

**A Guide to the Last Planner for Construction
Foremen and Supervisors
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“Last Planners” prepare assignments for people who do work. Last Planners can be found throughout construction organizations where they are called “Foremen”, “General Foremen” or “Superintendent”. This is a complex and difficult job because Last Planners must plan and prepare for the future, and supervise work underway. Keeping peace in the crew, assuring work is safe, coping with shortages, solving problems, and finding ways to make progress are all part of the job. Asking these people in this environment to do a better job planning seems like asking a lot and it would be if nothing else changed. But the situation does change when projects are managed under the **Last Planner System (LPS)** of Production Control. Last Planners working in this system report they spend far less time fighting fires and looking for work. This guide explains both the operation of the planning system and the Last Planner’s role in it.

Last Planners make assignments to crews and these assignments largely determine performance of that crew. This is obvious and important. Less obvious and often more important is the impact of one planner’s work on crews who follow down stream. If upstream plans are reliable, work is released to the next crew at the time and in the sequence to best support the overall project. In effect, assignments prepared by Last Planners are directions for their crew and promises (commitments) to others that makes close coordination possible. Creating and maintaining reliable workflow between crews is the first objective of the system. The LPS supports this objective both by providing a way for Last Planners to make reliable assignments, and by making work ready so that it can be assigned when required. Finally, the system provides feedback to improve performance.

System Overview

The Last Planner System provides the planning and control tools necessary to manage work on projects even when they are complex, uncertain and quick. Planning is defining what is to be done and how, control is a making it happen. A project is under control when we can do what we say we are going to do. Keeping commitments in the short term is essential if the project is to achieve its objectives. This is a very different definition of control than used in current practice. The design of the LPS makes it possible but people make the system work by how they make and keep commitments. Making and keeping promises is the essential skill required in this system. Plans prepared at each level are promises to someone; at the highest level to the client, at the Last Planner level to crews that follow and work in parallel. Coordination is tough when workflow is unreliable, impossible when people don’t keep their promises. Making reliable promises sometimes means saying “no”. The importance of commitments and saying “no” will become more obvious in the discussion about lookahead and last planning practice.

The LPS has four levels of planning. The degree of detail in plans is refined and uncertainty is reduced through each level by careful consideration of what **SHOULD** and **CAN** be done. Planning this way keeps objectives firmly in front of the project

team and helps them identify and remove obstacles to their achievement. Coordination happens through the continuous process of making and keeping commitments for action. Planning in this system is not dreaming or hoping, rather it is the active hard work of creating the future. The resulting predictable flow of work from one crew to the next reduces waste, simplifies further planning and finally is the key to delivering value to the clients.

The master or project schedule is developed from design criteria that support the client's project objectives. The basic structure of work, that is the big chunks that make up the project, is determined by breaking the project into pieces and establishing their sequential relationships. Current planning practice produces good enough master schedules for use in the LPS but we advocate reducing the level of detail in the master schedule to key milestones and then developing phase schedules as the milestones approach.

