
FIELD-DRIVEN COURSE BOOK · FIRST EDITION 2026

Lean Construction Mastery

*Reliable planning, concrete production,
leadership, and continuous improvement —
built for the people closest to the work.*

Prepared for **London Wulfe**

COURSE BOOK + WORKBOOK + MOCK EXAMINATION

16 Chapters · Field Templates · Concrete Operations · 20-Question Assessment

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Standards, codes, contract requirements, manufacturer instructions, project specifications, and competent-person determinations govern actual field work. Standard designations and editions cited in this book were current at the time of writing; verify the current edition and local requirements before use. Safety-critical decisions must be made by qualified project personnel.

How to Use This Book

- ▶ Read one chapter each week and immediately apply one tool on a live project.
- ▶ Complete each field assignment with the superintendent, foreman, project manager, or trade partner closest to the work.
- ▶ Keep PPC and reasons-for-variance data visible. Data that stays hidden cannot improve behavior.
- ▶ Use the appendix templates as starting points; simplify them until the crew will actually use them.
- ▶ Finish with the capstone: a complete Lean execution plan for a concrete-intensive project.

Core idea. Lean construction is not about squeezing more labor from people. It is about designing a reliable production system so skilled people can perform safe, quality work without avoidable waiting, rework, confusion, or overburden.

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16	Capstone Implementation	A 90-day deployment plan and execution playbook
A	Appendix A — Field Templates	Conditions of satisfaction, logs, plans
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Lean Foundations

Build more value with less waste — without overburdening people.

LEARNING OBJECTIVES

- Define Lean construction in field language
- Explain customer-defined value and the six Lean tenets
- Separate activity from production
- Describe why respect for people is an operating principle, not a slogan

1.1 Construction as a Production System

Every project is a network of commitments. Drawings, approvals, labor, equipment, materials, access, inspections, and predecessor work must arrive in a usable condition. When one condition fails, the visible delay is only the symptom; the production system failed earlier.

Traditional management often rewards local busyness: each trade starts as soon as possible and produces as much as possible. Lean asks whether that activity improves overall flow. Starting work that cannot continue, installing ahead of unresolved design, or delivering material before storage is ready may increase local utilization while damaging the project.

- ▶ Manage flow, not appearances.
- ▶ Plan from the customer need backward.
- ▶ Make problems visible early.
- ▶ Protect people from chaos and overburden.

FIELD LENS

A crew waiting beside a concrete pump is not a labor-effort problem. The constraint was likely missed during make-ready planning.

1.2 The Six Tenets

Lean project delivery connects people, principles, and systems. The practical foundation is *respect for people, optimize the whole, focus on customer-defined value, eliminate waste, focus on process and flow, and maintain a mindset of continuous improvement*.

Respect changes how planning meetings work. The foreman who will perform the work helps plan it. A reliable promise is requested, not assigned from above without consultation. A missed commitment becomes a learning opportunity first and an accountability issue second.

LEADERSHIP STANDARD

No-blame does not mean no accountability. It means learning the system cause before judging the person.

1.3 Value and Conditions of Satisfaction

Value is defined by the customer and other key stakeholders, not by the amount of effort expended. On a slab project, value may include flatness, levelness, finish appearance, load capacity, turnover date, low maintenance, safe access, and minimal disruption.

Convert broad expectations into measurable Conditions of Satisfaction. A strong condition states who needs what, by when, and how acceptance will be determined. This prevents teams from optimizing the wrong target.

- ▶ Define acceptance before execution.
- ▶ Distinguish must-haves from preferences.
- ▶ Expose conflicts among cost, schedule, quality, and operations early.

1.4 Motion Is Not Progress

Lean measures completed, usable work. Rebar partly tied, forms partly set, and embeds partly coordinated may create the illusion of progress while producing no releasable work area. Smaller finished zones usually beat many open zones because they reduce work-in-process and make handoffs clear.

A good superintendent asks, “What can be finished today?” and “What condition must be true for the next crew to succeed?” Those questions shift the project from activity management to production management.

