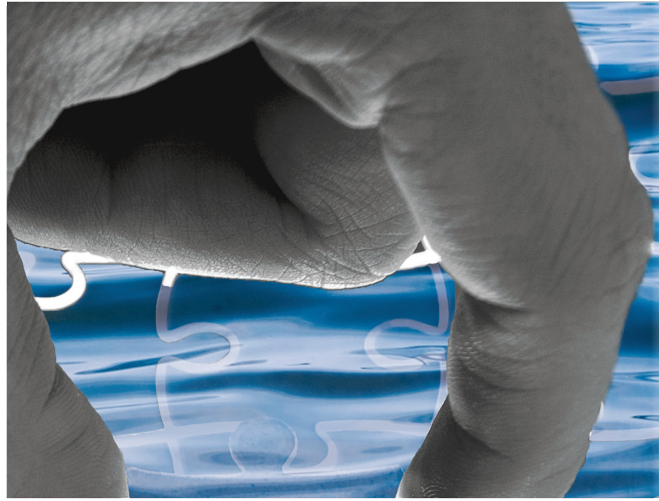
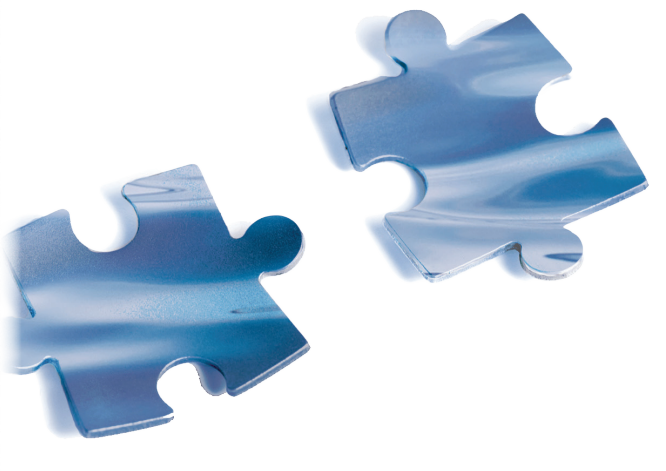


Design-Build FOR Water AND Wastewater Projects



Holly L. Shorney-Darby, PhD, PE, Editor



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Edited by Holly Shorney-Darby, PhD, PE



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Preface

Design-Build for Water and Wastewater Projects was published in response to a growing interest in alternative delivery methods for water and wastewater infrastructure projects in the United States. Most water and wastewater industry professionals know that the processes and procedures of design-build (DB) differ from those of design-bid-build (DBB); however, gaining an understanding of why those differences impact decisions about preliminary design and planning activities, procurement, and project execution is challenging. General information about DB for water and wastewater projects is not widely described in the literature, and DB practices are not currently common knowledge because only a small percentage of industry professionals currently perform DB. The idea for a new book that focuses on DB for water and wastewater projects was initially proposed by the American Water Works Association (AWWA). Preparation of text ultimately became a collaborative effort of the AWWA, the Design-Build Institute of America (DBIA), the Water Design-Build Council (WDBC), and Water Environment Federation (WEF).

The intent of this book is to provide a basic understanding of how DB projects can be planned, procured, and executed. Best practices are highlighted with the goal that future DB projects are successful for the owners, communities, design-builders, and other trade practitioners.

Design-Build for Water and Wastewater Projects provides water and wastewater utility management, engineers, operators, and water quality staff, as well as city officials, utility policy-makers, and DB practitioners (e.g., the design-builder and other trade professionals) with knowledge about:

- The history of DB
- The status of DB in the United States
- The current state laws which limit DB
- Types of projects well-suited for DB
- The preparation steps for DB projects
- How to procure a design-builder
- How to execute DB projects and perform acceptance tests
- Bonding, insurance, and dispute resolution for DB projects

Utility management and operations staff (referred to as *owners*, both private and public) can also learn what organizational and operational changes can be implemented to enhance the performance of a DB project. Other relevant topics include planning and execution tasks for design and construction, permitting and regulatory agency approvals, and schedule development. Whenever possible, examples of recently completed projects are cited, helping to illustrate lessons learned.

Authors for the chapters in this book were solicited from all aspects of the DB industry. They are active in DB organizations and are enthusiastic about educating the water and wastewater industry about DB practices. They authored chapters with topics related to their areas of expertise and injected personal project experience to help convey pertinent concepts.

The development of *Design-Build for Water and Wastewater Projects* greatly benefited from the assistance of several people. Sarah Chittenden of the WDBC provided industry information and a link to several authors. Chuck Williams and Patrick Gallagher were willing advisors for technical and editorial decisions. The WDBC provided guidance on topics for the outline. Lisa Washington, John Young, and Jack Gallagher, leaders within DBIA, provided assistance and guidance throughout the book effort. Marlay B. Price of Gannett Fleming Inc. and past president of the American Water Works Association helped solicit the case studies. Black & Veatch Corporation supported the editorial activities. Beth Edie and Julie Farmer, both at Black & Veatch Corporation, worked diligently on formatting of text and figures.

*Holly Shorney-Darby, PhD, PE, Editor
Senior Process Engineer, Black & Veatch Corporation*

Foreword

During the last two decades, the use of integrated design and construction as an approach to deliver capital projects for water and wastewater utilities has increased dramatically. Facility owners have increased their use of the design-build approach, or one of its variations, because of the value they can receive from reduced risks, enhanced schedules, and potentially lower costs. At the same time, design and construction professionals have gained significant insight in how to increase the value of the overall capital delivery process for their treasured clients.

Integrated design and construction have been used for centuries to successfully deliver complex capital facilities. As the design and construction professions became more specialized after the Industrial Revolution, separation of the design and construction processes became favored. During the last quarter century, however, the integrated design-build approach became more common for commercial and industrial facilities as the significant benefits of this approach became irrefutable through execution of innovative and successful projects. As design-build delivery became more established, the concept of an integrated approach for water and wastewater facilities was discussed and explored. The best practices from commercial and industrial sectors were applied to water and wastewater projects: the early projects usually had significant schedule and budget constraints. Though not every project was implemented perfectly, the financial and quality results were substantial and encouraged more owners to consider design-build. The success and process improvements have continued, and today's new variations (e.g., progressive design-build and construction management at risk) of the design-build delivery method offer more flexibility to owners with respect to procurement and project execution.

The *Design-Build for Water and Wastewater Projects* book provides a summary of the best practices of the design-build industry for water and wastewater projects. In addition to providing a compendium of lessons learned, this book serves as a guide with recommendations on when and how to use the design-build approach to deliver safe, high quality water and wastewater facilities within budget and schedule constraints.

This book was written by people who are performing and/or supporting design-build projects every day. These include engineers, constructors, financial experts, attorneys, and professors. They have succeeded in producing a succinct introduction to the main aspects of the design-build process for water and wastewater facilities. They outline the history of design-build, current state regulations, and the status of the design-build industry in the United States. The authors describe how to develop a comprehensive plan for a design-build project, with a fair and transparent approach to selecting the design-builder. The authors have described the advantages and disadvantages of different procurement methods and outline the benefits of performance-based criteria. Topics such as insurance, bonding, and dispute resolution are also covered to provide a comprehensive view of the design-build process.

One of the unique features of this book is the emphasis on the perspective of the owner relative to the planning, procurement, and implementation of the project. Authors

have summarized characteristics of owner organizations that are vital to successful implementation of a design-build project. There is also information about selection committees, evaluation and scoring of proposals, and myths to dispel. Considerations for risk allocation are also presented. How value engineering and acceptance testing are performed during design-build projects is also discussed.

Variations of design-build are also included: design-build-operate, design-build-operate-finance, and alliance contracting. Improvements to the design-build process that enhance the safety, quality, budget control, and schedule adherence for projects continue to be developed.

Finally, twenty case studies are included after selected chapters. These illustrate what types and sizes of water and wastewater projects can be built using design-build. Each showcases a successful project, with unique challenges that were overcome more efficiently due to design-build delivery.