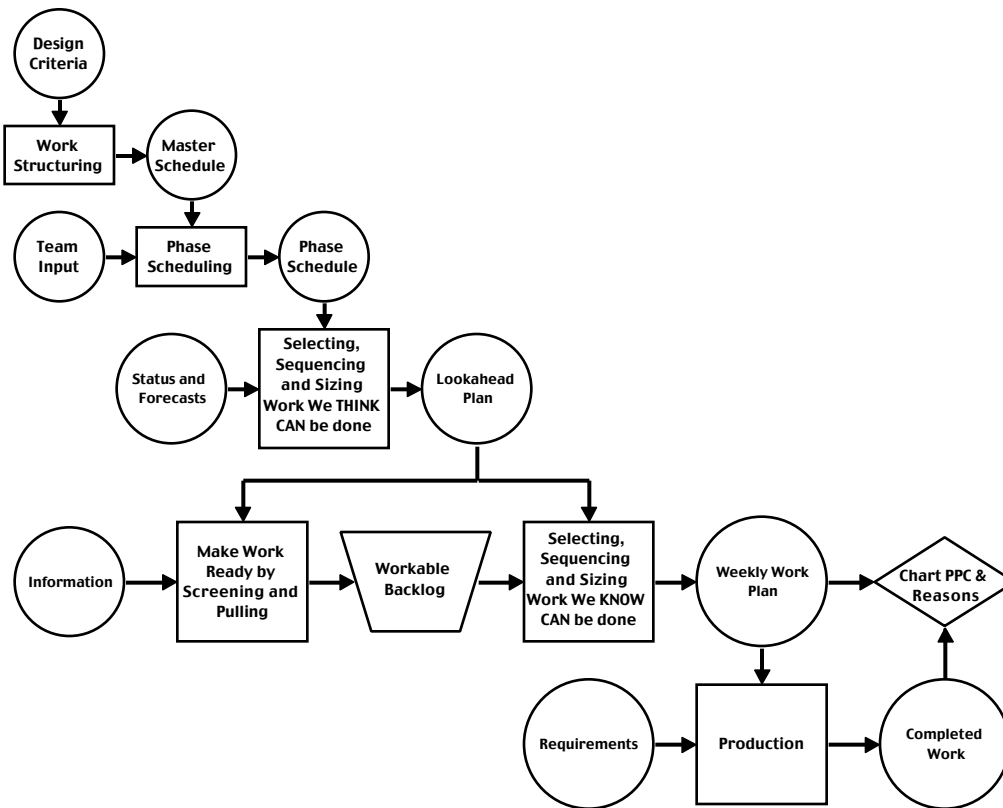


Figure 1: The Planning System

The master schedule must demonstrate the feasibility of completing the work in the available time, develop and display execution strategies, determine when long lead items are needed, and identify milestones important to clients and stakeholders. It cannot and should not be used as the tool for managing activities except on relatively small and simple projects. More detail schedules are developed in the phase schedule to support completion of master schedule milestones. While we believe overly detailed master schedules are not needed to manage the project, their

preparation early in the project is vital to developing the best understanding of the project.

The master schedule should be developed in as much detail as possible early in the project so as to learn as much as possible about the relationship between the pieces, to determine when long lead items are required, to identify areas of greater uncertainty and those subject to change, and to gain confidence that project objectives are achievable. This is an essential exercise but it does not design the way work will be done, that is the production process that will complete the project. Highly detailed master schedules cannot be used to manage the work itself as they rest on an incomplete model of the work. By this we mean that schedules identify activities but do not portray the flow of requirements within and between tasks or activities beyond simple sequential relationships.

Phase schedules are prepared by the team of people who manage the work in the phase. While phase schedules may not be required on small less complex jobs, their function should not be overlooked. Master schedules can be understood as a sort of exploded assembly drawing of the project showing how the big pieces come together over time. This view of the project is important but does not show the way work will be done to complete the work within each piece or to coordinate the details of their assembly. This is the role of a phase schedule. Developed by those responsible for the work, a phase schedule identifies the rules for release of work from one activity to the next and sets the sequence and timing of activities in finer detail than the master schedule. Activities from the phase schedule enter the lookahead process where they are magnified into task level detail, screened for to assure all requirements are made ready for the assignment. The Last Planner then completes the assignment to meet specific criteria, and after the work is performed measures the percent of tasks complete. Reasons for incomplete tasks are identified and action taken to prevent recurrence.

PHASE SCHEDULING

Activities on the master schedule will sooner or later need to be magnified and posted to a lookahead schedule. When projects are large and complex, a single master schedule should represent activities only in broad terms. In these cases, a single lookahead to cover all tasks will be unwieldy. Accordingly, the master schedule should be maintained at the milestone level. Phase schedules developed to achieve the milestones should be prepared closer to action but early enough to make work ready and assure coordination. Phase schedules should be prepared at least 6 weeks prior to the start of their first activity or even sooner if longer lead times have been identified.