CREW QUESTION

At the start of each shift ask: what work will be fully complete and ready for the next customer by the end of today?

Field Assignment • Lean Observation Walk

1. Choose one active work area.
2. Identify the customer of the work.
3. Write the exact completion condition.
4. Record three interruptions or sources of waiting.
5. Ask the crew for one change that would improve tomorrow.

Deliverable. One-page observation with value statement, three wastes, one countermeasure, and one responsible owner.

KNOWLEDGE CHECK

1. **Which statement best defines Lean construction?**
 - A.** A scheduling software method
 - B.** A cost-cutting program
 - C.** A production system that maximizes value and minimizes waste
 - D.** Maximum labor utilization at all times
2. **Who defines value?**
 - A.** The superintendent alone
 - B.** The lowest bidder
 - C.** The customer and relevant stakeholders
 - D.** The estimator alone
3. **Respect for people means:**
 - A.** Including performers in planning and solving system problems
 - B.** Avoiding difficult conversations
 - C.** Eliminating accountability
 - D.** Letting every person choose any method
4. **The best measure of progress is:**
 - A.** Equipment operating
 - B.** Completed usable work
 - C.** People visibly busy
 - D.** Materials delivered

Answers in Appendix F.

CHAPTER CLOSEOUT Start where you stand. Pick one work area this week, name its customer, and write the completion condition in one sentence. That single habit begins the shift from managing activity to managing production.

Seeing Waste

Learn to see what the schedule and cost report hide.

LEARNING OBJECTIVES

- Identify the eight wastes in field operations
- Conduct a waste walk without blaming people
- Quantify the cost of waiting and rework
- Prioritize waste based on impact and controllability

2.1 The Eight Wastes

A practical construction mnemonic is **DOWNTIME**: defects, overproduction, waiting, non-utilized talent, transportation, inventory, motion, and extra-processing. The categories overlap; the purpose is not perfect classification. The purpose is learning to see conditions that consume resources without creating value.

Defects include rejected work, punch-list repair, and missing embeds. Overproduction includes installing or fabricating before downstream need is confirmed. Waiting includes labor, equipment, information, and inspections. Non-utilized talent occurs when people closest to the work are excluded from planning. Transportation is unnecessary movement of material. Inventory is material or unfinished work beyond near-term need. Motion is unnecessary human movement. Extra-processing is work beyond acceptance requirements or repeated data entry.

CONCRETE EXAMPLE

A finishing crew walks 300 feet repeatedly for tools: motion. Trucks queue at the gate: waiting. Excess concrete ordered “just in case”: inventory and overproduction. Grinding a slab because screed setup was wrong: defect and extra-processing.

2.2 Waste Walks

A waste walk is observation, not an inspection ambush. Go to the work with the foreman. Follow one worker, one material, or one piece of information. Record start-stop cycles, travel distance, queue time, unclear decisions, and rework. Ask neutral questions: “What makes this task harder than it should be?” and “What do you wait for most often?”

Observe long enough to understand the pattern. A five-minute snapshot may mistake necessary setup for waste. Compare current conditions with the intended standard and verify your interpretation with the people doing the work.

- ▶ Separate facts from assumptions.
- ▶ Measure time, distance, quantity, and frequency.
- ▶ Do not confuse safety or quality controls with waste.
- ▶ Test small countermeasures before changing the whole project.

2.3 Cost of Waste

Waiting cost is more than hourly wages. It may include payroll burden, rented equipment, supervision, extended general conditions, lost production opportunity, demobilization, and schedule ripple effects. A one-hour delay to a 12-person crew at a loaded labor rate of \$68 per hour costs \$816 in direct labor before equipment and indirect impacts.

Rework cost should include removal, disposal, replacement material, repeated layout, repeated inspection, schedule disruption, and lost trust. The first cost code rarely captures the full impact.

SIMPLE FORMULA

Waste cost = frequency × (duration or quantity) × loaded rate, plus material, equipment, and indirect impacts.

