

Commissioning and the Design/Build Process

Greg Cunningham, AIA and Jonathan Soper, P.E.
Enovity, Inc.

Synopsis

Developing a design/build project offers unique challenges when commissioning is an owner objective. The potential benefits of the design/build approach, which include cost and time savings, are facilitated by the owner giving up a great deal of design control and by shifting most of the risk to the contractor.

Commissioning program elements for design/build and traditional design-bid-build are fundamentally the same; both require stakeholder input at the earliest stages and oversight throughout the process. But by shifting the responsibility of commissioning entirely onto the contractor, the Owner runs the risk of allowing the fox to run the henhouse. By intelligently including commissioning elements within the design/build contract, and by creating proper review and oversight, an owner can create a structure that allows the contractor design flexibility while ensuring that the completed building operates at peak energy and operational efficiency. Planning and effective oversight are key to successful commissioning in design/build projects.

In most cases it is impossible to complete a detailed commissioning plan for the bridging documents because the building systems have not yet been fully designed. How does an Owner achieve their commissioning goals given these constraints? What elements need to go into the bridging documents? Who writes the commissioning specifications and commissioning plan? How do the lines of commissioning authority differ? How are energy efficiency goals established and verified?

This paper describes some of the important issues related to commissioning in design/build projects and will summarize the authors' experience on projects that used different approaches to achieve success.

About the Authors

Greg Cunningham, AIA and Jonathan Soper, P.E. are co-principals of Enovity, Inc., a San Francisco-based commissioning provider and energy engineering firm. The firm's recent commissioning work has focused on large design/build construction projects for federal and local governments. Enovity is a member of the Building Commissioning Association. Mr. Cunningham has written papers and has been a presenter at conferences and seminars on a diverse range of topics related to building performance and energy solutions throughout his more than 25 years of professional service. He is a member of the American Institute of Architects. Mr. Soper is a licensed engineer and specialist in building operations and performance, commissioning, and measurement & verification. He is a member of ASHRAE.

Introduction

Over the last ten years or more, design/build construction has seen a dramatic rise in popularity as an alternative to traditional design-bid-build (low-bid) construction. Design/build project delivery has grown from 5% of U.S. construction in 1985 to 33% in 1999, and is projected to surpass low-bid construction as early as 2005¹. Owners, particularly in the public sector, look at design/build as a way of saving time, money and aggravation in light of constrained funds and bureaucratic red tape involved in launching a construction project.

The rise in popularity of the building commissioning process comes at a time when design/build construction is at an all-time high. The design/build process requires that the owner relinquish some level of control over the design and construction details but not at the expense of building performance. Building commissioning gives owners assurance that the completed building performs as required, and the need for commissioning is especially crucial in design/build construction because the contractor is contractually responsible for executing the detailed commissioning elements of the construction documents.

There are plenty of cases of design-bid-build projects where the best owner intentions for commissioning success go awry; lowest-bid, inadequately specified, planned and executed commissioning efforts often result in poorly operating facilities. Similar pressures exist in design/build construction, but the key is that the owner must clearly communicate performance expectations within the design/build contract.

The commissioning process for design-bid-build and design/build is fundamentally the same. Design/build offers unique challenges for the owner and demands a level of attention to process detail, especially for those not well-versed in the legal complexities of the contract.

There are a number of steps that an owner and commissioning team should address that are unique to the design/build process. This paper will explore the unique challenges of planning the commissioning process in developing design/build projects, with an emphasis on larger public sector endeavors. It will explain the advantages and disadvantages of design/build compared to other delivery methods, will outline the nuances of developing performance specifications, will discuss the responsibilities for commissioning activities including who creates the commissioning plan, will explore the process of selecting the contractor, and will discuss the similarities in commissioning during the construction phase between design/build and design-bid-build.

Advantages and Disadvantages of Design/Build

There are a number of good reasons for the growth of the design/build project delivery system. Contractors have unique and highly evolved skills in the area of construction means, methods and cost estimating and design/build can leverage those capabilities to the mutual benefit of the owner and contractor. In design/build the contractor is rewarded for finding ways of building

¹ Construction Specification Institute, 2003

things smarter, better, and faster. For owners, design/build can provide refuge from the “low-bid” syndrome where contractors find ways to secure greater margins through the “creative change order” process.