The best practice is to gather the work management team, review the master schedule and appropriate milestones and then working back from that milestone to identify the work needed to complete of the phase. This back-to-front process identifies the conditions required for work to be released from one activity to the next and the coordination necessary to allow multiple activities to proceed concurrently. This process is best done on a blank wall where people can add cards for each activity and move them as new work is revealed. A rough time scale should be established so people have a sense of the timing involved. This is a highly participative process often rich in horse-trading and negotiation. Activities in a phase

schedule are highly dependent on each other. They involve routine and repetitive interfaces between trades and therefore require close coordination.

A typical phase scheduling process will take a few hours although the time can be shortened if the team is experienced and/or templates from similar work are available. Near the end of the process, durations should be established for each activity. The durations themselves should represent the most likely duration for the task given the circumstances on the project and the team's estimate of their ability to be reliable. The durations will establish the critical path through the phase and in most cases float within the phase will be apparent. This time should be allocated by the team to the most uncertain activities in order to assure the timing of activities within the phase is stable. If the project is pressed for speed and early achievement of milestones is valuable, the team should explore how the phase can be accelerated, what actions will be required and how the group will respond to early completions.

By contrast, if the work in a phase exceeds the available duration, the team must carefully consider alternatives and their cost and then open negotiations at the project level in order to best achieve project objectives.

In summary, master schedule activities are magnified in phase scheduling. Each phase includes activities that in turn must be further magnified and screened in the lookahead plan that typically includes work for the next 6 weeks. This effectively means that 5 weeks of work are visible on the lookahead. The first week of the so-called 6 week lookahead, in effect, becomes the weekly work plan that is being executed as of the data date.

Lookahead Planning

If the master schedule is a sort of time based assembly drawing of the project and phase scheduling designs the details of the production process, then lookahead planning assures the requirements are in place to make it run. The process is straight forward; activities fall into the lookahead schedule, typically 6 weeks before the work is supposed to start. As time passes, the level of detail is magnified as specific tasks within the larger activity are identified. Each task is screened to assure requirements are identified and pulled into readiness to maintain a backlog of work available to the Last Planner.

The lookahead period is used to

- shape workflow sequence and rate; for example to adjust the time and sequence of work to conform with known availability of resources.
- match workflow to the amount of labor and equipment available.
- prepare and maintain a backlog of ready work to assure continuous work when rates of production vary from planned.
- develop detailed plans for how work is to be done considering safety, environmental, and quality issues.

Thus lookahead planning assures the flow of work through the production system. Commitment planning by the Last Planner involves committing to what will be done based on actual receipt of resources and completion of prerequisites.

What time frame does the lookahead cover?

As mentioned, the Master schedule identifies the project milestones over the life of the entire project. Phase schedules detail the production process to support those milestones and may cover several months. Lookahead schedule typically look 6 or 8 weeks into the future. Both the lookahead and the Weekly Work Plan increasingly magnify tasks to be performed, taking into account actual circumstances. The lookahead and, in turn, the Weekly Work Plan cover shorter time spans into the immediate future but reflect higher degrees of confidence that work will be executable.

Which activities get posted on the lookahead?

The lookahead window determines how far ahead of the scheduled start date activities in the phase schedule are considered for entry into the lookahead plan.

Once in the lookahead schedule the activities are -

Magnified: A greater amount of detail is needed during lookahead planning regarding the activity's inputs and outputs so that the planner can screen the activity to assure that the activity can be made ready by its scheduled start date.

Screened: Determining the status of tasks in the lookahead window relative to their readiness, then choosing to advance them into the lookahead schedule or delay tasks on the master schedule based on their status and the probability they can be made ready prior to the activity's scheduled start.

Made ready: taking actions needed to remove constraints from activities to make them sound so they will be ready at the scheduled time for assignment in a weekly work plan by the Last Planner.

