Understanding the Benefits of Design-Build Project Delivery Mechanism through Analysis of Baylor University Sciences Building, Waco, Texas, USA

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Abstract. This paper gives an overview of design-build project delivery system and explains the intricacies involved in the system through the case study of a Design-Build Institute of America (DBIA) Merit Award winning project, the Baylor University Sciences Building, Waco from its inception to completion. The paper further summarizes and analyzes the feedback gathered from Owner, Architect/Engineer and Design-Builder.

Keywords: Alternative Project Delivery Mechanisms, Design-Build, Selection Criteria, Owner, Architect/Engineer, Design-Builder

1. Introduction

Design-Build project delivery is an Alternative Project Delivery System. According to the Design-Build Institute of America (DBIA, 1994), the design-build form of project delivery is a system of contracting whereby one entity performs both architectural/engineering and construction under a single contract. Under this arrangement, the design-builder warrants to the contracting agency that it will produce design and construction documents that are complete and free from error, and will get the project constructed accordingly. In this project delivery system the design-builder takes the risk, which is contrary to a design-bid-build delivery system where the designer carries the risk. The selection process under design-build contracting can be in the form of a negotiated process involving one or more contracts, or a competitive process based on some combination of price, duration, and proposer qualifications. Portions of the overall design or construction work can be performed by the design-build entity or subcontracted out to other companies that may or may not be part of the design-build team (DBIA, 1994).

Design-build is a hybrid project delivery system, and according to Booth (1992), Design-Build construction is a partnership between the construction contractors, design professionals, environmental consultants, sub-contractors and material suppliers. Through this partnership, the design-build contractor has the capability of offering a complete construction agenda to the owner, which translates into positive benefits for both the design-build contractor and the owner. Design-build - once known as only one of many forms of alternative project delivery – may now be the most preferred method, Sell (as cited in Quatman et. al., 2003).

According to Beard, et al (2001), the earliest form of infrastructure delivery involved a master builder serving as both project designer and builder. Throughout most of recorded history, this form of design-build project delivery has been used to develop various projects such as pyramids, temples, aqueducts, cathedrals, and major public buildings. The widespread use of design-build project delivery reflected the need to have the project designer intimately involved in the construction of the project to ensure the proper execution of the design plans and consideration of construction challenges posed by the design before it is completed. This paper analyses and critiques an award-winning design-build project, the Baylor University Sciences Building through literature review and based on information gathered from various project parties involved in the project.

The project Baylor University Sciences Building (BUSB) is a key imperative of 'the Baylor 2012 vision'. In February 2002 the Regents of Baylor University approved the issuance of US$200 million in bonds to finance the construction of facilities forming 'the Baylor 2012 vision'. BUSB is a state-of-the-art facility,

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which comprises of 508,000 sq. ft. of workspace for chemistry, physics, biology and geology departments. The BUSB project with a budget of US$103,292,000 involved a team of Baylor University, Waco, TX (Owner); Harley Ellis, Detroit, MI (Architect & Engineer); Beck Group, Dallas, TX (Contractor); and Brandt Engineering, Mills Electric and Kewaunee Scientific (Specialty Contractors) for successful completion of the project. The BUSB is an excellent example of implementation of the design-build project delivery system and received the DBIA merit award for 2007 and AGC North Texas Chapter (QUOIN) Summit Award for 2005. In addition to being completed on-time and on-budget, the BUSB project was chosen for its advanced and innovative application of integrated project delivery and unique solutions.

2. BUSB: Design

The state-of-the-art facility is the largest project in Baylor's history. Dr. Ben Pierce, Owner's representative stated that there are many impressive and significant things about this new science facility: its size, its cost, and the cutting edge technology that will fill its spaces. Salient features of the five-storied BUSB facility are its diversity of spaces with varied functional requirements. It has classrooms varying in size from small 12-15 seat rooms to a 300-seat auditorium, totalling 33 in number; there are 161 faculty offices, a total of 153 labs in the building - 75 for teaching and 78 for research.

Despite the complexity of design and multi-functional spaces the Beck Group delivered the facility as per the Owner's Requirements. In addition to this, the designers at the Beck Group showed agility by modifying the design in a quick response to a flood threat. The original plans for the facility called for a basement, but after a devastating storm which flooded the basements of downtown Houston buildings in 2001, designers at Beck Group instead decided to add a large fifth floor "penthouse" where electrical, plumbing and air conditioning equipment is located (Baylor). The designers and engineers at the Beck Group paid special attention to every single detail in the facility – whether it was a technical detail like sensors to control the fountain height or design details such as the inscription of a biblical verse above the columns.

