

BEST PRACTICES IN DESIGN PROCESS DEVELOPMENT FOR ACCELERATED CONSTRUCTION PROJECT DELIVERY

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The traditional system for highway delivery has served the public well for over 60 years. The foundation of this system, often called Design-bid-build (DBB), is the principle of selecting designers based on qualifications and selecting construction contractors based on competitive sealed bids. Though successful in the main, this process can foster adversarial relationships, limit innovation, result in high cost and time growth, and may not necessarily provide the best-value to the owner. In recent years, these issues have become a more pressing concern for highway agencies in the US, as deteriorating infrastructure and an increasing population have created pressure to move critical projects quickly from planning, through design, and into construction, without a cost increase. The wide range of options for project delivery available today is a recent development for publicly funded highway projects in the US. Design-Build (DB) was introduced in the Intermodal Surface Transportation Efficiency Act of 1991. After the successful experience with DB, many states passed legislation to allow alternative project delivery methods, such as DB and Construction Manager / General Contractor (CMGC). In the rush to construct projects faster, the need to change the design process was a subject that did not receive proper attention. This paper, based on research sponsored by the US Federal Highway Administration, discusses and documents findings on these and other facets of the research.

Keywords: Design Process, Accelerated Construction, Project Delivery, Fast-track, Design-Build, Construction Manager / General Contractor.

1 Introduction

Traditionally, highway construction projects have been procured by means of a qualifications-based and competitive low-bid selection process familiarly known as Design-Bid-Build (DBB). This procurement system involves the separation of design and construction services wherein designers are chosen for their qualifications and

construction contractors are chosen by competitive bidding. As such, DBB offers a checks and balances system by executing separate contracts with both of the parties. Unfortunately, this division between design and construction limits innovation, results in increased time and cost growth, and cultivates antagonistic relationships between the project parties.

Recent concerns with population growth and deteriorating infrastructure have inspired urgency on behalf of highway agencies to move critical projects through the planning, design, and construction stages faster without a commensurate increase in available funding. Alternative project delivery methods, such as Design-Build (DB) and Construction Manager / General Contractor (CMGC), have been legislated in some states to expedite delivery and promote improved efficiency and quality. DB also offers single point of responsibility, while both emphasize teamwork, innovation and early involvement by the constructor in the planning and design processes.

Successful implementation of a DB or CMGC program requires a significant and aggressive change in the culture and philosophies of the designers from traditional DBB design projects. By studying different approaches for exercising control of design decisions throughout the process, the researchers will assess the relative merits of alternative approaches to managing key aspects of the design that affect project scope, quality, and cost.

2 Literature Search

The foundation of the DBB system is the principle of selecting designers according to set qualifications (Brooks Act – Public Law 92-582) and selecting contractors per competitive sealed bids, with award going to the lowest responsive and responsible bidder, usually based on 100% Plans, Specifications and Estimates (PS&E) (Scott 2006). Over the decades, this system has provided taxpayers with adequate, safe, and efficient transportation facilities while preventing favoritism in spending public funds. However, DBB did not always provide the best value to the owner for all project circumstances or types.

Mounting pressure to expedite projects while maintaining quality prompted the call for highway agencies to review and evaluate alternative procurement and contracting procedures. DBB was the traditional project

delivery method in transportation projects in the US from the 1930s until the introduction of DB in the Intermodal Surface Transportation Efficiency Act of 1991. In 1996, the Federal Acquisition Reform Act authorized the use of DB for federal projects, and then in 1998 the Transportation Equity Act for the 21st Century allowed federal funding for state Departments of Transportation (DOTs) to award DB contracts if enabling state-level legislation was in force. Some states subsequently passed new legislation and codes to allow the use of alternative project delivery methods.

An obvious drawback to DB was less agency control over design. Since the single design-builder entity often contracted out the design services, the management of design was substantially different from what agencies were accustomed to under DBB. Furthermore, the line of communication between agency and design professional had to go through the same design-builder entity, which was often a contractor or joint venture of contractors.

