Constructability

Maximizing Simplicity

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Sometimes the simplest answers are very hard to see in the heat of the moment…

Scene: *Construction site, Anywhere, USA (tension is in the air – AGAIN)*

Steel Fabricator/Erector: *We need to build it this way because THIS is the way it must be built!*

General Contractor: *We don't have the time or the money to do that – WHAT were you thinking when you designed this?*

Architect: *My design is complete, the drawings are clear – Do not expect me to get involved with your means and methods!*

Owner: *Six months and *^%# hundred thousand dollars later…*

Could this scene have been avoided? Perhaps, through the incorporation of Constructability…

What is Constructability?

Constructability has been defined by the Construction Industry Institute as the optimum use of construction knowledge and experience in planning, design, procurement and field operations to achieve overall project objectives. Those who advocate it as a concept claim that it can bring real benefits to all involved – clients, engineers, architects, contractors and users.

Constructability involves the process of thinking through the entire project prior to beginning the actual design. Such an activity focuses on maximizing the simplicity, economy and speed of construction, while considering the site conditions, code restrictions and owner's requirements. Constructability requires consideration of the entire construction process, begins with the conceptual stage and is based on the philosophy that maximum project benefits occur when construction industry professionals become involved during the earliest stages of development (see *Figure 1*).

Such infusion of construction knowledge and experience expands the decision matrix and fosters many more alternatives, facilitating more informed decisions. By integrating construction knowledge and experience, the design process is supplemented by more accurate and up-to-date cost estimation and value-based design concepts. In addition, design document reviews, subcontractor qualifications, site constraints, weather impact and schedule concerns are evaluated during the early project development stages up to and including design development.

Constructability and the Steel Industry

The construction industry separates the individual functions involved in planning, design, procurement and construction into specific tasks to be performed only by specific professions, such as:

- planning by the architect,
- design by the engineer,
- procurement by the construction manager, and
- construction by the trades.

The steel industry is no exception. The design process is typically separated from the fabrication and erection process. The design professional tends to place emphasis on the design program, budget, schedule and liability, while the fabricator and erector concentrate on making the project schedule and budget. And while value engineering may provide improvements on many projects, fine-tuning the individual parts does not yield a finely-tuned project!

Integration of the development process with all of the players engaged at the earliest possible stage is the best way to assemble a qualified, cooperative design and construction team and implement Constructability.

Constructability **IS NOT** Value Engineering!

Constructability is not value engineering. The major differences between Constructability and value engineering are timing and scope of service. Value engineering has been performed within the industry for some time, traditionally after substantial design decisions have been made. As such, it can be perceived as a criticism of the designer, self-serving for the fabricator/erector and too little, too late.

Constructability is most beneficial when performed prior to establishment of a defined scope, during early planning and design phases. At this time, industry knowledge and experience is least restricted by design decisions and most capable of affecting the final project. Because value engineering is typically performed only during the final stages, it has limited opportunity to make a significant impact on the project's cost or schedule.

Some familiar value engineering concepts also are included within a typical Constructability review:

- Periodic reviews of design documents
- Development of more efficient framing
- Simplification of details and connections
- Modifications for more efficient fabrication or erection
- Modular construction or shop assemblies
- Post-design audits by field personnel

However, these activities represent a small segment of the basic Constructability concept. Constructability also includes areas such as:

Development of the Project Plan – Construction industry experience can avoid flaws such as a sequence and completion schedule that hinders delivery and installation, or construction durations that are not feasible, or overlooking local conditions that create opportunities for innovative solutions (or generate major production problems).

Site Layout – While process and plant operations generally dictate the site layout for industrial projects (based on standard industry clearances and work station layouts), these layouts are not always compatible with structural requirements. Constructability can identify potential conflicts and facilitate a balance between production requirements and building constraints.

Commercial buildings maximize the use of space within the governing code provisions. However, a poor layout may cause construction inefficiencies such as: inadequate laydown area for subassembly, shakeout or project sequencing, limited access for personnel and material delivery, limitations on the availability of installation methods and or equipment, and inter-contractor coordination issues. Constructability reviews can reduce or eliminate these problems without compromising the basic structural design.

Establishing Project Requirements and Budget – General building projects often struggle to balance a facility's aesthetic and functional requirements when identifying and evaluating alternatives. Aesthetic requirements often are impacted by value engineering alternatives suggested late during the bidding phase; however, when these issues are addressed in the concept/design phase (via Constructability input), the project can more easily meet design intent and become easier to build. Further, the constructed facility is usually designed to meet the owner's budget rather than the budget designed to conform to a set of minimal performance criteria. The early involvement of Constructability can pay big dividends and avoid conflicts between budget and performance criteria.

Basic structural design decisions – The selection of the basic structural system may require several iterations from initial concept to the final design. Such iterations are a vital step in developing potential savings and reduced risk for the owner. Determination of the structural concept should be based on proven structural systems, specific project constraints, knowledge of industry standards and consideration of the fabrication and installation processes available. Design decisions made without the input of industry professionals may create major coordination problems during construction or missed opportunities for cost or schedule savings (through use of alternative materials, selecting most readily available materials, or maximizing shop fabrication) or both.