SCREENING

Screening is the process of preparing activities for advancement into the lookahead schedule or delaying entry of activities from the phase or master schedule based on the known status of constraints (requirements necessary for work) and the probability of removing them prior to the task's scheduled start. Screening does not prevent an activity with outstanding constraints from moving forward as long as the person responsible believes there enough time remaining before action to remove the constraints. Screening is first done when activities are considered for entry into the lookahead. It is then repeated in each planning cycle, when the planner updates the lookahead and advances tasks into the next week.

CONSTRAINTS ANALYSIS

A constraint is anything that stands in the way of a task being executable or sound. Constraints concern directives such as specifications and procedures, prerequisite work done by others whether on or off site, or resources such as labor and equipment and space – things that carry load. Typical constraints on construction tasks are the completion of design or prerequisite work; availability of materials, information, and labor or equipment resources.

Constraints Analysis aids in systematically identifying and tracking activity status. Identifying and removing constraints is one of the most important steps in reliable production planning and control.

REMOVING CONSTRAINTS

Planners remove constraints to advance activities into weekly work plan assignments. An activity with its constraints removed is available to enter the weekly work plan. There are two groups of constraints that must be considered by planners at every level. The first are those normally within their control. For a foreman these might include the tools kept in a gang box. Each planner should assure that the constraints within his control will be on hand. The second category of constraints is any constraint that require action of others (in the case of gang box tools, a shortage may put tools in this category.) The second category is removed by making a request to someone else. Planners should not assume that their requests will be filled until they receive a promise of delivery. Even then should be wary if they are not confident of the supplier will deliver.

The first step is to make a request of the supplier to deliver what is needed to make the task ready. The second is to assure a promise has been received and to assess its reliability. This may include assuring the lead time for supplies is shorter than the time remaining. However, unforeseen events may always come up, so contacting the supplier is the typical make-ready step. Confirming lead times is part of the screening process and may be repeated during weekly updating of the lookahead schedule

Expediting may be required if the constraint (supply) does not appear to be forthcoming. In most cases this will require action by more senior people and they should be alerted as soon as the planner loses confidence.

Making work ready during the lookahead period is the key action then for Last Planners and their supervisors. The system can cope with delays and problems if they are identified early enough in planning and elevated to those with authority to cause action.

The Last Planner

Telling people what should be done isn't enough. The planning system must assure they have what it takes to do the job. Discovering what CAN be done only after the crew arrives won't assure reliable workflow between crews.

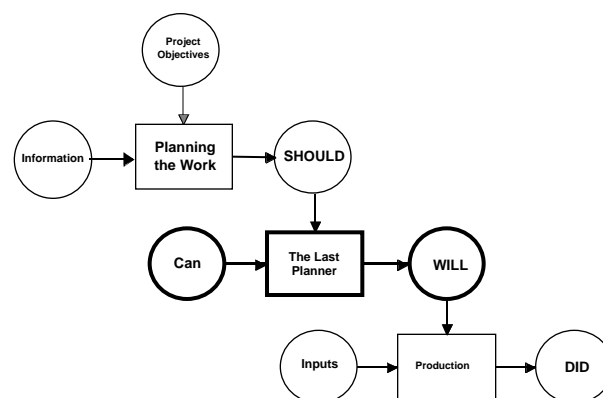


Figure 2

A reliable assignment, one that gets done at the required time, determines what **“WILL”** be done, after considering both what **“SHOULD”** from higher-level schedules and what **“CAN”** be done based on the situation at hand. Assignments are likely to get done when they are well defined, resource sound, in the right sequence, and within the capacity of the crew. The Last Planner’s job is to make certain the task in the assignment meets these criteria, and to reject assignments that do not. Last Planners can reasonably commit to completing the tasks on weekly work plans that meet these criteria.

The Last Planner's Weekly Work Plan is a commitment plan. By committing only to work that CAN be done, the Last Planner **SHIELDS** crews from uncertainty. The crew will be more likely to accomplish what they set out to do with this kind of assignment. Increased plan reliability improves performance of the crew and simplifies coordination with others because they will be better able to organize their work and plan the methods to be applied.