These concerns motivated transportation agencies to seek alternatives to DBB and DB, and Construction Management at Risk and the similar Construction Manager / General Contractor (CMGC), offered expedited project delivery while allowing the agency to retain control of design. Previous studies also found that adding CMGC to a DOT's delivery toolbox provided several benefits (NCHRP 2009, 2010). CMGC provides DOTs with a conservative option when DB and DBB are unable to satisfy contrasting project objectives. As illustrated by the Utah Department of Transportation's (UDOT) use of CMGC for projects, Figure 1 shows the recommendations for selecting a project's delivery method (Alder 2007, Alder 2010). Additionally, CMGC was perceived as "a less radical shift in procurement culture than design-build" (NCHRP 2010, pp. 3), and was used to initiate change in transportation agencies that had not adopted DB.

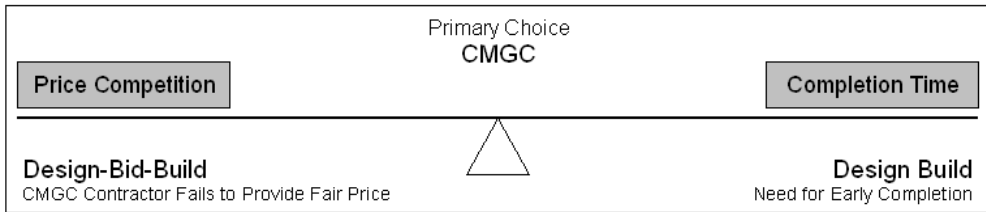


Figure 1. UDOT Balanced Delivery Approach

Exhibiting an integrated team approach, CMGC applied professional management during the planning, design, and construction of a project. As with DBB, the owner contracts separately for design and construction, but the construction manager (CM) is best retained around the same time as the design consultant by means of a best-value or qualifications-based selection process.

The CM acts as a consultant to the owner during the pre-construction phase through a pre-construction services contract, assisting with constructability reviews, estimates, scheduling, and budgeting in addition to non-standard duties such as helping to secure financing or aiding in the selection of design professionals. During the construction phase, the CM is “at risk” and functions similar to the general contractor (GC) on a DBB project.

Subcontracts made under CMGC can be fixed-price, cost reimbursable, or guaranteed maximum price (GMP). When bound to a GMP, a CMGC’s relationship with the owner has changed, as it manages and construction costs to keep them below the GMP. Additional design advantages to using CMGC over DBB include:

- Early innovation and constructability recommendations
- Significant control over design by the agency
- Fast-tracking early construction components prior to complete design resulting in potential time savings
- Earlier, more accurate cost estimate by the designer

- Design accomplished in priority order by construction needs and budget constraints

Wisely selecting between implementing a DB or CMGC program requires understanding certain general concepts. A change in design philosophy from traditional DBB projects is necessary to successfully implement a DB or CMGC program. Agency design management practices must be adjusted to educate the design community while creating and maintaining a collaborative culture among all participants. Under CMGC, early and continuous value engineering, right-of-way phasing, real-time pricing, and accelerated design may require additional education or shifts in responsibility for full project schedule and budget management. Successful implementation also requires a project be broken up into multiple phases to allow for early starts early product or material procurement, or working around right-of-way (ROW), permitting, or utility relocation challenges.

3 Research Methods

Data were obtained from individuals within and outside state transportation agencies. Although the primary study population was comprised of select DOT officials familiar with their state agency’s design management process, additional individuals were contacted from various local government agencies (e.g., cities, counties, toll and airport authorities, and transit agencies). Also queried were design consultants and CMs (contractors).

The first task was to define a state of practice for the use of DB and CMGC project delivery systems in highway construction. Every state DOT was contacted by telephone and individuals were identified as being most knowledgeable on the agency's design process. A total of 52 state agencies were contacted, including Puerto Rico and the District of Columbia. The team also contacted 13 non-DOT public transportation agencies.