Design-Build for Water and Wastewater Projects is comprehensive reference book that will serve as a tool to design-build professionals for years.

*Don Evans, President of Evans Group International LLC,
Director of the Water Design-Build Council,
and former Chairman of the Design-Build Institute of America*

About the Water Design-Build Council

The Water Design-Build Council seeks to advance the development and rehabilitation of municipal water and wastewater systems through the sound use of design-build and construction management at-risk (CMAR) methods of project delivery. We fulfill this mission by working with all stakeholders to define and disseminate those best practices that facilitate a productive and collaborative relationship between service providers and local government officials. Above all, these best practices should enable owners who choose to implement design-build and/or CMAR to realize benefits resulting from the integration of design and construction: innovation, speed, improved quality control, and single-point accountability.

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The History of Design-Build

Walker Lee Evey, former president and CEO of DBIA

INTRODUCTION

Whenever a single source is responsible for both design and construction of a project, the delivery method is termed *design-build*. From the perspective of an owner, a design-builder has sole responsibility for the cost, the schedule, and the quality of a project, and for all issues of coordination and control. That definition, however, fails to clearly convey the principal advantage of design-build (DB) over traditional design-bid-build (DBB); it eliminates the friction between designers and constructors that occurs when they are hired under separate contracts, which then may create an adversarial relationship. Because this advantage is significant, there has been a large increase in the use of DB for water and wastewater projects worldwide. Owners recognize that, through the use of DB competition techniques and the ability to overlap construction and design activities of a project, the final cost and schedule for a project by DB can be much improved over traditional DBB.

The recent growth of DB is considered by some to be a dramatic transformation of the water and wastewater industry, a revolutionary development moving toward new and different ways of doing business. In reality, the industry is not embarking on a voyage into the unknown. Instead, it has come full circle; it is returning to a historically successful and well proven design and construction methodology.

Within DB project delivery, there are many different ways to structure projects, allocate or share risk, incorporate qualifications into selection of a design-builder, control or monitor design decisions, incorporate advanced or emerging technologies, foster team-building relationships through incentives, and include operations contracts or special financing arrangements, if desired. This potential for flexibility in DB further increases its attractiveness and, as owners become more familiar with the advantages inherent in this flexibility, DB will continue to grow as a more efficient and effective project delivery method for meeting owner needs in water and wastewater projects.

As the industry progresses, it is also adapting traditional DBB and other project delivery approaches to better suit project and owner needs. For example, construction

management at risk (CMAR) is gaining in popularity as a way to include qualifications as a selection criterion for the contractor, instead of a low-bid selection. CMAR still maintains two separate contracts for the project (i.e., one for the contractor and one for the designer) but is viewed as a delivery approach that incorporates some principles of DB into the project structure.

THE HISTORY OF DESIGN-BUILD

The history of DB is a fascinating tale that chronicles its rise, its fall, and its ultimate re-emergence as a leading methodology for design and construction delivery. Moreover, the history teaches a number of critical lessons about DB and, indeed, about the design and construction industry as a whole. Among them are the critical roles of motivation and incentives, law, and the effects of inertia on human thinking.

The Pyramids: Motivation

The pyramids were extraordinary DB projects. The first pyramid-like project was built in the Egyptian Third Dynasty by a design-builder named Imhotep for the Pharaoh Djoser. Built in the City of the Dead, the pyramid looked like six stacked boxes, with each higher box slightly smaller than the one below. The result was a step pyramidal structure that was about 200 ft tall.

The Egyptian Fourth Dynasty built the first smooth-sided, stone-clad, “traditional” pyramid. After several attempts and one unfortunate Bent Pyramid, which had its angles changed in mid-construction, Fourth-Dynasty builders finally succeeded with the most dramatic pyramid, the Great Pyramid built for Pharaoh Khufu. His son Khafre built the slightly smaller Second Pyramid shortly thereafter.

Although the technical aspects of pyramid design and construction are interesting, it is the manner in which people harnessed their design and construction capabilities toward achieving the pharaoh’s objectives that is relevant to the current DB industry. Modern DB is so successful because it enables people to work in a collaborative environment, which makes them more productive. Having the ability to work collaboratively, however, is not the same as actually doing it. Inherent in the DB process is the opportunity to influence the motivation of the participants. Motivators can be positive or negative.

For Fourth-Dynasty pharaohs, negative motivation prevailed. The extent of the enslavement and cruelty was so great that Egypt was described as being reduced to a “truly awful condition” with almost everyone being harnessed to build the pyramids. The construction of the Great and Second Pyramids tested the limits to which people can be motivated through the use of negative incentives. When Khafre died, his son Menkaure inherited a population ready to revolt and, despite his status as a living god, the people refused to continue building extravagant pyramids. There were ultimately more than thirty dynasties that reigned over ancient Egypt, but after the Fourth Dynasty, there were no more great pyramids.

If ancient negative motivational techniques such as threats, torture, and death failed to provide long-term motivation, their pale modern counterparts such as penalties, liquidated damages, or deductive assessments may likewise temporarily spur performance, but are ultimately less effective than positive motivators that provide rewards for good

performance. Fortunately, DB allows for positive motivators and incentives that foster success.

The Code of Hammurabi: Laws Governing Construction

The Code of Hammurabi is a set of laws carved into stone that codified the governance of the Babylonian Empire under King Hammurabi. The stone is beautifully embossed with a carving of the God of Justice, Shamash, granting Hammurabi authority to issue laws.

To a great extent, Hammurabi's laws were oriented toward taxation and control of fractious populations; however, one section specifically addresses design and construction and deals with topics that still cause concern today—fair prices and quality of work. For example, one part of the law establishes fair prices: “If a builder builds a house for someone and completes it, he shall give him a fee of two shekels in money for each sar (unit) of surface.” Another part establishes quality in performance: “If a builder builds a house for someone, and does not construct it properly, and the house which he built falls in and kills its owner, then that builder shall be put to death.” Although these were only a few laws for design and construction, they represent the first attempt at developing an enforceable legal code for the industry.

Interestingly, the code presumes the use of DB for design and construction in that it does not distinguish between the responsibilities of the designer and the constructor, assuming them to be the same person. It is likely that the designs of the day had been developed over time through trial and error, which resulted in generally accepted standards.

The Middle Ages: Qualifications and Teams

During Roman times, the architect and engineer, Vitruvius, wrote a collection of ten books that served as the standard for design and construction for centuries. As with Hammurabi, the assumption was made that the designer and the constructor were one and the same person. For an extended period of time after the fall of Rome, there was limited experimentation with new design methods or means of construction. Over time, however, new designs began to develop as well as new construction methods. In addition, during the Middle Ages, growth of the guild system fostered collaborative design and construction activities, as well as reward systems in the workplace.

There were dozens of guild associations of craftsmen organized into something that is a cross between a modern trade union, a cartel, and a secret society. They were typically granted “letters of patent” by their government, which gave them authority to control the flow of trade to their members, to retain ownership of tools, and to manipulate the supply of materials. Operating together, these guilds were powerful organizations that controlled the quality of their products and services and ensured that work flowed smoothly between the various guilds working on a project.

Filippo Brunelleschi of Florence, Italy, was the foremost architect and engineer of the early Renaissance; he was also the archetypical design-builder of the time. He was a leader in the movement away from Gothic architecture and back to more classical Romanesque forms and is most famous for his construction of the church dome for Santa Maria del Fiore, beginning in 1420. He worked from a previously prepared conceptual design

(currently this might be considered a DB *bridging* concept), which called for an octagonal dome higher and wider than any ever built previously. To achieve success, Brunelleschi had to invent special hoisting machines and brilliant masonry techniques that were ultimately his most spectacular contributions to architecture.

Brunelleschi's experience had many similarities to modern DB. He was selected as the design-builder based on a competition that emphasized demonstrated performance and capability, rather than competitive low-price bidding. The guilds, which formed the DB team, were oriented toward highly competent performance rather than just low price, and they were motivated by positive inducements, such as reasonable wages. The team members operated in a collaborative manner to identify and solve problems. The team was challenged by the owner to achieve success but was given great latitude in the method and manner of the performance of the work. Finally, the outcome was highly successful and, just like the pyramids, proved to be remarkably enduring.

