A Synthesis of Fast-Track Highway Construction Delivery in the U.S.

Edward Minchin[1], Lourdes Ptschelinzew[2], Giovanni Migliaccio[3], Umberto Gatti[4], Kenneth Atkins[5], and Gregg Hostetler[6]

Abstract

Fast-tracked construction projects are nothing new. The use, however, of some types of fast-track contracts in certain sectors of the construction industry is new. One example of this is the use of Construction-Manager-at-Risk (CMR) within the highway construction industry in the U.S. Even newer is the similar concept of Construction-Manager-as-General-Contractor (CMGC). The traditional system of design-bid-build (DBB) has been employed by all Departments of Transportation (DOTs) in the U.S. for almost a century. The shift toward design-build (DB) as a time-saving method has been successful in many ways, but use of the system during the past decade has revealed some disadvantages. CMR is a delivery system often employed in vertical construction, and transportation agencies have recently begun to use it for horizontal construction. The fact, though, that fewer than 15 states have used CMR or CMGC to date points to challenges in its use. The biggest challenges are in the areas of construction, design and statutory standing and this paper discusses all three. CMGC cannot legally be used for public transportation construction projects in most U.S. states, but once an agency has decided to pursue the implementation of CMGC, there are certain broad concepts that must be understood. In many cases, this requires a significant and aggressive change in the culture and philosophies of the constructors and designers from traditional DBB design projects. For instance, the standard design methods, schedules, and plan review stages that are frequently used in designing DBB projects, may prove to be inadequate to realize the advantages of CMGC. Designers are required to take a much more active role in working with the owner and constructor during the entire design process, for such things as early and continuous value engineering, right-of-way phasing, real-time pricing, increased coordination meetings, accelerated designs, etc., during the early stages as well as throughout the entire design process. Designers may therefore need to be educated in the process of receiving real-time input

[1] Associate Professor; Rinker School of Building Construction; University of Florida; P.O. Box 115703 Gainsville, FL 32611; minch@ufl.edu.
[2] Ph.D. Student; Rinker School of Building Construction; University of Florida; P.O. Box 115703 Gainsville, FL 32611; gatrgrl@ufl.edu.
[3] Assistant Professor; Department of Construction Management; University of Washington; 120D Architecture Hall, Box 351610, Seattle, WA 98195; gianciro@uw.edu.
[4] Research Associate; Department of Construction Management; University of Washington; 120D Architecture Hall, Box 351610, Seattle, WA 98195; ucg@uw.edu.
[5] Contract Administration & Project Management Engineer; FHWA; 12300 West Dakota Avenue, Suite 340, Lakewood, CO 80228; kenneth.e.atkins@dot.gov.
[6] Principal; Infrastructure Engineers, Inc., 9636 N. May Ave., Ste 200, Oklahoma City, OK 73120; ghostetler@infrastructureengineers.com.

from the constructor, as well as being flexible in modifying standard items such as traffic control plans, to best fit the chosen approach to construction.

Keywords: Fast-track, Project Delivery, Design-Build (DB), Construction-Manager-General-Contractor (CMGC), Accelerated Construction.

1. Introduction

Highway construction projects in the past were procured by way of qualifications-based submissions design and competitive low-bidding construction. This procurement method, commonly known as Design-Bid-Build (DBB), involves the division of the design and construction processes: designers selected on their credentials, construction contractors chosen by lowest bid. With this divided structure and implementation of separate contracts, DBB provides a checks and balances system for both parties involved. Unfortunately, this division limits innovations, results in increased cost and time growth, and promotes hostility between owner, design and construction personnel.

Growing concern with deteriorating infrastructure and population growth have underscored the necessity of highway agencies to expedite key projects from planning, through design, and on to construction in a shorter period of time without the requisite increase in available funding. In an effort to encourage improved quality and efficiency, and as a means to accelerate project delivery, some states have legislated alternative project delivery systems including Design-Build (DB) and Construction-Manager-as-General Contractor (CMGC). DB presents a single point of responsibility and both DB and CMGC underscore innovation, teamwork, and early involvement by the constructor during both design and planning phases.

The successful execution of a DB or CMGC program entails a considerable and aggressive change from the traditional philosophies and cultures associated with DBB project designers. The researchers will examine the varying approaches for managing design decisions and assess the comparative advantages of alternate methods of overseeing key aspects of the design process that influence project cost, quality, and scope.