Thus the certainty of workflow from one crew to the next is a key to improving project performance.

(Flexibility is the only alternative strategy. This means mobilizing resources sufficient to do whatever work happens to be available, allowing for multiple stops and starts of operations best performed as a whole, inefficient sequencing of tasks, and inability to do detailed advance planning. When the flexibility strategy is applied, workflow uncertainty increases multiplying the project uncertainty and the expense. In the short term, the flexibility strategy seems relatively easy to carry out! Responsibility for poor performance can be avoided by blaming others for failing to keep their commitments.)

Lets look in more detail at the criteria because assignments that meet these criteria will most likely be done. If they are not, the reason for failure can be traced to its root cause and action taken to prevent recurrence. Experience in construction shows that poor information on the availability of resources is often the most frequent source of planning failures.)

Quality Criteria for Assignments

The Last Planner makes the Weekly Work Plan by identifying tasks that both **SHOULD** be done and **CAN** be done because they meet the planning criteria. Activities that do not meet these criteria will have to be made ready first.

Choosing what work **WILL** be performed in the next week from what **CAN** be performed is termed **making reliable assignments**. Weekly Work Plans are effective when assignments meet these four specific quality criteria;

Definition: Are assignments specific enough that the right type and amount of information or materials can be collected, work can be coordinated with other disciplines or trades, and it is possible to tell at the end of the week if the assignment has been completed?

Soundness: Are all assignments workable? Do you understand what is required? Do you have what you need from others, are all materials on hand; is design complete; is prerequisite work complete, etc.? Note that some

make-ready work will remain to be done during the week, e.g., meeting with other designers or fabricators, coordinating with trades working in the same area, moving materials to the point of installation, etc. Nonetheless, the intent is to do whatever can be done to get the work ready before the week in which it is to be done.

Sequence: Are assignments selected from those that are sound in priority order and in order of workability? Will doing these assignments release work needed by someone else? Are additional lower-priority assignments identified as workable backlog, that is, are additional quality tasks available in case assignments fail or productivity exceeds expectations?

Size: Are assignments sized to the productive capability of each individual or crew while still being achievable within the plan period?

Only tasks that meet these quality criteria should be put on a Weekly Work Plan.

Workable Backlog

Workable backlog is work that is ready to do but not assigned because it is beyond what the crew can reasonably be expected to do. If it were placed on the Weekly Work Plan, the assignment would overload the crew and thus break the sizing criteria. Ready work that cannot be assigned is recorded as **Workable Backlog** on the Weekly Work Plan. Workable Backlog provides ready work that can keep the crew working in the right sequence when they are not be able to complete an assignment on their Weekly Work Plan, or when they complete assignments sooner than expected. Workable Backlog prevents the crew from doing work that makes later work more costly or difficult. Items in workable backlog must meet all quality criteria except sizing.

Remember that the Last Planner aims to assure reliable work for their crew as well as crews downstream. Plan reliability is key to system performance. Accordingly, the Last Planner should **under load** the crew, that is, make assignments that absorb less than 100% of its capacity to do work required downstream. This assures it will get done even when small things go wrong. Workable backlog will provide work to use any time not applied to produce the work required downstream. Remember, reliable workflow is the first objective of the planning system and is more important than the short-term productivity of your crew. Maintaining workable backlog allows you to keep productivity high while serving those who rely on your crew.

