Case Studies in Innovative Quality Assurance Methods for Alternative Delivery Projects

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ABSTRACT
This paper presents the results of a multiple-case study, designed to explore, reveal, and consider evolving techniques used for managing quality assurance systems, especially in cases of alternative forms of delivery, such as construction manager/general contractor (CMGC), Design-Build (DB), and Public Private Partnerships (PPP) forms. The study discovered many notable quality assurance methods, including methods that take advantage of design-phase contractor involvement and methods that respond to the increasing use of non-agency designers.

The study of ten distinct projects that cross four different project delivery methods found eighteen notable quality assurance methods that generally are not applied in the traditional Design-Bid-Build (DBB) form of contracting. These methods exist in both the pre-award and post-award phases of the projects, and several of the methods were found to be used on more than one form of project delivery. These innovative quality assurance methods may be viewed as tools that a project manager should consider when developing a whole quality assurance system on either a traditional DBB project or on a project that uses one of the alternative forms of contracting. Or—these methods may be used as starting points for further quality assurance innovations.
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INTRODUCTION

Increased Use Of Alternative Delivery Systems

In the past decade, transportation agency procurement programs have matured and various forms of project delivery have been institutionalized and now are viewed as available tools in the typical agency’s procurement toolbox (Trauner Consulting Services, 2007). Miller et al. (2000) suggested that “simultaneous use of multiple project delivery methods” have become the “new paradigm.” It is observed that many project delivery methods are used in highway construction throughout the United States, including the “traditional” Design-Bid-Build (DBB), Construction Management/General Contracting (CMGC), Design-Build (DB) and Public-Private Partnerships (PPP); there are other forms of these major categories, of course, and these forms have been called by alternate names. The guiding observation among these forms, however, is that the organizations that own, design, and construct major transportation facilities are no longer necessarily separate, but these roles may exist in any combination within any one organization. Further, the involvement of constructors no longer necessarily occurs after completion of design; rather, constructors are increasingly becoming involved in providing input during the design phase. These changes are causing a shifting of responsibilities and liabilities across all phases of project development and beyond.

As noted by Gransberg et al. (2008), it is useful to understand how agencies that are using non-“traditional” project delivery forms are approaching quality assurance on their projects. The purpose of this set of case studies is to explore the emerging state-of-the practice regarding quality assurance as implemented in projects delivered using alternative project delivery methods. The salient question to be answered is: What quality assurance tools, techniques and methods are currently in use on alternative project delivery methods for highway design and construction?

METHODS

The case studies presented in this paper represent some of the information sources used for a larger, in-process NCHRP 10-83 research project. The case studies followed principles set out by Yin (2003) and included a formal case study protocol. The case study methodology emphasized gathering both unique information as well as common, readily comparable details from each. The final approach, after adjustment based on lessons learned from three pilot case studies, utilized questionnaires and open interviews of each project participant, generating information that provide for comparison among the case studies. The interviews clarified uncertain questionnaire answers, investigated differing opinions, and most importantly focused on unique and innovative aspects of the project and notable quality assurance methods. A key to the successful completion of these case studies was identifying and securing the support of a champion for the research effort. Since participants from the owner, designer, builder, and program manager were not compensated for their time, the assistance of an enthusiastic project participant was crucial in securing the support of the remaining participants.

In addition to the personal and professional knowledge provided by the participants, project documents were solicited for each case study to provide yet another source for analysis and investigation. These documents included project contracts, quality management/assurance
plans, quality control plans, and other assorted quality-focused documents. Combining these three sources of information – questionnaires, interviews, and documents – allowed researchers to conduct a rigorous analysis and to generate important findings.

**CASE STUDY DEMOGRAPHICS**
The primary criterion for the selection of case studies was that they make use of some form of alternative quality assurance, and that they span across most common forms of alternative project delivery. Further, to improve the value of the information discovered, a concerted effort was made to reach out to transportation agencies that were mature in their use of the particular delivery method when possible and that were somewhat geographically dispersed. Finally, a transit project and an Army Corps of Engineers project were included to provide a broader perspective. TABLE 1 displays a list of the case studies examined along with the agency that owns the project, the approximate size of the project, the delivery method used, and the type of construction.

