Academia in construction? Should it only be one of furnishing graduates or should the university community be involved in projects of the construction industry? If academia is knowledgeable of state-of-the-art issues and current research implementation, and if it has a high payoff, then shouldn’t companies be utilizing their knowledge?

Academia can play a significant role to minimize the existing and future construction challenges by preparing better graduates who can understand and solve the problems by their critical and quick decisions. One of the truly critical issues will be insuring that students do not lose their *practiced eyes* and the ability to think. In that case, both teaching and research have an effective role. Teaching and research should be based on industry problems and challenges rather than on very fundamental science, although the authors are not against carrying out important fundamental research. The academics can make sure that their students should have the following qualities after graduation:

- Basic skills of estimating, scheduling, techniques, safety and project management,
- Can work in inter- and multi-disciplinary teams and contribute effectively in a timely manner (should be a team player),
- Can respond quickly to world market opportunities,
- Can make quick and accurate judgments under pressure for companies of different focus and experience,
- Can satisfy the client's needs while satisfying their own company needs,
- Can predict different variations on the projects both before and during construction,
- Can understand local and market conditions to choose technology, materials, workers and even projects,
- Can transfer and use past experiences and knowledge for the benefit of the future project.

Academia can also help the industry by conducting research to solve some of the burning problems. The research focus may be in advanced information and communications technology, environmental-friendly construction, innovative construction technologies and innovative construction business processes. Research into innovative materials, novel construction technologies, advanced analysis and design of facilities, collaboration, client satisfaction, constructability, TQM, knowledge management, innovative procurement practices, organization, value engineering, IT integration, energy conservation, pollution control and reuse/recycling of construction material will have a significant impact on minimizing potential threats from both human and national forces.
Conclusions

The future of construction is difficult to predict because performance of the construction industry depends on many internal and external factors, even those independent of the industry. But this article highlights the existing and future issues and challenges for the industry from the perspective of trends and new technology development. The authors have explained qualitatively what steps industry should take to minimize these future challenges. The paper describes the role of management, technology, owner, industry and academia. This paper also identifies the qualities or abilities students should achieve during their construction study time. And last, foci of potentially meaningful research are listed.

Bibliography


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