

## **Critical Commissioning Communication**

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### **Synopsis**

Do all hugely successful commissioning projects share common attributes relative to communication? Is there a common thread in the weave of all disastrous commissioning projects? Do these commonalities determine the level of commissioning success for any given project? Through reflection on 25 years of combined building commissioning the authors have identified specific elements of communication that were shared by all of their most successful projects; and which were lacking in the most difficult ones. This paper summarizes these critical communications of a commissioning program, identifies the needed elements to make these communications effective and finally compares two projects as examples.

### **About the Authors**

Karl Stum is a senior mechanical engineer and project manager focusing on building commissioning for large facilities. He was the 2001 winner of the Benner Award for Commissioning Excellence. He was on the founding board of the Building Commissioning Association and on the ASHRAE committee that just completed Guideline 0—The Commissioning Process.

Kent Barber has been a building commissioning provider since 1992. He is one of the original founders of the Building Commissioning Association (BCA), and he assisted the State of Idaho in developing their new building and retro-commissioning guidelines. Kent's primary field of expertise is HVAC systems commissioning. Presently he is the Vice President of the Northwest Chapter of the BCA.

## Overview

Do all hugely successful commissioning projects share common communication attributes? Is there a common thread in the weave of all disastrous commissioning projects? We began asking ourselves these questions hoping to identify commonalities appear to be key determining factors for achieving commissioning success. After reflecting on our 25 years of combined commissioning experience, we believe that we have identified several elements of communication that have had critical impact on the success of our past projects. All of these elements were addressed well on our most successful projects, while they were ignored, or not well emphasized, on our most difficult ones. They fall broadly into three broad categories: 1) communicating important functional requirements and intent, 2) clarifying commissioning processes that are repeatedly found confusing by owners, contractors and designers, and 3) utilizing successful communication styles and avoiding ones that don't work. The following paragraphs summarize the elements by category.

### ***Communicating Functional Requirements and Intent***

The Building Commissioning Association (BCA) defines the basic purpose of commissioning as follows: "*The basic purpose of building commissioning is to provide documented confirmation that building systems function in compliance with criteria set forth in the Project Documents to satisfy the owner's operational needs. .... This definition is based on the critical understanding that the owner must have some means of verifying that their functional needs are rigorously addressed during design, construction and acceptance.*" As recognized by this statement, a primary goal of commissioning is to verify that the owner's functional needs are satisfied throughout the process of designing, building and turning over the project. Our project experience indicates that the most effective way to do this is to make the owner's needs and the designers' intended means of addressing them, common knowledge for the entire project team, from concept design through owner acceptance. This is a challenging communication task, given the disjointed nature of typical design/construction processes.

Even the best construction plans and specifications tend to be materials and methods oriented, with limited information regarding the functional performance goals of the project. As a result, contractors and commissioning authorities may end up following the plans and specifications and still not addressing the owner's needs, as the designer intended. Our experience shows that clearly communicating the following information in a user-friendly manner makes a critical difference to the long term success of a project. Commissioning documents that contain this type of information have already been described and promoted by others. Our purpose is to emphasize how the effective use of these documents can make a critical difference to a project's success.

### ***Owners Functional Requirements***

In order for owners to receive a product that fulfills their expectations, designers, contractors and commissioning professionals need to understand how owners expect their new buildings to function, and how they intend to measure the project's success. Understanding the owner's

functional requirements is the cornerstone of the commissioning process. The design/construction team needs a document that:

- Details the functional requirements of a project
- Explains how it will be used and operated
- Describes the project design goals and measurable performance criteria.

This document may be viewed as tool by which the functional success of the project is measured. Such a document is obvious importance to the design and commissioning teams; however, we have seen conscientious contractors ask for this sort of information in order to facilitate their performance.