2.4 Prioritization

Do not attack every waste at once. Rank issues by safety risk, quality risk, schedule impact, cost, frequency, and ease of control. A recurring 10-minute delay across every crew can matter more than a dramatic one-time event.

Choose one high-frequency issue and one high-consequence issue. Assign owners, due dates, and a visible follow-up. Improvement without ownership becomes another meeting artifact.

Field Assignment · DOWNTIME Waste Study

1. Select one repeatable task.

2. Observe at least one full cycle.

3. Classify observed waste using DOWNTIME.

4. Quantify the top two wastes.

5. Propose a countermeasure and a one-week test.

Deliverable. Before/after cycle data and a brief recommendation.

KNOWLEDGE CHECK

1. Which is an example of overproduction?

A. Performing a required inspection

B. Fabricating embeds before design is released

C. Using a backup pump for a critical pour

D. Ordering forms for approved work

2. A waste walk should primarily be:

A. A payroll review

B. A disciplinary audit

C. A collaborative observation of the process

D. A safety inspection only

3. Which cost is commonly missed in rework?

A. None — all costs are captured in the first code

B. Removal labor

C. Replacement material

D. Schedule ripple and repeated inspection

4. The first improvement target should usually be:

A. The easiest cosmetic issue

B. The most expensive tool

C. Every issue simultaneously

D. A high-impact recurring issue with an owner

Answers in Appendix F.

CHAPTER CLOSEOUT You cannot cost what you have not observed. Walk one task, time one cycle, and put a dollar figure on the top waste you find. A number changes conversations that opinions never will.

Production Thinking

Control flow, variation, batch size, and work-in-process.

LEARNING OBJECTIVES

- Explain flow and variation
- Use buffers intentionally
- Compare push and pull
- Apply takt and location thinking

3.1 Flow and Variation

Flow is the steady movement of value through connected activities. Variation in crew output, truck arrival, inspection time, weather, information release, and predecessor completion disrupts handoffs. Lean does not assume variation disappears; it designs the system to expose, reduce, and absorb it deliberately.

- ▶ Track cycle time by location.
- ▶ Separate common variation from special events.
- ▶ Stabilize prerequisites before increasing speed.

RULE

Speed without stability increases defects and waiting.

3.2 Push, Pull, and Work-in-Process

Push releases work based on an upstream schedule or local availability. Pull releases work when the downstream customer is ready. Excess work-in-process hides defects, consumes access, increases damage risk, and makes priorities unclear.

- ▶ Limit open work areas.
- ▶ Define handoff criteria.
- ▶ Finish zones before opening new zones.