3.1 Level 1 Interviews

An initial set of interview questions was developed to ascertain each agency's recent experience with DB and CMGC delivery systems. This Level 1 Interview Instrument was divided into a telephone portion and an email supplement. The decision to partition the questions was made to improve data acquisition – allowing interviewees sufficient time to gather accurate information concerning specific job details while permitting them to answer principal questions immediately. This division of questions also provided for continued contact with the agencies.

The initial telephone portion asked a series of "Yes/No" questions relating to each agency's awareness of DB and CMGC project delivery systems; if either system had been implemented in their agency; and if so, when the first project was implemented and how many total projects had since been executed. The initial interview also inquired as to the use of "other" innovative project delivery methods (other than DB and CMGC).

The email supplement was submitted as a separate correspondence and was distributed to those agencies having worked with DB and/or CMGC projects (as obtained from the telephone portion). Questions were asked relating to the type of project, location, cost, and any noteworthy information regarding project execution.

An examination of the Level 1 Interviews helped in isolating those agencies that would comprise the pool of Level 2 candidates.

From the data, the researchers established the following criteria in determining whether an agency had demonstrated sufficient experience with either DB or CMGC:

- Recent use of the delivery system (within the last five years)
- Consistent use of the delivery system (more than five projects)
- Potential case study project examples (provided in the supplemental forms or by research member knowledge)

A list of thirteen non-DOT contacts was also compiled from the Level 1 Interviews, the purpose of which was to accurately represent the activities of local government agencies that have implemented, or plan to implement, DB or CMGC on transportation projects outside the realm of state transportation agencies. Level 1 and Level 2 Interviews were conducted on these select agencies.

3.2 Level 2 Interviews

Members of the research team developed a series of in-depth questions that evaluated key aspects of project implementation, scope, quality, and cost, and explored major issues relating to liability and responsibility within the design process. These questions were then compiled by relevance, practical application to post-award design management, and suitability as a telephone/email interview or a Case Study visit.

Agencies (DOT, and non-DOT alike) with especially long-term or otherwise interesting or innovative experience in either DB or CMGC (as obtained from analysis of the Level 1 interviews and supplements) were contacted, again via telephone and email. The telephone portion for these interviews asked a series of "Yes/No", multiple choice, and open-ended questions relating to design management issues (cost and scheduling, risk management, phasing, etc.) as they relate to typical design-bid-build projects. If the

answers warranted further data gathering, an email was sent requesting details.

3.3 Case Study visits

After conducting and evaluating the Level 2 Interviews for all agencies, a list of potential Case Study visits was assembled. Notable agencies and projects were selected and immediate contact information was gathered for key personnel for these projects (e.g., agency personnel, project managers, designers, DB/CM firm agents, and construction managers).

The questions developed for the Case Study visits investigated such issues as the designer selection process, the nature of preconstruction services, subcontractor involvement, value engineering, payment procedures, change order management, and other such issues that could affect successful implementation.

The Case Study interviews were conducted by both Principal Investigators (PI) and were divided in accordance with each PI's specialization: one dedicated to DB-focused programs, the other to CMGC-focused programs.

4 Results

Data from the Level 1 Interviews were compiled into a spreadsheet allowing for comprehensive review of the knowledge and application of DB, CMGC, and "other" alternative delivery systems; the frequency of use of the systems; and first integration within the agency. From the preliminary numbers in Table 1, DB systems are overwhelmingly recognized by DOT agencies, are predominantly used by DOT agencies, and in only a minimal number of circumstances do DOTs (that were previously identified as not having used DB) claim to have no enabling state legislation.

Table 1. Numbers on Knowledge and Use of Design-Build Delivery Systems by Agency.