An example of the value of documenting the owner's functional requirements is an actual incident in which the contractor consulted the owner about a sequence of operation that he was having difficulty implementing. He asked the owner what the functional goal actually was. The owner's answer soon revealed that the designer had not understood the owner's actual need regarding this system. As a result, considerable time was wasted designing, building and trying to get the wrong system to work. Documenting the owner's functional requirements might have alerted the designer, commissioning authority and owner to the mistake early in design. Better yet, it may well have helped the designer avoid this mistake in the first place.

ASHRAE Guideline 0 refers to documentation of this type as the "*Owner's Project Requirements*" (OPR). The OPR can be documented effectively by experienced owners, designers or commissioning professionals that fully understand the purpose of the document and believe in its importance.

### ***Designer's Functional Intent***

A design is successfully implemented when it performs as designers intended it to work. However, project plans and specifications focus on construction materials and methods, often without clearly communicating how the final product is supposed to function. Even sequences of operation often describe the operation of single items of equipment, neglecting to explain what the designer intended it to accomplish relative to the big picture. Full knowledge of the designer's functional intent is critical information for contractors and commissioning professionals tasked with successfully implementing and commissioning a project. We're aware of several instances where not understanding the design wasted critical construction and commissioning time. Documenting the designer's functional intent early in design also provides the designer, owner, and commissioning professional with a tool to verify that the design goals are consistent with the owner's functional requirements.

The Basis of Design Document for this project records the concepts, design assumptions, important calculations, decisions, and product selections used to satisfy the Owner's Project Requirements (OPR), regulatory requirements, and industry standards and guidelines. The document, which consists of narrative descriptions and data, evolves throughout the design process, cross-referencing the OPR, and documenting and explaining the reasons for changes as they occur. Updated editions of the Basis of Design Document are required as a part of each design submittal

Typically a separate document is thought of for documenting the designers' functional intent. ASHRAE Guideline 0 calls this the "*Basis of Design*" document, and the LEED® system refers to the design narrative. An alternative that we've seen very successfully employed is to include a statement of the functional intent along with the associated sequences of operation and equipment specifications. More critical than the exact format of this documentation is that the information be readily available and easily understandable. Important document content includes:

- A description of functional performance goals
- Critical and anticipated systems interaction
- Design assumptions;
- Decisions and selections made to satisfy the Owner's Functional Requirements, regulatory requirements, and industry standards and guidelines.

Effective means of communicating the information within the documentation are:

- narrative descriptions
- 1-line system diagrams
- control logic diagrams or statements
- cross-referencing the owner's functional requirements

We suggest that a formal owner and commissioning professional review be a part of the design process. For the construction phase we recommend that the project specifications require some form of contractor submittal verifying their understanding of the designer's functional intent. One form of this is a *control/implementation logic submittal*, described in the following section.

### **Control / Implementation Logic Clarification**

In order to successfully commissioning a project it is essential that the commissioning team understand the owner's functional requirements and the design engineers' functional intent. It is equally critical for the owner, designer contractor and commissioning professional to obtain a common understanding of how the contractor intends to implement the functional requirements of the design. For HVAC systems, a significant part of this is understanding the specific control logic that the contractor intends to use to implement the specified sequences of operation. As an example consider the following sequence of operation for resetting the discharge air temperature (DAT) for an air handling unit (AHU) that serves a constant volume reheat system: "the air handling unit discharge air temperature shall be reset based on the zone cooling and heating requirements." This sequence, which uses the wording from an actual project, can be implemented in several ways. Simple control logic statements for two possible approaches are:

- Option A: Repeat the following every XX minutes:  
If the lowest heating output of all of the terminal units is greater than Y%; then increase the DAT setpoint by X°F.  
If the lowest heating output of any terminal units is less than Z%; then decrease the DAT setpoint by X°F.
- Option B: Repeat the following every XX minutes:

If the average of the heating outputs to all of the terminal units is greater than 5 Y%; then increase the DAT setpoint by X°F.

If the average heating output to all of the terminal units is less than Z%; then decrease the DAT setpoint by X°F.

