

## **Communication of Constructability: A Comparative Analysis Between Design-Bid-Build and Design-Build Delivery Methods**

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### **Abstract**

Project Constructability represents the ease of transforming the design into a constructed facility in accordance with the owner's objectives. This requires great construction knowledge/experience integration throughout the early phases of the project life cycle. Effective coordination and communication between designers and constructors is then essential especially during the design phase. This paper aims to identify the optimum delivery method that enables the integration of the required construction knowledge/experience during design development and hence producing a design with minimum constructability problems. Available delivery methods provide a matrix of organization with formal and informal relationships between the participants. Depending on the delivery method, the communication model changes, and thus the potentiality, to integrate the needed construction knowledge and experience into the design, varies. The paper first presents the problem of developing a constructible design with its causes and impacts. Then, the paper briefly presents the traditional Design-Bid-Build and the Design-Build delivery methods as they are currently the two most widely used delivery methods. The paper compares how project participants communicate together, and how communication of constructability issues is being handled in each approach. Finally, the paper identifies which delivery method is optimum for improving design constructability.

### **Keywords**

Constructability, Delivery method, Design-Bid-Build, Design-Build, Communication.

### **1. Introduction**

From start to completion, construction projects undergo a number of phases characterized by many tasks aimed at identifying, planning, designing, and constructing the proposed facility. Such phases and tasks may be grouped into two main stages: The Pre-construction Stage including the conceptual planning phase, the design phase, and the procurement phase and the Construction Stage, which includes the construction and close out phases.

During *the conceptual planning phase*, the owner hires key consultants to select the project site, to make the required feasibility studies, and to develop a conceptual estimate, plan, and program. This is the phase when the owner, after gathering information about the project, makes a decision whether or not to proceed with the project. *The design phase* comprises of: (1) the schematic designs where the design team investigates and decides on alternate design solutions and alternate materials and systems, and (2) the detailed design where the design team evaluates, selects, and finalizes the systems and components of the project. The design phase also includes the preparation of technical documents and specifications. The

project's schedule and budget continue to be developed and monitored during this phase. *The project procurement phase* is the time when the project formally transitions from design preparation into construction preparation. This phase includes the bidding and award process. The Contractor is selected and the Contract is negotiated and concluded during this phase. The project schedule and budget are finalized in this phase. *The construction phase* presents the actual physical construction of the project. This phase begins with the mobilization to the site, then the implementation, and finally ends by the project closeout and handing over.

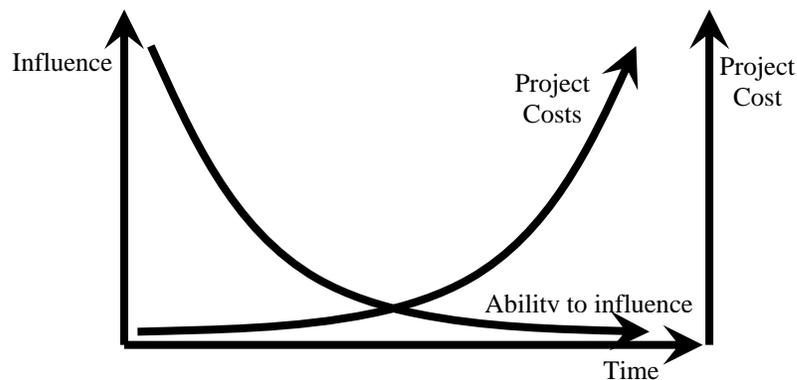
Throughout the various phases of the project, the project participants – the owner, designer, contractor, subcontractors, and suppliers – are required to make several decisions, which affect the success of the project. Decisions made during early phases, especially in the design phase, are the most significant and have a tremendous impact on the constructability of the project. If these decisions are inappropriate, this will lead to many constructability problems during the construction of the project.

In order to assist in reducing these constructability problems, we need to ensure pertinent integration of construction knowledge and experience during design development. This requires studying the approaches through which the project team is organized and how its participants communicate together. These approaches are called “Delivery Methods” provide a matrix of organization with formal and informal relationships between the participants, hence arrange how the project participants will cooperate and communicate together during the different phases of the project. Examples of these delivery methods are: Traditional Design-Bid-Build, Design-Build, and Construction Management.

In the following sections, the author aims to demonstrate the optimum delivery method that enables the integration of the required construction knowledge/experience during design development and hence producing a design with minimum constructability problems.

