A graphic of a network diagram with several nodes connected by lines, overlaid on a dark blue background.

(PS2949)
**Pull Planning and CPM
Scheduling: Counterparts Not
Competitors**

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- Satinder Baweja is the founder and CEO of Milestone Consultants, with over 25 years of experience assisting manage large programs, launch products, and enter new markets.
- His expertise is in planning large scale complex initiatives and the turnaround of troubled programs and projects.
- Satinder has a Masters in Engineering from Texas A & M
- Something you do not know about Satinder:



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Satinder has lived, worked, and studied in East Africa, India, and the US, giving him a unique global perspective and an ability to work with diverse cultures.



- Lori Vidak is the researcher and marketing director for Milestone Consultants.
- She owned and managed a small business for over 30 years.
- Her business experience and fitness training give her insights into creative problem solving, ethics, and stress management.
- Something you do not know about Lori: She is a fitness instructor certified in Aquatic and Group fitness, Pilates, and Kickboxing.



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She is a longtime Texas resident with roots in Colorado and Missouri.

- Lean Construction methods introduced Pull Planning or the Last Planner system.
- Pull planning was intended to be a better means of project planning and the utilization of the CPM schedule.
- However, CPM scheduling was replaced by pull planning in many cases.
- There is a need for the integration of both in construction management, as the Master Schedule reflects the efforts of pull planning and progress is more easily identified then communicated to all stakeholders.

Over twenty years ago, CPM scheduling was seen by some in the construction industry as an inadequate project management tool because too many projects experienced completion delays. (1)

In response, the Lean Construction system was created in 1993, borrowing principles from Lean manufacturing, which was based on the Just-in-Time process developed by Toyota executive Taiichi Ohno after World War II. In 1996, the book *Lean Thinking* (James P. Womack, Daniel T. Jones, 2003) brought this method to the attention of the modern business world (2)

Lean Construction methods introduced **pull planning**.

Contractors heralded it as the silver bullet to solve all their scheduling issues. But that never happened because they discarded CPM scheduling, a key project delivery navigation tool.

This presentation shows that both systems complement each other and work best together to achieve project management success.



The Role of Scheduling

CPM Scheduling and Pull Planning

History & Basics

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- Scheduling is integral to the planning process. It results in time-scaled plans of tasks and a list of resources, including materials and equipment, needed to get such work done in the scheduled period (5).
- It is instrumental in reducing stacking of trades and congestion in the area, effective deployment of equipment, and the strategic delivery of materials (5).
- A well-developed schedule helps communicate the project plan thus resulting in a well-coordinated project(5).

Scheduling is more than a process to develop an approved fixed schedule, the master/baseline schedule. It involves an ever-changing schedule that reflects project progress, as well as specific schedules that capture details of a project's progress for different key project players and decision-makers.

Critical Path Method (CPM) scheduling and pull planning are two scheduling practices developed in the 20th century as tools to establish a consistent, adaptable process for managing multiple, varied projects.

CPM Scheduling

- Gantt chart was developed in 1908 by Henry Lawrence Gantt (6 p. 191).
- Dupont and Remington Rand Univac collaborated to produce the Critical Path Method in 1956 (8).
- In the 1980s, CPM's effectiveness had become challenged by a lack of collaboration in planning, and software advances (9 p. xxi).

Pull Planning

- The Lean Construction system was created in 1993 by the International Group for Lean Construction (1).
- The Last Planner System of Production Control®, involves the last people to plan the work during collaborative planning and scheduling sessions (10).
- Lean Construction methods introduced **pull planning** as part of the Last Planner system (10).

CPM Scheduling

Basics and Development of CPM Schedule

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The focus of CPM scheduling is about breaking the work down into measurable components called tasks or activities.

These activities need two key pieces of information for successful development of a schedule:

- The duration or how long an activity will take
- What needs to be done before the activity can be started (also called the predecessors or preceding work) (6 p. 111).

Using CPM scheduling requires knowledge of both the duration and the precedence of each activity.

When developed using established project management standards, the CPM schedule is an effective tool for identifying critical and near-critical work and for providing the contractor with a way to level its resources. It also enables tracking and reporting on the project's progress. The CPM schedule has been widely used to identify areas of risk and to develop alternative approaches for how work should be executed. Impact analysis using CPM schedules is now largely accepted as a valid analytical technique.