The specific control logic used has an effect on the way the design functions. Option A, which is weighed toward making sure that adequate cooling is provided for all zones, might be preferable for a system serving a temperature critical environment, such as a Lab system. Option B might be preferable where it might be acceptable to sacrifice some level of temperature control in order to increase energy savings. Different test procedures are required to verify the functional performance of each of these approaches. Without knowledge of the designer's functional intent, it is possible for the system to operate well using one logic approach and still fail a functional performance test that is perfectly valid for the other. The resulting confusion can cause critical delays and expense during the stressful time and cost sensitive project closeout period.

We prefer to see the control logic specified by the design engineer as a part of the project plans and specifications. This can be done effectively using logic diagrams or simple logic statements, such as the ones used in the preceding AHU DAT example. Specifying the control logic in the bid documents has several advantages:

- It gives the design engineers more control over the functional details and ultimate performance of the systems they have designed
- It further clarifies the designer's functional intent for the contractors and the commissioning professional
- It provides enough information during the design phase to allow fully developed draft functional performance test procedures to be included in the bid documents, which improves project bid-ability.

Another alternative is to specify a requirement for the DDC contractor to submit the control logic documentation as a part of their shop drawing submittal. The DDC logic submittal review is used to verify that the sequences of operation will be implemented in full accordance with the designer's functional intent, and the final product becomes the basis for the function performance test procedures. Various combinations of specifying control logic and performing control logic submittal reviews may also be effective.

Many design engineers and DDC contractors resist control logic specifications and reviews when they first encounter the concept. The benefits of this type of communication become obvious, however, to all who try it. On one project, the exchange of this kind of information early in the process helped develop the contractors, designers, owner and commissioning professional into a particularly strong commissioning team. All team members took proud ownership of the control logic, the functional test procedures on which it was based, and the resulting systems' performance. The DDC contractor even incorporated the functional performance test procedures into their internal quality control. In the end functional testing was completed ahead of schedule with only one system requiring a retest. When queried at the end of the first year of operation,

the owner was still ecstatic with the commissioning results. The design engineer and DDC technician became big believers in the process and were eager to employ it on their next projects.

## **Clarifying Misunderstood Commissioning Processes**

Commissioning is still relatively new to many owners, contractors and design professionals, and many different commissioning processes are in use. Because of this, the commissioning professional (CxA) needs to clearly describe commissioning procedures and their purposes to the rest of the project team; with particular emphasis on how they involve and benefit each member. In our experience, the following commissioning practices are frequently misunderstood and require extra care in that regard.

The commissioning kick-off meetings at the beginning of design and again at the beginning of construction are critical to communicate the commissioning process to team members. However, we feel that the kick-off meeting will often cover the subjects too lightly and will be given too far in advance of when the process will actually be utilized by the designer or contractors. The solution is to repeat the explanation of the process *verbally, closer* to when the process will actually begin. Sometimes it helps parties to “think” harder and therefore understand better when there is an incentive. Strong specifications, commissioning plan language and most importantly, strong, visible owner support are incentives that “nurture” better communication.

### ***Integrating the Project Specifications***

In order to facilitate commissioning it is often necessary for the CxA to ask the design professionals to include additions or changes to their specifications. For example, support of the commissioning process may require the control submittal to contain more information than required in the design engineer’s standard Division 15 specification. As a result, the CxA may need to ask the engineer to add verbiage they supply to the Division 15 spec. The design professionals and the owner may be unfamiliar with this kind of specification coordination. We have been involved in projects where the designers essentially ignored the CxA’s recommendations, deferring a decision on whether to incorporate them to the owner. By the time we were able to make the needs understood, it was too late to incorporate changes in the bid documents, even by addendum.

As the commissioning authority, we were responsible to ensure that all parties understood the process. We thought we had adequately coordinated the process by providing clear written instructions with our recommended spec changes, but the written instructions were apparently not read, skimmed over, or ignored. In retrospect, adequate communication required direct discussion, supported by our written documentation. A meeting to discuss the concept before we distributed the written recommendations, or even following up our written recommendations with phone calls would have been better methods for achieving the desired outcome.