Late in Brunelleschi's lifetime, a contemporary by the name of Leone Battista Alberti began to argue that there should be a separation between the design process and actual construction. His arguments appealed to a group called *separationists* who argued for architecture to be separated from the construction process. Alberti was criticized for being a theorist and for lacking an appreciation for practical application. In comparison to his contemporary, Leonardo da Vinci, he was considered shallow. Lacking practicality, his ideas did not have significant impact for many years, but in the United States, they emerged as a driving force during the Industrial Revolution.

DESIGN-BUILD IN THE UNITED STATES

As the Industrial Revolution took hold in the United States in the mid-1800s, the success of DB initially expanded at the same time. In fact, DB served the American public with dramatic success throughout the nineteenth century.

Design-build proved to be remarkably effective in building the kind of construction projects that a burgeoning industrial economy needed and wanted. The most successful design-builders tended to specialize in design and construction of standardized infrastructure such as office buildings, banking facilities, and manufacturing shops. They could show examples of their previous successes, and they could quote firm prices and schedules. These were strong attractions for a nation that was experiencing rapid industrial expansion.

At the same time, the repetitive use of standardized designs reduced the demand for architectural services, putting design-builders and the American Institute of Architects (AIA) at odds. The AIA was founded in New York City in 1857 by 13 architects and was dedicated to promoting architecture as a full-fledged profession, with requirements in education, training, and organizational membership, and with a goal of separation from actual construction. As the AIA promoted its goals, it successfully pushed for legislation, both nationally and locally, to codify its objectives, which ultimately resulted in political decisions across the United States to move away from DB and toward DBB as the dominant model.

The primary leverage for this change was AIA's code of ethics, which defined DB as, essentially, an unethical business practice. It barred involvement by architects in the actual construction of their designs and denied membership to architects involved in DB.

Unfortunately for DB, the approach promoted by the AIA dovetailed neatly with prevailing government practice, which was to maintain a government workforce for construction activities with separate contracts for design services. As a result, the government increasingly began to codify the use of DBB and it became the generally accepted model. The use of DB fell dramatically.

However, as time went on, the Industrial Revolution that had helped drive the use of DBB through the advent of standardization, remote manufacture, and highly exact and repeatable dimensions, now conspired against it. As design and construction became increasingly complex, a single individual or firm could not know or understand the totality of the many variables involved. At the turn of the twentieth century, standardization made possible by improved manufacturing techniques had actually decreased the difficulty of achieving coherent design. Gradually, however, designers were increasingly faced with a plethora of technologies, manufacturers, and components, especially for water and wastewater projects. The variety of technologies became increasingly complex and continued to expand. To successfully deal with this increased complexity, it became more desirable to integrate the knowledge, skill, and experience of many different team members. Design-build is ideal for exactly that environment.

Through the early to mid-1900s, DBB predominated for key projects and owners. However, in the 1940s, the Naval Facilities Engineering Command turned to DB to satisfy the demand for housing projects driven by World War II. In the 1960s, National Aeronautics and Space Administration (NASA) began to experiment with DB. The space race was exactly the kind of challenge (i.e., complex, difficult, and requiring extraordinary teamwork) at which DB could excel. The US Department of Housing and Urban Development (HUD) in 1968 began supporting the use of DB turnkey projects under authority provided by the US Housing Act of 1937. The technique based contract award on the highest-rated turnkey proposal, representing the best *total package*.

Federal Laws

In 1972, the Brooks Act amended the Federal Property and Administrative Services Act of 1949 that had established the General Services Administration (GSA). The act required all federal agencies to select architects/engineers based on their qualifications, not cost, in a process characterized as a *qualifications-based selection* (QBS). The law specifically precluded cost from being used as a consideration for selection, with cost negotiations being conducted with only the successful offeror, or proposer, after selection. Although the Brooks Act has sometimes caused confusion with respect to authority to award DB contracts, its promotion of QBS represented a significant step forward for the use of DB.

Following passage of the Brooks Act, two additional laws have enhanced the use of *best-value* source selection for DB. The Federal Acquisition Streamlining Act of 1994 and the National Defense Authorization Act of 1996 permitted the federal government to use two-phase source selection procedures to award DB services. The portion of the 1996 act that authorized the two-phase selection procedures was later renamed the Clinger-Cohen Act. Under these laws, agencies can make a determination that DB is appropriate for use on a project and then use a two-phase source selection procedure.

In the first phase of the source selection, proposals are evaluated with respect to the specialized experience and technical competence of the offerors. During this first phase,

there is no cost evaluation. In the second phase, offerors that were selected during the first phase propose specific technical solutions and prices for the project. Based on an integrated assessment, a contract is awarded to the most highly qualified DB team based on the overall highest ranking, taking into consideration qualifications, technical solution, and cost.

The Federal Acquisition Regulation (FAR) was amended in 1997 to reflect DB procedures. FAR Part 36.3 now provides explicit procedures demonstrating how to solicit, evaluate, and award DB contracts in accordance with the 1996 legislation. The intent of the policy is to ensure an emphasis on identifying the most highly qualified competitors in the first phase, without requiring the competitors to incur the costs inherent in design work and cost proposal preparation. Although this process is often referred to as a *prequalification*, it is, in fact, not. Prequalification implies that a minimum capability is established by the owner agency and that all offerors who exceed that minimum are allowed to continue into phase two competition. Instead, phase one competition is normally used to identify the most highly qualified competitors, allowing only the most highly qualified to continue into the phase two competition.

State Law

At the state level, the status and use of DB has been much less clear. The past few years have, however, seen remarkable changes in legislation among the states. In 1993, there was only one state, Virginia, that authorized the use of DB for any type of design and construction project. At that time, the majority of states had legislation that precluded the use of DB. Since then, there has been steady progress and, by 2010, all 50 states accommodated the use of DB to at least some degree. Chapter 4 addresses legislation for DB in more detail.

International Use of Design-Build

Design-build is widely used internationally. In some markets, such as the water and wastewater industry of the United Kingdom, DB is a dominant delivery mechanism. Variations of DB are also common in Australia, Asia, and the Middle East.

The predominance of DB in the international market is reflected in Figure 1-1, which includes all types of projects. Using 2004 as a base year, the use of DB has rapidly increased through 2008, more than doubling both domestically as well as internationally. International growth has been much more rapid than growth within the United States.

This dramatic shift in the use of DB internationally has led some to label the United States as, “the last bastion of design-bid-build.” This dubious distinction results from the realization that the United States has fallen behind much of the rest of the world in the adoption of new project delivery techniques, including DB; DB plus finance, operate and maintain; and developer-owned leaseback or product-sale arrangements. It is anticipated, however, that growth of DB in the United States will continue.

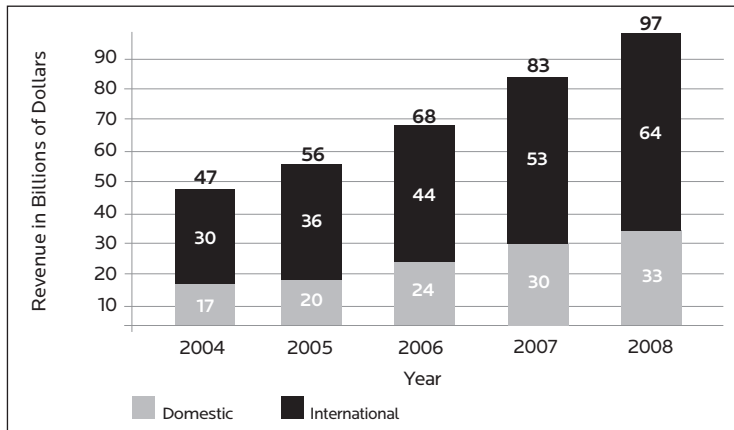


Figure 1-1. The total revenue for international and domestic design-build projects

Source: Computed from *Engineering News-Record* (ENR) top 100 firms ranking information.

