Evidence suggests design-build wins in head-to-head competition with other project delivery methods

By Victor Sanvido and Mark Konchar

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Design-build, construction management-at-risk and design-bid-build are the three principal project delivery systems used by the U.S. building industry today. Under the lead sponsorship of the Construction Industry Institute (CII), our recent research empirically compares cost, schedule and quality performance of these methods, using actual construction data from 351 projects.

We looked at projects from 37 states that had been completed within the last five years, ranging in size from 5,000 to 2.5 million sq ft. Our research indicates that design-build beat the other project delivery methods on cost and schedule and yielded quality that was at least equal to or better than the others.

Sanvido and Konchar (right) say design-build is winning cost and schedule battles, while holding its own on quality front.

According to our data, design-build (DB) unit cost was at least 4.5% less than CM-at-risk (CM@R), and 6% less than design-bid-build (DBB). For its part, CM@R unit cost was at least 1.5% less than that recorded for DBB projects.

We defined construction speed as the rate at which the construction team built its facility. Measured in sq ft completed per month, DB work was at least 7% faster than CM@R, and 12% faster than DBB jobs. For that matter, CM@R's speed was at least 6% faster than that of DBB.

Factoring the project team's design effort into its construction speed yields the delivery speed, again measured in sq ft completed per month. In this category, DB's delivery speed came in at least 23% faster than that of CM@R, and 33% faster than the DBB method. And CM@R's delivery speed was at least 13% faster than the traditional DBB method.

These results mirror a similar recent study done in the United Kingdom by the University of Reading's design-build forum. That research showed DB project delivery produced a 12% improvement in construction speed, 30% improvement in project delivery speed, 13% reduction in unit cost and more certainty in finishing on time.

In addition, DB use also produced a greater chance of finishing within 5% of the project's original budget, as well as a higher possibility of achieving specified quality, according to the Reading research.

At Pennsylvania State University's College of Engineering, we conducted our study as part of a task force of 12 industry practitioners chosen by CII. Our scope was limited to measuring the cost, schedule and quality performance in six building categories: light industrial; heavy industrial; multi-story dwelling; simple office building; complex office building; and high-technology structure.

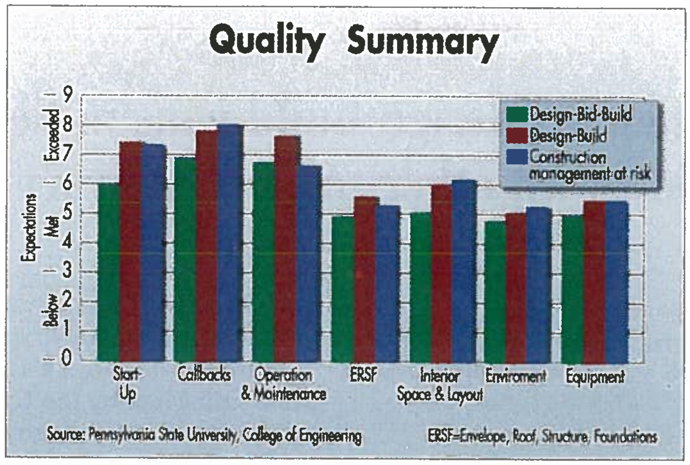
Quality was determined by asking new facility owners to measure the difficulty of their turnover process and the actual versus expected performance of each principal facility system. All surveyed projects had been completed after 1992 and were adjusted for inflation.

We divided our research into four distinct phases. The first developed and pilot-tested a formula to collect and analyze project data objectively. Our comprehensive collection formula included quantitative cost, schedule and quality performance measurements, 19 characteristics of the project team environment, building system characteristics, success criteria and lessons learned.

Next, we interviewed nearly 300 facility owners directly by telephone to obtain objective quality data. The remaining owners responded in written form. After receiving the data, we used several critical checking techniques, such as respondent interviews, to verify answers. These greatly improved the consistency and accuracy of our project data.