### ***Integrating the Controls Submittal Review***

We utilize a special process for dealing with review of controls submittals. The process entails compiling comments from the owner, designer and commissioning team on forms provide and managed by the CxA. The forms are issued to the contractor and the designer, if the review raises design questions. The contractor and designers respond in writing on the form, answering the questions or giving their disposition on the comments. The authors of the original comments use the form to reply back to the contractor and designer. In the end, the form contains a record of all comments and responses. Meetings are used to resolve the more complex or contentious issues. The contractor then makes a final submittal based on the agreed upon resolutions.

This process differs from the more common approach of having the submittal reviewed exclusively by the designers, with input from the owner. While our process is more formal and involved, we believe it has the benefit of addressing important functional performance issues before they become difficult and expensive to resolve.

We provide specifications and a controls review preface that describe the entire process in step-by-step detail. Even so, we have had situations where the process is misunderstood or ignored and the design team resists participating in the process. Serious confusion that delayed project closeout resulted on one project when the designers did not follow through with the process of finalizing issues with the controls contractor. In another project the designer ignored the specified review process and without input from the rest of the team, stamped the control drawings “approved” as soon as they completed their own review.

Better communication minimizes or eliminates problems like these. The desired results were achieved for other projects by utilizing open dialog via meeting and phone calls to explain the process and its benefits.

### ***Addressing Commissioning / Design Issues and Enhancements***

The commissioning process often identifies worthwhile enhancements for the design, commonly with regard to the sequences of control. Sometimes the critical details of vaguely specified sequences of operation may end up being worked out during functional testing or functional test writing. When this happens the commissioning authority may be asked, or feel compelled, to make judgments and recommendations, especially if the incidents occur during the time critical closeout phase of the project. Unless this process is well managed, it can cause confusion regarding the CxA’s role.

An example case involved the staging of multiple chillers. The designer left it up to the DDC contractor to determine when the chillers would be staged on and off. The approved controls submittal stated that the chillers would be staged “based on chiller data parameters.” The CxA asked the DDC contractor to clarify what parameters would initiate staging so that a detailed functional test could be written. The final response was that staging would be based on chiller

amps. Functional testing was performed under the pressure of a very tight, politically charged deadline. It revealed that the plant was being staged up based on chiller amperage. Down staging, however, was based on the building load, which was calculated from flow and temperature. Testing also demonstrated that the DDC system programming for the upstaging sequence didn't work and had to be changed overnight. The CxA suggested that since reprogramming was required it might make sense to stage up and down based on the same parameters; either amps or load. The contractor chose to reprogram such that up and down staging was based on the calculated building load. Later it was discovered that because of a construction error, chilled water flow to two of the air handlers was not being measured by the flow meter.

The contractor claimed that the CxA caused the problem by directing them to stage the chillers based on calculated building load. Clearly, more complete design documents may have prevented this situation, but a better understanding of the CxA's role in these matters might have minimized the confusion. It is important that the CxA repeatedly emphasize to the commissioning team that she or he does not have the authority to direct the contractor.

### ***Issue Management***

A user-friendly, clearly understood procedure for managing commissioning issues is an essential commissioning tool. We have incorporated a process where new issues are added to a comprehensive issues log at the same time as they are immediately forwarded to the contractor via email. Each issue is uniquely identified by a number and the contractors' responses are to be provided in writing referencing the issue number. When poorly understood or enforced, even this fairly simple process can breakdown. Contractors often make their corrections without documenting them, or they provide a list of corrections without the corresponding issue number. Clear project specifications and owner support are essential to make a process like this effective; however, even this simple process is vastly more successful when the CxA guides the team into the procedure with direct verbal communication.

## **Critical Communication Styles**

Well-managed communication is the key to effective teamwork. The following elements of communication have contributed significantly to the level of success on our projects.