As these examples illustrate, the full benefits of Constructability extend well beyond value engineering. However, these benefits are possible only through the effective and timely integration of the knowledge and experience of construction professionals into the early planning and design stages and continuing through the procurement and construction, not after the design is complete and the team is focusing on cost reductions.

1. *Owner and contractor (design and construction) managers are committed to the cost effectiveness of the **entire** project, recognize the benefits of early construction input and are committed to the Constructability process.*
2. *Project cost and schedule objectives are based on the Constructability process.*
3. *Knowledgeable construction personnel are brought on board early. These are experienced construction personnel with a full understanding of the planning, design and construction process.*
4. *Structural designers and architects are receptive to improving the Constructability of their project. They think **Constructability**, request industry input freely and evaluate that input objectively.*

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Why Does Constructability Matter?

Constructability can deliver significant cost savings (as discussed above), however, it can also improve quality and reduce project risk.

Constructability provides resolution of many Quality Assurance issues. By bringing the construction perspective into the design stage (when contract documents are created), the contractor's perspective is inherently incorporated into the drawings, which improves the completeness of the documents and results in a level competitive playing field, where the best contractor wins.

Documents (drawings and specifications) are the tools that structural engineers use to communicate the elements of the design of structures to contractors. Contractors use the documents to develop and submit bids for construction of the structure, and then (if selected) to implement the design. For the bid to be accurate, the documents must describe in sufficient detail the ele-

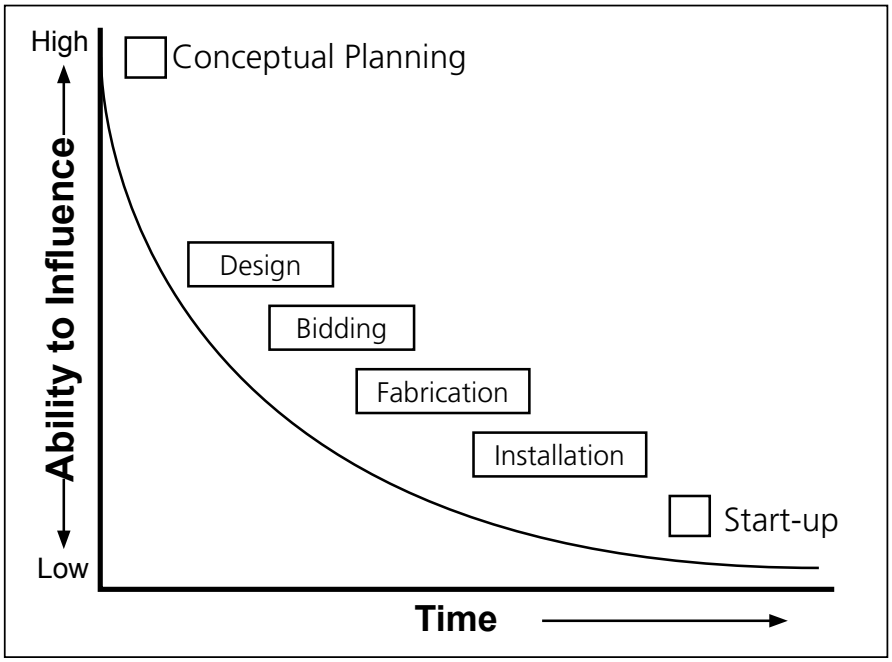

Figure 1: Integration of the project development process with all of the players engaged at the earliest possible stage is the best way to assemble a qualified, cooperative design and construction team and implement Constructability.

ments of the structure to be built, the quality with which it is to be built, and any special requirements governing its construction. Inherent in this process are the issues of what is customary in terms of the level of detail, coordination of the documents and the degree of scrutiny of the bidder (CASE, Document 962 D, 2003).

While that explanation makes complete sense, engineering documents are delivering undesirable results too often. They are providing the opportunity for shrewd contractors to "low ball" a project because important details are not provided and they defer to what is "customary" to them, while their more conscientious counterparts build-in the extra cost for doing what they know is needed on the project and price themselves out of the competition. The result? Owners are forced to select the "low ball" bid, and suffer the consequences: budget and schedule overruns, disappointing results, and a potential risk to the safety of building occupants and the public.

The root cause of problems with producing "complete" documents lays in communication. Engineers and architects must communicate effectively to produce documents that enable the contractor to develop a competitive bid. Poorly prepared Contract Documents lead to equally poor contractor selections. Implementing Constructability drives collaboration between engineers, architects, construction professionals and owners that results in high quality construction documents, the selection of qualified construction firms, and the successful construction of the facility.

Who Drives Constructability?

Constructability usually requires that owners go beyond conventional approaches to project execution by expanding front-end planning and investing additional money, time and effort to enhance the final design and address any issues that may impact the successful completion of the project. In fact, the full benefits of Constructability can only be achieved by a proactive design professional that takes a proactive approach to the Constructability concept and educates the owner on the benefits of engaging construction industry professionals in the design process.

How Do You Do Constructability Reviews?

Future articles will present specific applications of Constructability principles in the context of case studies and discuss the project benefits that resulted.▪

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All photos courtesy of Ruby + Associates, PC.