The critical path schedule should be developed at varying levels of details based on project phase.

- Bid Level Schedule
- Preliminary Schedule
- Master/Baseline Schedule
- Control Schedule
- Lookahead Execution Schedule

For the purposes of this paper, the project's lifecycle begins when the owner decides to proceed. The primary focus of the master schedule is design/preconstruction/construction. For the general contractor (GC), developing a CPM schedule typically begins during the project pursuit. For the purposes of this presentation, the structure of a concrete-frame hotel building will serve as a basis for an example of how the schedule may be successively detailed during the various phases of a project and how/when the concepts of pull planning and the last planner system fit in.

A bid level schedule will focus on the feasibility and evaluation of equipment and manpower needs.

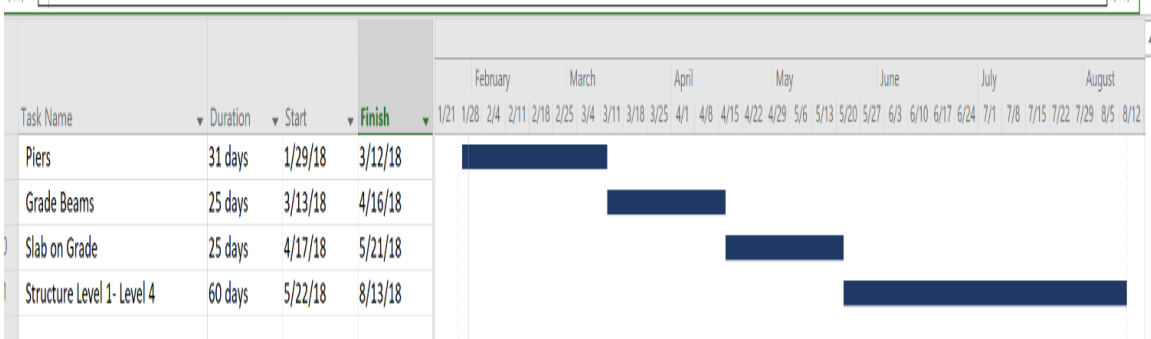


Figure 1 - Bid Level Schedule Sample – Created with Oracle P6

A bid-level schedule is used by the GC to solicit subcontractor bids and to obtain early consensus on milestone timing. It is used to demonstrate to the owner that the GC has invested thought and time into the project planning during the bid phase

Using just the one task, the example below shows how the bid schedule may be further detailed into a preliminary schedule.

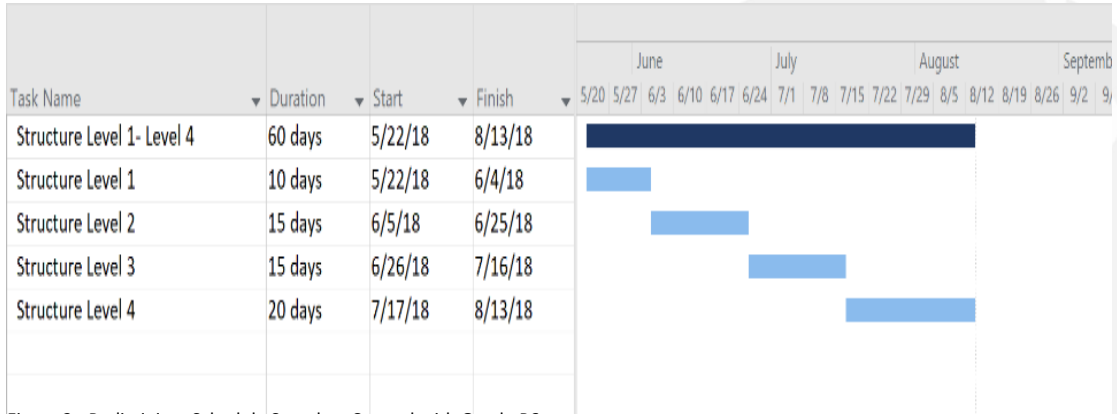


Figure 2 - Preliminary Schedule Sample – Created with Oracle P6

As the scheduling process moves forward, if the project is not hard bid (or fixed-priced), the owner will usually invite a short list of companies to present their plans. At this stage, the GC will usually invest further time and effort in validating the bid schedule, detailing areas that may be considered challenging, and highlighting areas and sequences where contenders believe they have innovated, adding significant value to the client. This allows them to be differentiated from their competitors.