There are a variety of other factors that make design/build attractive to owners. Design/build allows the owner to take advantage of the potentially superior project management experience of contractor. Having a single entity responsible for design and construction can reduce owner costly administrative and project management costs, particularly in the public sector, although like many aspects of design/build, the owner still pays for these services, whether they are executed by the design/build team or by the owner’s team.

Another key advantage is potentially shortened design and construction timeframes since the contractor is generally allowed to proceed with whatever independent or concurrent design and/or construction activity that expedites the project. This can work well as long as owners begin with a good understanding of the process as well as the inherent risks, and assuming that adequate project oversight is maintained.

Perhaps most advantageous to the owner is the potentially lower construction costs that can occur through innovation and value-add processes that the design/build team can undertake without being overly constrained by the multi-tiered design approvals. In this way, design changes can be more easily facilitated if they are a proven best value. With a quality design/build team, this can also result in a more “integrated design” approach that ultimately benefits the owner. Finally, an owner can gain a better understanding of the expected costs at an earlier stage in the design and will be able to adjust those expectations based on the reality of the construction marketplace rather than risk a time-consuming and costly complete re-design and/or change order effort.

The design/build process can be a leap of faith for the uninitiated. The traditional design-bid-build approach offers the security of control over design decisions; giving up this control can be considered risky for those distrustful of contractors. But it is also clear that there are equally challenging risks to the owner in the low-bid approach. Measured by the level of effort taken to develop the information in the design/build contract, an owner can control how much flexibility the contractor is allowed, what items are critically important and, wherein like commissioning, there is no room for compromise.

Perhaps the most important negative perception of design/build is its potential to result in a completed building that does not rise above a minimum quality standard. Herein lies one of the most important dilemmas for design/build planners: how does the owner convey the full weight of expectations for the building “look and feel”, as well as the expected high performance and maintainability, without undermining the contractors incentive to perform “smarter, better, and faster”? Poor communication of owner expectations will result in a minimally-performing building while over-specification of the project will undermine the potential for cost savings and application of innovative design features and construction methods.

There are a variety of factors that influence an owner's decision about how much detail to include in the Design/Build Request for Proposal (contract documents), including the program constraints, environmental criteria, street pricing uncertainties, the capabilities of the pre-qualified design/build pool, and the amount of risk with which the owner is comfortable. For public projects, where the design often requires approval by an independent design review authority, owners will often pre-design the building in order to obtain preliminary approval prior to the design/build contract. In that way the contractor's risk and the higher costs of approval uncertainty are reduced.

Finally, a design/build team that does not work well together can cause problems during detailed design, construction and/or commissioning, adversely affecting the final product. While this is also a potential problem for low-bid projects, it is especially critical for design/build projects, where having everyone on the same page is an absolute necessity.

In summary, there are many valid reasons for owners to consider design/build, but for many, negative perceptions about the construction industry must be overcome. However, with proper planning, management of risk and adequate oversight, an owner can take advantage of the best that design/build offers, while maintaining control over their commissioning and related Q/C programs.

Commissioning in the Design/Build Process

Owner's Project Requirements

A key first task in the development of any commissioning program begins with the distillation of the owner's requirements into narrative form. In design/build projects this narrative is usually developed by the team of architectural/engineering professionals hired to produce the contract documents. In larger public competitively-bid design/build projects, these contract documents are the Request for Proposal (RFP), which includes contract terms and the "bridging documents" (drawings and specifications) that convey the project architectural program requirements and building performance specifications.

The document that distills the owner's requirements is referenced by ASHRAE's Commissioning Guideline Committee GPC-1-1996R² and is similarly referred to here as the Owner's Project Requirements (OPR). Developing and documenting the OPR is fundamental to proper commissioning in both design-bid-build and design/build projects. However, while design-bid-build allows detailed plans and specifications to accurately convey owner requirements, OPR is more critical in design/build projects because it may be the only document available to the design/builder that conveys the expectations of the user and operator. The OPR is the reference document used continuously throughout the commissioning process, by the

² ASHRAE Guideline 1-1996, The HVAC Commissioning Process) uses the term "design intent" to describe the owner's project objectives and/or requirements. In recent ASHRAE articles, Stum, Dorgan and others have further re-defined design intent as the Owner's Project Requirements (OPR). They point out that many documents entitled "Design Intent" only convey the systems descriptions and systems performance expectations of the designer. The authors continue to encounter this mis-application on a variety of projects.

bridging team, commissioning agent and contractors, as the benchmark for the expected performance and operational imperatives of the project.