3.3 Buffers

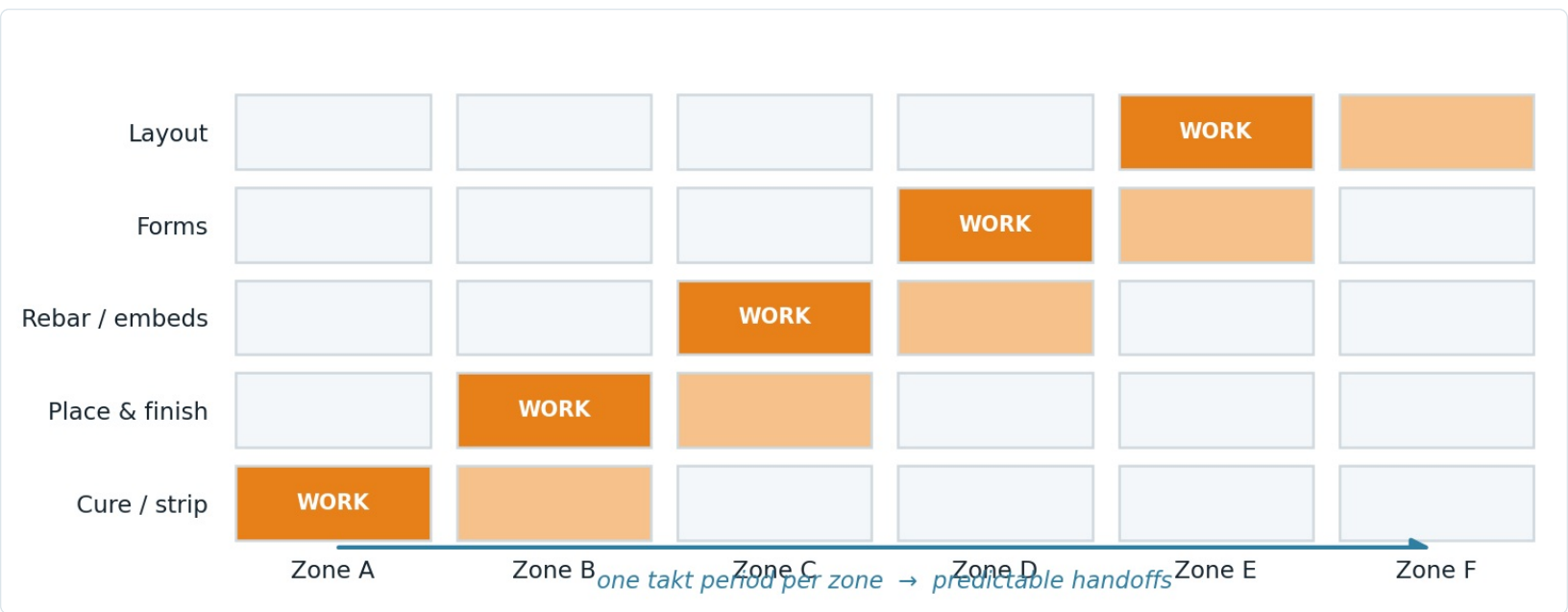
Time, capacity, inventory, and space buffers can protect flow, but every buffer has a cost. A backup pump may be a rational capacity buffer for a critical mat pour. Ten truckloads queued on a city street are an unmanaged inventory buffer.

DECISION TEST

Use a buffer only when the risk it protects is greater than the cost and side effects it creates.

3.4 Takt and Location-Based Planning

Takt planning divides the project into zones and establishes a planned rhythm for crews. The goal is not forcing identical production; it is balancing work packages, crew size, and zone size so handoffs become predictable. Start with stable, repetitive work and adjust from field data.



Takt and location-based planning. Each trade advances one zone per takt period, so every crew knows where it works next and each handoff lands in a predictable place. The rhythm — not the individual crew speed — is what makes the sequence reliable.

- ▶ Define zones visually.
- ▶ Calculate workable quantity per zone.
- ▶ Balance trades around the bottleneck.
- ▶ Protect handoffs with readiness checks.

Field Assignment · Flow Study

1. Map one repeated sequence by location.
2. Measure cycle time for each trade.
3. Find the bottleneck.
4. Propose a smaller batch or zone.
5. Identify the minimum buffer needed.

Deliverable. A location-flow map with a recommended rhythm.

KNOWLEDGE CHECK

1. **What does excessive work-in-process usually do?**

- A.** Guarantees flow
- B.** Improves transparency
- C.** Hides problems and consumes space
- D.** Eliminates variation

2. **Pull means work is released when:**

- A.** Downstream is ready
- B.** Upstream is idle
- C.** Material is cheapest
- D.** The master schedule is printed

3. **A takt plan primarily creates:**

- A.** A safety citation
- B.** A predictable location rhythm
- C.** A concrete mix
- D.** A bid tab

4. **A buffer is justified when:**

- A.** It is traditional
- B.** Its protection exceeds its cost
- C.** It hides missed commitments
- D.** It is unlimited

Answers in Appendix F.

CHAPTER CLOSEOUT Stability comes before speed. Before you push for more output, close one open zone and measure whether the next handoff got easier. Flow improves in small, provable steps.