### ***Distinguish Between Communication and Documentation***

The previous section of this paper, *Clarifying Misunderstood Commissioning Processes*, contained excellent examples of how trying to use documentation for communication is inefficient and ineffective. Informal day-to-day communication that is required for members of the commissioning team to work together. We call this *working communication*. Open working communication occurring directly between commissioning team members is essential. Overbearing project leaders that try to micromanage all communication through themselves can stifle the commissioning process into inefficiency. An elemental part of working communication, however, is that all resulting conclusions and agreements that affect the commissioning process must be formally documented.

When such informal, direct communications involve proposed changes to existing Contract Documents, schedule, costs, or scope of work for any of the parties involved (Owner, A/E, Contractor, CA), they must be confirmed in writing via the formal channels of communication specified in the Contract Documents. Communications outside formal channels should not authorize changes.

### ***Avoid Throwing the Ball Over the Wall***

Throwing the ball over the wall is employed by parties less concerned with resolving issues and more concerned with getting issues off their plates or getting fingers to point somewhere else. It is characterized by addressing issues vaguely or narrowly, only as it affects an individual's own interests, and then forwarding the issue to other interested parties for resolution. Commissioning providers, contractors, designers and owners are all guilty of throwing the ball over the wall at various times, but doing runs counter to an effective commissioning program.

Commissioning issues often involve multiple disciplines and are not always "cut and dried" regarding who the responsible party or parties are. Skilled ball-throwers can keep these balls in the air for a very long time, slowing the commissioning process and creating detrimental frustration and negative attitudes. For these types of issues, a team approach is required. Effective commissioning requires all parties to be committed to working together to efficiently resolve issues. Project leaders can best facilitate resolving difficult issues by holding the issue themselves long enough to obtain the necessary input to assign responsibility to the appropriate party(s). A good style when forwarding issues to others is to thoughtfully identify what players may need to provide input. Informally obtain information from these parties to make sure you fully understand the issues. Then send out a common email to the various parties as to what your investigation has found and request input from each of the other parties. Hold a conference call or meeting if necessary to more clearly communicate the problem with your proposed solution and additional input needed from others.

## Example Projects

One of the authors had the experience of simultaneously commissioning two similar projects for the same agency, with vastly differing results. One of the projects was proclaimed as one of the most successful ever accomplished by the owner, contractor, design team and commissioning consultant. The functional testing for this project was completed ahead of schedule with only one FPT retest required. Commissioning for the other project was terminated with a considerable list of unresolved issues, nearly a year after substantial completion. A comparison of these two projects is summarized in the following table. We believe it sheds light on the importance of the issues discussed in this paper.

	<b>Project A</b>	<b>Project B</b>
Project type	Critical detention/medical; identical function as B	Critical detention/medical; identical function as A
Project	1 large building; about 1/3 square footage of Project B	3 buildings
Commissioning began at:	Design Development	Construction on the building structure had already begun
Owners Functional Requirements	No formal documentation produced. Design engineer/owner meeting held to discuss issue. Owner attended all commissioning meetings (design through construction), frequented the project site, and proactively reminded the team of the owners needs.	No document produced. Design engineer/owner meeting held to discuss issue. Owner's rep until closeout, interacted little with the commissioning team – stated that they felt commissioning was the CA's responsibility and should not require owner involvement.
Designers' Functional Intent	Included with some portions of the specifications and sequences of operation.	No document produced. Lack of basis of design information for the complex hydronic system caused confusion and delay for TAB, DDC and Cx.
Control Logic Clarification	Control logic statements used to clarify some of the more critical specified sequences of operation, DDC control logic submittal review performed early in construction	Specified sequences of operation complex in concept but vague regarding the specifics of implementation. Control logic communication was not included in the specification and the DDC contractor and design engineer responded poorly to the CA's attempt to reach a common understanding. Similar systems were programmed by different techs using differing logic and yielding varying performance.