THE PERFECT STORM

The past decade has seen an ever accelerating flow of new technologies and work methods into the design and construction workplace. While the nature of these new developments varies, they typically have certain characteristics in common: (1) they are inherently collaborative in nature; (2) to be optimized, they require early application; and, (3) the manner in which they operate cuts across the traditional design/construction boundary that anchors DBB. A partial list of these new approaches includes such things as building information modeling (BIM), aggressive commissioning techniques, lean construction, public-private partnerships, integrated product teams and matrix management, and green building construction.

These new technologies and work methods exemplify the adage that “the whole is greater than the sum of the parts.” Employing two of these new procedures does not simply double their cumulative impact; instead, their interaction multiplies the degree of change that occurs, providing extraordinary results for the resources expended. As these new methodologies displace outdated processes and are imported into the workplace to interact with DB project delivery techniques, the result is a “perfect storm” of change within the industry. Unfortunately for those owner organizations and industry firms that are wedded to old ways of doing business, DBB is proving remarkably ill-suited to dealing with this ongoing change.

Using BIM as a representative example, BIM enables modern design-builders to replicate a technique that was often used by renaissance design-builders, the use of models to effectively communicate what is to be built. In those days, the master builder would often augment designs and drawings with actual models showing in three dimensions the work to be done. The model then served to facilitate communication and collaboration between the master builder and the guild workers on the work site.

BIM produces a three-dimensional representation to serve a similar purpose, but now the model can be distributed over computers and made accessible to many people and locations simultaneously. Similarly BIM facilitates interaction among all the parties

to accelerate responses to questions or to communicate changes with greater efficiency. In addition, BIM, when used in conjunction with DB, can bring the entire team together early in the design so that valuable early information from every team member can be incorporated into the planning and design process.

Design-build, more than any other delivery method, provides opportunities for both owners and industry practitioners to leverage the benefits derived from these new ways of doing business. In addition, DB can structure the most effective reward arrangements to optimize team innovation and motivation.

As captured in the Penn State/Construction Industry Institute (CII) study by Konchar and Sanvido, (1998), DB has demonstrated its mastery of cost containment (e.g., 6 percent lower cost than DBB), reduction in construction time (e.g., 13 percent faster than DBB), and overall schedule (i.e., 33 percent faster than DBB). Also, as indicated in the research titled *Independent Comparative Evaluation of Design-Build V. Conventional Design-Bid-Build Project Delivery for Municipal Water and Wastewater Facilities*, conducted by the University of New Mexico, University of Colorado, and Iowa State University (Bogus, Shane, and Molenaar 2009), DB had shorter project durations and 50 percent less schedule growth than DBB.

These superior performance outcomes are not the result of serendipity. They are the result of many hundreds of years of hard-earned lessons learned.

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Benefits and Challenges of Design-Build

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INTRODUCTION

Design-build (DB) and design-bid-build (DBB) each offer specific benefits and challenges as project delivery methods. Design-build, unlike DBB, has a unique structure for an integrated project delivery method. For example, the integration of design and construction services under a single contract can lead to improved communication, because there is a single point of responsibility; however, structuring procurement to meet the owner's needs within the confines of restrictive local procurement laws can be challenging. Understanding the potential benefits and challenges of DB is the first step in deciding on an appropriate project delivery method.

BENEFITS OF DESIGN-BUILD

Several benefits of DB project delivery are presented and discussed in the following sections.

Single Point of Responsibility

The DB project delivery method is characterized by a single point of responsibility between the owner and the design-build firm. As illustrated in Figure 2-1, the design-build structure has a single contract between the owner and the design-build firm that covers both design and construction services. By comparison, the design-bid-build project delivery

method is characterized by separate contracts between the owner and the designer and the owner and the construction contractor (Figure 2-1).

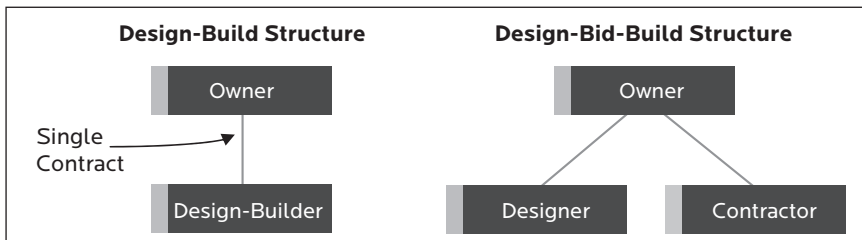


Figure 2-1. Single point of responsibility for DB compared to DBB

In a 2008 survey of owners who had used DB for their water or wastewater projects, the single point of responsibility was the top reason given for using DB (WDBC 2008). In this same survey, the owners also reported a high degree of satisfaction with respect to their expectations of the single point of responsibility associated with their specific DB projects.

For an owner, having a single design-builder under contract can result in several benefits (ASCE 1992):

- Improved accountability and reduced administrative tasks associated with tracking multiple contracts
- No disagreements over project responsibility between the designer and the construction contractor
- Fewer change orders by eliminating those associated with the design/construction interface (e.g., design errors and omissions)
- Increased protection from liability for design defects or omissions
- Rapid reaction to scope changes because designers and constructors are working together

All of these benefits result from the fact that both the designers and constructors are part of the same team, which means that the owner has a single point of responsibility for project delivery.

Innovation

The potential for increased innovation on DB projects is a result of having both the designer and the constructor collaborating together early in the project, as is the case for projects that are procured with a best-value or price-based approach (see chapter 7). For these types of DB projects, the design-builder is formed during the procurement phase, which allows both parties to work closely together to create innovative design and construction solutions as part of the proposal. Creating a competitive procurement environment can increase the potential for innovation as design-builders compete to develop the proposal with the best value for the owner. The potential for innovation continues after contract award as the design-builder has the opportunity to identify innovative designs and construction procedures that may result in schedule, cost, and quality benefits.

Schedule

One of the most cited benefits of DB is the potential to reduce the project schedule. The schedule savings can come from eliminating the bid phase associated with the more traditional DBB project delivery method and from the overlapping of the design and construction phases (Figure 2-2).

Some of the first research studies to document the time saving benefits of DB were performed for vertical structures (i.e., buildings) and transportation projects. Although the infrastructure elements and performance requirements for water and wastewater projects differ from those of vertical construction or transportation, the approach of having design and construction performed by the design-builder and the project execution tasks are similar. These studies found that construction speed for DB projects was 12 percent faster than for DBB projects and total project delivery speed was at least 30 percent faster than for DBB project (Table 2-1). In a similar study of transportation projects, DB was found to reduce overall project delivery time by 14 percent (Table 2-1).

Likewise, in a study specific to water and wastewater facility projects, DB projects were found to have significantly shorter schedules and less schedule growth than design-bid-build projects (Table 2-2). The median schedule duration for DB projects in the study was 23 months compared to 40 months for DBB projects. In terms of schedule growth, design-build project schedules grew (i.e., the difference between the original contracted duration and the actual duration) by half as much as DBB project schedules (i.e., 1 month for DB projects versus 2 months for DBB projects).

It is the integrated project delivery approach of DB that promotes schedule savings by allowing construction to begin before the design is complete. Because the designers and constructors are part of the same team, there is no need to develop 100 percent design drawings for bidding purposes. Depending on the level of detail necessary and the requirements of permitting agencies, construction can begin before design is fully detailed, thus resulting in time savings for DB projects.