Last Planner System

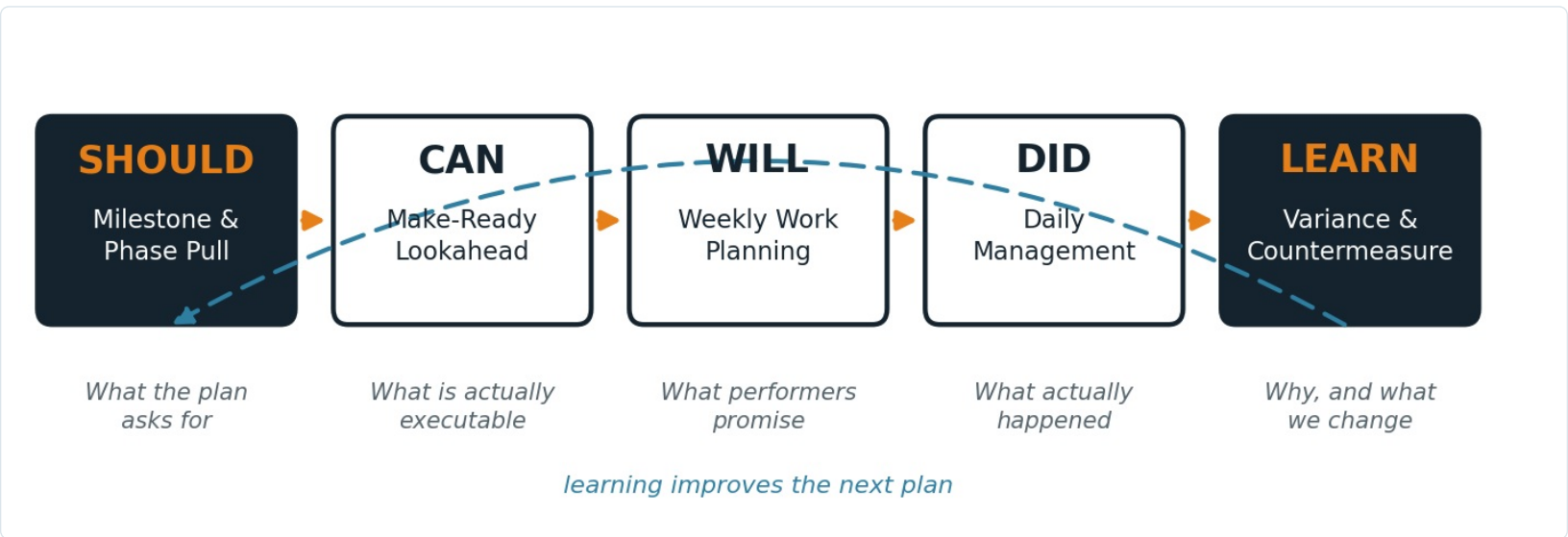
Turn schedules into reliable conversations and commitments.

LEARNING OBJECTIVES

- Describe the five conversations
- Identify the Last Planner
- Connect master, phase, lookahead, weekly, and daily planning
- Use learning loops

4.1 The Five Conversations

The Last Planner System connects **should**, **can**, **will**, **did**, and **learn**. Milestone and phase planning establish what *should* happen. Make-ready determines what *can* happen. Weekly planning records what performers *will* do. Daily management checks what *did* happen. Learning identifies why and improves the system.



The five connected conversations. Each level narrows from strategy to execution, and the learning loop feeds what the team discovers back into the next plan. Omitting a level does not remove the work — it pushes unresolved problems downstream into the weekly plan.

MEMORY AID

Should → Can → Will → Did → Learn.

4.2 Who Is the Last Planner?

The Last Planner is the person closest to the work who can make a reliable commitment for that work. Depending on the operation, this may be a foreman, general foreman, superintendent, design lead, procurement lead, or fabrication manager.

- ▶ Authority must match the promise.
- ▶ The planner must understand current capacity.
- ▶ Commitments should be negotiated, not imposed.

4.3 Connected Planning Levels

A master schedule sets contractual and strategic milestones. Phase pull plans define handoffs. Lookahead planning removes constraints. Weekly work plans capture promises. Daily huddles coordinate actual conditions. Skipping a level overloads the weekly plan with unresolved problems.