Measuring Planning System Performance with PPC

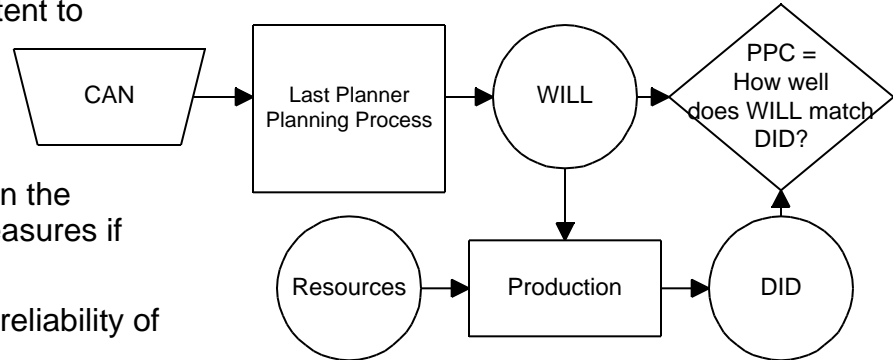
Planning is always an exercise in judgment. Last Planners will be using their judgment in lookahead planning when they assess the likelihood that constraints will be removed and when they make assignments. The information planners rely upon is often incomplete and seldom certain. Supervisors should take active role in lookahead planning and review weekly work plans to minimize errors. But mistakes will be made by the best of planners because their work often relies on long strings of commitments by others and of course, projects are uncertain and complex. So it is important to measure the success of the entire planning system and to take action to

improve its performance. Measuring reliability is the first step. The Last Planner System measures reliability in terms of **Percent Plan Complete** or **PPC**.

PPC is the number of actual task completions divided by the number assigned for a given week.

PPC assesses the extent to which the Last Planner was able to anticipate what work would get done in the upcoming week. It measures if **WILL** matches **DID**.

PPC thus reflects the reliability of planning system.



Complete or Not Complete? That is the PPC Question.

Whether or not an assignment has been completed requires a **YES** or **NO** answer. The Last Planner only marks those tasks complete that are in fact complete. Work is not complete even though it may have been started or even nearly complete. This no-partial-credit rule means credit is taken only for completed work that can be handed off to the next crew. If any part remains incomplete, no clean handoff can take place. In order to create reliable flow from one crew to the next, end-of-week completion commitments must be met.

The Last Planner System normally allows some leeway regarding schedule variation by assessing completion only once per week. In cases where timing is critical, PPC can be measured to the day or hour. In any case incompleteness of work may be caused by -

- failure to deliver prerequisites as promised,
- unclear or inapplicable procedures,
- failing to understand the effort required,
- unforeseen site conditions or bad weather,
- conflicts with other crews for space or equipment.

Learning from Plan Failures

When an assignment is not completed by the end of the plan week, the Last Planner must record the **reasons** for non-completion. Reasons for plan failure fall into categories pertaining to directives, prerequisite work, resources, and process or output failures. Construction people will recognize some of those commonly mentioned

	CONSTRUCTION
Directives	Design Changes Not informed of performance standard
Prerequisite Work	Submittal approval not received Materials did not arrive as promised Request for information unanswered Other contractor still in area No access to work area
Resources	Crane not available due to breakdown Unexpected absentees
Process or Output	Planned too much work Inadequate coordination Emergency

Reasons for plan failure can be plotted based on their frequency of occurrence. This highlights which failures are predominant and where process improvement efforts may be most beneficial.

After noting reasons for non-completion, a **root cause analysis** must be performed. The reason that is first apparent may in fact be a consequence of other actions and events that took place on the project. Each company should establish a process to determine the source of the action or event chain in order to learn how repeat failures can be prevented. The purpose of this effort is to discover the action needed to prevent future failures and not to assign blame to any individual. The Reasons Analysis Hierarchy may help you determine root causes.

For instance:

- If you did not have something you needed as a prerequisite to your process,
 - Did you request those needed prerequisites?
 - Was your request specific and complete?
 - Were you promised the prerequisite but did the provider not deliver? or
 - Were you not able to reach agreement with the supplier of the prerequisite?

Each of these in turn leads to further questions that will let you pin down the cause of failure, so you may be able to prevent it from reoccurring.

