

Scheduling Best Practices

INTRODUCTION

Long a mainstay of effective construction project management, scheduling deserves a fresh look. Trends in technology, labor shortages and new production techniques are here to stay and are changing the way contractors operate. Adapting and improving skill and competency at scheduling, in its various forms, is necessary to deliver the value our customers expect on time.

Construction projects are complex products. Effective delivery depends on effective coordination across multiple disciplines and technical specializations. Scheduling is the primary means of defining and controlling the sequencing and timing of work processes and the resources required to execute work processes on time so that the overall project is delivered as expected. As any seasoned construction professional knows, unreliability and unpredictability in the scheduling function are the greatest sources of risk to efficient and on time production. Unreliability is often driven by deficiencies in quality of scheduling processes that must cope with a vast volume of information. Mechanical contractors are particularly vulnerable to failures in the quality of project scheduling when they find themselves dependent on schedules developed with low levels of collaboration and/or little to no routine maintenance, especially in lieu of other scheduling and planning tools. That said, mechanical contractors can exert a great amount of influence on the quality of scheduling functions and, at the very least, can be proactive in demonstrating diligence to protect against risks and disputes. Reducing uncertainty, defining what resources are required to execute work effectively, and mitigating risk are the ultimate goals of scheduling.

There are four primary scheduling functions at the project level that should be used to create to achieve those ends. The complexities of the products



IMPORTANT

The quality of project scheduling suffers when schedules are developed with low levels of collaboration and maintenance.

we build require a multi-tiered approach to scheduling. The quality and effectiveness of other, supplementary schedule tools (BIM coordination, prefabrication scheduling, etc.) are usually dependent on the quality of the four major project level tools. The four primary scheduling functions are:

1. [Master Scheduling](#)
2. [“Pull” Production Scheduling](#)
3. [Look Ahead Scheduling](#)
4. [Weekly Work Planning](#)

Understanding what to look for, how to use, and how to supplement these four functions are essential to operating effectively in today’s construction environment.

MASTER SCHEDULING



TIP

The mechanical contractor should request the opportunity to provide input for work sequencing, work durations, and material/equipment lead times as early as possible.

While master schedules are primarily the responsibility of the CM/GC and usually begin development in the pre-construction phase of a project (often well before the mechanical contractor is on board) the best practice for developing reliable master schedules is collaboration with the subtrades. The mechanical contractor should request the opportunity to provide input for work sequencing, work durations, and material/equipment lead times as early as possible. Don’t wait to be invited.

Mechanical contractors will run into significant variety in the quality of project level master scheduling. In all cases, mechanical contractors should look to get the following information out of a master schedule:

Overall risk assessment – How will the work have to be done, and in general, what resources will have to be provided to comply with the contract schedule requirements? How does this compare with other project requirements during the same timeframe?

Clear project milestones – Understanding overall milestones on the project is imperative. They will provide an indication of what is most important to the client and construction manager and will likely influence the direction of work. Milestones should be clear and stand alone, but you may have to make deductions based on how the schedule is organized.

High level work sequence and duration – Often limited in ability to provide detailed and specific coordination requirements, the master schedule should still provide a broad understanding of the sequence of work flow—top-down



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or bottom-up? Which area first? Activity definition, durations, and resource requirements should be revised from any initial pre-bid, scoping, or other negotiations to align with the master schedule requirements as soon as possible to provide a more accurate picture of what will be required and when.

Long lead, locked lead, other critical material & equipment procurement –

Specific to mechanical trades, a master schedule should provide a milestone or target date for critical equipment installation (air handlers, boilers, etc.) from which a submittal and procurement schedule can be derived and “pulled” from. Preferably, procurement scheduling is included in the master schedule and linked to construction activities. Especially in cases where suppliers are communicating long lead times, it’s imperative to begin defining long or “locked” lead times as early as possible.

Logistical considerations – Coupled with a site plan, a master schedule should provide information useful for planning access, material staging, and heavy equipment needs for heavy lifts or long reaches. A master schedule should be useful for providing information for forecasting peak manpower requirements as well.

If these items are not clearly defined in the master schedule, the mechanical contractor should request the information or offer to provide direct input where relevant.

In addition to providing input to the project master schedule, the mechanical contractor should maintain their own master schedule specific to their work. Both the project level master schedule and the mechanical contractor’s schedule should work hand in hand and be routinely updated to maintain consistency. The mechanical contractor’s master schedule should include all construction activities aligned per phasing or milestones from the project level master schedule and should incorporate procurement and prefabrication schedules linked to construction activities. Sharing the mechanical contractor’s master schedule with the party responsible for maintaining the project master schedule can greatly enhance the quality of the project schedule.