## 2. The Problem: A Constructible Design

The successful completion of a construction project requires making proper decisions throughout the various phases of the project. However, as illustrated in Figure 1, the decisions' greatest influence falls off sharply as time of the project passes. This indicates that early decisions during conceptual planning and design phases have much greater ability to impact than later ones. Furthermore, decisions during the early phases will cost much less than if made after the construction has started.



**Figure 1: Impact of Early Decisions**

Design professionals have then a great responsibility during design development and the preparation of the construction documents. Their decisions will extremely affect the success of the project and will tremendously impact the constructability of the project.

Many researchers have defined constructability and studied the causes of constructability problems in order to gain a better understanding of what should be done to improve it. The Constructability Task Force of the Construction Industry Institute (CII) has defined constructability as “the optimum integration of construction knowledge and experience in planning, engineering, procurement, and fields operations to achieve overall project objectives” (O’Connor *et al.*, 1987). The Construction Management Committee of the American Society of Civil Engineers (ASCE) Construction Division (1991) has defined constructability as “the capability of being constructed,” and has defined a constructability program as “the application of a disciplined, systematic optimization of the construction-related aspects of a project during the planning, design, procurement, construction, test, and start-up phases by knowledge, experienced construction personnel who are part of a project team”. Glavinich focused his research on constructability during the design phase and defined constructability of a design as the ease with which raw materials of the construction process can be brought together by a builder to complete the project in a timely and economic manner (Glavinich, 1995). Mendelsohn also noted the importance of constructability during the design phase by stating that 75% of the problems encountered in the field are generated in the design phase. Mendelsohn defined constructability as “the integration of construction expertise into the planning and design of a project so that the construction forces have the maximum opportunity to deliver the project in conformity with cost, quality, schedule and safety objectives of the project’s stakeholders.” (Mendelsohn, 1997)

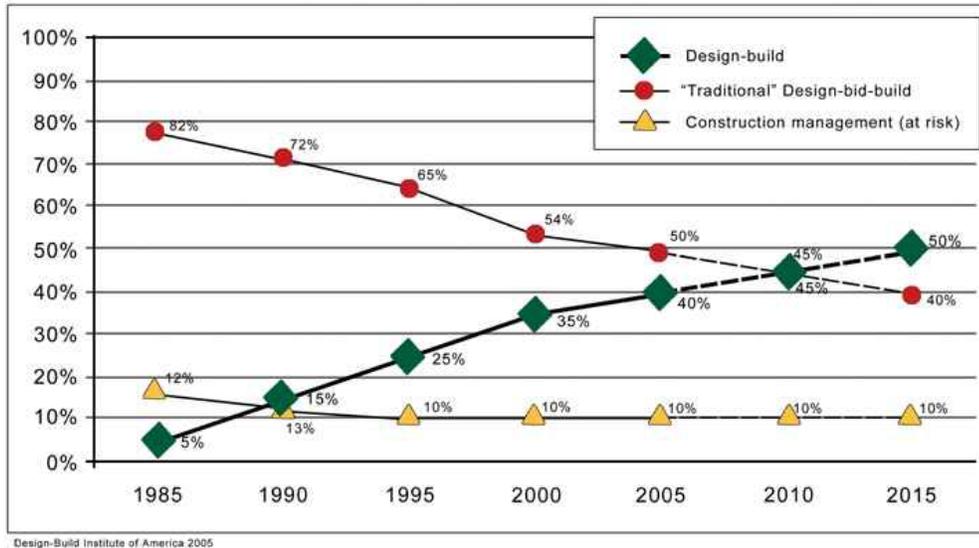
Poor constructability is due to many reasons. First, some design professionals have little experience in construction practices, local considerations, the availability of different resources, and are not necessarily experts in construction means and methods (Glavinich, 1995). Second, when the Architect/Engineer (A/E) selects the specifications and methods deemed appropriate for implementing the project, the contractor is typically not included or consulted. The contractor then tries to achieve what the A/E wants without needed insight or understanding (Cross, 1991).

The impact of poor constructability is obvious and creates many problems during the construction of the project. These problems are manifested mainly in change orders, out-of-sequence work, inefficient use of resources, time extensions, increased costs and litigation (McCullouch and Patty, 1994).

