

## Commissioning the Project Schedule

**Matthew S. Malinosky, PE, LEED AP BD+C, CCP**  
*Questions & Solutions Engineering, Inc.*

**Molly B. Meyer, PE, LEED AP BD+C, CEM**  
*Questions & Solutions Engineering, Inc.*

### Synopsis

Typically, the General Contractor or Construction Manager is charged with maintaining the project schedule, and we've observed that often there are issues with communication and understanding which lead to scheduling problems. This can be avoided quite easily by understanding what activities are on a project's critical path (including Commissioning) and by using accurate information to plan the remaining work. Mismanaged schedules can create confusion, delays, and unnecessary frustration for Owners as well as other project team members.

In order to obtain a comprehensive (and accurate) project schedule, it is vital that all parties whose activities are on the schedule's critical path are regularly solicited to provide accurate information. It is also imperative that those who are charged with managing the schedule understand the differences between substantial completion, Owner turnover, and project completion. All of this becomes even more essential with increasing project size and complexity, as with phased turnovers, fast track, or multi-bid package projects, for example. The critical path ends with Owner turnover which, in our experience, is one of the Owner's highest concerns and the more the turnover date moves, the more difficult their job becomes.

The intent of this paper is to educate the reader on what typical commissioning-related critical path activities are, how they influence the project schedule, and how to commission a project schedule. We will also use real project examples which include end-of-project issues largely caused by problems with the construction schedule. We will also explain the importance of defining the terms that describe the end of a project and offer some suggested definitions.

### About the Authors

Mr. Malinosky has been a Mechanical Engineer at Questions & Solutions Engineering since 2006. He has 8 years of experience in executing and managing commissioning, recommissioning, and LEED projects. His specialties include building systems trending and analysis, controls integration facilitation, systems functional performance testing and test procedure development, commissioning plan and specification development, schedule integration, commissioning process training, commissioning for LEED, and operations and maintenance training planning.

His project history ranges from local municipalities to international corporations, from 15,000 to 800,000 square feet, from office buildings to hospitals, and from \$500,000 to \$250,000,000 construction projects. Some of his more notable projects include recommissioning of Medtronic's World Headquarters, recommissioning of Boston Scientific's Maple Grove, Minnesota campus, commissioning for the Mayo Clinic's proton beam therapy treatment facility, LEED commissioning of a Hormel Foods production plant, and LEED commissioning for the Duluth Entertainment Convention Center's Amsoil Arena in Duluth, Minnesota.

Molly Meyer, PE has been a Mechanical Commissioning Engineer at Questions & Solutions Engineering, Inc. since 2006. Ms. Meyer has been assisting Owners in both the technical details of mechanical system operations and commissioning process fundamentals for over 13 years. She works with design teams, construction teams and facility operators to document and test integrated building systems controls and HVAC systems. Her focus is on energy conservation with a specialty in hospital and health care facility commissioning. Ms. Meyer works with both existing buildings and new construction to document system operation and train facility operators to extend the life of the building.

In addition to Facility Commissioning, Ms. Meyer's project experience encompasses a variety of services including LEED® Commissioning, retrocommissioning, facility energy analysis, Owner's project technical representative and building systems strategic planning. Ms. Meyer is a licensed professional engineer with a Bachelor of Science from Marquette University, a LEED® Accredited Professional, and a Certified Energy Manager.

## Define Project Completion

Every project starts out with an enthusiastic and idealistic project team. This applies to many aspects of the design, including the approach to the project schedule. The most devastating blow to those ideals is to find out you can't make it all fit. The successful integration of the commissioning activities begins by the project team determining how the commissioning milestones are going to tie into the typical construction completion milestones. These include Substantial Completion, approvals by Authorities Having Jurisdiction (AHJ), and Owner /Beneficial Occupancy.

These definitions are sometimes located in the Division 1 documents or in the Owner contract documents. Understanding the definitions of the individual project contracts can help the project team determine how commissioning activities will interface with these requirements.