Mechanical contractors can influence much at the master scheduling level regardless of who is contractually responsible for it. Being competent and proactive in interpreting and influencing the quality of the master schedule is a highly valued asset by most partners on projects, not to mention an essential element of operational excellence. Diligence in providing the above can significantly protect risk in the event of mismanagement regardless of the quality of the project level master schedule.



IMPORTANT

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Diligence in providing updates to the master schedule can significantly protect against risk in the event of mismanagement—regardless of the quality of the project level master schedule.

“PULL” PRODUCTION SCHEDULING

“Pull” Production Scheduling is a relatively new approach to scheduling and coordination that has grown rapidly in use across the industry due to the results it generates. More detailed than a master schedule but less detailed than a look ahead, the pull production plan is the transition between the formality of a master schedule and eyeball to eyeball negotiation required for effective jobsite planning and coordination. There are a variety of approaches to the execution, but all should possess the following elements:

Overall project milestones defined and dated – Milestones are typically represented as a diamond shaped and/or red sticky note to create a strong visual of its importance. All parties in the project team should have a clear understanding of project milestones. Milestones should be considered and created in the following order of priority:

1. Commitments to/from the owner
2. Locked lead time dates for critical material & information
3. Significant work milestones – inspections, permanent air, major pours, etc.

Construction activities defined; durations aligned to phasing – It’s helpful for mechanical contractors to know and understand the general phasing of the project and be prepared to align their activities and durations per phase. It also makes the pull production plan more accurate. Often activities and durations developed during pre-bid or during scope reviews and negotiations must be reworked to better align with actual construction sequencing.

Last responsible start dates & handoff dates – A key function of the pull production plan process is to make visible the core “value stream” of activities on the project – those activities that must be worked with unbroken flow to avoid bloating the schedule. In pull planning, less emphasis is placed on overall activity durations and more emphasis is placed on planning & defining the time and conditions one trade needs in a given area before “handing off” to the next trade in line. Handoff targets are established by working the schedule backward from the end date (from the last activity to the first). The duration required by downstream activities establish handoff targets for upstream activities. Negotiation and planning occur throughout the process. Once handoff targets are established, the amount of time between the “last responsible start” and “handoff” become a simple means to understand routinely and objectively how the project is progressing relative to milestones

and whether or not process improvement or other corrective actions are required to meet milestones. Such reviews should occur weekly once the pull plan is in place. If the review does not happen regularly, the Mechanical Contractor should request it.



Figure 1 above shows Collaborative Pull Scheduling: Milestones in red; Activities in yellow.



Figure 2 above shows the team negotiating responsible starts and handoffs. Defining activities, handoffs, and duration is a planning-intensive process.

Constraint Board – As the negotiation and planning for sequencing and duration occur, it's important to capture and define any constraints and conflicts that must be “cleared” in order for the committed durations to be realized. These are best posted visually to a constraint board, usually one issue per sticky note. The date the constraint must be cleared and should be pulled from the date required to not impede the flow of work as defined on the pull production schedule, and the party responsible for clearing the constraint should be identified. Boards are best organized into a rolling 6-week format to prioritize constraints, with a portion of the board allotted for urgent or late items. Maintaining a public interface in the job meeting space brings a high level of team accountability and shared responsibility for clearing constraints and conflicts in order for the job to flow. The aim is to create shared understanding and accountability to what the pull production schedule requires from all team members rather than leave consideration of what is important and when it's important to more subjective means.

Constraint Board



Figure 3. A constraint board prioritizes and tracks issues needing to be cleared for hand-offs to occur smoothly. Routine review of the status of constraints is required to make work ready.

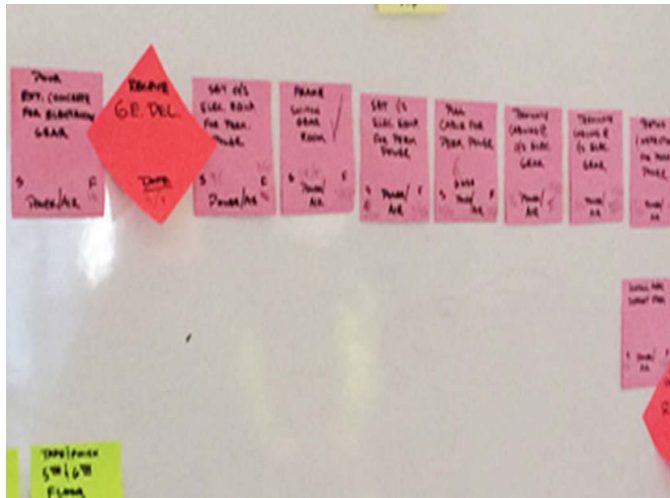
The process of pull production scheduling should be field focused. Field leaders should be defining work activities and requirements with Project Managers, helping to fill in important details about information and material procurement.

