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CPM Schedules – Why and How

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Critical Path Method (CPM) of scheduling has become the de facto standard in the construction industry for planning, management and controls of projects. However, even today, CPM scheduling is not used to its full potential. Many times the extent of the use is to fulfill a contract requirement or for reporting status. The reason is primarily in why and how the schedules are developed and the approach each party has to the evaluation and use of the schedule during the life of the project.

The original intent of this article was to survey the two major communities in the construction environment. The goal was to present the findings on why each community uses CPM schedules on construction projects, how effectively they are used and to identify the disagreements, when they occur.

The intended communities were the contractor community, the owner community and the owner representatives including engineers/architects. The contractor community includes the construction managers (CM) (at risk), and owner community includes CM (for a fee).

After initial discussion with a couple of parties in each of the above communities, this paper is presented as a result of case studies on projects my firm, Milestone Consultants, Inc., has worked on the last five years vs. doing a formal survey.

Most of this relates to projects in commercial construction. I believe the petrochemical and industrial/power turnaround projects have used CPM schedules to a lot more detail, and none of the projects studied were in that industry.

You've heard this before !

Most of the times we get a call for a new project, the following are typical "quotes" we hear in the first meeting with the client.

From Contractors:

- We just read the contract and we have to do a schedule on this project.
- We've got an x#\$!!* for an owner and we really need a very good schedule to make sure we cover our behinds!

- The schedule on this project is very aggressive and the owner is not forgiving.
- Corporate Policy dictates we hire scheduling consultants for projects above x dollar volume.
- The last project I worked on had a really responsive schedule. It was very beneficial to us and we would like to do it on this project.
- We are three months behind schedule. We need to document our delays.
- We are behind and need to develop a recovery plan.
- The owner is denying all our requests for time extension, we need help in documenting the validity of our claims.

From Owners:

- The contractor is already behind and we are not getting good schedule updates. We need an evaluation of the schedule and current status.
- We have no confidence on the schedule created by the contractor and need independent verification.
- There are a lot of changes on this project and we need to evaluate their impact.
- Act as third party verification right from the start.

Irrespective of the reasons the schedule is built or specified, when done effectively, it helps the project. Note, that I said the project. Not the contractor or the owner, but the project as a whole and all its stakeholders, which would happen to include the owner and the contractor community.

REASONS CPM SCHEDULES ARE DEVELOPED ON PROJECTS (THE WHY)

This section lists the main reasons schedules are developed on construction projects. Most the reasons apply to both sides. However there are still disputes, because of the way the reasoning is applied when building and managing the schedule.

Contract Requirement

This may be the single largest reason for the popularity that CPM schedules enjoy in the construction industry. It is also the reason I see our firm called in most often to develop or manage schedules for contractors. Sometimes it's the only reason the contractor wants the CPM schedule. Sometimes these requirements on smaller projects seem to frustrate the contractors. In such cases, the quality of the schedules leaves much to be desired.

Over the years, we have noticed, even though the contract dictated it, the act of having to build and manage the schedule has converted many a contractor. They have learned from the experience and learned to leverage the value derived from CPM scheduling methods. The contractors find it benefits them in the long run and if the company culture calls for continuous learning and excellence, CPM schedule becomes a requirement within company, irrespective of contract requirements.

Owners specify CPM schedules in contracts in the hopes of making the process of communication and controls simpler. They hope it establishes best practices within the company. The primary interest for the owners is getting insight to the plan from the contractor to get a reasonable prediction of when to expect the facility for use. The reason CPM schedules are specified as a contract requirement by owners is really a combination of all the reason that will appear below.

Differences and Area's of Contention

The problems occur when the contractor believes the requirements are too rigid or the owner believes the contractor is not submitting schedules per the spirit of the contract. Most of the disputes are about the following.

- Level of detail.
- Tools used to submit the schedule (when not specified). P3 vs. MS Project.
- Owner believes the contractor is not following the specs in "spirit," but just fulfilling a contractual obligation.
- Owner doesn't believe the contractors schedule.

These issues are discussed in section 3.

Risk Mitigation and Risk Avoidance

In the past few years, there has been an increasing trend among the leading contractors to develop detailed and well thought out construction schedules for ALL projects in their portfolio. The primary driver here is risk mitigation. The contractors sincerely believe that a well thought out schedule, when used effectively, reduces their risk since the project tends to be well thought out, better controlled, more effectively recognizes impact and has better communications with both the subcontractors and the owner. Most of the projects we have seen this happen on, are valued at above \$30M in value.