### **3. Project Delivery Methods**

Throughout the different phases of the project, the project participants communicate together in various manners in order to discharge their obligations and in order to successfully complete the project. The time and method of communication depends mainly on the Delivery Method selected for the project.

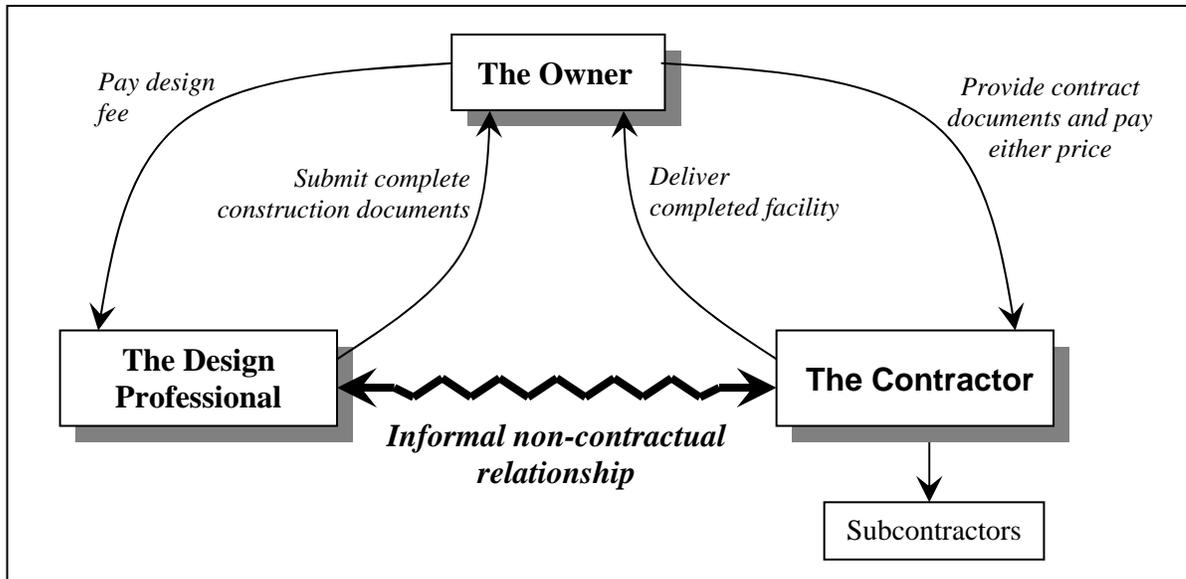
The delivery method of construction projects may be defined as “the comprehensive process by which a building is designed and constructed” (Spink, 1997) and (Johnson, 1997). There are number of proven delivery methods that can be used (e.g. Traditional/Design-Bid-Build, Design-Build, Construction Management at risk), each offering some advantages and disadvantages (Gould, 1997). The paper concentrates on the Traditional Design-Bid-Build and Design-Build Delivery methods as they are the two most widely used delivery methods. According to statistics released from the Design-Build Institute of America, these two delivery methods are currently being used in 90% of non-residential projects in the United States of America (Figure 2) (Design-Build Institute of America, 2008).



**Figure 2: Non-Residential Design and Construction in the United States (Source: [www.dbi.org](http://www.dbi.org))**

### 3.1 The Traditional Delivery Method

In the traditional delivery method, the owner contracts separately with a design professional and a construction professional (Figure 3). The design professional prepares a complete set of contract documents for the project. Then the owner, or the design professional, usually negotiates a price with a general contractor or bids out the work. The contractor selected enters into an agreement with the owner and is totally responsible for delivering the project in accordance with the drawings and specifications. The general contractor may subcontract out parts of the project. Each subcontractor reports directly to the general contractor. Depending on the owner's needs and capabilities, the design professional usually supervises the works and conducts periodic site inspection to oversee the construction work in the field (Bartholomew, 1998). The main advantage of this delivery method is that, with a defined scope upfront, the owner can get a firm fair price prior to construction.