Of particular importance, we also conducted a *non*-response study to verify the appropriateness of collected data. We believe this type of verification has never been done before in researching the U.S. construction industry. By gaining additional perspective from a sample who did *not* respond to our initial effort, we were able to validate the fact that collected data was representative of the overall industry.

Finally, our fourth phase tested several hypotheses to distinguish significant differences in delivery performance. Significance testing and multivariate comparisons used nearly 100 explanatory and interacting variables to explain cost, schedule and quality performance.



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Project types

Of the 351 projects we surveyed, 23% were delivered using the CM@R method, 33% used DBB and 44% used DB. Our sample was unbiased toward any of the three project delivery systems.

The six facility types we studied broke out into samples of 28% light industrial projects, 5% heavy industrial, 8% multi-story dwellings, 24% simple office buildings, 18% complex office buildings and 17% high-technology facilities. Of the jobs surveyed, 57% were privately-owned and 43% were publicly-owned.

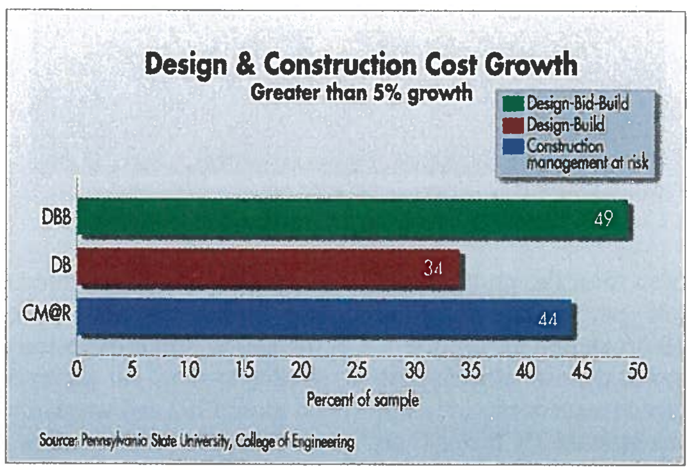
As stated, projects ranged in size from 5,000 sq ft to 2.5 million sq ft. About 28% were less than 50,000 sq ft and

13% were larger than 350,000 sq ft. Some 22% of the projects had unit costs less than \$60 per sq ft, while 26% ranged from \$60 to \$100 per sq ft, 19% from \$100 to \$140 per sq ft, 13% from \$140 to \$180 per sq ft, and 19% were over \$180 per sq ft.

High-technology jobs, nearly one fifth of the entire sample, accounted for most of the high unit costs, while light industrial facilities made up the bulk of low unit cost structures.

Responses came in from private and public owners (32%), design-build entities (28%), architects and designers (8%) and general contracting or construction management firms (32%).

This research offers a performance-based, empirical investigation of the three principal delivery systems used in U.S. industry today. It is hoped that an effort will be made to use our data as a benchmark from which comparisons between systems can be made in the future.



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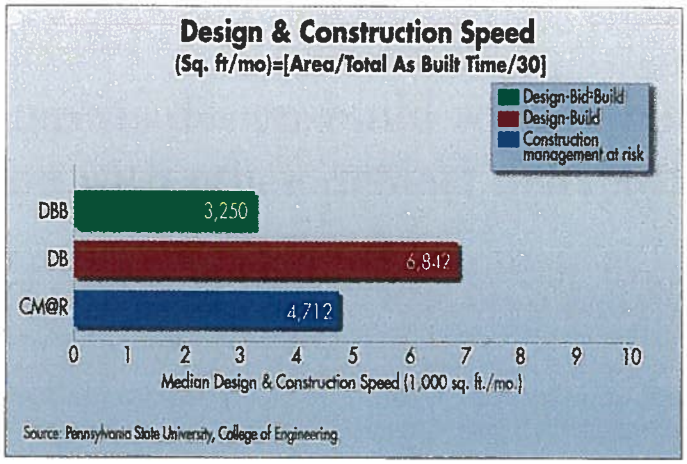
Statistical regression was utilized to explain the variability of unit cost, construction speed and delivery speed among all projects. This process explained the highest level of variation about unit cost and speeds. Using regression, the effects of each delivery system on each of these metrics were separated from the effects of other explanatory variables.