**TABLE 1 - List of case studies**

<table>
<thead>
<tr>
<th>#</th>
<th>Agency</th>
<th>State</th>
<th>Size</th>
<th>Delivery Method</th>
<th>Project Name</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>WSDOT</td>
<td>WA</td>
<td>$18 M</td>
<td>DBB</td>
<td>George Sellar Bridge</td>
<td>Bridge</td>
</tr>
<tr>
<td>2</td>
<td>ODOT</td>
<td>OR</td>
<td>$135 M</td>
<td>CMGC</td>
<td>Willamette River Bridge</td>
<td>Bridge</td>
</tr>
<tr>
<td>3</td>
<td>TriMet</td>
<td>OR</td>
<td>$113 M</td>
<td>CMGC</td>
<td>Portland Transit Mall</td>
<td>Transit</td>
</tr>
<tr>
<td>4</td>
<td>USACE</td>
<td>KS</td>
<td>$175 M</td>
<td>CMGC (ECI)</td>
<td>Tuttle Creek Dam</td>
<td>Dam</td>
</tr>
<tr>
<td>5</td>
<td>UDOT</td>
<td>UT</td>
<td>$730 M</td>
<td>CMGC</td>
<td>Mountain View Corridor</td>
<td>Highway</td>
</tr>
<tr>
<td>6</td>
<td>CDOT</td>
<td>CO</td>
<td>$29.5 M</td>
<td>DB</td>
<td>U.S. 160 4th Lane Addition</td>
<td>Highway</td>
</tr>
<tr>
<td>7</td>
<td>UDOT</td>
<td>UT</td>
<td>$135 M</td>
<td>DB</td>
<td>I-15 Widening-Beck Street</td>
<td>Highway</td>
</tr>
<tr>
<td>8</td>
<td>MnDOT</td>
<td>MN</td>
<td>$120 M</td>
<td>DB</td>
<td>Hastings River Bridge</td>
<td>Bridge</td>
</tr>
<tr>
<td>9</td>
<td>FDOT</td>
<td>FL</td>
<td>$1.2 B</td>
<td>PPP</td>
<td>I-595 Express Corridor</td>
<td>Highway</td>
</tr>
<tr>
<td>10</td>
<td>TxDOT</td>
<td>TX</td>
<td>$1.5 B</td>
<td>PPP</td>
<td>SH 130 Turnpike Extension</td>
<td>Highway</td>
</tr>
</tbody>
</table>

The resulting list of case studies includes:
- One dam project;
- One transit project;
- Three bridge projects;
- Five highway projects;
- Eight states represented;
- $3.8 billion in construction represented;
- One DBB project, utilizing an external constructability review in the design process;
- Four CMGC (or U.S. Army Corps of Engineers equivalent) projects;
- Three DB projects; and
- Two PPP projects.

**CASE STUDY RESULTS**
The following are descriptions of the ten case studies examined for the research project noted above and a discussion of the notable quality assurance methods identified from each project. These methods are important project-proven tools that could be incorporated into a quality assurance system for the form of project delivery noted, or potentially for any form of project delivery.
delivery. Note that, among the methods discovered in these case studies, many of the methods occurred in more than one form of project delivery. A complete list of these methods, considered as quality assurance tools, is found in the next section in TABLE 2.

The case studies that follow are organized in four categories of project delivery, each with successively increased involvement of a non-agency designer and/or design-phase constructor involvement:

- Design-Bid-Build with Design-phase External Contractor Input;
- Construction Manager/General Contractor (CMGC);
- Design-Build; and
- Public-Private Partnerships (PPP).

**Design-Bid-Build Project with Design-phase External Contractor Input**

*George Sellar Bridge, Washington*

**Scope** The primary focus of the George Sellar Bridge project was to add an additional eastbound lane to the George Sellar Bridge near Wenatchee, WA in order to substantially increase its capacity. To do so, sidewalks on either side of the roadway were removed and the bridge deck was expanded from 54 ft. to 61 ft. wide using the new space. The new configuration accommodates five 11 ft. wide lanes and a narrow median and shoulders and added a 10’ wide cantilevered pedestrian and bike pathway to the south side of the bridge. Additional work included construction of a tunnel through the East side approach to accommodate a new recreational trail and significant strengthening of 100 truss members and modification of the parabolic portals at either end of the bridge. The project utilized a DBB delivery method and a best-value procurement process to select the general contractor.