4.4 Learning

PPC without reasons for variance is a score without coaching. Teams should classify breakdowns, identify recurring system causes, test countermeasures, and report whether the change worked.

- ▶ Discuss failures without humiliation.
- ▶ Distinguish controllable and uncontrollable causes.
- ▶ Look for patterns across weeks.

Field Assignment · LPS Health Check

1. Interview three Last Planners.
2. Map existing planning meetings to the five conversations.
3. Identify one missing conversation.
4. Record how constraints are assigned and closed.
5. Recommend one meeting change.

Deliverable. One-page LPS maturity assessment.

KNOWLEDGE CHECK

1. **The “can” conversation is mainly about:**
 - A.** Removing constraints
 - B.** Punch list only
 - C.** Final payment
 - D.** Contracting
2. **A Last Planner should be:**
 - A.** The owner only
 - B.** Any meeting attendee
 - C.** Closest to the work with authority to commit
 - D.** The scheduler only
3. **PPC is incomplete without:**
 - A.** More milestones
 - B.** Reasons for variance and learning
 - C.** Cost codes
 - D.** A larger font
4. **Which sequence is correct?**
 - A.** Should, can, will, did, learn
 - B.** Will, should, can, learn, did
 - C.** Can, did, will, should, learn
 - D.** Should, will, can, did, learn

Answers in Appendix F.

CHAPTER CLOSEOUT Skipping a conversation does not save time; it moves the problem into the weekly plan. Audit your meetings against should, can, will, did, and learn, and restore whichever one has gone missing.

Pull Planning

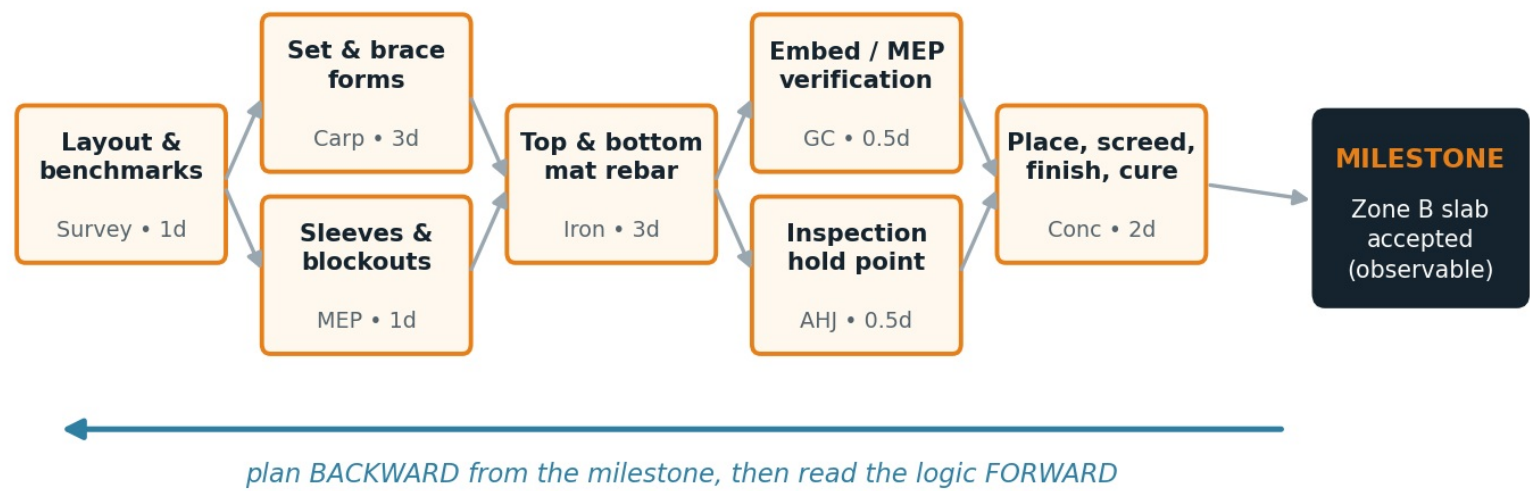
Plan backward from milestones and make handoffs explicit.