The development of OPR is often facilitated by owner-stakeholder-bridging team workshops, interviews and end-user surveys. OPR authors must avoid their own biases when assimilating this data. The OPR should be open for change and amendment, particularly during the bridging documents/RFP development stage, as project goals and expectations collide with and impact the budget realities.

The OPR document should include all owner project goals and requirements; i.e., LEED™ Silver rating, lowest life cycle cost, controls integration to other owner facilities, etc. The OPR can also include budget and funding constraints and payment schedule, environmental constraints, construction completion milestones, existing conditions, and other critical and mandated criteria.

Developing Performance Specifications as Part of Bridging Documents

Contrasted to the OPR document, a Basis of Design (BOD) document takes on new meaning (and value) for design/build projects. In design-bid-build projects the BOD may include narrative descriptions of building systems along with the designer's programmatic, energy, operational, maintenance, code and other performance criteria demanded for those systems. For many design/build projects the BOD includes no narrative systems descriptions; often only the performance criteria (performance specifications) and the OPR together serve as the roadmap that will be used by the design/build team in developing the detailed design and construction program. The OPR and BOD are the two documents that form the basis of the design/build construction contract between the owner and builder.

The BOD is the written performance specification, developed from and an extension of, the OPR document. The BOD defines the design criteria and boundaries allowed to the design/build team for development of the solution. The Design/Build RFP that is prepared by owner's legal counsel and bridging team includes the contract terms and conditions, OPR, BOD, and graphical/narrative representations of programmatic requirements necessary to convey the owner's entire building program.

For those unfamiliar with the development of the design/build bridging document package, the process of creating a performance specification can be somewhat challenging. A good design/build performance specification is one that accurately, concisely and thoroughly encompasses all of the requirements of a system without being so prescriptive as to limit the range of solutions, unless that happens to be the intent of the owner.

While CSI-based specifications have been used for developing performance specifications, the CSI format was originally created for design-bid-build project delivery. Others have recently stepped in to create specification formats that are arguably better tailored to design/build. One example is *PerSpective*, a specification system that uses project performance-based templates organized around a database of integrated construction disciplines. *PerSpective* includes basic

commissioning language with tags to related sections that can be helpful in fleshing out commissioning elements. The author's limited experience with this system suggests that, even with a relatively steep learning curve, it can help in the development of performance specifications that are better adapted to the requirements of the design/build approach.

It is far easier to create performance specifications for generic building systems than it is to create comprehensive performance-based commissioning requirements because commissioning tests and acceptance criteria tend to be system-specific. To the extent that these are normally covered in the commissioning specifications for design-bid-build projects, they can similarly be adapted to design/build. However, design/build performance specifications must encompass not only the elements of traditional commissioning specifications but also convey the requirements of the entire commissioning program, while maintaining conciseness and clarity.

The requirements of the entire commissioning program are normally the domain of the Commissioning Plan. In design-bid-build projects it is preferable to develop a Commissioning Plan in concert with commissioning specifications, thereby fully informing all parties about the length, breadth, scope and potential cost implications of the commissioning program prior to the execution of the contract. In design/build projects, this is not possible or practical. A Commissioning Plan should outline the "who, what, where, how, when (and why)" of the commissioning program. In most cases, there is no "what, where, how and when", and in cases of a competitively-bid RFP, the "who" is also missing. The challenge for design/build projects is to convey as much of these commissioning program requirements within the performance specifications.

Commissioning performance specifications can be developed that convey the elements and expectations of the commissioning program while including provisions for development of the Commissioning Plan. These specifications should outline roles, responsibilities and milestone deliverables for the parties involved in the commissioning effort during the detailed design and construction phases, a description of the types of systems (scope) expected of the commissioning, the level of expected commissioning (performance), lines of communication, the responsibilities of the owner's commissioning authority, and the elements to be covered in the Commissioning Plan. In developing commissioning performance specifications, the author should strive to minimize potential conflicts between related sections so that the requirements of subcontractors are clear.