The process is fully scalable, rolling whiteboards in a hallway will suffice if project conditions require it, though the planning environment matters and should be taken into consideration. Pull production scheduling techniques should be utilized even if they are not done at a project level. The process of collaboratively defining step-by-step work sequence is valuable in many applications and almost always uncovers items that need to be resolved sooner and in more detail.

Milestones on diamonds in red. Step-by-step activities are filled in between milestones. The process of two trades defining what needs to be done goes a long way to reduce assumptions and build shared understanding of what needs to happen.

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Figures 4 and 5 are examples of a “mini” pull production schedule developed during a stand-up session between an electrical contractor and mechanical contractor to determine, step-by-step, what needs to be executed to establish permanent power to air handler units.

Mechanical contractors can get the most out of Pull Planning by following these simple guidelines:

Be prepared. Try to get the phasing of the project defined before the pull production scheduling starts and align activities and durations per phase. Come prepared to share lead times on materials or information. Have discussions with suppliers prior to the pull plan meeting.

Plan your work. Have step-by-step discussions with the PM and the foreman about what needs to happen with major activities before the meeting.

Be clear and firm about what you require. Be prepared to define what you require in order to make commitments to durations – include information, work space conditions, material staging considerations, etc. Be firm about your requests but also remember it’s a negotiation, give and take will be required.

Mechanical contractors can influence much in this process, in some cases taking the lead in scheduling and mapping work is critical to their success. Preparation drives how much value you receive. The collaboration afforded in this process and your understanding of specific requirements for the project can go a long way in negotiating favorable outcomes.

LOOK AHEAD SCHEDULING

Look ahead scheduling is not a new concept; however, the speed and complexity of modern construction projects requires more discipline in the look-ahead function than ever. Ask any seasoned field leader skilled in look ahead scheduling and they'll tell you it's here that the project "gets built."

The following are best practice guidelines to consider and perhaps revisit when thinking about your current look ahead scheduling process. If you don't have one, start now. It's that valuable.

Update weekly – Thursdays work best. It's close enough to the following week to be reliable and allows time on Friday for last minute changes & urgent reaction. The nature of scheduling and planning is that not all information is available when you need it, especially detailed information. The look-ahead schedule should be thought of as a rolling schedule or plan where upcoming activities and the "make ready" needs for those activities are considered and planned for in increasing detail as the work approaches. After several weeks of planning, the work should be ready to commit to a weekly work plan for the upcoming week.



IMPORTANT

Increasingly, mechanical contractors are finding it useful to extend the traditional two-week look-ahead time frame, depending on specific job requirements.

Be flexible on time frame – Two-week look ahead schedules are common, but increasingly, mechanical contractors are finding it useful to extend that timeframe depending on specific job requirements. Some coordination needs to be thought through further than two weeks out. As a minimum standard, or to get the process started, two weeks is fine. But look to encourage flexibility in building to a timeframe that makes sense for the specifics of the job. Six weeks is ideal. Detail should be emphasized in the first two weeks with less detail as work is planned further out.



IMPORTANT

The value of loading look-ahead schedules with critical resource requirements cannot be overstated.

Load with critical resources – The value of loading look-ahead schedules with critical resource requirements, especially manpower, cannot be overstated. It requires the field leader to consider if they have the resources available to actually execute the work activities they've listed as planned, often requiring re-sequencing or thinking through at a higher level of detail than just jotting down what they "should" be able to do. Forecasting manpower and equipment needs on a look-ahead schedule provides invaluable information for management personnel responsible for allocating labor and equipment across multiple projects.

Make ready – For each activity, the following simple questions should be asked each week – "Do I have all the tools, materials, equipment, information, and labor to do the work effectively? What do I want the work area to look like for the crew?" Ideally, work would not be committed to a weekly work plan or executed if the answer is no to any of those questions.