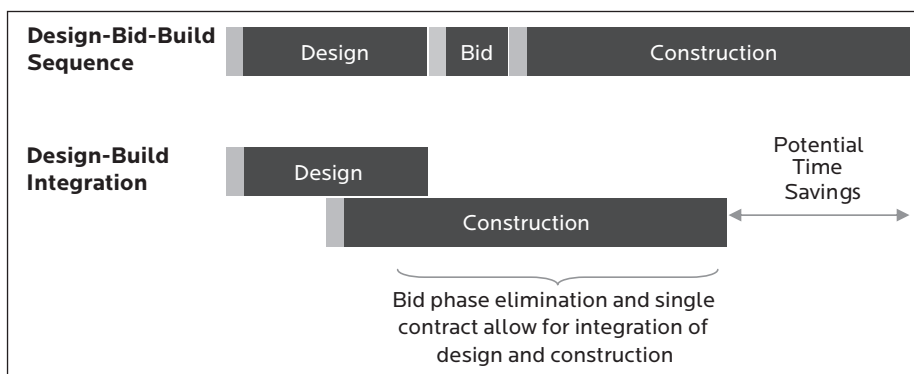


Figure 2-2. Potential time savings with design-build

Table 2-1. Comparison of schedule performance by delivery method for building and transportation projects

Item	CII/Pennsylvania State University Study*	University of Reading Study†	FHWA Report to Congress‡
Construction Speed	DB 12% faster than DBB	DB 12% faster than DBB	—
Total Speed of Project Delivery	DB 33.5% faster than DBB	DB 30% faster than DBB	DB 14% faster than DBB

* Konchar and Sanvido 1998, Sanvido and Konchar 1999

† Bennett, Potheary, and Robinson 1996

‡ FHWA 2006

Table 2-2. Comparison of schedule performance by delivery method for design and construction of water and wastewater facilities (median values) (Bogus, Shane, and Molenaar 2009)

Performance Measure	Design-Build	Design-Bid-Build
Schedule Duration (months) *	23	40
Schedule Growth (months) *	1.0	2.0
Proportion of Projects with Schedule Growth ≤ 0 *	41%	36%

* Statistically significant results

Source: Bogus, Shane, and Molenaar 2009.

Cost

Design-build can also provide benefits in terms of cost savings. The cost savings can come from many areas including design and construction innovations, fewer change orders, improved communication, shorter project schedules, and reduced claims. For building projects, DB was found to have lower project or unit costs of between 6 and 13 percent (Table 2-3). For transportation projects, DB was found to reduce the total project cost by 3 percent (Table 2-3). Design-build projects also were more likely to be completed within 5 percent of the project budget compared to DBB projects. In a study specific to water and wastewater facility projects, DB projects had lower cost growth and were significantly more likely to finish within budget, even while the total project size was generally larger (Table 2-4).

The mechanisms by which DB projects can achieve cost savings are not as clearly defined as they are for schedule savings. In terms of schedule, time savings can clearly be achieved by eliminating the contractor's bid phase in DBB and overlapping design and construction in DB. For costs, there are many areas where savings can be achieved, although actual DB performance is more variable in terms of cost benefits than it is in terms of schedule benefits.

Table 2-3. Comparison of cost performance by delivery method for building and transportation projects

Item	CII/Pennsylvania State University Study*	University of Reading Study†	FHWA Report to Congress‡
Project Cost or Unit Cost (\$/Area)	DB 6.1% less than DBB	DB 13% less than DBB	DB 3% less than DBB
Projects completed within 5% of budget	DB—58% DBB—47%	DB—75% DBB—65%	—

* Konchar and Sanvido 1998, Sanvido and Konchar 1999

† Bennett, Potheary, and Robinson 1996

‡ FHWA, 2006

Table 2-4. Comparison of cost performance by delivery method for design and construction of water and wastewater facilities (median values)

Performance Measure	Design-Build	Design-Bid-Build
Cost (\$millions)	12	8
Cost Growth (%)	1.6%	3.6%
Proportion of Projects with Cost Growth $\leq 0^*$	38%	20%

* Statistically significant results

Source: Bogus, Shane, and Molenaar 2009.

Quality

Another benefit of DB is that it can produce projects with comparable quality to DBB for less time and cost. Several research studies have shown that DB projects are of similar quality to DBB projects. For building construction, one study concluded that DB projects were considered slightly better in meeting owner expectations of quality than DBB projects (Konchar and Sanvido 1998, Sanvido and Konchar 1999). Another building study showed that slightly more DBB projects met owner expectations of quality (Bennett, Potheary, and Robinson 1996). Studies of transportation and water/wastewater projects showed no difference between the quality of DB projects and DBB projects (FHWA 2006, Bogus, Shane, and Molenaar 2009). While owners often express concern that DB does not offer the same quality assurance as DBB, actual project data show that both delivery methods produce comparable projects in terms of quality.

CHALLENGES OF DESIGN-BUILD

The commonly cited challenges to DB project delivery are discussed in the following sections.

Experience With Design-Build

Water and wastewater systems in the United States are very fragmented, consisting of a large number and varying sizes of public and private utility owners. While DBB project delivery is considered to be the traditional project delivery method for water and wastewater projects, the use of the DB project delivery method has been increasing in the public and private sectors for more than 30 years (Twomey 1989, ASCE 1992, Federal Construction Council 1993, Songer and Ibbs 1995, Molenaar and Songer 1998, Molenaar et al. 1999). Unlike the federal building sector or even the state departments of transportation, many utilities undertake significant design and construction projects on a relatively infrequent basis. Thus, some owners in the water and wastewater industry have not had extensive experience with DB or other alternative project delivery methods. One 2004 study found a very limited number of projects were completed using DB; however, this number is steadily increasing (Figure 2-3) (Molenaar et al. 2004).

Another study completed in 2009 contacted more than 500 owners of public water and wastewater facilities requesting information for projects completed between 2003 and 2008 with more than \$3 million in total value. Of the 100 responses with projects completed that met the criteria, 31 projects were completed using DB (Bogus et al. 2009). Two recent owner opinion surveys have been completed, which provide some insight into the use of alternative project delivery methods for water and wastewater projects (R. W. Beck Inc. 2009, WDBC 2008). The survey by R. W. Beck Inc. (2009) determined that most utility owners are at least somewhat familiar with alternative project delivery methods (at least 90 percent were somewhat or very familiar with alternative delivery methods). However, only half of owners had actually delivered a project using a method other than DBB.

This limited use of alternative methods leads to the challenge of understanding the roles and responsibilities of the various parties once the decision is made to use a project delivery method other than DBB. Barriers that may exist and challenges to overcome include the institutional barrier within the owner's agency and with understanding the change in roles between the parties. Often people become comfortable with the way activities are carried out, and if these activities are done the same way over an extensive time, people may have a hard time accepting changes to the system. Design-build projects require a different set of the owners' internal resources and thought processes than DBB requires (see chapter 6). Additionally, the designer (i.e., architect/engineer) is no longer the owner's representative but is now working as a part of the team with the contractor to form the design-builder. Trust becomes an important part of the relationship among all parties, and this can be challenging for some people (Levy 2006).

The limited use of DB is in many ways due to the legal and legislative constraints in the public sector (see chapter 4). Some state and local governments do not allow owners to use DB to deliver projects to the public. Others may allow the use of design-build but constraints on procurement may inhibit the use of DB (Beard et al. 2001, Levy 2006).

To help overcome a lack of experience with DB, owners can use a DB consultant (see chapter 10) to assist with the owner's tasks for planning, procurement, and project execution.

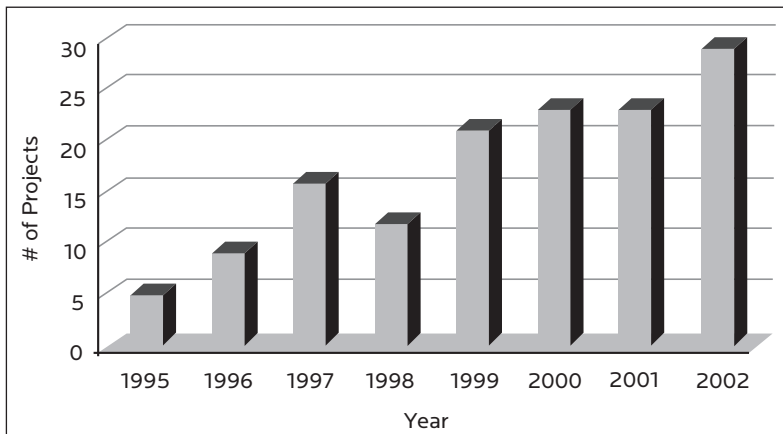


Figure 2-3. Sample trend for design-build projects in water

Source: Molenaar, Bogus, and Priestley (2004)

Planning

Not all projects are suitable for DB delivery. Sometimes owners are pressured to use a specific project delivery method; however, a project delivery method should be selected based on a number of characteristics (see chapter 5). Owners should work to ensure that the selected project delivery method allows for a successful project. Selection of the delivery method can pose a challenge to owners, especially inexperienced owners. Some characteristics to consider include scheduling, funding, owner organization, constructability, unique project features, technology, the owner's need to have input during design, project size, permitting, and ability to do pricing without a complete design (Gransberg et al. 2006).