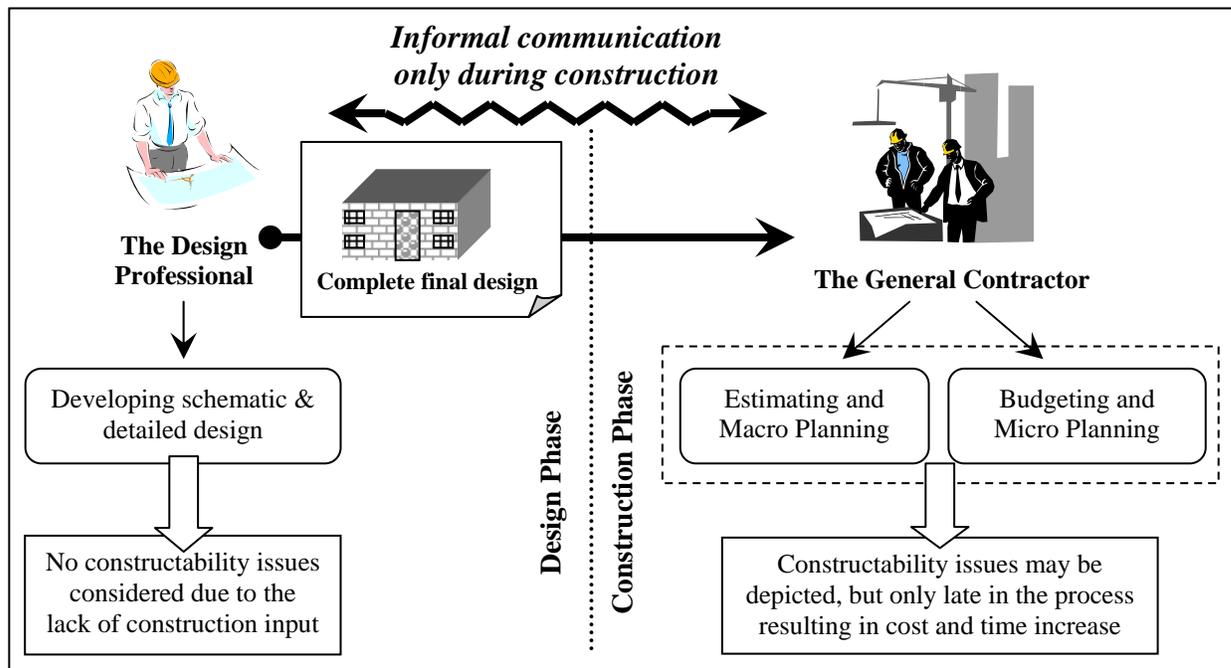


**Figure 3: Traditional Delivery Method Relationships**

### 3.1.1 Communication of constructability issues

One of the major disadvantages of this traditional delivery method is that the contractor has no input during design development. Due to the linearity of this approach, the contractor is only selected after the contract documents are finalized. This scenario leads to conflicts and communication gaps among designers and contractors (Rizzo, 1997). In addition, when the Architect/Engineer (A/E) selects the specifications and methods deemed appropriate for implementing the project, the contractor is typically not included or consulted. Then, during the procurement phase, and due to the short time usually available for bidding the project, the contractor attempts to understand the design of the project. The general contractor plans the project at the macro level in order to develop an estimate and bid for the project (Figure 4). Macro planning involves selecting the appropriate sequence of different assemblies, selecting the methods used for the execution of these assemblies, and allocating appropriate resources (Gupta *et al.*, 1998). At this phase, if, while performing macro planning, the contractor depicts design-related constructability problems, it usually requires cost and duration increase to solve these problems. This cost and duration increase could have been eliminated if these problems were depicted early during design development.