2. Literature Review

The groundwork of the DBB project delivery system is the practice of choosing designers in accordance with pre-established qualifications (Brooks Act – Public Law 92-582), and choosing contractors from sealed bids, where the lowest responsive and responsible bidder is awarded the contract, typically based on 100% Plans, Specifications and Estimates (PS&E) (Scott 2006). This system has offered taxpayers, over the last few decades, safe, adequate, and efficient transportation facilities while simultaneously preventing partisanship in public contracting. DBB, however, did not always offer the owner the best value for all project types and circumstances.

Growing pressure to accelerate projects and a mounting burden to maintain quality prompted highway agencies to evaluate the use of alternative contracting procedures and

procurement methods. DBB had been the conventional project delivery method for transportation projects in the U.S. from the 1930s until the Intermodal Surface Transportation Efficiency Act of 1991 introduced DB. The Federal Acquisition Reform Act (1996) had sanctioned the use of DB for federal highway projects, and the Transportation Equity Act for the 21st Century (1998) permitted federal funding for state Departments of Transportation (DOTs) to award DB contracts if enabling state legislation was in existence. Consequently, some states passed new codes and legislation to permit the use of alternative project delivery methods.

One obvious drawback to the DB project delivery system is less agency control over design. Because the design-builder often contracts out design services, design management was significantly different from what agencies were previously familiar with under DBB. Further, communication between the agency and the design professional goes through the same design-builder entity, which frequently was a single contractor or a joint venture of contractors.

Transportation agencies are motivated by these concerns to seek alternatives to DBB and DB. Construction-Manager-at-Risk (CMR) and the comparable Construction-Manager-General-Contractor (CMGC) offers accelerated project delivery while permitting the agency to maintain design control. Earlier studies discovered that adding CMGC to the delivery toolbox of a state DOT offered several benefits (NCHRP 2009, 2010). For DOTs, when DBB and DB cannot meet contrasting project objectives, CMGC provides a conservative option. Illustrated by the Utah Department of Transportation (UDOT) in their use of CMGC projects, Figure 1 recommends a project delivery method selection process (Alder 2007, Alder 2010). CMGC was also recognized as "a less radical shift in procurement culture than design-build" (NCHRP 2010, p. 3), and was utilized in prompting change from transportation agencies that had not embraced DB.

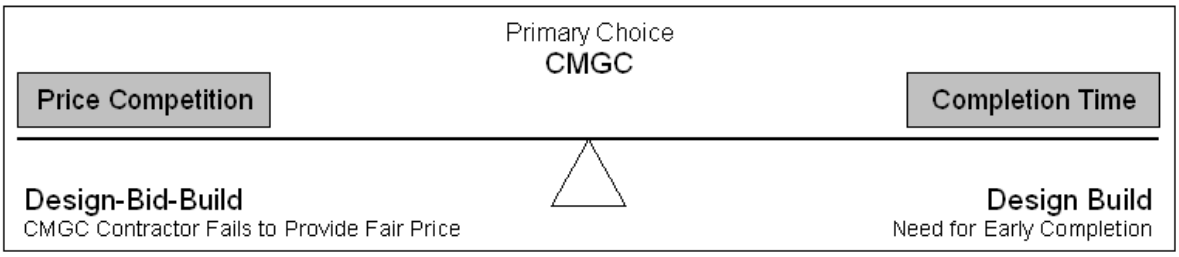

Figure 1: UDOT Balanced Delivery Approach

CMGC employs an integrated team approach, incorporating professional management into the planning, design, and construction phases of a project. Similar to DBB, the owner contracts design and construction separately; however, it is best to retain the construction manager (CM) and design consultant at, or nearly at, the same time by way of a qualifications-based or best-value selection process.

During the pre-construction phase of a project the CM behaves as a consultant. With a pre-construction services contract, the CM aids the owner with constructability reviews, design reviews, estimating, scheduling, and budgeting. The CM may also provide non-standard services including the securing of financing or selection of the design professionals. During

the construction phase of a project, the CM is “at risk” and behaves as a general contactor (GC) would on a DBB project.

Under CMGC, subcontracts may be cost reimbursable, fixed-price, or guaranteed maximum price (GMP). The relationship between the CMGC and owner changes when bound by a GMP, as they now have to manage construction costs below that amount. Further advantages to using CMGC instead of DBB include the following:

- Recommendations for constructability and early use of innovation
- Agency has considerable control over the design
- Construction components are fast-tracked prior to complete design, resulting in potential time savings
- More accurate and earlier cost estimating by the designer
- Budget constraints and construction needs dictate priority order of design

In order to sensibly select between the implementation of a DB or CMGC program, an understanding of general concepts is required. Successful implementation of a DB or CMGC program calls for a change in the design philosophies from the traditional DBB project. To facilitate the education of the design community – while at the same time generating and maintaining collaboration among the participants – the design management practices of the agency must be adjusted. Additional education may be needed in the fields of accelerated design, continuous value engineering, real-time pricing, and right-of-way (ROW) phasing. Shifts in responsibility may also be needed for budget management and full project schedule. Requiring that a project be divided into multiple phases is also key to successful implementation as it allows for the early start of a project, early product or material procurement, permitting, utility relocation, and ROW challenges.