Selection

Design-build is a project delivery method in which the design and construction services are procured at the same time, instead of separate procurements for the design and construction phases. Design-build combines these two phases into a single procurement effort that can incorporate value-based and/or qualifications award criteria (see chapters 7 and 8), versus the traditional qualifications-based designer selection criteria and separate low-bid selection for the contractor.

Projects traditionally completed using DBB are procured using 100 percent design drawings and specifications. With DB, this is not the case. Owners may only have 30 percent of the design complete when projects are released for procurement. This creates a challenge for owners on how to specify the desired outcome of the project without the detail provided in the traditional system. The traditional DBB method primarily uses prescriptive specifications to detail the process, method of construction, and products to achieve a goal. In DB projects, performance specifications are often included to indicate the end result without providing the particulars of how to obtain that result (Beard et

al. 2001, AGC 2004). This different method of expressing the owner's desires can create challenges, including the method of expression, how to address all necessary areas, the amount and type of risk, and who inherits the risk. Chapter 13 discussed prescriptive versus performance-based criteria.

Risk Allocation

There are three types of risk: scope, schedule, and cost. The entity that is responsible for different aspects of these risks is not consistent between DB and other project delivery methods (see chapter 9). Perhaps two of the most notable scope risks are a clear project definition and design errors and omissions. Using DBB, the owner can rely on the complete plans and specifications to define the project, but in DB this is not the case, so owners must work to clearly define the project in a way that conveys the owner's needs and desires without limiting the innovation of the design-builders. With DB the design errors and omissions are the design-builder's risk. These are not only a scope risk but also translate to a cost risk as the design-builder becomes liable for the cost of redesign and construction rework. Finally, the shift of the design errors and omissions risk to the design-builder creates an associated schedule risk. Another challenge for the owner is that DB often moves at a fast pace, if the contract requires owner approval or owner-furnished equipment, the owner needs to be cognizant of the fast pace of work and not hinder the design-builder's schedule (Gransberg et al. 2006).

Execution

During the design process, the design documents may not be brought to the level of detail that owners and permitting agencies are used to seeing (AGC 2004). This is because the contractor and the designer are working together and the documents only need to communicate enough information for the team to work with in actually delivering the final project. This may represent an obstacle to people who are unaware and a system that is not used to dealing with design documents at that level of detail. Additionally, during the design phase, decisions are made in a different order than in other delivery methods (AGC 2004). Decisions in DB projects are made in an order that facilitates efficient construction.

Licensing poses a challenge in DB. This is because the design-builder must meet the licensing requirements for the designer as well as the requirements for the contractor. Each state has different laws for each type of license. While this is a challenge, it is not a prohibiting factor and should be investigated for all projects (AGC 2004, Levy 2006). There should be a similar consideration for insurance, as requirements differ between states for the various project parties.

Other challenges that owners may encounter are funding and cash flow. The accelerated schedule of DB projects can cause problems as owners may have an assumed schedule for payment for work and the design-builder may be working at a faster pace. Owners should make any limitations on funding and cash flow known during the procurement phase of the project so that this does not become a problem during the design and construction phases. This up-front knowledge allows the design-builder to plan accordingly (Beard et al. 2001).

SUMMARY

There are many benefits as well as challenges associated with any project delivery system, including DB. The most notable benefits of DB compared to the more traditional DBB project delivery method are a single point of responsibility, increased opportunity for innovation, schedule reduction, and cost savings. There are also several challenges with implementing DB, especially for owners who are using DB for the first time. Some of the challenges associated with DB are related to project planning, selecting a design-builder, and project execution. Later chapters, however, provide more detail on how best to plan for a DB project, select a design-builder, and execute a successful project.

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Project: Arbennie Pritchett Water Reclamation Facility

Owner: Okaloosa County, Florida

Design-Build (DB) Entity: CDM

Completion Date: September 2009

Description of Project

Okaloosa County, located in Florida's western panhandle, needed increased wastewater treatment capacity and new treatment technology to treat future wastewater flows. The existing wastewater treatment plant (WWTP) was past its effective life span and had serious odor control problems that had generated numerous community complaints. The County needed a new facility in a new location.

Why the Owner Chose Design-Build

A number of factors contributed to the County's decision to utilize DB for this project, including:

- Ability to compress delivery schedule
- Opportunity for innovation
- Single-source responsibility
- Performance guarantees to manage risk

In addition, the County had negative experiences with a number of large projects implemented by traditional design-bid-build (DBB) and had successful experiences with construction management at risk delivery of a major conference center and a regional airport terminal. These alternative delivery projects encouraged the County to take the step to DB for the new WWTP.

Lessons Learned

The County's success in DB delivery of the new water reclamation facility was based on mutual trust, close collaboration (starting with proprietary design workshops during proposal preparation), the design-builder's use of 3D/4D design to facilitate owner review, early and proactive permitting, and flexibility of both the owner and the design-builder. Some specific features used by the owner included:

- A defensible qualifications-based selection process was used that allowed the incorporation of critical design elements
- A detailed construction cost estimate was obtained to support project financing and contract negotiations
- An appropriate level of design development was provided to the proposers

- Risks to be assumed, transferred, or shared were identified
- The number of proposers should be limited to a short-list of three or four

Success Outcomes

The 10-mgd (38-ML/d), \$48 million Arbennie Pritchett Water Reclamation Facility was built on land leased from the US Air Force, which was far from the original facility. To facilitate project communication and efficiency, 3D design was used with all engineering disciplines for more than 20 buildings and structures. The project also incorporated 4D design, which linked the 3D model to equipment data, operations, and maintenance manuals; a computerized maintenance management system; and process monitoring and control software. This intelligent process and instrumentation database was used as the single source of data from which the design of the facility was developed.

Construction was completed on time and on budget due to timely completion of complex designs and a collaborative environment with real-time technical and visual data. In addition, the DB approach streamlined the aggressive project schedule, allowing final design to be completed in 5.5 months.

Project: Cedar Water Treatment Facility

Owner: Seattle Public Utilities, Washington

Design-Build (DB) Entity: CH2M HILL

Completion Date: July 2004

Description of Project

Seattle Public Utilities (SPU) needed to provide advanced treatment to meet disinfection requirements for a surface water supply. A new water treatment plant (WTP) was needed. SPU selected CH2M HILL as the prime contractor to design, build, and operate a new \$79 million, 180-mgd (681-ML/d) water treatment facility. CH2M HILL also provides operations and maintenance (O&M) services under a 25-year contract. The full design-build-operate (DBO) project value was \$109 million.

The new facility has two independent treatment trains, each providing (1) ozone generation, injection, contact, residual quenching, and destruction systems, and (2) ultraviolet (UV) disinfection. The UV disinfection system consists of 13 UV reactors: 6 for each process train plus 1 spare. The facility is the largest UV drinking water facility in the world, providing regulator-credited 3.0-log *Cryptosporidium* disinfection.

The project included construction of a new intake and raw water pump station. One of the innovations that was gained through the DB delivery method was to reline existing transmission pipelines and convert them into highly efficient ozone contactors. This approach avoided costs and site impacts associated with constructing conventional ozone contactors. Treatment also includes chlorination and lime addition for corrosion control. Other facility components include two 10-mil-gal (38-ML) clearwells for treated water storage and flow metering and control stations designed for an ultimate capacity of 275 mgd (1,040 ML/d).