Engage the CM/GC – Where appropriate, the look ahead should be provided or shared with the CM/GC and other trades affecting the mechanical contractors work. Many CMs and GCs will welcome advanced notice of issues and appreciate avoiding surprises. Proactively demonstrating diligence in communication and planning, especially coupled with daily reports, can be highly valuable to prevent unfair treatment, prevent disputes from occurring, or aid in resolving disputes favorably.

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There are a variety of tools available to execute look-ahead scheduling, but the most popular and effective varieties continue to be a simple graph paper template or Excel-based template (see **Figures 6 and 7**). Form should follow function.



Figure 6. Paper-based template.

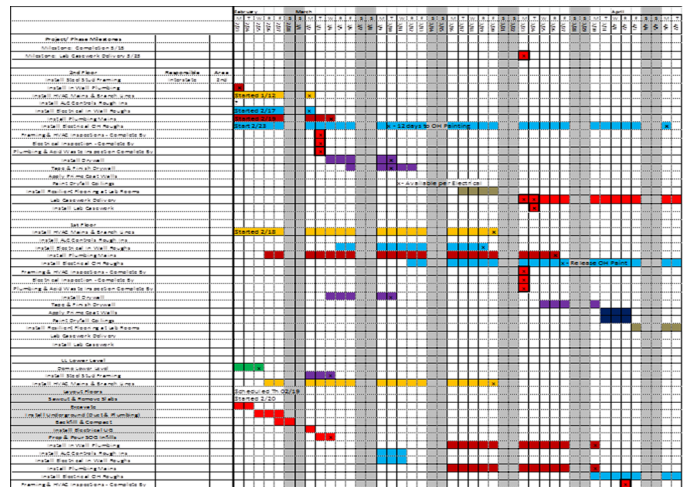


Figure 7. Excel-based template.

WEEKLY WORK PLANNING

Weekly work planning is a simple exercise that can be thought of as a final commitment to work that will be completed each day in the upcoming week. Good quality weekly work plans include a production goal for each crew/work activity. If coupled with a high-quality look ahead, they can often be pulled directly from the look-ahead schedule, requiring very little time to put together.

Weekly work plans should include specific crew assignments and resources to the specific activities – it’s a final check that all the necessary resources are available to do the work as planned.

It’s helpful to review weekly work plans daily, usually accomplished in 5–10 minutes, to determine causes for work that doesn’t go as planned. To remain competitive in the industry today, we need to move beyond citing people,

IMPORTANT

Weekly work planning should not take the place of a look-ahead schedule.



TIP

Ask “Did the activity get done or not; if not, why?” to aid in uncovering trends and fixing problems.

crews, or weather as the source of every plan failure. Considering activities on a routine basis can be useful to understand process or resource bottlenecks and constraints. While there are always constraints we can’t control, there are often many that we can.

Simply establishing the routine of asking “Did the activity get done or not; if not, why?” can go a long way to uncover trends and opportunities to fix problems associated with production that otherwise go unstated or unnoticed until it’s too late. It also promotes routine communication between field leaders and crews. Crews should be engaged in problem solving.

Coupled with daily reports, it can create a highly effective means for documenting risks and obstructions to work outside the mechanical contractor’s control.

There are some companies that take the use of tools like weekly work plans to another level of process improvement, periodically reviewing to spot trends or opportunities to improve processes at a root cause level. In some cases, routine review of weekly work planning can provide a wealth of information in the development of internal “best practice” libraries and modular proactive training & planning guides.



TIP

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Weekly Work Plan	Monday 13-Aug		Tuesday 14-Aug		Wednesday 15-Aug		Thursday 16-Aug		Friday 17-Aug	
Crew/Foreman	Commitment	Y/N	Commitment	Y/N	Commitment	Y/N	Commitment	Y/N	Commitment	Y/N
Bill's Crew	Brach Duct East	N1	Brach Duct East	Y	Brach Duct East	Y	Brach Duct West	Y	Brach Duct West	Y
Tom's Crew	Mains 2nd Floor	Y	Mains 2nd Floor	N2	Mains 2nd Floor	N5	Mains 3rd Floor	Y	Mains 3rd Floor	Y
Joe's Crew	Valve's Room 101-105	Y	Valve's Room 106-110	N3	Valve's Room 111-115	Y	Valve's Room 116-120	Y	Complete Valves 1st	Y
Ed's Crew	Piping 2nd Floor	Y	Piping 2nd Floor	N4	Piping 2nd Floor	Y	Inspections 2nd	Y	Start 3rd Floor Piping	N
Planned/Complete PPC	4	3	4	1	4	3	4	4	4	3
	75.00%		25.00%		75.00%		100.00%		75.00%	
Week Planned	21						Saturday		Sunday	
Week Complete	14									
Week PPC	70.00%									
Cause Log										
N1 - Eqp. - Crane Time										
N2 - Manpower										
N3 - Manpower										
N4 - Space Not Ready										
N5 - Material Late										
N6 - Inspection Not Done										
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Figure 8 and 9. Weekly work plans are best executed on a whiteboard located on the jobsite but can also be maintained in other forms. Again, form should follow function.