Weekly Planning Cycle

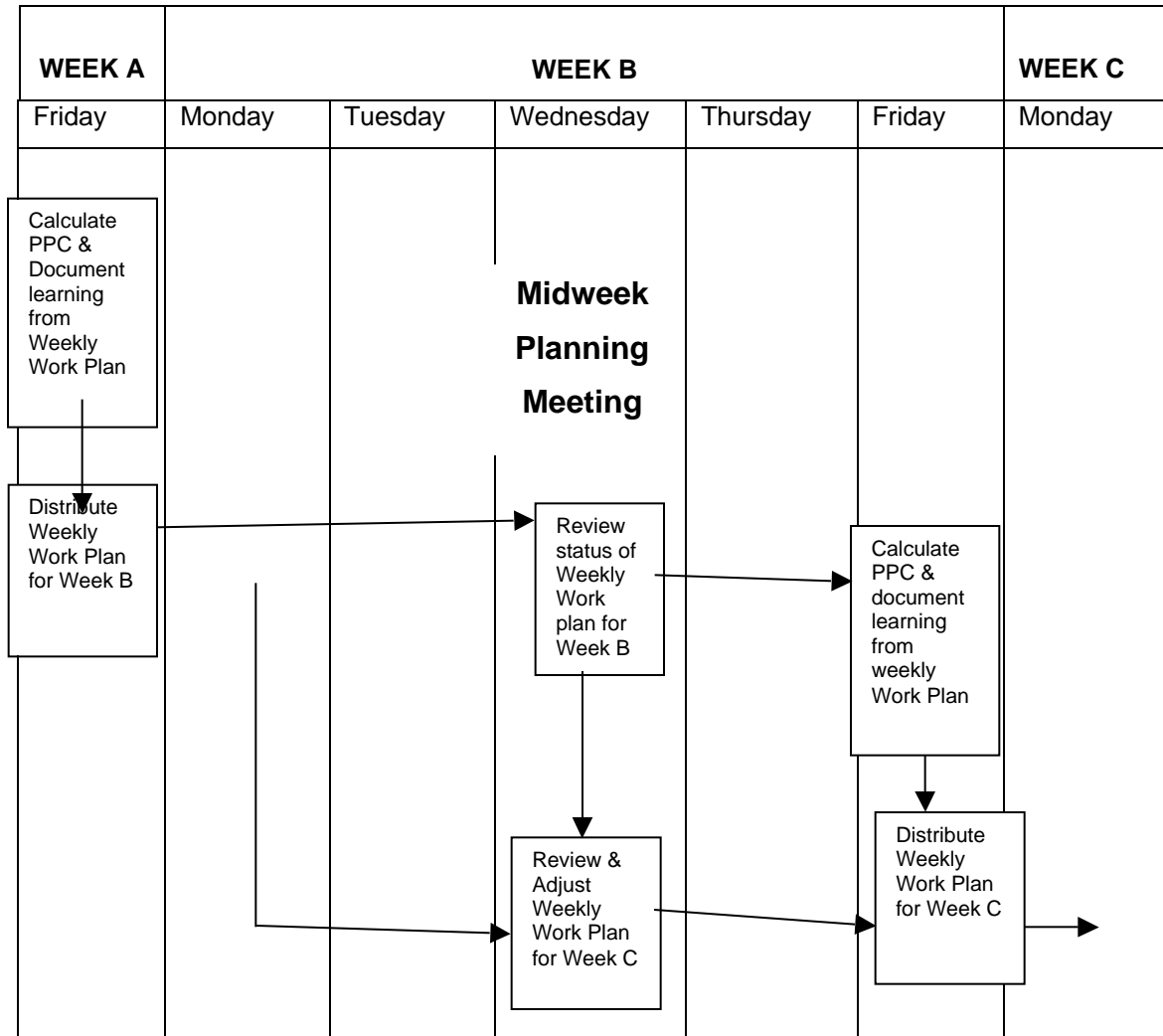
Weekly Work Planning is done shortly before performing work. Assuming that the plan week begins on Mondays—though other plan weeks are possible—planning for next week should begin this week and coordination with others completed during a mid-week meeting. This meeting involves a meeting coordinator and all Last

Planners on a project whose work is related by prerequisites, shared resources, directives, or other potential constraints. The purpose of the meeting is threefold:

- Assess and learn from last week's PPC,
- Create the work plan for the following week, and
- Determine make ready needs for the remainder of the week.