**Notable Quality Assurance Methods** The project made use of *External Contractor Input* in the form of a joint AGC/Washington DOT (WSDOT) structural design panel. This standing committee of rotating members is one of several topic-specific committees that meets on a regular basis and is open to review designs or concepts at the request of a WSDOT project manager. The panel responds to previously submitted questions or concerns and allows designers free-reign to ask questions of practicing constructors. Contractors on the panel are allowed to bid on projects they’ve reviewed, as the meetings are open to the public and the minutes are posted online.

The second tool identified on this project was the use of a *Pre-Bid Meeting with Specific Focus On Quality*. At the meeting, project designers from WSDOT’s bridge engineering department were on hand to answer questions from contractors interested in bidding on the project. While the meeting was open to the public and bidders were not required to attend, the winning bidder indicated that the meeting was extremely useful in preparing its bid and clarifying the intent of the designers.
Discussion  External contractor review of designs can be an important tool used by transportation agencies to not only reduce design errors, but also improve the overall quality of the plans produced for their projects. While many agencies utilize internal design reviews to consider constructability issues, input from practicing construction professionals, with current knowledge of available equipment and local conditions, is often more valuable. Pre-bid meetings like the one used here—or portions of broader meetings focused on quality—provide interested parties an opportunity to ask clarifying questions of an owner’s design team and project managers. Such meetings are designed to reduce or eliminate confusion during the bidding process in order to receive more accurate and responsive bids that have adequately considered all of the key project issues and quality concerns.

Construction Manager/General Contractor Projects

Willamette River Bridge, Oregon

Scope  The project comprised the construction of two 1800+ ft. long concrete deck arch bridges capable of carrying three lanes of traffic, requiring construction of the first bridge, demolition of an existing temporary bridge, and construction of the second bridge. In addition, the project included the replacement of the nearby 100 ft. long Canoe Canal Bridges, realignment and grading work along I-5 to match the new bridges, and construction of sound walls, associated pedestrian trails, and extensive public artwork. The project was conducted above an active railroad corridor, a key thoroughfare, and pedestrian trails.

Notable Quality Assurance Methods  On the Willamette River Bridge project, the CMGC contract allowed use of a Best Value Procurement for Sub-Contractors, allowing the general contractor (with agency approval) to retain their rebar sub-contractor from the first bridge for construction of the second bridge, without the need to go through another bidding process. The main bridges of the project were iconic in nature and contained very complex rebar geometries requiring exceptionally tight tolerances to construct.

  Formal Partnering with Regulatory Agencies was crucial to the timely start of this project due to the number of agencies (fourteen) involved with permits for the project. An offshoot of the CMGC process, this technique involved direct meetings between the contractor (in a construction manager’s role at that point), ODOT, and the various regulatory agencies.

  ODOT encouraged Contractor Involvement in Establishment and Streamlining of Quality Control Standards. In two key instances, the contractor (acting as a construction manager) recommended revised quality control standards to better meet the specific needs of the project. For example, while development plans called for the use of hot-mixed asphaltic cement (HMAC) for the surrounding park paths, ODOT’s manual of quality control standards and tests only provided for interstate highway applications. The contractor recommended adopting the standards of local park agencies instead and ended up saving significant time and money in unnecessary quality control testing.
**Discussion** On projects where the general contractor, design-builder, or CMGC is procured using methods other than low-bid, many contracts require the sub-contractors to be procured using a low-bid method to ensure the lowest possible cost to the agency/owner. In this case, if the general contractor was forced to utilize a low-bid process for the rebar contractor on the second bridge, they may have ended up with a different sub-contractor, potentially resulting in the loss of a sub-contractor with a demonstrated commitment to exceptional quality and a resetting of the difficult learning curve overcome on the first bridge. As an open-book project, ODOT was still able to verify that the general contractor was seeking multiple bids for sub-contracted work and could request an explanation for the subcontract award decision if ODOT was concerned that the balance of cost/quality was not favorable to the agency.

Through the use of formal partnering—which included the contractor—with regulatory agencies, permits were received more quickly and regulatory agencies were more fully satisfied as they received *actual* construction means and methods rather than the best guesses of the designer.