In cases where the owner's commissioning program is predicated on owner-hired independent third party commissioning oversight (commissioning authority), we recommend that the specification require the design/builder to empower a "Commissioning Coordinator" (contractor's agent) who assumes responsibility for coordination and communication between the designers of record and subcontractors within the design/build entity throughout the design and construction project phases. By requiring that a sole design/build representative report directly to the owner's advocate, communication, reporting and documentation is centralized, helping to minimize misunderstanding and finger-pointing during the critical project phases.

Provided that the performance specifications included in the bridging document package adequately stipulate the requirements for the Commissioning Plan, who develops the Plan becomes arguably less important. Where the owner has hired a third party Commissioning Authority, that entity can create a Design Phase Commissioning Plan for the project after contract award and during the earliest detailed design stage. This requires design/builder “buy-in”, with the potential for trouble if the commissioning program scope and costs have not been appropriately understood by the design/builder and subcontractors. This approach still relies on the design/build team to provide a significant level of involvement in the development of the construction phase Commissioning Plan, starting with design development review, and through the submittal process and approval of test procedures and methods. In stipulated sum contracts, some design/builders might favor this approach as it takes the cost of developing the Plan out of their scope. The owner pays for the development of the Plan in either case. However, having the Commissioning Authority develop the Commissioning Plan can provide the owner with a greater level of assurance that the commissioning program is developed and overseen by an entity under their direct control.

When the design/build team is required to develop the Commissioning Plan, oversight and approval of the plan by the owner, bridging team and/or Commissioning Authority must be ensured. Some see an advantage to this approach as it empowers the design/builder to “take ownership” of the commissioning process, leveraging the skills and experience of the designers and subcontractors hired by the design/builder. This approach forces the design/build team members to focus on the commissioning program while they actively develop the plan, rather than being “reactive” to a plan forced upon them.

Some owners may be reluctant to give away so much of the Commissioning Plan development responsibility to the builder. This can be especially important in larger competitively-bid public projects where it is not unusual for the owner to effectively give up control over who the design/builder elects to manage the commissioning program. The owner takes arguably more risk in giving up direct control over the development of the Commissioning Plan in that it sets up the potential for the fox guarding the henhouse. The authors recommend that if an owner chooses this approach, a third party Commissioning Authority should be hired to oversee and watchdog the process, supported by as much legal authority as the contract allows.

Whether the Commissioning Plan is developed by the design/builder or a third party, the Commissioning Specifications that are developed coincident with the detailed design should remain the responsibility of the designer of record. The commissioning specifications help bridge interdisciplinary responsibilities and confirm the scope of the commissioning activities by discipline. These can be reviewed and approved by the owner, bridging team and commissioning authority.

The process of identifying and selecting the design/builder is equally important in ensuring a smooth and effective commissioning program. In large public projects, a pre-qualification process is often used and the owner can establish the minimum qualifications of the design/build team in the commissioning arena. The authors have had success with a “weighted points” system that facilitates evaluation of these qualifications together with other specific experience

requirements. In developing the pre-qualification criteria, it is necessary to have decided on the manner in which the program will be executed; i.e., who will develop the Commissioning Plan, will there be a third party Commissioning Authority, etc.

The pre-bid conference allows the owner and owner-advocate the opportunity to further query the design/build team regarding commissioning experience, and more specifically, the qualifications of the individuals directly responsible for directing the commissioning effort. It also affords the design/builder the opportunity to confirm specific contract and performance specifications language, benefiting all parties by limiting potential for miscommunication prior to final selection (in competitive bidding) and before contract award.

Following contract award, the roles and responsibilities of bridging team members tend to be focused primarily on certifying that the detailed design and construction documents conform to the OPR. The Commissioning Authority can assume a greater or lesser role, depending on who develops the Commissioning Plan.

The following is a discussion of recent large-scale public design/build projects in California that are shown as examples of varying approaches to development of bridging documents, the Commissioning Plan, and delineation of commissioning roles and responsibilities.