Risk mitigation is the primary reason owners like specifying schedules in their contract requirements. There is the belief that the schedule requirement would allow better project controls,

thus reducing surprises and risk. It also forces the contractor to pre-plan the process and provide significant thought to means and methods prior to the start of construction.

Differences and Area's of Contention

Most of the disputes will happen when one or the other party believes the other is unfairly trying to shift risk. Typical examples of this are the following.

- Building of schedule is a manner where float is sequestered.
- Using the schedule to unfairly get or refuse time extensions.

Claims Prevention and Claims Support including Dispute Resolution

After contract specifications, this seems to be the second biggest reason why there is increased focus on CPM scheduling during the construction phase. Most of the time, the focus on schedules increases after a delay to the project, anticipated delay or when the owner believes there is not enough progress on the project.

Although the initial thought would be that claims prevention and dispute resolution would fall under the risk mitigation and risk avoidance categories, this section deserves mention of its own because the approaches taken during the construction phase to manage the schedule to either prove or deny claims because of time impacts.

Schedules perform best for claims prevention and avoidance when they are well thought out and created for planning and controlling the project. The schedules do not perform well when created with a claims mentality in mind.

Differences and Areas of Contention

When approached with planning and controls in mind, well created, updated and managed schedules provide significant support and evidence to issues related to time impact. The disputes the most commonly occur between the two communities during the construction phase as it relates to claims prevention are:

- Disagreements on the start and end dates of the "impact."
- Disagreements on what schedule should be used to evaluate the impact. Some would like to see impacts inserted in the baseline, some in most current update and other prefer to wait till the impact activity is complete and then analyze the "net" impact. There is no clear preference by community, but the preferences are more driven by which approach produces the best result for personal advantage.
- When one party tries to "tweak" the results for maximum advantage.
- When the owner believes that the contract is "using" the schedule to lay the groundwork for a claim, that may not be justified.
- When the contract believes that the owner is refusing entitlements because of time impacts based on "technicalities" of the schedule. i.e., using a schedule with

poor logic to deny a claim since the schedule is non-responsive, even though in reality it is obvious the impact item would cause a delay.

Project Controls

This is one reason why CPM scheduling should be used by both the construction communities. Unfortunately, it seems to be low on the priority on why schedules are developed. However, irrespective of why the schedule was developed, once they are developed, most of the more sophisticated contractors and owners seem to use the schedules well for controls.

Track and Report Construction Progress (Owner and Contractor)

Whereas the pay application will give you idea's of percent complete, a well updated CPM schedule is an excellent gauge of overall project status. Schedule reports are also an excellent and effective communication tool. Schedule submittals are an important component that accompanies the pay application even if the cost and schedule programs are not truly integrated at the applications level.

Subcontractor Management

One of the easiest ways of ensuring all the subcontractors are on the same page, and communicating expectations is the sharing of a well developed CPM schedule. In the last couple of years, I see increasing realization on the part of the general contract to ensuring they provide their subs with a copy of the CPM schedule (at the very least, the subs activities). This practice is often subverted by the GC, by preparing parallel schedules for sharing with the subs.

Areas of Contention

During the controls phase of construction, the disputes are equally divided into the technical use of the schedule and the field projections that are used for schedule updates. Most common area of contention are the following.

- Use of the schedule by one party to hit the other party over the head vs. a tool for controls and communication. This causes a natural resistance to using the schedule, no matter how much it will help.
- Differing opinions on actual progress or remaining duration of the activities being worked.
- The methods in which changes are inserted into the schedule.
- Disagreement on the insertion of logic changes to the schedule when the contractor changes the intended plan or when changes are forced because of site conditions.
- The owner not accepting a schedule update that shows a completion date beyond the contract completion. This often forces an artificial acceleration, if the delay to the completion date is being caused by impacts that would justify granting of time extensions.

As stated in the claims avoidance section, and would hold true here, disagreements on which schedule to use, and how to insert the "fragnet" seem to be key areas of contention

Pre-Construction Planning

The first schedules are most often developed during the pre-construction phase in collaboration with the architect and engineers. Whereas these may not be detailed construction schedules, they are usually quite accurate and have information with detail available during that stage of design. Schedules developed during the pre-construction planning phase are often used to get approval of the project or the execution plan. It is also often used as the key communication tool to get buy in and commitment from the major stakeholders of the project.