	<b>Project A</b>	<b>Project B</b>
Test readiness definition	As a part of their internal QC the DDC contractor tried the FPTs and consulted with the CA regarding the results. In accordance with the specifications, the contractor submitted completed FPT record sheets as evidence of test readiness. All final FPTs went smoothly and quickly – only one retest was required.	Specifications did not include a test readiness definition. FPTs required many retests.
Owners commissioning understanding and involvement	After the CA presented the commissioning plan, the owner had a reasonable understanding of the commissioning process and showed full support to the design and construction teams. Owner attended all commissioning meetings (design through construction), frequented the project site, and proactively reminded the team of the owners needs.	Owner’s rep minimized interaction with the commissioning team – stated that they felt commissioning was the CA’s responsibility and should not require owner involvement.
Fine-tuning	The commissioning plan was reviewed and understood by the entire commissioning team. The contractor did a good job of fine tuning the systems and demonstrating this to the CA during functional testing and trend log evaluation.	The contractor utilized the functional testing period to fine tune the systems, resulting in long delays and making it difficult to achieve satisfactory results.
Specification enhancement process	The commissioning plan was reviewed and understood by the entire commissioning team. Separate commissioning sections were included in the project specifications, but section-specific commissioning requirements were also integrated into the Division 15 and 16 specifications. The Ca and design team worked together in a cooperative manner and resulting bid documents provide effective commissioning support.	The CA was not involved in the development of the commissioning bid documents. The various conflicting interpretations of the commissioning specifications became a severe impediment to the commissioning process.

	<b>Project A</b>	<b>Project B</b>
Control Submittal Review Process	The designer and CA understood and embraced their roles in the controls submittal review. The engineer integrated the CA's comments with their own to produce a single review document for the design team. The designer and CA comments were not separately distinguished for the contractor.	Submittal reviews were not well coordinated. Commissioning review enhancements not effective because they were not supported by the specifications.
Design Enhancements	Clear definition in the commissioning plan, support by the specifications, enforcement by the owner and GC/CM, and team cooperation resulted in an effective process.	It was difficult to resolve design related issues discovered in commissioning because of the lack of participation by the design engineer and the owner. Costly closeout delays resulted.
Issue Management	Clear definition in the commissioning plan, support by the specifications, enforcement by the owner and GC/CM, and acceptance by the contractors resulted in effective process. Team approach and good documentation resulted in many issues being identified and corrected before they were difficult to resolve.	Process clearly defined in the commissioning plan, but not supported by the specifications, or enforced by the owner and GC/CM. Never fully accepted by the by the contractors. Issues were difficult to resolve.
Communication Style	<ul style="list-style-type: none"> <li>• Open communication with vigilant documentation</li> <li>• The entire team took ownership of the overall project communicating freely with one another</li> </ul>	<ul style="list-style-type: none"> <li>• Weak GC/sub management, heavy handed, no team approach</li> <li>• Little frank communication during commissioning meetings; even less communication outside of the meetings.</li> <li>• Attitude of if I don't talk about it it's not my problem</li> </ul>
Commissioning outcome	<ul style="list-style-type: none"> <li>• Functional testing completed ahead of schedule with only one retest</li> <li>• Owner was extremely happy</li> <li>• Everyone benefited financially from the commissioning process</li> <li>• I year later the operator's were still very happy with results</li> </ul>	<ul style="list-style-type: none"> <li>• Functional testing completed a year after substantial completion</li> <li>• Owner could see how they benefited from commissioning but knew there had to be a better way</li> <li>• Everyone lost money on the commissioning process except for the owner's long term benefit</li> <li>• Over a year after substantial completion the operator's were still trying to get final issues resolved</li> </ul>

## **Summary**

We have identified several elements of communication having a critical bearing on a project's level of success. Among them is achieving a clear understanding of the project's functional requirements throughout the project team. The CxA's willingness and ability to clearly explain and guide the commissioning team regarding the commissioning process is also equally important. Both of these broad elements require open, cooperative and responsible communication. Commissioning objectives are deterred when commissioning team members attempt to shed responsibility rather than identifying and implementing holistic solutions.