	DOT of 52 (%)	Non-DOT of 13 (%)
Knowledge:	52 (100%)	11 (85%)
Use:	42 (81%)	9 (69%)
No Legislation:	4 (8%)	

Comparing the DB numbers from Table 1 with the CMGC numbers in Table 2, we see how CMGC project delivery systems are not as universally known by the DOT agencies, are marginally used by the DOT agencies, and half of the DOTs (that were previously identified as not having used CMGC) claim to have no enabling state legislation.

Table 2. Numbers on Knowledge and Use of CMGC Delivery Systems by Agency.

	DOT of 52 (%)	Non-DOT of 13 (%)
Knowledge:	50 (96%)	8 (62%)
Use:	10 (19%)	6 (46%)
No Legislation:	26 (50%)	

5 Findings

Although not all DOT agencies have experience with DB or CMGC design services, some potentially have sound and effective design practices in place that might serve as building blocks for other strategies.

The data supplied from the Level 1 Interviews on the knowledge and use of DB and CMGC in local government agencies do not provide as clear a view as to the popularity or acceptance of either system for transportation projects within the realm of these type agencies.

Although it can be speculated from the Level 1 Interview data how modern legislative authority may have a prominent influence on the acceptance of CMGC project delivery systems – because of the severe restriction on their use – no information is provided with

regards to the relative ease of integration of CMGC projects into modern design management practice.

Future studies can conduct mass surveys on DB/CM firms inquiring as to the relative ease of use between methods. Nonetheless, from any and all studies, accurate comparisons between delivery methods can only be executed with ideal side-by-side comparisons. In order to accurately show superiority of one system over another, identical projects in identical locations, with identical crews and resources would have to be designed under the different delivery methods. And as individual projects lend themselves to case-by-case circumstances, a true evaluation between traditional DBB and innovative systems such as DB, CMR, or CMGC (just to name a few) can never truly be conducted.

6 Summary

Information garnered from the Case Study visits provide the groundwork for identifying practices related to DB and CMGC procurement and contracting that will be most applicable for transportation projects and promote successful outcomes.

Conceptual and relational analysis of the several factors will reveal the significance of each element as well as the different approaches associated with governing design decisions that influence scope, cost and quality. Details of the Case Studies will soon be in the Literature.

Acknowledgments

The authors would like to thank the Transportation Research Board (TRB) and the National Cooperative Highway Research Program (NCHRP) for their continued support in our research endeavors. Extended thanks also go out to all the state and local authorities

who participated in the extensive interview process.

References

Journal Papers

Li, X. X., Minchin, R. E., Issa, R., Evaluation of Project Delivery Systems for Highway Construction, Submitted for Publication to *ASCE Journal of Construction Engineering and Management*, American Society of Civil Engineers, November, 2011.

Strang, W., The Risk in CM "At-Risk", *CM eJournal*, 1-9, 2002.

Reports

Alder, R., *UDOT Construction Manager General Contract (CMGC) Annual Report 2007*, Salt Lake City, UT, 2007.

Alder, R., *Construction Manager General Contract Utah Annual Report 2009*, Salt Lake City, UT, 2010.

Minchin, R. E., Li, X. X., *Performance of Construction Manager-at-Risk for Highway and Bridge Projects in the Southeastern United States*, Balfour Beatty Research Report No. 1, Miami, FL, November, 2011.

NCHRP, *NCHRP Project 20-68A, Scan 07-01: Best Practices in Project Delivery Management*, TRB, Washington, DC, 2009.

NCHRP, *Synthesis 402: Construction Manager-at-Risk Project Delivery for Highway Programs*, TRB, Washington, DC, 2010.

Scott, S., III, *NCHRP Report No. 561: Best-Value Procurement Methods for Highway Construction Projects*, TRB, Washington, DC, 2006.

Acts and Statutes

Brooks Act. Pub L. No. 92-582. 40 U.S.C. § 11101 (1972).

Federal Acquisition Reform Act of 1996 (FARA). Pub L. No.104-106. Div. D (1996).

Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). Pub L. No. 102-240 (1991).

Transportation Equity Act for the 21st Century (TEA-21). Pub L. No.195-178 (1998).