These schedules seem to address aspects related to:

- feasibility of the project;
- assistance in value engineering; and
- development of contractual binding milestones.

Both communities are coming to the realization that effort invested in the early stages of the project creates tremendous benefit and contributes to the eventual success of the project. Since it's early in the project, most times the schedule development process seems to be more collaborative then contentious during this time.

Feasibility Analysis

I was very surprised when we were called in to do a full blown schedule during the bid phase of a project. It was actually a negotiated GMP, and the contractor wanted to make sure the timeline being dictated by the owner was achievable. We put significant effort into the schedule, and it was used extensively by the contractor during the negotiation process. In this particular case, the contractor chose to walk away from the contract since the numbers and the time line did not relate well.

Owners have been using CPM schedules for feasibility analysis for a long time. It's been extensively used to dictate contract completion dates and interim milestones. Many times it's used to justify funding for a project and develop cash flow projections.

Whenever schedules are developed for this purpose there seems to be very little dispute relating to the scheduling effort. This may be because at this stage schedule development is primarily a planning effort. However, there do seem to be disputes when there is attempt to enforce these schedules during the construction phase.

COMMON AREAS OF DISPUTE

As seen in the section above, many of the reasons CPM schedules are developed on construction projects apply to both the contractor and the owner community. With common drivers

for the use of schedules, there are still disputes relating to the development and use of schedules. This section discusses the underlying reasons disputes occur even though they are developed for all the right reasons.

Initial Schedule Construction

The biggest hurdle either party faces is to agree to a baseline schedule. This is going to be the schedule everything will be measured back against and many of the disputes happen early on. Owners may have had a schedule used against them in a claim, or a contractor may have lost a request for time extension because of a technicality in the schedule. In the initial development (and acceptance) process, most of the disagreements happen over the following areas:

Capture of Scope

Is the entire scope of the project captured in the CPM schedule and do the activity descriptions accurately represent the scope being captured.

Organization of the schedule

A good work breakdown (WBS) goes a long way in avoiding this battle. The schedule need to be organized to be able to evaluate area's and/or trades important to the contractor or the owner. How the schedule is organized or coded to be organized is very important during the life of the project. Disagreements often arise when one party believes additional coding is needed to be able to evaluate the schedule to a greater detail.

Use of logic for convenience (Soft vs. Hard Logic)

In schedules relating to high rise construction or campus style construction, where there may be multiple physical area's that do not physically restrict the other areas. Once the typical construction sequence has been built into the logic, there is usually soft logic applied to represent crew or equipment constraints. A lot of disputes are to the validity of the soft logic. If the owner believes the soft logic is an attempt to sequester float or "tie-up" the project, they will not accept the schedule. The contractors feel, that schedules without any soft logic exposes them to potential productivity impacts since area's would tend to get stacked vs showing a delay in the absence of soft logic.

Level of Detail

The arguments on the level of detail in a schedule happen not only between owners and contractors but there is disagreement within each community as well. There are certain owners who believe that they need to only look at a high level schedule and milestones and the detail schedule should be the responsibility of the contractor. Other owners believe the contractor owes them a schedule detailed to the level to which work is going to be managed by the contractor. Contractors also disagree on the level of detail needed in the schedule.

Specifications on Level of Detail Help Alleviate Some of the Issues—Another way to overcome this obstacle would be to develop industry standards on level of details based on use of schedules, relevant industries and scope of the project.

How Changes are made to the Schedule

Projects are a dynamic environment. The usability of a good schedule depends on the ability to manage your plan, and thus the schedule, to these changing environments. Disputes occur because of the owner not accepting changes to the schedule or the contractor not adequately changing the schedule to reflect changed conditions.

Logic Changes

Changes on how work will be accomplished, is a source of contention during the life of a project. Owners would like to see no changes to the schedule during the life of the project unless they dictate it and contractors want to continuously change the schedule because of "reality". The bottom line is that a well constructed schedule will require some changes during the life of a project because of occurrences on the project, but will not need to be modified for every little shift on the project. Changes in logic should be adequately documented and justified based on field performance. This will provide the basis of a change and understanding that the changes are valid and not manipulative for claims submission.