Involving the contractor in establishment of the quality control plan may provide for streamlined and more efficient quality control standards or techniques that are fine-tuned to the project at hand. Where such standards are defined before receipt of final cost proposals (as in the case of CMGC), the agency has more flexibility to evaluate suggested changes without the administrative and potentially costly process of using a change order to establish the changes. In the case of a Design-Bid-Build project, such streamlined quality control opportunities may never even be exposed.

*Portland Transit Mall Revitalization, Oregon*

**Scope** The Portland Transit Mall revitalization project case study dealt with the installation of the light rail line along the full length of the Portland Transit Mall; the project was managed by the TriMet transit agency. The project allowed for simultaneous operation of an extensive bus and light rail transit system along the same corridor from Portland’s Union Station south to Interstate 405.

**Notable Quality Assurance Methods** TriMet allowed *Contractor-Controlled QC Testing*. TriMet’s willingness to do this was based in part on the reputations for quality and integrity of both parties in the construction contracting joint venture and in part on their requirement that all inspectors and technicians be nationally certified to perform their field inspections.

*Electronic Collection and Reporting of Quality Control System* to TriMet’s resident engineer streamlined the reporting process and provided easy access to a searchable database of reports to consult as needed including field reports and laboratory testing results.

**Discussion** The decision to allow contractor-managed quality control saved the contractor money and streamlined the scheduling process by removing the inherent scheduling complications that occur when dealing with an independent firm.

Quality control inspectors from the general contractor were equipped with electronic recording devices and very comprehensive checklists to complete their daily inspections and reports. The extensive checklists ensured that multiple features of every item of work were physically checked and attested to in the daily reports before being listed as complete.
Tuttle Creek Dam Safety Assurance Project, Kansas

Scope The Tuttle Creek Dam Safety Assurance Project, owned by the U.S. Army Corps of Engineers (USACE) was the largest ground modification project on an active dam that has ever been performed. The CMGC base contract for Ground Modification was awarded in 2005, a contract to provide structural reinforcement and bearing rehabilitation on the 18 Spillway Tainter Gates was awarded in 2007, and the wire ropes for the Tainter Gates will be replaced in 2011 and 2012. The project included the stabilization of the downstream foundation with bentonite slurry walls, installation of an upstream riprap overlay, construction of a relief well buried collector system, and substantial spillway rehabilitation.

Notable Quality Assurance Methods The USACE utilized External Contractor Input in a standardized process that it calls Agency Technical Review (ATR), which provides for a critical examination of the project during the design phase. In addition to the construction knowledge provided by the CMGC during the preconstruction phase, the project also made use of an advisory panel during design development; both of which, while focused on constructability issues, were very much a part of the overall quality assurance effort on the project.

The USACE used its own Electronic Collection and Reporting of Quality Control System, known as the Resident Management System (RMS), on this project. This system automates document submittal and control and it allows for the creation of reports that are tailored for the project, office, fund type, and customer as required.

Discussion As mentioned earlier, external contractor input provides valuable insight that prevents costly changes due to constructability conflicts, and raises helpful value engineering suggestions that may be incorporated into the design before finalization of construction pricing. The further focus on external technical design review enhances the solidity of the end product.

The USACE’s Resident Management System is useful beyond just the quality control focus; custom reports can be created by utilizing data elements such as administration details, finances, quality audits and testing results, submittals, and project schedules.

Mountain View Corridor Project, Utah

Scope The Mountain View Corridor (MVC) is a planned highway, transit-way, and trail system in western Salt Lake and northwestern Utah Counties that will serve 13 municipalities. The initial build-out considered for this case study focused on the construction of two lanes of divided highway in each direction with at-grade intersections, requiring extensive grading, excavation, utilities relocation, and associated trails, bridges, and structures. The MVC project included a large number of stakeholders and construction types spread over 10 miles of construction, with a diverse set of goals.

Notable Quality Assurance Methods Cooperative Constructor/Agency Goal Setting was used as an opportunity for UDOT to review its goals for the project and to ensure that the general contractor fully understood them. It also provided the general contractor an opportunity to recommend to UDOT ways to achieve the goals that had not previously been considered.