3. Research Methods

Data for the research project were obtained from those within and external to state transportation agencies. The primary sample population consisted of select DOT officials who were familiar with the design management process of their agency. Additional individuals were obtained from local government agencies, including city, county, airport, toll, and transit authorities. Also included in the study population were select design consultants and contractors (CMs).

The primary task for the research team was defining the state of practice in the use of DB and CMGC delivery systems for highway construction projects. State DOT offices were contacted by telephone, and individuals having explicit knowledge regarding the state’s design process were identified. Fifty two state transportation agencies (including the District of Columbia and Puerto Rico) and 13 non-DOT public transportation agencies were contacted, 65 in all.

3.1 Level 1 interviews

A primary set of interview questions was developed as a means to assess each state agency's recent experience with DB and CMGC project delivery methods. The initial set of questions were identified as the Level 1 Interview Instrument and it was separated into a telephone component and an email supplement. Dividing the questions was a means to improve the data acquisition process. Interviewees were able to answer brief, principle questions almost immediately, and they were permitted ample time to gather job-specific details for the more complex queries. Further, the division of questions allowed for a continued level of contact between the interviewers and the state agencies.

The telephone portion of the Level 1 Interview consisted of a series of "Yes/No" questions that related to the agency's familiarity with DB and CMGC project delivery systems. The questions inquired if either system had been implemented within their agency, and if so, what year the first project was executed and how many total projects have since been completed. The research team also inquired into the use of "other" alternative/innovative project delivery systems (besides DB and CMGC).

The email supplement was distributed to state agencies that had prior experience with DB and/or CMGC projects (as determined from the initial telephone portion of the interview). These questions were submitted as a separate correspondence and inquired about the types of projects executed, their locations, final costs, and notable details concerning project execution.

Investigation of the Level 1 Interview responses helped in identifying state agencies as potential candidates for the Level 2 Interview. The data from this primary investigation also provided the researchers a set of criteria to determine if an agency displayed satisfactory experience with DB or CMGC delivery systems:

- Recent application of the project delivery system (i.e., within the past five years)
- Consistent application of the project delivery system (i.e., having completed more than five projects)
- Prospective as a case study example (as determined from their supplementary information or through direct knowledge by a research team member)

In order to accurately represent the construction activities of local government agencies, 13 non-DOT transportation agencies contacts were included in the Level 1 Interviews. These agencies were identified as entities outside the realm of the state DOTs that have either implemented or plan to implement a DB or CMGC project. The research team conducted Level 1 and Level 2 interviews on these non-DOT agencies using the same process as for the DOTs.

3.2 Level 2 interviews

A series of in-depth interview questions were developed by the research team as a means to evaluate key aspects of project scope, implementation, cost, and quality. The questions also investigated strategic issues that related to responsibility and liability within the design process. They were compiled according to their general relevance and appropriateness of delivery (e.g., as a telephone interview, emailed supplement, or case study interview). Also, the questions were geared specifically towards their practical application to post-award design management.

The initial telephone portion of the interviews consisted of “Yes/No”, multiple choice, and open-ended questions that related to specific design management problems including cost and scheduling, risk management, and phasing. The questions compared the agency’s experience with DB/CMGC as they related to typical design-bid-build projects. Email supplements were provided to agencies whose telephone answers warranted further investigation.

3.3 Case studies

A detailed evaluation of the Level 2 interviews produced a list of noteworthy projects or programs that could be investigated with the goal of developing a collection of descriptive case studies that could provide a good cross-section of the current practice on fast-track highway projects in the U.S. Key personnel for these projects or programs were contacted and site visits were scheduled. During the site visits, the authors were able to conduct interviews with project managers, DB/CM firm agents, designers, agency employees, and CMs and to collect project documents and other archival material. This well-rounded approach to data collection provided the authors with a large and redundant amount of information according to guidelines on case study research (Yin 2009).

According to Yin (2009),

these case studies were conducted by through a review of contractual documentation, agency documentation, and archival material; and, interviews with key project participants. On-site iinterviews investigated issues such as designer selection process, value engineering, the nature of the pre-construction services, subcontractor involvement, change order management, payment procedures, and other issues that could potentially influence successful implementation of the project delivery system.