Quality checks

Quality performance was measured in seven specific areas. The facility owner was asked directly to rank the actual performance of their facility, versus expected performance. The mean performance of each project delivery system for individual quality metrics shows that design-build projects achieved equal, if not better quality results on average than the other projects studied. Admittedly, quality results are offered separately because it is the least objective of all the metrics that we calculated.

In the turnover process, a score of 10 represents low difficulty of facility start-up, and a low number of callbacks and maintenance costs for the facility. A score of 5 represents that there was medium difficulty, and a score of 0 reveals high turnover difficulty, the worst possible outcome. DB and CM@R significantly outperformed DBB start-up quality, each scoring about 7.5 on our scale. DBB scored about 6.



Similarly, DB and CM@R significantly outperformed DBB work in terms of callbacks, both scoring about 8 to DBB's tally of 7. DB also beat both CM@R and DBB in terms of operation and maintenance quality, scoring close to 8. The other methods both scored slightly below 7.

We consistently found that the top performing jobs shared several attributes. Of these projects, 95% had an adequate to excellent ability by the owner to make decisions; 90% had adequate to excellent scope definition; 87% boasted excellent team communication; 85% had a qualified contractor pool; and 71% had a high ability to restrain the contractor pool.

Of the worst performing jobs, 73% engaged the contractor late in the design process; 76% had limited or no prior team experience; 69% had numerous onerous contract clauses; 65% had poor ability to make decisions; and 62% did not prequalify bidders.

From this data, it seems that design-build project delivery offers the project team the highest chance of attaining successful project attributes and also has built-in

mechanisms that allow the owner to prevent against the worst attributes.

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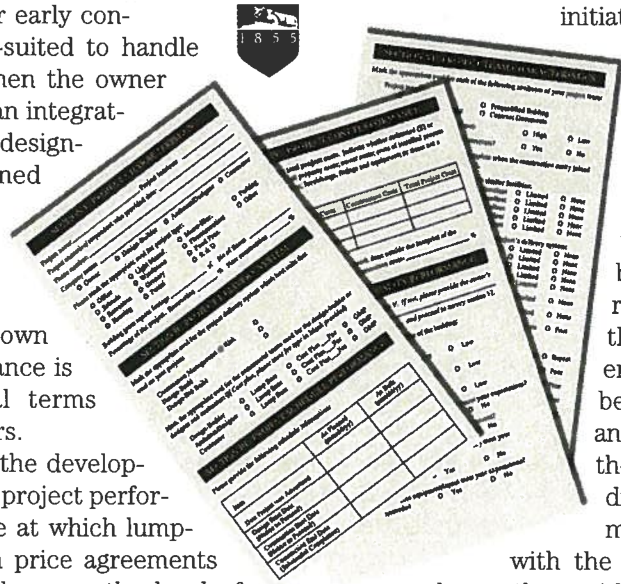

The benefit of having either early contractor input or a team well-suited to handle changes was only realized when the owner had the capability to manage an integrated approach. By definition, design-build projects generally gained construction input very early, engaging the construction entity when little of the design was complete.

Our research also has shown that project delivery performance is affected by the commercial terms between project team members.

However, it is unclear how the development of these terms relates to project performance. It seems that the time at which lump-sum or guaranteed maximum price agreements are set is important. This is because the level of uncertainty that exists at the 10 to 30% design stage—regardless of the facility type—allocates a great deal of risk in the agreement between the owner and bidder.

As designs become more certain, costs become more firm. Therefore, setting project costs early may initiate long-term growth in cost if preliminary estimates or projections are inaccurate, or miss appropriate contingencies.

Collaboration

Finally, our study has shown that a collaborative environment between industry and the research community can foster the advancement of project delivery systems. In particular, alliances between universities, corporations and trade organizations can promote the execution of future research directions. These are driven primarily by owner dissatisfaction with the delivery process and efforts to educate them with specific performance data.

Structural changes in construction, we believe, will demand a more focused balance of education, research, and application by industry/university partnerships. ■