The project also made use of Quality Management Training for the Project Team specific to the project. While many personnel involved with quality management roles receive broad-
based training applicable to many different projects, these training sessions were designed around the particular needs of the Mountain View Corridor.

Discussion The primary benefit to the quality of the project was in making sure the owner and contractor were in alignment with their expectations both for the project as a whole and specifically for the quality of the project to avoid future conflicts or misunderstandings. These sessions are similar to a formal partnering process. Additionally, quality management training is useful to emphasize to the project team the importance of quality, facilitate the exchange of quality-related information among project participants, reduce non-compliance issues, and ensure that all personnel understand how the project Quality Control Plan will be carried out in the context of their particular roles and responsibilities.

Design-Build Projects

U.S. 160 4th Lane Addition, Colorado

Scope The expansion of U.S. 160 near Durango, CO was overseen by the Colorado DOT (CDOT) and included the design and construction of four bridges across U.S. 160 in mountainous and environmentally-sensitive terrain in order to facilitate the construction of a 4th lane of travel for the highway.

Notable Quality Assurance Methods CDOT provided an Agency Independent Design Review for the project, which required a full-time CDOT staff member to fill the review role. Due to budget constraints, CDOT was forced to remove this requirement and instead performed these design reviews, or over-the-shoulder reviews, itself.

Discussion CDOT’s provision of the independent design review by the agency itself saved the agency $150,000-$200,000 in monitoring costs. While the agency had originally contemplated the use of a third-party independent reviewer, the arrangement ended up working and satisfying CDOT.

I-15 Widening, Beck Street Project, Utah

Scope The widening of Interstate 15 by UDOT called for the design, reconstruction, and widening of the mainline highway to include an express lane and three general purpose lanes in each direction, requiring the rapid replacement of two nearby bridges as well as the standard replacement of the Beck Street bridge over the highway.

Notable Quality Assurance Methods UDOT used a Quality-Based Selection System for the design-build team and its subcontractors, including a quality component in its best-value procurement process. UDOT developed a set of quality requirements it was seeking from the proposing teams, included them in the RFP, and then added a corresponding category to its scoring process.

Alternative Technical Concepts (ATCs) were allowed to be included in the DB proposals. An ATC is a suggested alternative to some component of a project that will deliver a higher level of quality or performance. The agency only responded to the ATCs with acceptance, rejection, or a qualified rejection (the ATC was not acceptable, but might be if certain aspects of it were changed).
UDOT used a one-on-one **Pre-Bid Meeting with Specific Focus On Quality** during procurement to discuss alternative quality assurance methods. The meetings were conducted by UDOT with each proposing team to clarify any confusion surrounding the RFP and to respond to questions regarding a proposing team’s ATC(s). Participation in these meetings by proposers was mandatory and the agency reserved the right to share issues discussed during the meetings with other proposers provided they did not impair the confidentiality of a proposer’s ATC(s) or proprietary business strategies.

Additionally, UDOT used a **Quality-Focused Incentive Program**; the pool of money available for incentives was fixed at the beginning of the project and was not to be added to in the case of cost increases but could be reduced in the case of cost reductions.

**Discussion**  On standard DBB projects using low-bid procurement, the contractor is selected on the basis of price only. By using the quality-based selection system, the agency was able to explicitly consider a proposing team’s commitment to quality and was able to convey the importance the agency placed on quality to proposers.

For the alternative design concepts, the process allowed competing teams to present their ideas for innovation to UDOT prior to submitting them in their proposal, to determine if they were acceptable or not. The process encouraged quality innovation by removing the uncertainty whether an innovative idea would be accepted by the agency or not.

UDOTs one-on-one pre-bid quality meetings helped to discover areas of possible misunderstanding or ambiguity and clear them up prior to the submittal of proposals or the selection of a winner at which time a change order would be required to resolve them.

While incentive based programs related to project schedules are often used, ones related to quality are not. The program was designed to reward consistent, excellent achievement of technical specifications, workmanship, and administrative requirements related to quality. Individual criteria were developed for portions of the funding pool and weighted to encourage focus on project aspects most important to the agency.

**Hastings Bridge Project, Minnesota**

**Scope**  The key component of the Minnesota DOT (MnDOT) Hastings Bridge project was the construction of a four-lane bridge over the Mississippi River near the city of Hastings, MN, including the removal of an existing two-lane bridge and construction of approaches.