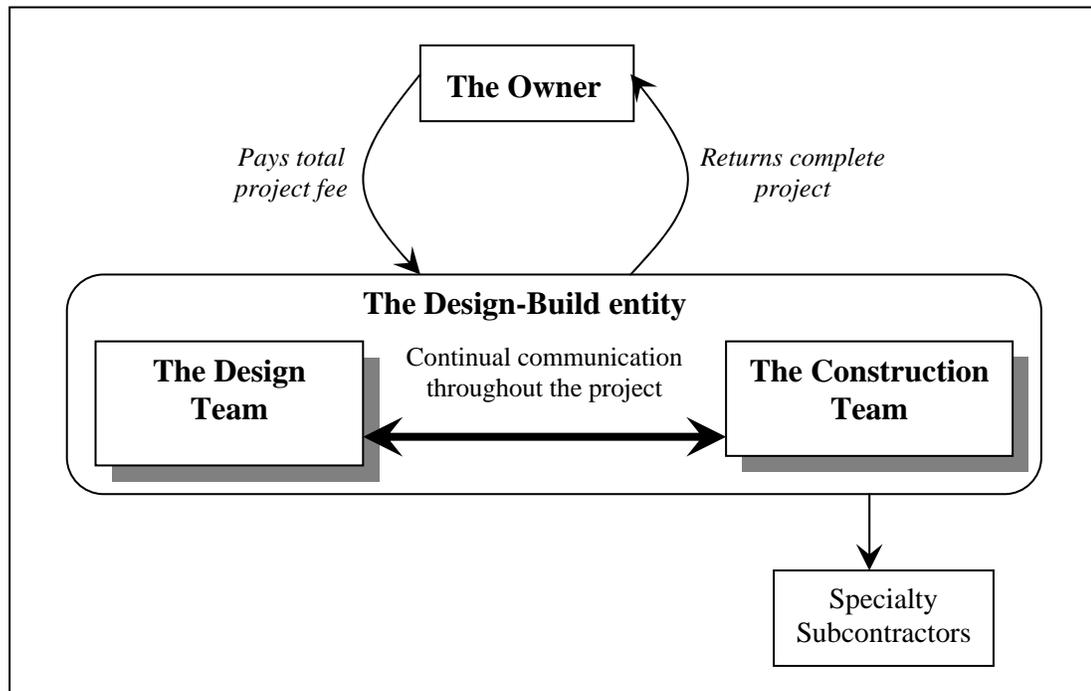
During construction, no direct or contractual relationship exists between the designer and the contractor. These two parties communicate formally only through the owner. However, there exists an informal non-contractual relationship between the designer and the contractor during the construction phase. For example, during inspection, the designer may directly inform the contractor of any work not done as spelled out in the contract documents. The contractor may also demand any clarification or discuss any omissions in the contract documents. If the designer and the contractor can't solve the problem informally, then, they have to inform the owner, with whom they have separate contracts, to solve the problem or to take legal action. This usually leads to adverse relationship that often develops between the designer and the contractor (Rizzo, 1997).



**Figure 4: Communication of Constructability Issues in a Traditional Delivery Method**

### 3.2 The Design-Build Delivery Method

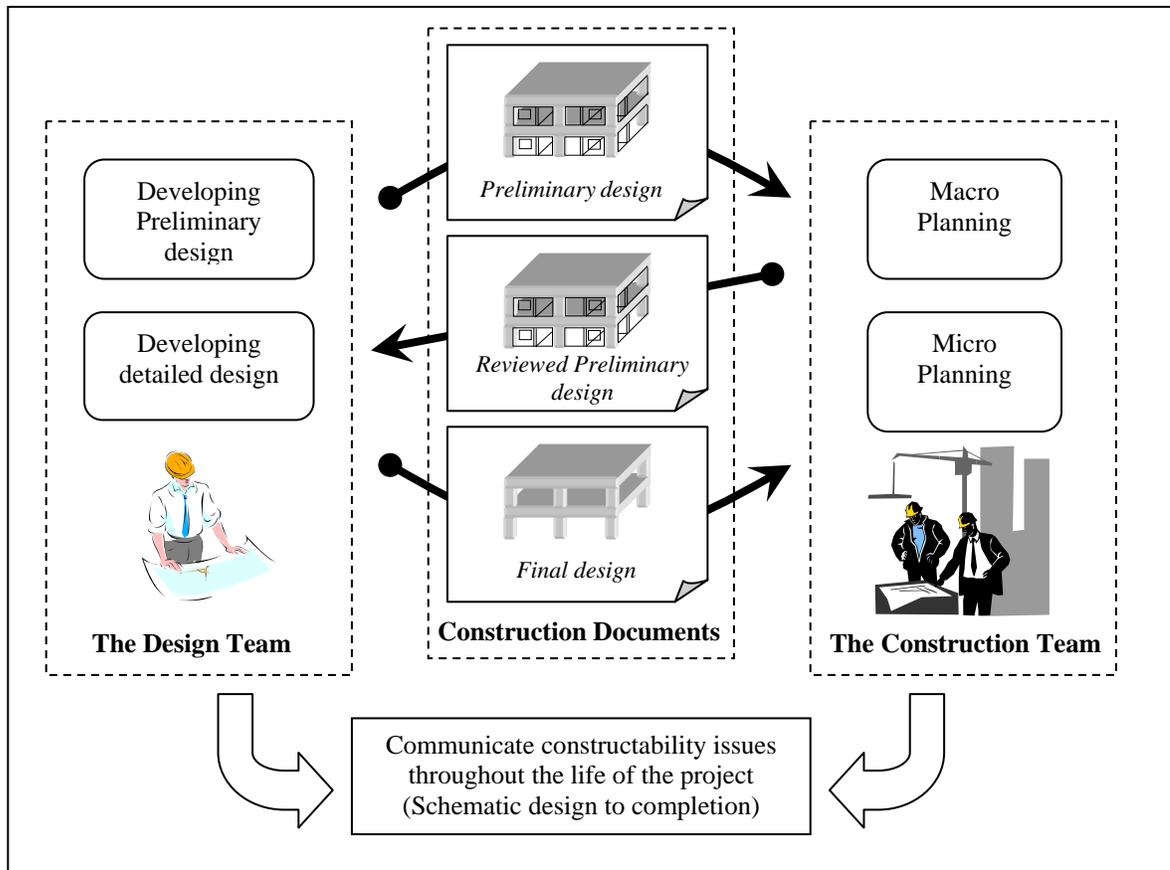
In the Design-Build delivery method, the owner contracts with a single entity that provides both design and construction services under a single Design-Build contract. This entity is usually a single company that has in-house design and construction professionals (Figure 5), or a joint venture between two companies. There also exists other Design-Build format, such as Designer-Led Design-Build, Contractor-Led Design-Build.