LEARNING OBJECTIVES

- Facilitate a pull plan
- Write good activity cards
- Validate logic and durations
- Convert pull plans into actionable phase plans

5.1 Start at the Milestone

Pull planning begins with a clear milestone and acceptance condition. The team works backward, asking what must be complete immediately before the milestone and what each predecessor requires. This reveals handoffs and decision needs that forward planning often hides.



A pull plan for one milestone. The team starts at an observable, accepted milestone and works backward, so predecessors, decisions, and inspection hold points surface as explicit handoffs. Reading the logic forward afterward is what exposes the gaps.

MILESTONE TEST

The milestone must be observable and accepted — not merely “start slab” or “finish design.”

5.2 Card Quality

Each activity card should name the responsible party, action, location, duration, predecessor need, and completion condition. “Rebar” is weak. “Ironworkers complete and self-inspect top mat in Zone B, ready for MEP verification” is actionable.

- ▶ Use verbs and nouns.
- ▶ Keep durations in workable crew terms.
- ▶ Separate work from approvals and decisions.
- ▶ Mark long-lead and high-risk items.

5.3 Facilitation

Invite the people who know the work. Establish rules, define the milestone, plan backward, challenge logic respectfully, identify handoffs, then read the plan forward. The facilitator protects participation and prevents one voice from planning for everyone.

5.4 From Wall to Schedule

The pull wall is not the final product. Transcribe activities, preserve trade ownership, add constraints, verify calendars, and connect the phase plan to lookahead and weekly planning. Photographing the wall without operational follow-through creates theater, not Lean.

COMMON FAILURE
A beautiful pull plan that never becomes make-ready actions or weekly commitments.

Field Assignment · Mini Pull Plan

1. Select a milestone within six weeks.

2. Bring at least three performers.

3. Plan backward using activity cards.

4. Read forward and correct logic.

5. Create a constraint list from the plan.

Deliverable. A photographed or digitized pull plan plus constraint log.

KNOWLEDGE CHECK

1. Pull planning starts from:

A. The bid date only

B. Today

C. The largest trade

D. The milestone, and works backward

2. A strong activity card includes:

A. Only duration

B. A vague noun

C. Only predecessor

D. Responsible party, action, location, duration, completion condition

3. After the wall session, the team should:

A. Archive the photo

B. Stop updating it

C. Delete constraints

D. Connect it to make-ready and weekly planning

4. Who should participate?

A. People who understand and perform the work

B. Only management

C. Only the owner

D. Only the scheduler

Answers in Appendix F.

CHAPTER CLOSEOUT A pull plan earns its value after the sticky notes come down. Convert the wall into constraints with owners and dates within 48 hours, or the session becomes theater.

Make-Ready and Constraints

Ensure planned work is actually executable.

LEARNING OBJECTIVES

- Screen work for readiness
- Build and manage a constraint log
- Assign owners and need-by dates
- Calculate a workable backlog

6.1 Ready Work

An activity belongs in the workable backlog only when prerequisites are satisfied or reliably scheduled before need. Typical constraints include information, materials, labor, equipment, predecessor work, access, permits, inspections, safety controls, environmental limits, and customer decisions.