In addition to working out the intricate details in the design, the designer and engineers at the Beck Group achieved significant energy efficiency by selecting energy efficient equipment and using sustainable climate-conscious design strategies. The facility exceeds by more than a third the energy-saving requirements of the 2000 International Energy Conservation Code. The design of the BUSB directs natural light into almost all the research laboratories and faculty offices. 260 fume hoods are provided for air change. Researchers generally require 24-hour access to the facility, so there's never a down time and irreplaceable experiments require fail-safe redundant back-up systems and uninterrupted power supply. To achieve this, the design and construction team at the Beck Group worked together and selected the 'right' equipment and systems with low life-cycle costs. The builders at the Beck Group achieved a good equilibrium between designing the facility's historic architectural appearance and incorporation of modern structural techniques. The architecture is Baylor Georgian and brings some of the features of the historic buildings from the original campus into a newer area. The cast-in-situ concrete structure is designed to control vibration velocities throughout the wings that could adversely affect sensitive equipment (Beck).

Despite the design complexities and design modifications during the construction stage the project was delivered ahead of schedule. This was possible because the design-build delivery mechanism reduces the time for approval and interdisciplinary coordination. In a traditional design-bid-build delivery mechanism multiple parties are involved and a lot time is wasted in interdisciplinary coordination. The Beck Group as the single entity responsible for the delivery of the project ensured that all deadlines were met irrespective of the complexity of the building and multiple design changes during the construction process.

3. Owner's Perspectives

In September 2001, the regents approved the architectural plans of BUSB and decided that the facility should be completed by fall 2004. Seeing the tight time frame and intricacies involved in construction of science/research facility they decided to go for design-build delivery system. The design-builder i.e. the Beck group was selected on the basis of "best value" (technical and price) with discussions (Beck). The key point of discussions was to get assurance of timely delivery of the project from the Contractor and the Beck Group could assure this only because they had a single party to deal with and at the same time they were performing

as a single entity – the design-builder. With a “best value” selection, the owner consciously makes a trade-off between price considerations and considerations of quality. After weighing all the factors, the owner determines which proposal offers the best value in terms of quality versus price (AGC, 2004). The evaluation criteria for selection were:

- Innovative technical solution
- Operation and maintenance costs
- Past performance of the firm
- Management plan
- Completion schedule
- Construction cost
- Fee

These evaluation criteria were possible only because it was a design-build project. If it was a traditional design-bid-build project then it would not be possible to assess the contractor's bid on 'innovative technical solution' and 'operation and maintenance costs' as both these criteria are controlled by the designer. The three major parties involved in the project were Baylor University (Owner), Beck Group (Design-Builder) and Harley Ellis (Designer). Initially the Owner signed a contract with the Designer for schematic design using AIA standard forms of contract. After the completion of schematic design, Owner decided to go for design-build project delivery and signed the contract with the Design-Builder using AIA Design-Build documents. The development of the design-build family of AIA documents began at AIA National Convention in 1978, when AIA approved the design-build “experiment” by repealing its long-standing ethical restriction against its members engaging in construction, Sieben (as cited in Quatman et. al., 2003). This happened because AIA could sense the clients’ growing inclination towards design-build and the increased popularity of design-build delivery mechanism. In 1985, AIA approved and published these documents. All the project parties agreed to enter contract using AIA family of contracts because it provides bargaining power to each party. In addition, AIA documents anticipate many of the challenges arising during the project and also provide possible solutions. In construction industry most of the projects get delayed because disputes are not resolved on time; and having a solution in hand for potential problems helped the before-time delivery of the BUSB project.

The facility is designed in a flexible manner so as to accommodate future needs. Dr. Ben Pierce oversaw its academic planning. He remarked at the groundbreaking ceremony that, the science facilities that we create over the next two years will need to serve Baylor for the next 50 years. It is impossible for us to know the nature of science teaching and research 50 years from now. So we can't really construct a science building for the year 2050. But what we can do is create a building that is flexible and that can change as the nature of science teaching and research changes over time. The way you do this in the sciences is to design the laboratories and classrooms on a modular basis, so that the spaces and their uses can change over time (Baylor). The Beck Group could help the Client to achieve their vision because of close intra-team coordination between their design and construction team. The coordination becomes much easier and hassle-free when both design and construction parties are under same contract. Contrary to this, coordination among parties in traditional design-bid-build project may become a ‘blame game’ when things start to go wrong and every party tries to save themselves to avoid contractual penalties.

The Owner was pleased with the design-build team's performance and delivery of the project. Overcoming severe setbacks and obstacles, an electrical fire for one, the Owner was able to meet its obligation of opening the facility in time for fall 2004. The Owner’s satisfaction is seen in the letter written by Baylor President Robert B. Sloan Jr. to the Beck Group stating, ‘It is with appreciation that I write this letter commending The Beck Group for the work on the Baylor University Sciences Building. Beck’s team was highly qualified, professional and motivated, which carried across all involved in the design and construction of this impressive building. The Sciences Building project was high profile on the campus with critical deadlines due to commitments made to arriving students as well as the University’s commitment to our Master Plan; Vision 2012. Beck provided service above and beyond at every phase of design and construction to ensure the success of the project. The spirit of cooperation and collaboration Beck brought to the table day in and day out resulted in an enjoyable project experience for all involved and a successful end

result. We appreciate the team's dedication and the ongoing relationship our organizations have established through this experience.' The Design-Builder received this commendation from the client because of the selected delivery mechanism of design-build. There are two key situations in any construction project that hinder its successful completion: first, if there is a schedule creep, who is to be blamed; and second is when the contractor starts requesting claims due to insufficiency and inaccuracy of design. The design-build delivery mechanism prevents occurrence of both of these situations by having a single entity responsible for both design and construction.