This schedule becomes a contractual document and is the schedule to be measured against during the life of the project.

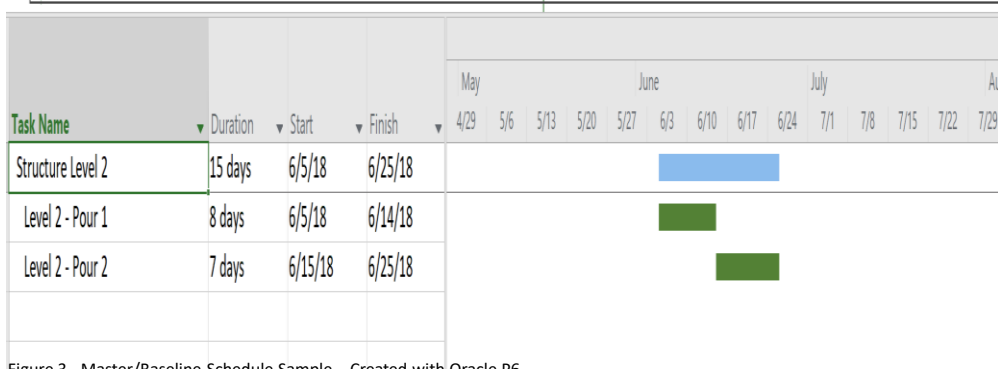


Figure 3 - Master/Baseline Schedule Sample – Created with Oracle P6

If the project is not hard bid (or fixed-priced), the owner will usually invite a short list of companies to present their plans. At this stage, the GC will usually invest further time and effort in validating the bid schedule, detailing areas that may be considered challenging, and outlining areas and sequences where contenders believe they have innovated, adding significant value to the client. This allows them to be differentiated from their competitors. Once the project has been awarded, the GC will have identified the project manager and superintendent. The baseline schedule is their attempt to refine it. It will usually include input from the subcontractors that have already been bought out (or contracted). It is during design, procurement, and construction that regular reports and supplemental CPM schedules are made, which compare real-time progress with the master schedule.

Using the concept of Lean Scheduling, a control schedule is created that details out 60–90 days at a time. It builds on the master schedule mapping out in additional detail the coming 2-3 months.

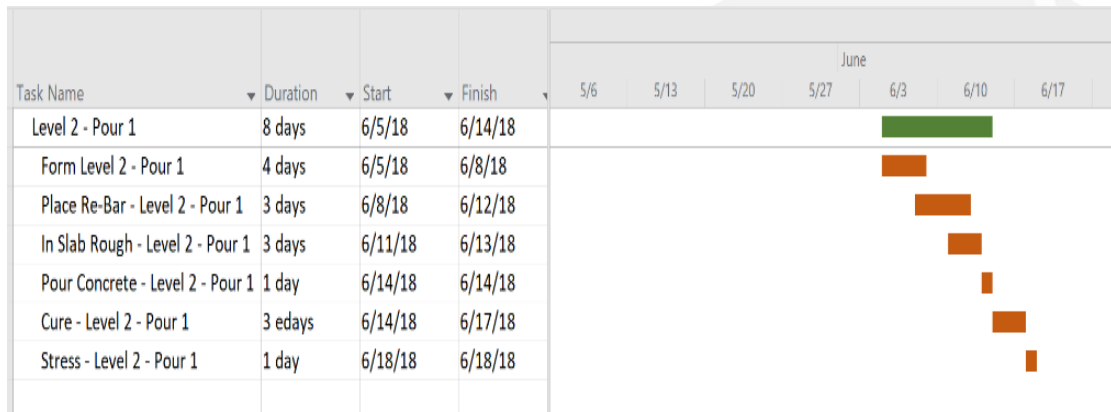


Figure 4 - Control Schedule Sample – Created with Oracle P6

This is where the pull planning system can be used to validate a project phase. By the time a control schedule is developed, the sub-contractor teams are usually in place, making this the perfect time to start integrating the **master schedule** with the last planner concept.