**Notable Quality Assurance Methods**  MnDOT defined an **Alternative Technical Concepts** (ATCs) approach in the DB RFP to solicit innovative approaches from proposers, specifically focused on geotechnical issues. After reviewing all the submitted concepts, MnDOT informed proposers whether they would be allowed to include the ATCs in their proposal and was careful not to share any of the details with other proposing teams. The use of this process is estimated to have saved the project $100 million.

The project also utilized an **Agency Independent Design Review**, which mainly assessed whether the requirements and design criteria of the contract documents were being followed and whether the contractor’s design quality management plan activities were being undertaken in accordance with the approved Quality Manual for the project. The primary purpose of this process is to improve the quality of design documents that later translate into the construction of a higher quality project.
MnDOT also used In-Progress Design Workshops; throughout the design process, either the design-build team or MnDOT could request in-progress design workshops to discuss and verify design progress and to assist the contractor and/or its designer(s) in resolving design questions and issues.

**Discipline Task Forces**—groups of individuals focused on a single discipline—were used to ensure coordination occurred across the various disciplines of the project.

The use of a Quality-Focused Disincentive Program for a lack of satisfactory progress in responding to documented issues of non-complying work called for $100/hour charges to the contractor for failing to correct such work unless corrected within one hour of receiving notification from MnDOT.

**Discussion** The provision for allowing alternative design concepts is powerful, but may place a burden on proposers if they spend valuable time and resources developing a concept that may be rejected. Providing for pre-approval reduces the proposers’ risk and creates a more conducive environment for innovation. Agency involvement in design review and concept concurrence provides the project with an efficient method for transfer of agency knowledge to the designers and potentially preventing erroneous assumptions or errors from reaching the construction stage. While the regular meetings of the discipline task forces were useful, the coordination after the meetings among the various disciplines was particularly useful for ensuring consistency and cooperation. Examples of these task forces include groups focused on roadway, drainage, structures, traffic control, geotechnical design, and quality among others. The financial disincentive clause ensured a prompt and focused response from the design-build team in addressing non-compliance issues rather than allowing them to linger or grow.

**Public-Private-Partnership Projects**

**I-595 Express Corridor Improvements Project, Florida**

**Scope** The I-595 Express Corridor Improvements project in Broward County, FL consisted of the reconstruction of the I-595 mainline and all associated improvements to frontage roads and ramps from the I-75/Sawgrass Expressway interchange to the I-595/I-95 interchange, along I-595 (10.5 miles) and along the Florida Turnpike (2.5 miles). The construction included three reversible, express toll lanes; the addition of auxiliary lanes on I-595; widening of the turnpike; construction of sound barriers; and the expansion of a regional greenway system.

**Notable Quality Assurance Methods** This project made use of a Quality-Based Selection System, which required the qualifications of the design and construction quality managers in addition to the rest of their quality management staff as a part of their proposal. Also required were descriptions or full copies of proposed quality management plans for both design and construction of the project, which was factored into the award decision.

The Express Corridor Improvements project also made use of a Cooperative Constructor/Agency Goal Setting, which included formal partnering. These meetings ensured that the Florida DOT’s (FDOT) vision for the project was matched and in agreement with the concessionaire’s plans and understanding of the project.

The project utilized a custom Electronic Collection and Reporting of Quality Control System, project management, and communications system. As with other projects utilizing a similar system, this system collected, organized, and stored quality control testing results and...
inspection checklists, generated reports, and streamlined communication among project participants.

FDOT required the use of Dual Construction Engineering Inspection/Inspector (CEI) Roles on this project. The primary CEI firm was hired by the concessionaire as an independent entity to inspect, test, and verify the quality of the product put in place by the concessionaire on a day-to-day basis. In addition, the agency retained the services of an oversight construction engineering inspector (OCEI) whose job it was to perform verification testing and statistical sampling of the CEI’s results.

The concessionaire held ISO 9000 Training Sessions with the 160+ subcontractors working on the project to help make them a part of and broaden their understanding of the overall quality assurance system for the project.