Case Study One: Capitol Area East End

The Capitol Area East End Complex was completed in early 2003 and is the largest design/build office building project ever completed for the State of California. Begun in 1998, the project includes five office buildings totaling 1.4 million square feet, two central plants and parking facilities, located adjacent to the State Capitol in Sacramento. The authors assisted in the development of the design/build bridging documents, created energy performance specifications, assisted in development of project sustainability (LEED™ performance), and provided commissioning oversight for four of five buildings in the latter project stages.

The project was separated into two design/build contracts: one encompassing four of the five office buildings together with a central plant (Blocks 171-174), and the other for one large stand-alone office building with a dedicated central plant (Block 225). Each project was competitively bid using a stipulated sum (maximum guaranteed price) design/build contract. Bidders were encouraged to offer additional project “best value enhancements” that exceeded the RFP requirements in order to gain a competitive advantage.

The effort to develop the bridging documents was significant and exceeded many typical design/build projects, largely due to the high standard of performance desired by the State. These standards encompassed commissioning as well as energy efficiency, sustainability and structural and architectural elements. LEED™ certification was a pre-requisite.

The project’s proximity to an established neighborhood necessitated public input that ultimately resulted in approval of a clearly delineated architectural scheme. The greater level of architectural detail required for public review resulted in a bridging document that greatly

limited architectural design flexibility, outside of architectural detailing and construction means and methods.

In order for the State to ensure that the project could meet the stringent energy performance and sustainable building requirements within the available budget, options for a variety of building energy systems and their effect on energy performance were confirmed through computer modeling. This largely became an exercise in verifying that the energy performance requirements could be achieved within the project budget.

The combined A/MEP design and analysis effort to develop the RFP exceeded that for many design/build projects but gave the State confidence that the completed project would be acceptable to the local community, would be sustainable from an energy and operational perspective, and could be built for the stipulated sum.

The RFP commissioning requirements were not extensive and largely relied upon the professionalism, capabilities and experience of the design/build contractor. The State's chose to allow the design/build to "take ownership" of the commissioning process, including authorship of the Commissioning Plan. This was in line with the contractual terms built into the design/build contract, where the State was limited to "review and comment", rather than "approval" of all design documents, submittal and other documentation required by contract. Avoiding approval of submittals shifted most of the entire risk away from the State. For commissioning planning and execution, the State had no actual contractual "authority", instead relying on the State's own construction inspectors only to review and comment on the progress documents.

The State pre-qualified three design/build contractors for each project and received multiple qualifying proposals for Block 225. The winning proposal for Block 225 offered additional enhancements including an underfloor air distribution system which the State agreed to help underwrite, in part to demonstrate the viability of the technology. The Block 225 design/build assembled a team with experience in innovative design, energy efficiency, sustainability and building commissioning. This project was completed relatively smoothly and the design/build team diligently wrote and executed their Commissioning Plan that was begun as soon as the contract was awarded. The project recently was awarded a LEEDTM Gold certificate by the U. S. Green Building Council.

The State received three bids for the Block 171-174 project but none included full compliance with contract terms for the stipulated sum. The State was faced with the choice of revising the RFP and re-bidding to better conform to economic realities, or to negotiate with one of the design/builders. The State chose the latter and a contract was awarded after contract concessions were made. However, the commissioning and energy performance requirements were maintained. Needless to say, the project did not include any design enhancements that had been hoped for by the State.

The Block 171-174 design/build did not embrace the commissioning program as diligently as the Block 225 team. A Commissioning Plan was not submitted for review until well into the construction phase and the overall effort clearly lacked the level coordination and planning

expected by the State. As the commissioning performance specifications in the contract were not rigorous, the contractor elected to focus on other more challenging aspects of the project. The State elected not to utilize outside resources to help in commissioning oversight until late in the project and became distracted by other problems that arose early during construction.

Likewise, the energy computer model submitted by the design/builder to verify compliance with the State's goal overstated the performance when compared against the design documents. In an attempt to remedy the situation, the design/builder proposed a systems design change that they claimed would satisfy the energy goal while maintaining proper operational performance. The State was skeptical and called upon the authors to design and oversee commissioning tests to verify proper operation of the altered systems. After repeated system failures during commissioning, the change was rejected by the State. In the end, the contractor was forced to meet the contracted performance requirements by adding additional controls that were not originally included in the design.