The lookahead schedule should typically be a 4 or 6-week detailed forecast schedule.

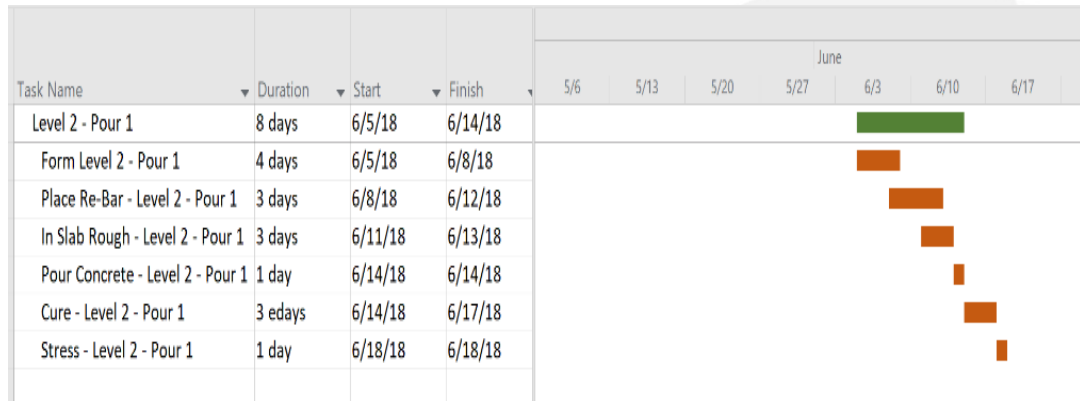


Figure 5 – Lookahead Schedule Sample – Created with Oracle P6

The Lookahead schedule provides an exceptionally structured way to detail out the work execution in a collaborative manner by the people who will be responsible for this work in the field. The CPM schedule can and should do this, regardless of whether pull planning methods are used. However, such collaboration and structure require rigor and effort, which typical CPM (construction project management) in the construction industry has not usually accomplished. The industry's current interest in pull planning methods makes this the perfect opportunity to blend the two methods to achieve effective results.

The master schedule is:

- A tool for planning,
- A tool to assess feasibility,
- A road map of the project's planned execution,
- A source of procurement and engineering information,
- A guide of workforce anticipation,
- The reference used for progress reporting,
- A snapshot of project's scope,
- A budget reference tool,
- A contractual requirement, and
- An excellent communication tool for all stakeholders of the project.

Oral References: (13 p. 166)

Of all these schedules, the Master Schedule is the most critical. It plays a major role in CPM scheduling and is a necessary tool for project management.

The master schedule is the official project plan for accomplishing a project scope within an authorized budget and within a specified period.

Fully developed, it is the work plan for the total project and should include all elements of work at a level of detail to adequately manage and monitor the project.

During the design-build phase, the master schedule is the principal guideline for execution (13 p. 166)

With a resource like CPM scheduling at hand, how could the commercial construction industry not embrace it with enthusiasm, give it the due diligence it deserves, and fully utilize it throughout the life of the project? The answer is that the perception of the CPM scheduling became corrupted.

The Corruption of the CPM Master Schedule's Perceived Usefulness

- Commercial construction has always had a love hate relationship with the use of construction schedules.
- The development of scheduling software has provided the general contractor the means to buffer completion dates and alter schedules to the GC's advantage.
- Shortcomings in the practices of the CPM schedule development process cause it to be ineffective (14 p.14).
- Most contractors want their senior superintendents or the project manager to own the schedule (15 p. 2).
- Most general contractors self-perform a very minute portion or none of the work; the project is subcontracted out to specialty contractors.