Why the Owner Chose Design-Build

Seattle Public Utilities wanted to take advantage of the innovations and cost savings inherent in design-build delivery. DBO delivery saved SPU \$50 million when compared with traditional DBB delivery.

Success Outcomes

One of the unique requirements of the project was that it had to meet LEED™ criteria, eventually receiving a rating of “gold.” LEED™ is a building rating system developed by the US Green Building Council to promote design of facilities that are

economically and environmentally viable through the use of sound design practices and the use of sustainable materials.

This facility was constructed in a sensitive wetlands habitat. Minimizing the project footprint, beyond conventional site evaluation methods, became an integral part of the design. To achieve the tightest footprint, the design reused as many existing facilities as possible and also incorporated many vertical features. For instance, normally ozone treatment requires large covered concrete structures for contact time. The design converted two existing pipelines into the ozone contact system. This reduced the environmental impact of construction in a sensitive habitat, streamlined permitting, and cut project costs. CH2M HILL also partnered with the UV vendors to design the first vertical equipment configuration.

In 2006, SPU and CH2M HILL were recognized by the National Council for Public-Private Partnership for their use of best practices and approaches as related to public-private partnerships.

Status of Design-Build in the US Water and Wastewater Sectors

*Christopher S. Frangione, Senior Director, Energy & Environment X PRIZE Foundation,
former staff for Water Design-Build Council*

INTRODUCTION

Design-build is gaining traction as a delivery mechanism for water and wastewater projects as both owners and design-builders (i.e., practitioners) learn to use it for mutual advantage. This chapter summarizes the status of the water and wastewater DB business and describes future trends. The chapter also identifies ways to expand and improve the use of DB.

RECENT GROWTH OF DESIGN-BUILD AS A DELIVERY METHOD

The historical events and drivers for DB in the United States were presented in chapter 1, but municipalities really began to experiment with DB for water and wastewater projects in the 1990s. By the year 2000, the use of alternative delivery was growing at an average annual rate of approximately 10 percent (Farkas Berkowitz & Company 2008). Although comprehensive statistics for water DB are lacking, industry professionals agree that the growth of DB has outpaced the growth of traditional project delivery between 1995 and 2009.

The steady growth of DB was disrupted by the recession of 2008/2009, which also slowed the growth of the overall municipal water and wastewater design and construction business. As the recovery from the recession progresses, it is believed that DB will continue to be implemented because of the benefits that owners are experiencing with this delivery method.

STATUS OF DESIGN-BUILD BUSINESS

Although published data on the size of the alternative delivery business are not available, the Water Design-Build Council (WDBC) estimates the business size in 2009 to have been between \$2 billion and \$3 billion (WDBC 2010). This estimate accounts for public water DB projects at the federal, state, and local levels, and it is believed that municipalities account for approximately 90 percent of the overall business. The state government portion of the business is negligible, and the federal business consists mainly of water and wastewater facilities at Department of Defense bases. The federal business in 2008–2010 is substantial due to the Base Realignment and Closure (BRAC) Program, which included several improvements to water and wastewater infrastructure.

To better gauge DB's growing popularity among municipalities, the consulting firm R. W. Beck surveyed 85 randomly chosen municipalities, which serve more than 100,000 customers and found that 49 percent of the utilities had used some variation of DB (R. W. Beck Inc. 2009). More details of this study are presented in chapter 8. The results show that municipalities in the United States are considering DB for their projects.

To compensate for the limited data on DB projects for water and wastewater projects, the WDBC, which is comprised of DB industry practitioners, also conducted a survey of project information, including sales value data, from its members for projects completed between 2005 and 2010. Sales value is the value of both the design and construction portion of the DB project on the day the contract was signed, and in this evaluation, the entire sales value was credited to the year in which the contract was signed. The total sales value for DB projects of WDBC members for the five-year period from 2005 to 2010 was \$8.8 billion, with the sales value for 2009 and 2010 being \$1.2 billion, with a decrease due to the continuing recession. It should be noted that because the WDBC is not represented by construction firms; the statistics do not include all the water DB projects in which a construction firm served as the prime contractor.

Certain states currently dominate the DB business. As shown in Figure 3-1, the four states that have the highest sales value for DB projects from 2005 to 2010 were Texas, California, Arizona, and Florida. The top five states in 2009/2010 were California, Texas, Washington, Arizona, and Florida. It should be noted that the use of DB in some of these states decreased in 2009 and 2010 (Figure 3-2) because of the recession.

Discussions with North American owners suggest that the number of DB projects will increase in the northeastern states in the future. The drivers in the northeast are consent decrees, regulations, and aging infrastructure. The use of DB in the northwest (i.e., Oregon and Washington) is also expected to increase due to aging infrastructure.

It is apparent that owners who are able to use DB do so for many types of projects. The WDBC data show that DB is used as much for water as it is for wastewater. In 2009/2010, 31 percent of the projects contracted by WDBC members were for water, while 27 percent were for wastewater. Figure 3-3 shows the distribution of WDBC surveyed projects from 2005 through 2010, with 41 percent for water versus 36 percent for wastewater.

The survey also showed that DB is used for projects of all sizes. In 2009/2010, on an average, 31 percent of surveyed projects were greater than \$10 million, and 1 percent were smaller than \$500,000. Figure 3-4 shows the distribution of sales value of surveyed projects from 2005 to 2010.

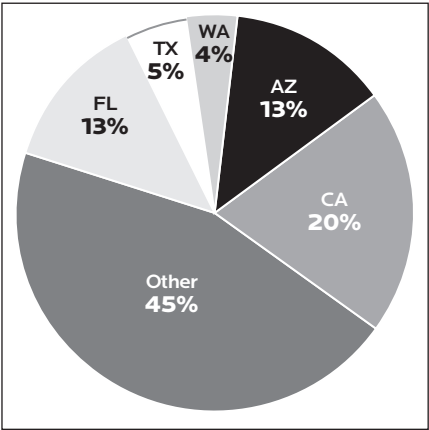


Figure 3-1. Percentage of \$8.8 billion sales value by state for 2005–2010

Source: Water Design-Build Council Proprietary Contract Database.

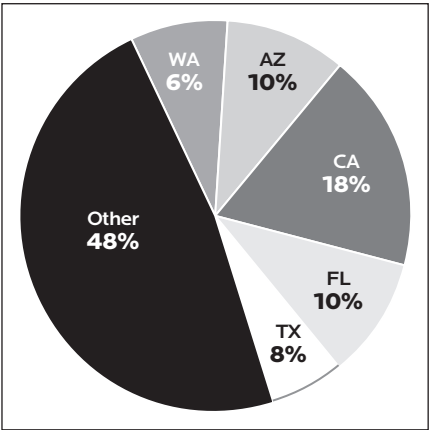


Figure 3-2. Percentage of the billion sales value by state for 2010

Source: Water Design-Build Council Proprietary Contract Database.

WHY IS DESIGN-BUILD GAINING SHARE?

Owners choose DB for a number of reasons. When properly planned and executed, DB can provide the owner with a number of benefits that traditional DBB does not. These benefits include:

- **Single-point accountability.** Having the designer and builder work together from the outset results in fewer constructability problems and design disputes. If they do arise, the owner can often hold the design-builder responsible for dealing with the problems. In contrast, in a design-bid-build procurement, separate contracts are

an “arms-length” and sometimes adversarial relationship between the designer and the builder and put ultimate responsibility for the project with the owner.

- **Value-based selection.** In a DBB project, the builder is typically selected solely on the basis of price. In DB, the owner can specify a range of criteria in addition to low price when awarding the contract. Selection factors include the design-builder’s experience with similar projects, innovative ideas for meeting project objectives, and ability and willingness to work as a team with the owner’s staff.