There are a few considerations regarding the construction milestones' ties to functional testing. Functional testing prior to substantial completion can be problematic if finishes are not complete and spaces are not clean. Systems that are capable of simply providing heating and cooling does not mean there has been enough time for the construction team to complete their work and confirm proper full functionality. Authorities Having Jurisdiction have specific goals which may or may not be as rigorous as those set by the commissioning scope. Owner Occupancy can have its own set of definitions. For example, is Owner occupancy needed for the Information Technology team to get the building set up or are users actually going to be starting their normal work activities?

The non-traditional concepts of Maintenance Acceptance and Operational Acceptance fit well with the commissioning process. The Owner's staff has been trained and is excited to get into the facility. The Maintenance Acceptance milestone (which follows successful completion of training and equipment installation and startup) allows the facilities staff to get hands on with the equipment. However, the facilities staff should not carry operational responsibilities until the systems' operation has been confirmed through functional testing and all open issues resolved. Allowing for a separation of Maintenance Acceptance and Operational Acceptance gives the project team more flexibility when a project is in its final stages.

## Common Obstacles

In an effort to navigate through the schedule management process, it is helpful to be aware of the obstacles that lie ahead so as to be prepared to address them when the time comes. Obstacles typically lie entirely in either the Design Phase or Construction Phase of the project, but there can be overlap in some cases.

### ***Design Phase***

First, let's establish who is managing the design phase schedule. Many times this is a collaborative compromise (yes, compromise) between the Owner and the design team.

However, in cases where a General Contractor or Construction Manager is onboard during design, this can fall on his or her shoulders. While this certainly has its advantages, many GC/CMs' main interest is when they can start mobilizing. Therefore, it is very important that project teams be careful not to rush the design in order to maintain the construction schedule. If this happens, the risk of increased administrative work required (across all parties) to complete the project grows exponentially. Adding volumes of Change Orders, Proposal Requests, Requests For Information, and Addenda can really make it challenging for the entire team to track the status of the design.

This is even further compounded by the presence of multiple design packages – particularly when multiple packages split the work of a single discipline. A clear, concise, and up-to-date tracking process is absolutely critical to the success of projects that incorporate multiple design packages, especially with respect to staying on track with the project schedule.

However, even if all these bases have been covered and a great set of processes has been set up to achieve the best result, this can all be undermined by vague specification requirements. It is important to specifically identify the requirements of the project schedule. Some pertinent questions to address might include:

- Who should manage the construction phase schedule?
- How often should it be updated and/or submitted?
- What format should it be in?
- What critical activities and milestones should appear?

Even with all these crises averted, you're still not out of the woods. There is one constantly looming concept that hasn't yet been addressed – **Value Engineering** (VE). This process has the potential to wreak havoc on a project schedule, and its severity can be influenced both by how far out of budget the design is as well as where in the design process VE occurs. Clearly, the later VE occurs and the more over budget the project is, the higher the probability of a negative impact to the schedule.

## **Construction Phase**

Once the design has been completed and construction begins, the GC/CM typically has a finite amount of time to submit the construction schedule. If the commissioning schedule requirements have been documented in the specifications, the resulting schedule should not need to be adjusted. This may be the ideal situation, but in our experience the most common result is a single line that appears toward the end of construction titled "Commissioning". This result tells us two things. First, the person who put the schedule together did not read the specification in detail. Second, and more importantly, the schedule manager(s) will need to be educated not only in what commissioning milestones should appear on the schedule, but also in what order and what related construction activities each depends on. It is necessary to recognize that while the commissioning agent should influence the schedule, it is (typically) the GC/CM who ultimately controls it.

It is crucial to keep communication flowing during construction so that the entire team stays informed of updates. The process that is used to accomplish this varies from project to project. For example, simply issuing the master project schedule on a regular basis might be appropriate for the average project, but, , would that be an effective approach for projects over one-million square feet? For projects with more than 20 phases? For projects whose construction spans more than two years? And how often should the schedule be updated? Depending on the work, it could be once every couple months or several times per week. Project teams need to be aware of these questions and need to be prepared to address them to meet the needs of the application.