The Weekly Work Plan developed during this mid-week meeting can be adjusted at the end of the week, when last-minute information is available regarding completion of make ready work and likely completion of work scheduled for that week.

WEEKLY PLANNING CYCLE



Last Planners must bring to the mid-week meeting their actual PPC data from last week with reasons identified for assignments that were not completed. This week's meeting is for all Last Planners to report the root causes for their plan failures and to identify how these can be prevented in the future. Prevention often requires consideration and action by other crews or higher levels of supervision, so the meeting is to clarify who must take action.

The review of the current week's Weekly Work Plan and information on the status of work is to communicate how things are going, to allow other crews to gain insight into plan changes or request adjustments from others, and finally to determine what action can be taken to increase PPC in this week.

Finally, each Last Planner then puts forward their Weekly Work Plan for the next week. This information exchange combined with negotiation among Last Planners will help resolve sequencing alternatives where shared resources are involved.

<p>Last Planners bring to the Weekly Work Planning meeting:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Last week's Weekly Work Plan with PPC and reasons for plan failure identified; <input type="checkbox"/> This week's Weekly Work Plan and information on the status of work; <input type="checkbox"/> A first cut at next week's Weekly Work Plan and a list of make ready needs; and <input type="checkbox"/> The Lookahead Schedule with the status of constraints as they are known. 	<p>The coordinator brings:</p> <ul style="list-style-type: none"> <input type="checkbox"/> The project's Master/Phase and Lookahead Schedules <input type="checkbox"/> Status information from the client, regulators, designers, suppliers, project managers, crews, or others with a stake in the project. <input type="checkbox"/> A Proposed Weekly Work Plan to support Phase Milestones. (if needed.)
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The Weekly Work Planning meeting can be followed by a second meeting held on the last day of the week. The time between the two work planning meetings enables Last Planners to take care of some make ready needs. At the second meeting, they will adjust and finalize the next week's Weekly Work Plan after reviewing the actual status of their Weekly Work Plan of the current week.

In addition, all Last Planners must check on the completion of make ready work for next weeks' assignments. Some may yet have to be completed in the upcoming week and will thus require timely tracking. If this make-ready work is not done in time, the corresponding assignment is doomed to fail. The crew should therefore not even start this work, but rather, select an alternative assignment on their workable backlog.

Before the end of work Friday, all Last Planners finalize their Weekly Work Plans and distribute them to their crews as well as supervisors.

The Weekly Work Planning Adjustment meeting is for Last Planners to determine:

- Which assignments will likely be completed later that day and so increase PPC?**
- Which assignments will remain incomplete when the day is over?**
- Will incomplete work be made up by working overtime that Friday or over the weekend, or should it be assigned for the next week?**
- What make ready work remains to be done during the next week?**
- If a make ready task or any assignment were to fall through, how will the work plan be affected?**
- Is alternative work available in the workable backlog?**

RECAP

The Last Planner system includes three levels of planning, each serving a very specific purpose. The purpose of the **master schedule** is to:

- Demonstrate the feasibility of completing the work within the available time.
- Display an execution strategy that can serve as a basic coordinating device
- Determine when long lead items will be needed.

The purpose of the **lookahead schedule** is to:

- Shape workflow in the best achievable sequence and rate for achieving project objectives that are within the power of the organization at each point in time.
- Match labor and related resources to work flow
- Produce and maintain a backlog of assignments for each frontline supervisor and crew, screened for constraints.
- Group together work that is highly interdependent, so the work method can be planned for the whole operation.
- Identify operations to be planned jointly by multiple trades

The purpose of the **weekly work plan** is to:

- Identify make ready actions and assessing their feasibility prior to making assignments so as to shield crews or design teams from uncertainty.
- Making best use of the crew or team's capacity, acknowledging individuals' differences, in light of the scheduled loads.