Discussion On a complex project such as this, clarifying and aligning goals among the various project parties is crucial. A cooperative constructor/agency goal setting process, like partnering, provides an opportunity to develop the positive working relationship needed to successfully deliver a project of this size without excessive conflict. As discussed earlier, electronic data and collection systems helps to correlate quality information with other important project systems, such as scheduling, change management, and payment systems. The use of dual CEI roles freed up agency resources for other projects and left primary control of quality assurance in the hands of the concessionaire.

The concessionaire selected for this project had little knowledge or experience with local subcontractors in the area and had little information regarding their quality assurance training or practices. The concessionaire had team members with significant international experience with ISO 9000 requirements provide subcontractor training. While these ISO 9000 trainings weren’t required and the project was not certified as ISO 9000 compliant (nor was it required to be), the interaction between the concessionaire and the subcontractors significantly increased the subcontractors’ knowledge of the PPP process and general ISO 9000 principles to be followed on the project and help develop the crucial working relationship between the two parties.

SH 130 Turnpike Project, Texas

Scope The Texas DOT (TxDOT) State Highway (SH) 130 Turnpike project was a new toll-way extending 49 miles from IH-35 US Highway 183 southeast of Austin, TX, including construction of a four-lane controlled-access toll-way as an eastern bypass to the city of Austin, TX, and up to 15 years of maintenance (if requested by TxDOT).

Notable Quality Assurance Methods The project used External Contractor Input for review of the project’s RFP that focused on quality assurance and quality control issues in addition to risk identification. TxDOT released draft versions of the RFP to previously short-listed firms (on the basis of their qualifications); received written comments, concerns, and suggestions from those firms; scheduled one-on-one meetings to discuss any issues; and finally issued a revised RFP for firms to respond to. This process was then repeated and on other projects may require between two and four rounds of meetings to develop a fully-detailed RFP.

The method of Co-Locating Quality Assurance Personnel in a single, central location for the duration of the project provided for close coordination and efficiency. Because the project was so spread out, it was vital to have a central meeting place, out of which all the quality assurance personnel worked.
This project also made use of an *Electronic Collection and Reporting of Quality Control System*, a part of an extensive, well-developed electronic data management system known as the Electronic Laboratory Verification Information System (ELVIS), a set of web-based data management and engineering analysis tools originally developed to process material testing data and electronically transmit them to TxDOT for statistical validation. To meet the project needs, the electronic quality control system was further expanded to support construction inspection reporting and to manage pavement surface ride quality.

**Discussion** On a project of this magnitude, focusing and streamlining the quality assurance for this project through alternative suggestions by the concessionaires was very important in keeping quality assurance activities running and holding down costs. Further, the co-location of quality assurance personnel was enhanced by the co-location of other staff as well; the use of this technique concentrated project resources, increased communication, improved overall project quality, and resulted in a more efficient quality assurance program. The electronic collection and reporting system served as a secure, real-time, common information-sharing platform among a broad constituency of users, including managers, engineers, QC technicians and inspectors, superintendents, and designers.

**CASE STUDY SUMMARY**

The case studies discussed in this paper provide valuable insights regarding the development of alternative quality assurance systems across the transportation industry, systems which take into consideration the conditions of alternative delivery methods and the resulting changes to traditional methods. Key components of those systems are the *Notable Quality Assurance Methods*, which may be used as tools for a quality manager when developing and implementing a quality assurance system on a future project. The tools identified in each of the case studies above are summarized in TABLE 2. Refer to TABLE 1, above, for the key to the reference numbers listed under the column “Projects” in TABLE 2. More detail is found by referencing the project noted in the section above and by consulting the summary description of the project and the tool in the subheading *Notable Quality Assurance Methods*.

The tools have been divided into two major categories: first, those instituted prior to the award of contracts (design, construction, or otherwise)—these tools primarily ensure clarity in the procurement process, convey a quality-focused message during procurement, and modify project or quality requirements when it is prudent to do so and helps better achieve the owner’s goals. Second are those tools used after the award, which are focused on improving the quality of design documents, improving the working relationships and exchange of information, improving the day-to-day process of quality control, and establishing a common foundation for quality training. Most of these post-award tools are focused on proactively improving the level of quality built into a project rather than retroactively measuring the quality of installed work.