Now, imagine all of these complexities combine to form one giant worst-case scenario. The result would be a project in which we are currently engaged. It is a multi-bid package, multi-phased renovation of an occupied facility where construction started before the design was complete and VE occurred after construction had begun. Couple this with a project team that has only just begun to start supporting the commissioning process and it is easy to see the challenges that lie before us.

## Identifying Commissioning-Related Critical Path Activities

Previously, we discussed the establishment of requirements surrounding the activities that should appear on the master construction schedule. While all aspects of the contents of the master schedule are important, we will focus on those directly related to commissioning activities. First, let's start with a list of typical end-of-project commissioning activities. For the purposes of this discussion, the list has been reduced to the essentials.

- Prefunctional Checklists Issued
- Functional Performance Test Procedures Issued
- Prefunctional Checklists Completed
- Functional Performance Testing
- Deficiency Correction
- Functional Performance Retesting

While these activities are important to appear on the schedule, time can be wasted or lost if they aren't triggered at the proper point. It is for this reason that it becomes necessary to identify the commissioning-related activities that also should appear to form a complete sequence of work. In order to see the whole picture, we need to add several activities. The following list shows the commissioning-related activities that were added to a project schedule for an addition to a corporate office.

- Permanent electrical power to equipment
- Equipment startup
- Controls pretesting & checkout
- Test & Balance

For the given commissioning activities, this may appear to be a reasonable list – even when the dependencies are linked correctly. However, in this case, the team failed to recognize until the project was nearing completion that the air handling equipment could not be started until the

drywall sanding was complete. When the equipment startup item was linked to the completion of the drywall system, the schedule was immediately delayed by two weeks. This is exactly the type of analysis that is required in order to avoid similar surprises at the end of a project and every project may have unique results.

## **Consequences of a Mismanaged Schedule**

The consequences of a mismanaged schedule are only partially quantifiable. Some of the obvious outcomes include confusion regarding the sequence of work, highly compressed completion schedules, as well as lost time and the potential for work needing to be redone. These are easy to track and quantify, but what about the additional costs across all affected parties? Maybe that's quantifiable as well, but certainly would be much more difficult to assess. Can lost credibility or diminished confidence in the team be quantified? What about the loss of future contracts as the result of a bad experience? These are almost impossible to quantify. Yet, we know they are real results.

Specifically addressing the commissioning process, the result of a mismanaged schedule may be premature functional performance testing and, therefore, a large number of deficiencies. For the commissioning agent, this requires more time than should be expected for documenting and tracking deficiencies and for retesting the corrected deficiencies. Clearly, effects are also felt by the contractors and, potentially, the Owner. This situation can be avoided by early education regarding schedule requirements and constant, open communication between project team members.

## **Multi-Level Communication**

Communication is key! The structure of today's project delivery method lends itself to the segregation of pertinent information. For example, the corporate hierarchies that are implemented to handle project delivery are organized in such a way that the people who are turning wrenches and pounding hammers are not the same people who are attending meetings and relaying information – and there are good reasons for that. However, at the end of the day, if the correct information doesn't reach the people who need it, the hierarchy is rendered useless.

As it pertains to this discussion, a similar picture can be painted for the contractual hierarchy of the project delivery process. If the subcontractor at the end of the chain isn't solicited for information, his or her work may not be represented on the master schedule. For those whose work appears on the critical path, this can have an enormous impact as the end of a project approaches. By regularly soliciting updates from critical path participants and making the necessary adjustments, the team will realize the benefits of having accountability for early construction work, allowing smoother coordination between trades due to a more constant flow of shared information, and avoiding finger-pointing at the end of a project.

## Communicating Schedule Requirements

Experience has proven that managing a successful commissioning project is the triumph of a good trial and error process. Every project team and every circumstance is different and, as such, no two commissioning projects are the same. What works for one project may not work for the next, and the documents that a project team actually reads on any given project is a toss-up. Previously, we discussed the concept of defining commissioning milestones with common construction completion definitions. The Commissioning Specification must also clearly define the relationships between the construction completion and Commissioning.