Oral References: (14 p. 14), (15 p. 2)

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- Many GCs are forced to build a CPM schedule to meet contract requirements, knowing that it might be used against them should claims arise, which they often do.
- With less motivation to develop realistic representations of the project's execution timeline, GCs often manipulate the schedule to their advantage. Such unrealistic schedules give owners false assurances and inaccurate measures of actual progress.
- Construction projects are inherently fragmented. Each team represents a trade or purpose, prioritizing their own project goals, often in conflict with other teams. Project delivery underperformance is partly due to a lack of synergy between teams (14, p. 14).
- Though excellent planners, expecting busy superintendents and project managers to develop accurate, detailed schedules is a lot to ask. Their resulting schedules convey the project's intent but do not respond to updates and impacts like a true CPM schedule (15 p. 2).
- Developing a schedule without each subcontractor's input also adds to the CPM's decline. Pull planning was one scheduling approach that emerged to address the lack of collaboration.

- With a lack of appreciation for the schedule, the role of the scheduler diminished to that of a schedule data entry specialist.
- In the 1980s, an estimated 90% of seasoned professional schedulers had changed jobs (9 p. 20).
- The scheduler's role was parceled out, because the PM was busy with his primary duties of project execution management. Planning and scheduling continuity issues were exacerbated, further lessening the master schedule's reliability (16).
- Pull planning became a major contender of alternative methods to solve project management deficiencies in planning and scheduling.

With the mass migration of these scheduling pioneers to other positions, their skills, experience, and perspectives went with them, leaving a void of experienced insights in CPM schedule development.

Pull Planning

Basics, Limitations & Benefits

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- One of the core underlying principles of pull planning is to get the subject matter experts (the superintendents and foremen) in the field, called the last planners, to come together and cooperatively work to deliver value to the project. (18)
- One question helps facilitate this collaboration:

How will we do our work to meet the client or project milestone? (Ted Smith, 2012) (17)

Oral References: (18)

Effective pull planning requires intense collaboration. The goal is to get the project's key stakeholders to identify needed milestones or deliverables, then work backward to identify removable constraints and proceed with the work. This process works backward towards the current date or the project's start. It transforms siloed subject matter and independent goals into working toward a common goal as a cohesive team. Every stakeholder's experience, talents, and skills are incorporated to identify potential issues and eliminate wasted time. (18)

The intention of pull planning:

- Identify milestones,
- Identify critical milestones,
- Put together a weekly plan,
- Review activities with crew leaders and evaluate what can be modified,
- Update and review activities on a weekly basis to analyze activities duration and prepare RCA if needed, and
- Update the schedule after reviewing activities and receiving feedback from the scheduler and all crew members (11)

Understanding the pull-planning concept will hopefully encourage its use alongside CPM scheduling.

Note that planning was never intended to replace CPM scheduling. Some CPM scheduling practitioners consider pull planning a tool that supports proper project planning and more accurate CPM schedules, and that helps communicate the project's progress (12).

Eventually, the goal of pull planning is to deliver a successful project to the project owner by collaborating to identify and solve problems (18).

Unfortunately, more than a few general contractors in commercial construction considered pull planning (which involved planning, planning, and more planning) the silver bullet to solve all the hairy project scheduling and cost overrun issues.


- Almost universally, construction projects are dynamic in nature. Plans are constantly changing due to the environment, site conditions, modified designs and substituted materials being among some of the reasons. Due to the nature of pull planning, such changes are difficult to analyze in a holistic manner.
- The communication of a design change to a future flow of construction is difficult to demonstrate using pull planning techniques. Pull planning does not allow for predictive analysis and metrics to be used for upcoming work (19).

The primary reason for the failure to use CPM scheduling was the lack of collaboration during planning, not any inherent deficiencies in CPM. Since pull planning alone had often failed to deliver projects on time and within budget, it can be argued that all the planning in the world will not bring a project to completion efficiently without an effective tool for progress measurement and project management controls (like a CPM schedule).

- A study by McGraw Hill Construction showed that 62% of general contractors surveyed have implemented at least one LEAN practice, and pull planning was used by 39% of the 62% (20 p. 1). These 62% experienced the following benefits (20 p. 3):
- Higher Quality Construction – 81%
- Improved Safety - 75%
- Greater Productivity – 74%
- More Focus by Supervisory Staff on Managing Workers – 61%
- Greater Profitability/Reduced Costs – 58%
- Improved Lifecycle Costs/Cost of Ownership – 49%

With all these benefits, denial of pull planning as a worthwhile addition to project management would be imperceptive or biased.