Duration Changes

Why durations are changed is more the area of disagreement, rather than the change in duration itself. Many times duration changes are made since the contractor is not meeting planned duration. In such instances, owners believe the change in durations is not valid, since the contract should hold to the durations submitted by managing crews and equipment. Changes in duration because of a change in scope can usually be negotiated. In such a case, the issue is now why, but how much. Based on performance, an owner may decide to allow less change in duration since the contract is performing better than planned, which would penalize the contractor for good performance.

Addition or Deletion of activities

Constant changes in addition and deletion of activities would represent a poorly thought out schedule. During the life of the project, there is need to add and delete activities. However, the frequency with which it is done is often a cause of contention, and rightfully so.

The need to add activities is justified in the following cases:

Detailing out a certain area or type of work. In this case, it is justifiable to ask why the area or work was not detailed out during the development of the baseline schedule. If there was not enough knowledge or detail available, then the addition of activities is justified. In such a scenario, the summary of the new

activities synchronizes with the activity it replaces. Addition of scope of work.

How Progress is reported

Progress on a schedule should be easy to identify by field verification. Most disagreements here are not about physical percent complete, but more about the projection forward of work in progress. Typical scenarios of areas of contention include the following.

Contractor Trying to Hide Delay—This happens when the project is being delayed because of contractor productivity. Rather than show a delay and submit an explanation of how the schedule will be recovered in the upcoming time frame, the contractors sometime choose to artificially show an on-time completion. This hurts both the parties, since any future impact will be distorted by the schedule manipulation.

Owner Not Accepting Schedules That Show a Delay to Contract Completion—Here, the owner will not accept a schedule that shows a current completion date past the contract date. This forces the contractor to artificially accelerate the schedule, the result of which is similar to the point made above.

Evaluation and Presentation of Delays

This area causes the most heated debates. Many problems arise when one or both parties do not either accept or understand how to use CPM schedules. Rather than learning to learn the scheduling techniques and associated tools, the individuals tend to rely on knee jerk reactions to protect themselves and are understandably reluctant to accept true schedule results that are adverse to their position.

There can be lots of suspicion on the part of the owner with regards to the logic and duration of new work added when it directly relates to a delay claim. Areas of dispute include the following.

Creation and Use of Fragnets Not Tied Into the Main Project—A fragnet by itself represents on how the impact will relate to the existing work, if not inserted into the existing schedule it will not represent the magnitude of the impact.

Changes in Logic to Demonstrate Delay—Many times, contractors are disappointed when a fragnet is inserted into an existing schedule and the results they see are not what they were expecting. There is then a natural tendency to go evaluate the reasons why. I compare the initial steps of this evaluation akin to a “reality check. However, when the reality check becomes a way to “maximize returns,” it hurts the credibility of the schedule, the validity of the claim and will often result in denial of a claim which may have been valid.

RESOLUTION

There seems to be consensus in the industry that CPM schedules provide a value to the planning and execution of the

construction process. However, before CPM schedules can be fully used to the extent of its capabilities, it is imperative that both communities learn to use it more effectively.

It would help to continue to build on best practices and introduce practices and improve the quality of CPM schedule development and management. This can be done by continuing some of the established practices and introducing new practices.

Some of the practices and trends that are in existence and should continue include the following.

- Continued specification of CPM schedule as a contract requirement. There needs to be industry standards developed to benchmark good specification practices and AACE International, as well as PMI College of Scheduling are moving in that direction.
- Treat the CPM update and reporting as a structured submittal process that requires review and acceptance/approval by the owner.
- Development of best practices and industry practices to help standardize reporting and update methods. This will reduce the number of disagreement on how items should be handled. There is significant work effort under way in both AACE International and PMI along these lines.
- Industry education in the use, understanding and evaluation of CPM schedules.

Other practices that would bring value to better creation and management of CPM schedules are:

Oversight and third party verification—Use of third party scheduling firm to create an independent CPM schedule based on inputs from all parties. This will foster the spirit of partnering and help elevate some of the basic disputes that arise.

Even in the most contentious of positions, we have managed to resolved the disputes relating to the use of the schedule over the years. This does not mean the project disputes goes away. However, there is one less area of contention and it eases the communication all the way around.

Most of the above disputes occur, some legitimately, others not so legit because of one party’s inability to see the other’s point of view or lack of experience or expertise in the development, review and use of CPM schedules.



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