Establishing construction schedule requirements during the design phase can get your foot in the door. In the commissioning specification be specific about the milestones that should be tied to particular construction activities and the milestones that are there to assist the construction team in being prepared for functional testing. Not all of the commissioning milestones need to be in the Master Construction Schedule. On a large project, trying to tie in too many commissioning activities can bog down the construction manager and render the schedule useless.

The commissioning agent's role in the schedule is not only to confirm that major activities are monitored but also that the activities that do appear are appropriately ordered to assist the project team (from project managers to field technicians) in preparing for systems readiness and functional testing. It's never safe to assume that the field technician knows anything about the systems readiness or functional testing process. Project Managers often forget to include the most important people in on the details.

There is no replacement for face-to-face meetings, but, even so, commissioning is not always the most captivating subject. Schedule requirements discussed in a meeting should always be followed up by a clear and concise document that can be passed back and forth to be updated. Locking meeting discussion up into meeting minutes may be risky – especially in cases where meeting minutes are not often read. Why not make it easy for people to focus on the important things that stemmed from the discussion?

Developing an activity outline to accompany the master construction schedule and providing additional details tailored to individuals who will need to coordinate the specifics of functional testing will provide a clear direction. A monthly or weekly test plan distributed to the project team can assist those new to commissioning in getting a bigger picture of how the process will unfold and what they need to do to be ready.

## Schedule Management Best Practices

Every project has its own unique set of best practices based on the circumstances and project team members involved, but there do tend to be a few recurring themes with scheduling. The most common being “**We should have started earlier**”. Educating the commissioning team members about scheduling for commissioning activities isn't just for the Construction Manager or General Contractor who is preparing the Master Construction Schedule; it's for everyone.

Design Team members need to consider construction documents that precisely define project completion milestones and how commissioning activities fit into those milestones. The success of a project is judged by the Owner's satisfaction at the end of construction and throughout the life of the building, not at the beginning.

Including commissioning in the completion goal will position everyone to be working toward the same common definition of success. On every project, the Owner expects the building systems to operate as designed without flaws – even if they don't articulate it well. Meeting a schedule milestone or a budget goal at the expense of quality (i.e., k commissioning) is unacceptable to any Owner who has high hopes for their new or newly renovated building.

The next education milestone is communicating that **commissioning activities are not independent line items in the schedule; they are always predecessors or successors to typical construction activities.** Once these initial relationships have been developed, you can start a working dialog about what construction activities need to occur when. An example was previously used about the requirements for drywall to be predecessor to readiness for functional testing. The commissioning agent should confirm that the scheduler links all required predecessors and work with the entire team to brainstorm any project-specific activities. This activity is not just for project managers. Field personnel are essential to this conversation since the details of construction is their responsibility and day to day reality. A group activity looking outside the mechanical/electrical/plumbing window sets all the contractors working toward the same goal instead of bumping against each other at crunch time.

There can never be enough said about a commissioning agent that is **proactive, persistent, and patient.** The trial and error process of communicating with the project team requires that there is follow-up and confirmation that messages were communicated and understood. When it's clear that a message was not received, the commissioning agent must try again with a new approach.

This brings us to importance of **Owner support.** The project team will be watching the Owner and the level of importance the Owner displays toward commissioning. If the Owner seems disinterested or is not making commissioning a priority, the project team will get that message and follow suit. This can be a devastating blow to the commissioning process and ultimately will result in the inability for the building systems and building operators to realize the maximum benefits of commissioning.

Finally, when in doubt, **provide something tangible** for people to look at. From simple to complex, a picture (or flowchart, graph, list, example, etc.) speaks a thousand words. If meeting attendees have a document to look at that connects with the words you are using, they are more likely to engage in the conversation. This is a great way to introduce what has worked before and see how it can be a stepping stone to a customized solution for the project at hand. Don't be afraid of bringing ideas from other projects or presentations or developing your own ideas. The business of constructing buildings is hands-on work and commissioning is, too.