The two Principal Investigators (PIs) for this project conducted the case studies interviews. One of the two PIs conducted the interviews to key personnel on DB projects and the other PI was in charge of interviews to personnel on CMGC programs. The PIs spent from 2-4 days on each location conducting the face-to-face interviews. In rare cases, these site interviews were anticipated or followed by over-the-phone interviews or email communications.

4. Results

4.1 Level 1 interviews

The Level 1 Interview data were compiled into a comprehensive spreadsheet that allowed for a thorough review of the information: familiarity and use of DB, CMGC and "other" (non-DB or CMGC) innovative delivery systems; frequency of use; and year of first execution. Preliminary numbers from the Level 1 Interview, as shown in Table 1, reveal that the DB delivery system is recognized by all state DOT agencies and 85% of non-DOT transportation agencies. The data also show that it is used by most DOTs (81%) and non-DOT transportation agencies (69%), and only 8% of states claimed to have no enabling legislation.

Table 1: Knowledge and Use of Design-Build Project Delivery Systems by Agency

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

Of the DOTs that have employed DB, the earliest use dates back to 1983 (Kentucky). The most recent initial use shows that six states first implemented DB in 2010. Several states introduced the system in the 1990s (11 states) and 2000s (24 states). Looking at non-DOT agencies, the earliest implementation of DB projects was in 2002 and the latest was in 2011. Table 2 shows the progression of DB implementation for both types of transportation agencies.

Table 2: Dates of Implementation of Design-Build Project Delivery Systems by Agency

	DOT Agency total (% of 52, % of 42 using DB)	**Non-DOT Agency total (% of 13, % of 9 using DB)**
1980-1989:	1 (2%, 3%)	
1990-1999:	11 (21%, 26%)	1 (8%, 11%)
2000-2009:	24 (46%, 57%)	6 (36%, 67%)
2010-present:	6 (12%, 14%)	2 (15%, 22%)

For DOT state agencies that have implemented DB, the number of projects each state has completed (or have begun) varies from the single digits to several hundred. At the time the interviews were completed, the following have been documented: three states have completed only one DB project; 22 states have completed between two and 10 projects; eight states have completed between 11 and 20 projects; two states have completed between 21 and 50 projects; two states have completed between 51 and 100 projects; and

four states have completed over 100 DB projects. Looking at non-DOT agencies, the number of projects per agency varies between one and 10. Table 3 shows the number of DB projects executed by both types of transportation agency. The discrepancy in total number of reported DOT agencies using DB projects (42 documented in Table 2 versus 41 reported in Table 3) is due to one agency failing to provide this information by the time of publication.

Table 3: Number of Design-Build Projects Implemented by Agency

	DOT Agency total (% of 52, % of 42 using DB)	**Non-DOT Agency** total (% of 13, % of 9 using DB)
One Project:	3 (6%, 7%)	2 (15%, 22%)
2-10 Projects:	22 (42%, 52%)	7 (54%, 78%)
11-20 Projects:	8 (15%, 19%)	
21-50 Projects:	2 (4%, 5%)	
51-100 Projects:	2 (4%, 5%)	
Over 100 Projects:	4 (8%, 10%)	

Comparing the familiarity and use of DB to that of CMGC in Tables 1 and 4, it is revealed that the CMGC delivery system is not as widely known by state DOT agencies. CMGC is also only marginally utilized, and half of the states claim to have no enabling legislation.

Table 4: Knowledge and Use of CMGC Project Delivery Systems by Agency

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

The implementation of CMGC began much later, with one state DOT first using the system in 2003 and eight others since then (it must be noted that one contact could not recall the exact year of implementation, but they noted their use of CMGC was more recent than the use of DB, and they first implemented DB in the mid-1990s). Looking at non-DOT agencies, the earliest implementation of CMGC projects was in 2000 and the latest was in 2009. Table 5 shows the dates of implementation of CMGC for both types of transportation agency.

Table 5: Dates of Implementation of CMGC Project Delivery Systems by Agency

	DOT Agency total (% of 52, % of 10 using CMGC)	Non-DOT Agency total (% of 13, % of 6 using CMGC)
2000-2009:	6 (12%, 60%)	6 (36%, 100%)
2010-present:	4 (8%, 40%)	

Of the 10 DOT agencies that have used CMGC, the number of projects each state has completed ranges from one to 25, with the vast majority having completed under 13 projects (nine states). Looking at non-DOT agencies, the number of projects per agency varies between one and 12. Table 6 shows the number of CMGC projects executed by both types of transporation agency.