Since its opening, the Block 171-174 project has been plagued with operational problems that still have not been completely resolved fourteen months later. For example, chronic comfort complaints may be related to non-compliance with performance specifications that stipulated the minimum number of VAV boxes. The State is in process of retro-commissioning these buildings and is requiring that the design/builder correct these problems prior to expiration of warranty. Many of these problems would have been detected and corrected if a proper commissioning program had been planned, executed and overseen.

Lessons learned from the East End Complex point to the potential problems that can occur when an owner fails to establish, control and maintain oversight of the commissioning program. This is particularly true in a competitively bid environment, where constrained funds can put pressures on design/builders to circumvent a comprehensive quality control program. Fortunately at the East End Complex, late construction phase third party oversight helped to avoid at least some potential operational problems. The design/build option offers many potentially attractive features, not the least of which is the ability to shift most of the risk to the design builder. However, without proper oversight, owners run the risk that design/builders will chose expediency at the expense of performance.

Case Study Two: A Tale of Two County Projects

The Alameda County GSA manages a growing portfolio of owned and leased buildings in one of the Bay Area's largest communities. Over the next five years, the County expects to invest from \$600 to \$700 million, totaling more than 2.5 million square feet, in new County facilities.

As part of this building program, the County has undertaken two large design/build projects that feature performance specifications encompassing progressive energy, systems commissioning and automated building controls. The two projects are the \$135 million Juvenile Courts and Detention Facility and the 200,000 square feet East County Hall of Justice.

The County has been aggressively pursuing energy performance and sustainability in its existing and new buildings program and the performance specifications developed for these projects include a minimum LEED™ certification requirement in addition to a measurable energy efficiency target that is based on exceeding California's stringent energy standard. The energy performance requirements are tied to the commissioning specifications, thereby relying on both computer modeling and the commissioning program to verify and sustain expected facility operational goals. The County's progressive building automation controls specification, which prescribes interoperability with other County facility control systems; i.e., BACnet™ and LonWorks, calls for point lists, trending capabilities, power monitoring and data collection activities that will facilitate commissioning tests and post-occupancy re-commissioning.

The commissioning specification defines design/build contractor roles and responsibilities while maintaining authority within the owner's Commissioning Authority. It describes commissioning programmatic activities beginning with detailed design through the post-occupancy phase, includes planning, scheduling, coordinating, documenting and reporting requirements. It calls for the Commissioning Plan to be developed by the Commissioning Authority and for the design/builder to name a Commissioning Coordinator, with specific design/builder deliverables to complete the Plan. Cross-referencing within the commissioning, energy performance, mechanical, electrical, lighting and building automation systems informs the design/builder's subcontractors of their scope items.

While the commissioning specifications for the two projects are virtually identical, the rest of the bridging document packages are not. The Juvenile Justice bridging documents included only conceptual drawings, allowing a great deal of design flexibility by the design/builder. Conversely, a greater level of effort was required to complete the bridging documents for the East County Courthouse, where, like the East End project, local community design review impacted the building's appearance. In both cases, value engineering and energy performance modeling help to validate conceptual building systems that could meet the stringent goals within the stipulated budget.

At the time of this writing, the County is waiting on proposals for the Juvenile Justice Facility and the RFP for the East County Courthouse is nearing completion. These projects have been met with a great deal of enthusiasm by the local building community and the County is looking forward to the challenging detailed design and construction phases where the commissioning program will be put to the ultimate test.

References

Carpenter, Stephen and Duschense, Rock: Achieving Green Buildings Using the Design/build Process.

Dorgan, Chad; Dorgan, Charles; Grindle, Chad: Developing Owner's Project Requirements During Pre-Design. ASHRAE Transactions, 2002, vol. 108, pt. 2.

Emmons, Terrel M., FAIA: Contracting Approaches: Their Plusses and Minuses from a Sustainability Standpoint. Office of the Architect of the Capitol, Ford House Office Building, Washington, D.C. 20515

Stum, Karl: Design Intent and Basis of Design: Clarification of Terms, Structure, and Use. . ASHRAE Transactions, 2002, vol. 108, pt. 2.