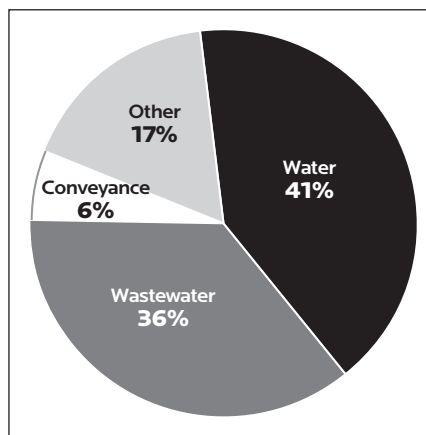


Figure 3-3. Percentage of surveyed project types for water versus wastewater infrastructure for 2005–2010

Source: Water Design-Build Council Proprietary Contract Database.

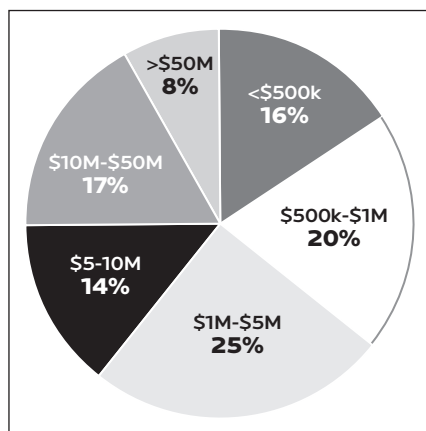


Figure 3-4. Percentage of projects by sales value for 2005–2010

Source: Water Design-Build Council Proprietary Contract Database.

- **Time and cost savings.** Design-build delivery has proven to be particularly effective for water and wastewater projects with demanding schedules by saving time in the overall project delivery duration. Time is saved in the execution through some overlap in design and construction because construction can often begin before the total design is complete. In addition, there is the potential to reduce time and costs through the efficiencies that can be gained through integration of design and construction.

“Design-build limits the unknown of having builders come in and low bid resulting in construction and operations problems. Design-build is not the cheapest, but you do not want a builder in there who does not know what they are doing resulting in problems later on.”

—Drew Goins, Assistant Director,
Water Production, Augusta, Georgia

- **Early knowledge of total costs.** Design-build water and wastewater projects are typically lump sum or guaranteed maximum price (GMP), which includes design and construction. In a competitive procurement process, a firm lump-sum price is provided in response to the Request for Proposals (RFP). In a qualifications-based selection (QBS) negotiated DB process, a firm lump sum or GMP is typically established at approximately 50 to 60 percent completion of the design.

The WDBC conducted a telephone survey of over 20 municipal owners who opted to use DB delivery for water and/or wastewater projects (WDBC 2008). Table 3-1 displays their reasons for doing so on a five-point scale, where five was a primary reason, three was a secondary reason, and one was not considered to be a reason. Single-point accountability and speed of delivery ranked the highest.

When asked an open-ended question on the most beneficial attributes of DB delivery, respondents identified single-point accountability and speed of delivery more than twice as often as any other attribute. The third most beneficial attribute cited was the ability to choose builders on the basis of other criteria, in addition to price.

Table 3-1. Reasons why owners use design-build

Decision Factors	Relative Importance*
Single-point accountability	4.3
Speed of delivery (Time savings)	4.3
Having the builder involved in the design process	4.2
Construction quality	4.0
Price certainty	4.0
Fewer change orders	3.9
Flexibility	3.9
Lower costs	2.9

*5 = primary reason; 3 = secondary reason, 1 = not a reason

Source: WDBC 2008.

Respondents also graded how their most recent DB experience met their expectations relative to the reasons they gave for using DB. Respondents graded their experience on a scale of one to five, where five was *exceeded expectations*, three was *met expectations*, and one was *did not meet expectations*. Table 3-2 shows the results.

All factors received a grade of 4 or above. Single-point accountability and speed of delivery were ranked highest as reasons to use DB. The grades show that the design-builders are delivering on the objectives that are most important to the municipality.

Additional follow-up questions to the respondents of the survey reinforce the positive outcomes of their DB experiences.

- Eighty-nine percent report that their DB project was completed on schedule. Six of these respondents stated that the project came in ahead of schedule. Only two respondents stated that their project did not come in on schedule, but neither blamed the design-builder.
- Eighty-nine percent of respondents who have completed projects state that their projects came in on budget. Four of these respondents explained that the project also came in ahead of schedule. Only two respondents stated that their project did not come in on budget. One respondent attributes the overrun to the fact that the design-builder increased the speed of delivery and therefore the slight cost overrun was worth it to the municipality.
- Ninety-four percent of the respondents who have completed projects report that their DB projects met their performance requirements.
- Every respondent who has a completed project stated that their DB project met their design requirements.

The R. W. Beck survey showed similar results: 76 percent of respondents would use DB again, and 94 percent would recommend DB to others (R. W. Beck Inc. 2009).

A WDBC-funded study by a consortium of universities observed similar results to the WDBC survey data and the R. W. Beck studies. The consortium included the University of Colorado, Iowa State University, and the University of New Mexico. In 2009, the consortium published a report entitled “Independent Comparative Evaluation of Design-Build v. Conventional Design-Bid-Build Project Delivery for Municipal Water and Wastewater.” The study included a survey of more than 252 owners who completed water and

Table 3-2. Owner satisfaction with design-build

Decision Factor	Degree of Satisfaction*
Single-point accountability	4.8
Having the builder involved in the design process	4.7
Price certainty	4.6
Speed of delivery	4.6
Construction quality	4.5
Fewer change orders	4.3
Flexibility	4.3
Lower costs	4.0

*5 = exceeded expectations; 3 = met expectations, 1 = did not meet expectations

Source: WDBC 2008.

wastewater projects of more than \$3 million in total value between 2003 and 2008. The study compared the performance of traditional DBB and DB project delivery.

The study found that DB projects had a shorter duration than DBB projects. The median duration of design and construction on DB projects was 23 months, compared to 40 months for DBB projects. Design-build projects had less schedule growth than DBB projects. Finally, the value of work completed over a fixed unit of time was nearly three times greater with DB than with DBB. Design-build had an average “intensity factor” of \$1.5 million of project value expended per month versus \$0.6 million per month for design-bid-build projects.

“Design-build removes the traditionally adversarial relationship between engineers and builders.”

—S. Ivan Velez, PE, Deputy Director, Lee County Utilities, Lee County, Florida

FUTURE TRENDS FOR DESIGN-BUILD

It appears that in the future, most utility executives will be motivated to choose DB if allowed by their state and local laws to benefit from qualifications-based contracting and single-point accountability. Single-point accountability may even increase as a reason to use DB as owners scale back their staff to lower their costs and no longer have a large and sophisticated engineering staff to manage traditional DBB projects. As owners learn of past successes of neighboring owners with DB and more streamlined procurement processes, DB will continue to be considered, and they will be more apt to use DB as their delivery method.

The industry has evolved and will continue to evolve. New delivery methods are being developed and some existing delivery methods are returning to favor. Additional competitors are entering the business as they learn more about DB. Some of the prominent developing trends are presented in this handbook and discussed in more detail in subsequent chapters.

Progressive design-build delivery (also known as phased DB project delivery; see chapter 7) is gaining momentum. Municipalities want to capture the advantages of fixed-price DB delivery while avoiding the significant up-front procurement costs and lengthy time required to develop fixed-price procurement documents. Progressive DB also allows the municipalities the opportunity of having their staff work directly with the DB firm or team throughout the project, allowing for as much owner control as possible.

Construction management at risk (CMAR; see also chapter 25) is growing in popularity as a complement to DB. CMAR is a project delivery method in which the client establishes a process to integrate the design and construction phases of a project while contracting separately with the designer and contractor. It still allows the builder (i.e., contractor) to be selected based on qualifications. This is an emerging delivery method that has many variations. WDBC members have seen CMAR become a fixture in the DB business. Figure 3-5 shows the prevalence of CMAR from 2005 to 2010, while Figure 3-6 shows the foothold that CMAR has secured. CMAR use is expected to increase in the water and wastewater business in North America. CMAR shares some of the benefits of DB, while maintaining a contractual structure that is similar to traditional DBB.