4. Design-Builder's Perspectives

When a project is proposed, the obvious decision to be made is whether the firm should pursue it. This is no different in design-build than for traditional architectural solicitations. A realistic look at the firm's credentials and the client's goals is necessary to make an informed decision, Chitwood (as cited in Quatman et. al., 2003)). The Beck group heard of BUSB through public notification and then responded to the Request for Proposal. The reasons for Beck deciding to pursue the project were Baylor's financial stability and market reputation, location of the project and the fact that this project could bring more projects of a similar type (i.e. science/research) and help expand Beck's business (Beck). The Client's financial stability and a good market reputation assured the contractor of timely and complete payment on delivery of services. BUSB's location of Waco, TX was close to the deign-builder's home office in Dallas, TX and assured them that they could always reach back to their home-office whenever an additional support or expertise was required.

The BUSB's project team was a builder-led team. The Beck Group was the team leader with Harley Ellis as architect and engineer. Brandt Engineering, Mills Electric and Kewaunee Scientific were specialty contractors. The Beck Group teamed with Harley Ellis as their design arm and novated the design liabilities and/or risks to Harley Ellis. This provided Beck Group a better control over design, while safeguarding the design intent, as Harley Ellis were the bridging designers and had done the schematic design.

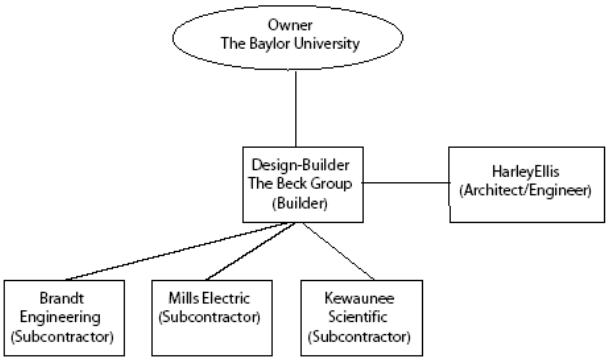

Fig. 1. Builder-led design-build team

The design-build team successfully completed the project, meeting the design criteria and performance requirements provided by the client. The design-builder stated that the project exhibited design excellence and was planned keeping future flexibility in mind. Energy-efficiency and safety design features for the BUSB go beyond building code requirements to create a state-of-the-art facility. High construction standards were achieved because builders at Beck were involved during the early design stage and advised the design team on constructability of the design. The builders provided efficient construction solutions to the Designers. This early involvement of the builder during the design process is only possible in alternative delivery mechanisms like design-build.

In addition to design and construction, Beck also provided value added services to Owner using their program management expertise. The services were (Beck):

- Improved faculty, student and community communication
- Coordinated and purchased the keying, signage and way finding system for the building

- Management of 'move services' from existing facilities to new building including a help desk for construction, housekeeping, IT and general issues.
- Review and tracking of all material testing deficiencies and closeouts.

The Beck Group submitted the Guaranteed Maximum Price (GMP) and completed the project on budget. The facility was scheduled to complete in August 2004 and in spite of an electrical fire the project was completed three months ahead of schedule. The team gives credit for this before-schedule completion to the design-build delivery mechanism as it condensed the schedule by 'fast-tracking' the design and construction phases.

5. Conclusion

Since its introduction, Design-build delivery system has gained in popularity, and many of the barriers to its use have now been removed. The construction industry is changing rapidly and some estimates suggest that in 2002 nearly 40 percent of all buildings were being produced using the design-build method, Sell (as cited in Quatman et. al., 2003). It is likely that this trend will continue in the future, because design-build delivery system deals well with complicated design issues and tight schedules (AGC, 2004).

Since the single entity i.e. the design-builder is responsible for both design and construction, there is nothing like 'design errors and omissions'. This is one of the most important benefits Design-Build provides to owner (AGC, 2004). Theoretically, changes that are entirely the result of design errors and omissions should be eliminated as a risk to the owner, because the same entity is responsible for the construction cost and design.

The single point responsibility inherent in Design-Build facilitates project coordination (AGC, 2004). Design-build facilitates fast-track project delivery. During the detailed design phase, the construction team at Beck had commenced construction and site-work. A Design-Build firm can begin design as soon as the owner's requirement are determined, and can begin construction of early project phases even while later phases are being designed.

The Design-build project delivery system is an excellent tool to achieve speedy and quality construction as demonstrated by the BUSB case.

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