**Figure 5: Design-Build Delivery Method Relationships**

#### 3.2.1 Communications of constructability issues

As depicted in Figure 5, the design team and the construction team work together since the beginning of the project to return a complete project to the owner. The most obvious change that distinguishes Design-Build from the Traditional delivery method is that the design professional is the construction professional teammate. Both parties have the same interest. They are at risk for cost, schedule, quality, and management of the entire process. During the design phase of the project, the designer and the construction professional communicate continuously to improve the constructability of the design. The design professional develops a schematic design for the whole facility. The construction professional reviews this conceptual design, performs macro planning, assists in the selection of appropriate construction means and methods, and the determination of alternative available materials taking into account budgetary and schedule considerations. After getting the feedback from the construction professional and discussing constructability issues, the design professional develops detailed design for the project (Figure 6). This continuous communication between the design professional and the construction professional facilitates the interpretation of constructability issues, which result in a more cost effective design, minimization of overall project duration and more effective transformation of design into construction reality (Rizzo, 1997).



**Figure 6: Communication of Constructability Issues in a Design-Build Delivery Method**

#### **4. Differences Between Constructability Interpretation in the Traditional and Design-Build Delivery Methods**

<b>Traditional Delivery Method</b>	<b>Design-Build Delivery Method</b>
<ul style="list-style-type: none"> <li>▪ No communication exists between the design team and the construction team during design development</li> <li>▪ Constructability issues are not considered until the procurement and/or construction phases</li> <li>▪ Even if depicted during the procurement and/or construction phases, constructability problems affect the project cost and duration</li> </ul>	<ul style="list-style-type: none"> <li>▪ The design team and the construction team communicate throughout the life of the project</li> <li>▪ Constructability issues are considered during design development</li> <li>▪ If depicted early, constructability problems can be solved without affecting the project cost or duration</li> </ul>

## 5. Conclusion

Constructability is a major factor that determines to a far extent the success or failure of construction projects. Constructability problems continue to be a leading factor to low productivity, higher costs and duration, and low quality of construction projects. Poor constructability can be greatly attributed to the limited understanding of the construction process by many of the project participants, and the lack of integration of the construction knowledge and experience during the design phase.

In the Traditional delivery method, and due to the linearity of this arrangement, there is no construction input during the design development. Therefore, the constructability problems cannot be depicted until the design is finalized and the contractor is performing macro planning for the facility. However, it is worthy to mention that the consultation of a Construction Professional during the design phase will improve, to a great extent, the constructability of the design. However, since the consulted professional will not be, normally, the contractor of the project, his opinion and advices may not be optimal to the Contractor executing the project.

In the Design-Build delivery method, constructability problems can be depicted early during design development due to the presence of the needed construction expertise. While reviewing the conceptual design and performing macro planning, the construction professional can depict the constructability problems and communicates directly with the design professional to solve any problem early without affecting the budget or duration of the project.

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