Though pull planning may not be a silver bullet, it is one shotgun shell loaded into a double-barreled shotgun. The other shell is CPM scheduling. When using both together, it is much more difficult to miss target dates and budgeted costs than using just one or the other, or worse—nothing at all.

A graphic on the left side of the slide shows a network of interconnected nodes and lines, resembling a globe or a complex project network, set against a dark blue background.

Using the CPM Master Schedule and Pull Planning as Counterparts

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- Having expounded upon the virtues and inadequacies of both CPM scheduling and pull planning, the time has come to show how these practices complement each other.

Role of Scheduling	Critical Path Method	Pull Planning
Facilitate project planning	Design and development of schedule gives focus to the intent of the plan	The collaboration required during planning session promotes accuracy in schedule
Facilitate collaboration of key project players		✓
Facilitate project feasibility assessment	✓	
Map out the project's planned execution	Documentation of execution	Collaborative meeting of key players to create accurate timeline of necessary activities to be executed
Create a resource of procurement and engineering information	✓	
Facilitate project progress reporting	Measure & Document	Collaborative meetings of key players to report and examine progress
Communicate details of project execution to all stakeholders of the project	✓	

This graphic shows how scheduling aids project management and demonstrates whether CPM or pull planning meets each criterion for that role. Where both meet common criteria, how they do so is specified to show how these methods work together. Where they do not meet common criteria, their compatibility is demonstrated by the fact that, together, all scheduling criteria are met.

Role of Scheduling	Critical Path Method	Pull Planning
Present a snapshot of the project's scope	✓	
Manage the overall project for timely completion (19)	Map, measure, document	Collaborative Meetings for Planning, Progress and Solution
Determine which activities are critical (19)	✓	✓
Communicate to resources mobilization, work performance, demolition and demobilization dates (19)	✓	
Manage activity of internal resources (19)	✓	
Manage and coordinate sub-contractors (19)	Documented list of subs, timing & location of their activities and manpower	Subs participate in collaborative meetings on when and where who will do what and how.
Coordinate with clients, owners or end users (19)	✓	

Role of Scheduling	Critical Path Method	Pull Planning
Manage a time-phased budget (19)	✓	
Predict milestones & completion dates (19)	Determined by PM, Scheduler &/ or others, documented in appropriate detail & made accessible to all stakeholders	Determined by Collaborative meeting of key players,
Fulfill contract requirements for schedule provision (19)	✓	
Manage change (19)	✓	✓
Control time-related costs (19)	✓	
Avoid, defend or document claims	✓	
Facilitate risk management	Measure progress and notate delays & potential risks	Collaborative Meetings of Key Players to Facilitate Innovative Solutions to delays & risks
Track, document and share lessons learned	✓	

28 Oral References: (12)

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This chart shows where both CPM and pull planning benefit project management. There are real benefits in integrating and implementing these systems. Planning the project in a collaborative team environment with key stakeholders should begin early in the project. This allows early identification of constraints and key areas where detailed coordination may be required. This effort needs to continue throughout the project’s lifecycle, using daily huddles and weekly planning sessions. It is important to instigate continuous learning by tracking variances and identifying the reasons why promised objectives are not met. This allows for group discussions on ways to eliminate the rocks and allow for project success.

It should be noted that most project management teams find it difficult or time-intensive to integrate both practices. While modifying the CPM schedule at each planning session and integrating the changes from a pull planning session into the CPM schedule might seem challenging, a structured approach to successively detailing the schedule, as described earlier in the paper, goes a long way toward smoothly integrating the two practices.



Conclusion

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- While there are contractors that swear by CPM scheduling or others that feel that some version of pull planning from Lean Construction principles is the answer, as demonstrated today, both the systems complement each other and work best to effect project management success when used together.

- In project management, especially for construction, there is need for CPM scheduling and pull planning operating together on a construction project so that the master schedule reflects the collaborative efforts of pull planning, and progress is more easily identified then communicated to all stakeholders.
- When integrating the two methods it is important to keep in mind that collaborative planning requires discipline, effort, and consistency for the desired results.
- Pull planning is insufficient to deliver complex projects without the direction of CPM scheduling for perfect aim in achieving the targeted project's timely completion, within budget, and with quality of work.

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