It should be noted that the tools presented in this paper are not intended to stand alone; they do not represent a fully implementable quality assurance system. Rather, they are intended to supplement and expand upon existing systems that a project manager may already use and may be used in a variety of combinations. It is hoped that some of these tools will spark creative thought and may be used to improve current quality assurance systems.
TABLE 2 – Emerging tools for alternative quality management systems

<table>
<thead>
<tr>
<th>Pre-Award Tools</th>
<th>Delivery Method</th>
<th>Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>External Contractor Input</td>
<td>DBB, CMGC, PPP</td>
<td>1, 4, 9, 10</td>
</tr>
<tr>
<td>Pre-Bid Meeting with Specific Focus On Quality</td>
<td>DBB, DB</td>
<td>1, 7</td>
</tr>
<tr>
<td>Alternative Technical Concepts</td>
<td>DB</td>
<td>7, 8</td>
</tr>
<tr>
<td>Quality-Based Selection System</td>
<td>CMGC, PPP</td>
<td>7, 9</td>
</tr>
<tr>
<td>Contractor Involvement in Establishment and Streamlining of Quality Control Standards</td>
<td>CMGC</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Post-Award Tools</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Agency Independent Design Review</td>
<td>DB</td>
<td>6, 8</td>
</tr>
<tr>
<td>In-Progress Design Workshops</td>
<td>DB</td>
<td>8</td>
</tr>
<tr>
<td>Discipline Task Forces</td>
<td>DB</td>
<td>8</td>
</tr>
<tr>
<td>Formal Partnering with Regulatory Agencies</td>
<td>CMGC</td>
<td>2</td>
</tr>
<tr>
<td>Cooperative Contractor/Agency Goal Setting</td>
<td>CMGC, PPP</td>
<td>5, 9</td>
</tr>
<tr>
<td>Co-Locating Quality Assurance Personnel</td>
<td>PPP</td>
<td>10</td>
</tr>
<tr>
<td>Best Value Procurement for Sub-Contractors</td>
<td>CMGC</td>
<td>2</td>
</tr>
<tr>
<td>Dual Construction Engineering Inspection/Inspector (CEI) Roles</td>
<td>PPP</td>
<td>9</td>
</tr>
<tr>
<td>Electronic Collection and Reporting of Quality Control System</td>
<td>CMGC, PPP</td>
<td>3, 4, 9, 10</td>
</tr>
<tr>
<td>Quality-Focused Incentive/Disincentive Program</td>
<td>DB</td>
<td>7, 8</td>
</tr>
<tr>
<td>Contractor-Controlled QC Testing</td>
<td>CMGC</td>
<td>3</td>
</tr>
<tr>
<td>ISO 9000 Training Sessions</td>
<td>PPP</td>
<td>9</td>
</tr>
<tr>
<td>Quality Management Training for the Project Team</td>
<td>CMGC</td>
<td>5</td>
</tr>
</tbody>
</table>

As a practical matter, the practicing project professional should first determine the type of project delivery system that is both allowable by regulation and by organizational practice. Then, when developing the quality assurance system for the project, the tools discovered and presented in TABLE 2 and elsewhere in this paper should be considered as possible additions to the quality assurance system. These tools are especially valuable, since they generally represent techniques that are not in common usage under the traditional Design-Bid-Build (DBB) form of project delivery and as such may not be considered under usual circumstances. Note, however, that use of DBB does not preclude the use of any of these tools either. Rather, the creative solutions presented here may very well strengthen a DBB quality assurance system, either in the form presented here or in some variation.
CONCLUSION
This paper has explored creative developments in quality assurance practices, especially those practices that have developed under forms of project delivery that do not follow the common design-bid-build format. These forms of project delivery challenge traditional roles of owners, designers, and constructors; further, these forms of project delivery often invite all three parties to collectively participate in establishing project-specific quality practices in the earliest stages of project development. This cross-communication has been found helpful in improving project quality.

The methods discovered might be viewed as tools that may be incorporated into a whole quality assurance system for any project. These tools include those to be implemented before award of construction or design contracts; others are implemented with the entire team in place after award. The tools should be considered as a possible addition to those tools traditionally used by the project manager’s organization. Further, the tools listed here are acknowledged as just a subset of all tools that may be applied; but by considering those presented here, a manager may creatively expand on the innovations by exploring options for the project at hand.

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