

# CONSTRUCTION ENGINEERING AND MANAGEMENT

## Scope of Research Interests and Capabilities

It is generally agreed that the construction industry can be broadly divided into four major categories. The first of these is defined as *residential* construction which includes both single family and multi-family dwellings. This category is dominated by small firms, is characterized as utilizing low levels of technology and usually requires small investments in equipment, personnel training, etc. The second broad category of construction is defined as *institutional / commercial*. Projects in this category include government office buildings, schools, retail facilities, office buildings, hospitals and even sports stadiums and coliseums. This category has a higher cost and sophistication than the residential category and often utilizes specific design and construction specialists to successfully execute projects. The third category of construction is defined as *industrial construction*. Considered the domain of the engineer, projects in this category include oil and chemical refining, manufacturing facilities, power generation facilities, and any facility that houses a production process. These facilities have a high degree of technological complexity and are designed and constructed by some of the most sophisticated engineering firms in the world. The final category of construction is best described as *heavy / highway*. Projects in this category include highways, mass transit systems, tunnels, airfields, pipelines, drainage systems, sewage treatment plants, and dams. Most of these projects are publicly owned and financed. Such projects are typically very large in scale, are equipment intensive, and technologically challenging.

Recognizing the distinction between these four categories of construction is fundamentally important to understanding the role of the Construction Engineering and Management group (CEM) at Clemson University. The CEM group focuses study and research on the categories of industrial and heavy / highway types of construction. To a somewhat lesser extent, commercial construction is incorporated but only as it concerns large projects such as high-rise office construction or stadiums and coliseums. Projects within these categories are extremely complex to design and construct, and require a multi-disciplinary team in every phase of project execution. Phases of project execution are generally identified as pre-project planning, engineering and design, procurement and materials management, construction execution, and start-up / commissioning. The CEM group at Clemson has completed research projects in support of each of these project phases.

## Recently Completed Research

Principally, the pre-project planning phase addresses the need for complete and accurate project scope definition. Research has clearly demonstrated that a project can be most favorably influenced in the planning phase where investments of time and energy yield significant benefits during the construction and start-up phases of the facility. The CEM group has specifically examined the following planning related topics in various funded research projects:

- Early estimating and schedule forecasting techniques
- Innovative contractor compensation strategies

- Impacts of various contract clauses
- Information flow to support pre-project planning
- Optimizing the project team's contribution to business results
- The role of leadership in project management success

Large projects in the commercial, industrial, and heavy highway categories require the design, specification, and implementation of virtually thousands of unique engineered parts and system components. The CEM group has completed several research projects in support of the design and materials management activities. These include:

- Materials management handbook for the Construction Industry Institute
- Impacts of bar coding for industrial construction
- Electronic data interchange applications
- Impacts of Information management.
- Benefits and recommendations for on-site design
- Applications of information technology for design

The construction and start-up phases must be executed expertly to achieve any level of project success. Research projects completed in support of these activities include:

- Cost and schedule impacts of work process change
- Quality management
- Safety for night-time construction
- Maintenance outsourcing strategies
- Project controls techniques for highway construction
- Pre-qualification techniques for contractors

The CEM group at Clemson also has expertise with the development of project management training. Perhaps the best example of this is the on-going work for Washington Group International, an international contractor working in all industry sectors with an annual construction volume in excess of four billion dollars. The Clemson CEM group has worked with Washington Group to develop 27 training modules on project management best practices. Washington Group, with Clemson's assistance, has delivered more than 140,000 man-hours of training in these courses in the last four years. The CEM group has also performed similar work for such corporations as Kodak, Glaxco SmithKline, and Cargill Corporation. In the public sector, the CEM group has done extensive work for the General Services Administration and Department of Energy. Additionally, the CEM group has consulted for the Army Corps of Engineers and the National Institute of Standards and Technology. The CEM group additionally conducts extensive on-site training on behalf of the Construction Industry Institute, being one of only three universities in America to have this capability.

The CEM group at Clemson University has expertise in all phases of project execution. The faculty have been recognized for their work with some of the industry's most prestigious awards and are frequent contributors to national/international conferences and symposiums. The faculty are qualified, licensed professionals with considerable real-world experience in project design and construction. Research pursuits continue to be focused on the development of tools that improve the facility delivery process.