OTHER SCHEDULING TOOLS

To this point, emphasis has been placed on the essential multi-tiered scheduling and planning functions required to define reliable and effective work sequence and requirements at a project level. Other scheduling functions critical to a mechanical contractor's success include BIM coordination scheduling, prefabrication schedules, and company labor and equipment scheduling. It's important to note that problems and unpredictability in these supplementary scheduling processes are often driven by problems and inaccuracies in project schedules, pull production schedules, and look aheads. In all cases, schedules such as BIM coordination scheduling, prefabrication, and labor and equipment scheduling should be routinely checked and coordinated against project level schedules.

The following best practices are essential to ensure supplementary schedules are effective:

- Routinely update in response to updates in project master schedules and pull production schedules.
- Clarify extent and scope of BIM coordination scheduling and prefabrication intent with GC/CM to ensure proper coordination of work sequencing. Include other trades that can impact your work.
- Ensure BIM sign off milestones are clearly defined, linked to pull production schedule required starts, and incorporate lead times for material, equipment, and assembly.
- Schedule prefabrication for as late of a start as possible to guard against rework due to changes and uncertainty. "Just in time" fabrication and delivery is the objective.
- Identify opportunities to prefabricate similar materials across multiple projects to reduce cost and "re-tooling" in prefabrication shops.
- Prioritize labor and equipment allocation, as much as possible, to project teams who routinely provide look-ahead forecasts to discourage last minute "emergencies" driven by a lack of planning and look-ahead scheduling.
- Routinely review root causes to changes or scheduling failures to build a culture of continuous learning and to understand underlying process issues that may be improved.
- Proactively communicate and submit BIM coordination scheduling and prefabrication scheduling that clearly shows lead times for information and material procurement on a routine basis.



TIP

Schedule prefabrication for as late of a start as possible to guard against rework due to changes and uncertainty.

CONCLUSION

Modern construction projects require expertise in multiple forms of scheduling to account for proper work sequencing, resource allocation, and production planning. The level of detail in scheduling and resource forecasting should progress from general work sequencing, long lead, and critical or big-ticket resource needs at the master level to detailed daily work assignments and process planning at the weekly and even daily level. Think “boulders to rocks to pebbles to dust” as you progress through each tier of scheduling function.

Don’t mistake the absence of a visible schedule or process at any of these levels as “not having a schedule.” There is always a schedule! The only question is what quality is that schedule, is it visible, and can it be measured, improved, and used to collaborate? The tools described above are simply examples of best practices to help ensure the scheduling function operates effectively.



IMPORTANT

Avoid “time sinks” by having a better understanding of the strengths and limitations of each tier of scheduling.

Time required to execute scheduling is a common challenge and can be made efficient by understanding what each scheduling function is good at and adjusting the amount of detail required accordingly. When scheduling processes get bogged down by excessive rework or turn into “time sinks” it’s usually an indication of the scheduling not being scaled to fit availability of information or a general lack of understanding of the strengths and limitations of each tier of scheduling. Expertise is derived from experience. Experience is simply retained learning. Coaching by mentors or internal experts should be an ongoing process and engaging outside consulting experts to assist in establish scheduling routines and best practices are an easy investment to recoup.

In all cases, scheduling should be regarded as a team effort. While it’s important to clarify the primary role responsible for routinely producing and maintaining a schedule, collaborating with team members and those that have direct knowledge or a direct effect on the work being scheduled is common sense.

The best way to learn and develop expertise is to establish routine and do it. Define minimum standards for each level of scheduling and then continuously improve the expertise based on purposeful learning from experience. Failures or struggles should be embraced as opportunities to learn and improve. The days of assuming someone is scheduling and/or scheduling only when feeling a need are over. Today’s projects require focused routines and continuous improvement.


Acknowledgements


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[Maxim Consulting Group](#) is a team of seasoned construction professionals who have worked with hundreds of contractors to help them improve business performance. Through this experience, Maxim identifies and synthesizes industry best practices and codifies them into a systematic process that is implemented to suit specific client needs that drive improved performance.



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