Table 6: Number of CMGC Projects Implemented by Agency

	DOT Agency total (% of 52, % of 10 using CMGC)	Non-DOT Agency total (% of 13, % of 6 using CMGC)
One Project:	3 (6%, 30%)	2 (15%, 33%)
2-10 Projects:	5 (10%, 50%)	3 (23%, 50%)
11-20 Projects:	1 (2%, 10%)	1 (8%, 17%)
Over 25 Projects:	1 (2%, 10%)	

4.2 Level 2 interviews

The Level 2 Interviews were conducted on select DOT and non-DOT agencies whose information from the Level 1 interviews showed proof of either prolonged experience with either DB or CMGC or innovative practice of either delivery system. The questions were divided into three sections: the overall approaches in managing post-award design activities; how the agency's methods affect the cost, schedule, or quality of the project performance; and other issues that affect, or are affected by, design management.

With regards to managing post-award design activities, interviewees were asked to comment on specific issues relating to the role of the DB or CM firm as compared with their experiences with typical (traditional) DBB construction. General queries as to the duties of the design team, if coordination processes vary, the level of project management, and if possible to design during "mini phases".

Specific methods affecting the project quality, cost, and schedule are addressed by identifying the occurrence of notable inspection, budget, and delay issues. An agency's approach in responsible and consistent project monitoring was key in amending and averting post-award design conflicts. Constructability reviews and the flexibility in implementing changes, whether in design, construction, or material methods, were markers for successful project administration.

Other observations by interviewees dealt with overall design management. These issues include the following:

- Education and training
- Culture and philosophy
- Industry collaboration

Supplemental interviews conducted with Level 2 interviewees dealt with design management practices, and opinion-based responses addressing perceived problems and noted solutions. Questions were geared towards defining the roles of designers, managing changes and omissions, design and construction costs, and level of risk for the designer/contractor.

4.3 Case studies

Case studies were conducted by reviewing project related documentation (e.g., contractual documents) and interviewing face-to-face project participants. The interview questions were divided into the same three categories as those established from the Level 2 interviews. The interviewees gathered provided varied points of view ranging from the owner and design entity to the project contractor. Interviews lasted an average of 90 minutes.

Those interviewed were asked to comment on matters regarding the percentage of plans completion and noteworthy milestones, including pricing the first GMP, right-of-way acquisition, and bringing in key personnel. Questions were geared towards the following topics:

- Relationship among participants
- Public involvement
- Communication and training
- Allowances for innovation
- Variances in design, versus DBB

Of note is the inconsistent use of project delivery methods between state agencies. In a few instances, it was made apparent that state agencies have varied definitions for the DB and CMGC project delivery systems. Some states claimed to perform DB, but in actuality they used a more modified version. Other states actually performed CMR while asserting they used CMGC.

5. Summary

The transition from the traditional Design-Bid-Build process to the more fast-tracked methods of Design-Build and Construction-Manager-as-General-Contractor has been a steady one. The decreased time and cost growth associated with both of these delivery methods has garnered popularity among transportation agencies that are progressively in search of ways to increase innovation and teamwork. DB has made its way into the mindsets and legislation of the vast majority of transportation agencies, and CMGC is securing its foothold as an innovative alternative. Not surprisingly, of the few states that have implemented CMGC all have prior experience with DB – as the latter lends itself to the easy transition of the former. This also lends credence to the finding that CMGC finds favour with agencies because it returns control of the design process to the owner.

Earlier and more active roles taken upon by the constructor under the DB and CMGC systems provide for projects with added value engineering and improved coordination. The increased control in design associated with CMGC also attracts participants.

Data obtained from the case studies, and supplemented by the Level 1 and Level 2 Interview Instruments, provide a view of the key tasks that affect overall project cost, quality, and scope. Approaching the interviews from the design and contractor points of view has revealed the relationship between design elements and perceived issues.

Changes in educational practices and cultural philosophies are integral processes in the proper management of post-award design activities. Education and training of personnel were also shown as fundamental necessities in properly managing innovative delivery systems.

Fast-tracking critical projects from the planning phase through construction is an ongoing effort and constant objective for progressive transportation agencies. Efforts to lower costs, while increasing job efficiency and delivery, are the current trend in highway construction.

References

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

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

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).

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

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

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

Strang W (2002) “The Risk in CM ‘At-Risk’ ”, *CM eJournal*, 1-9.

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

Yin R K (2009) Case Study Research, Design and Methods, 4th ed., Thousand Oaks, Sage Publications.