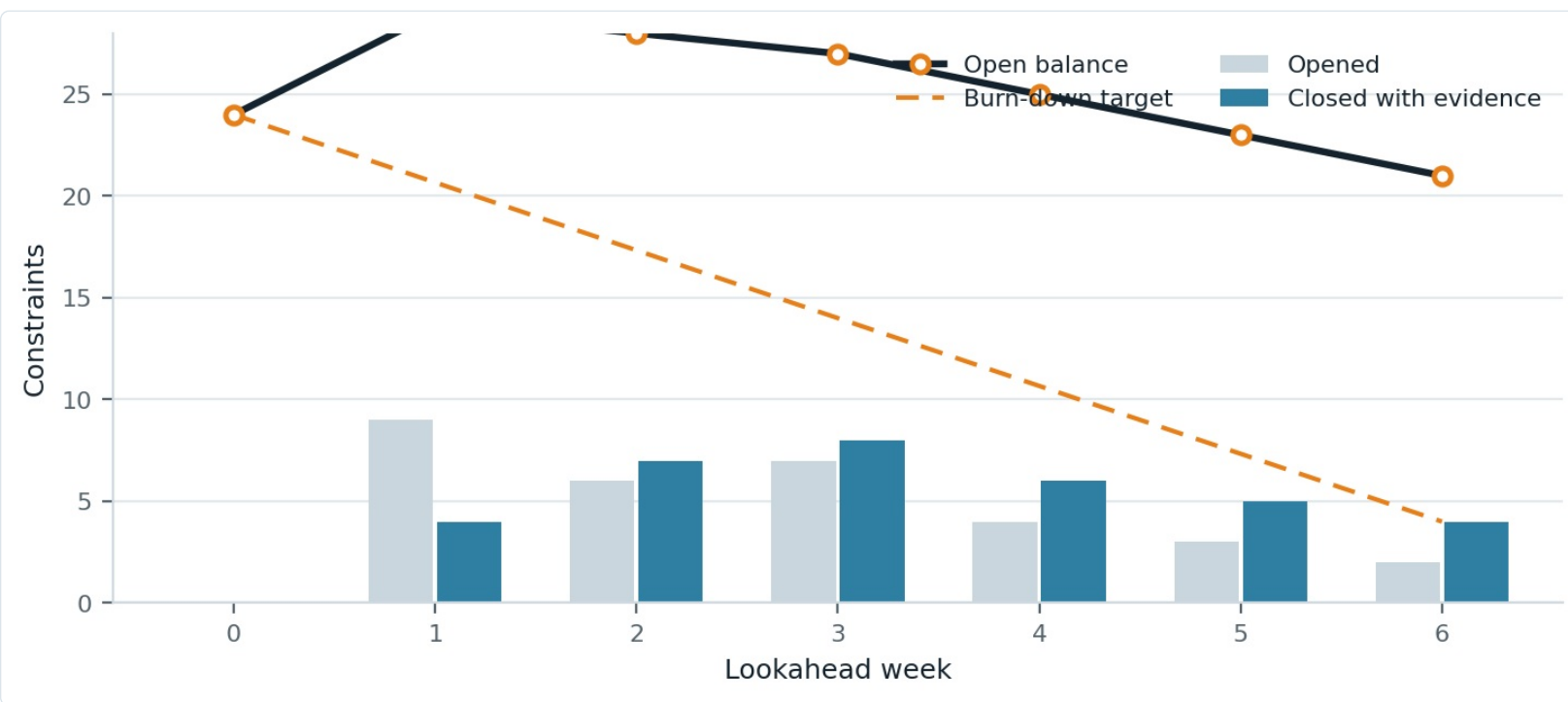
Screen every activity against the categories of readiness that recur on almost all work — commonly described as the *flows* that must arrive together: information and design, materials, labor, equipment, external conditions (weather, permits, inspections), space and access, and preceding work. Safety controls belong in the same screen. If any flow is missing, the activity is not ready, no matter what the schedule says.

READINESS QUESTION

Could the crew start and finish this assignment as promised without avoidable interruption?

6.2 Constraint Log

A useful log identifies the constrained activity, constraint description, category, owner, date identified, need-by date, status, and evidence of closure. “Waiting on drawings” is not managed until a named person owns a dated action.



Constraint burn-down. Track what opens, what closes with evidence, and the running open balance against a target. A balance that will not fall usually means constraints are being logged without owners, or closed on optimism rather than proof.

- Use one source of truth.

- ▶ Review by need-by date, not only by category.
- ▶ Escalate aging constraints.
- ▶ Close with evidence, not optimism.

6.3 Lookahead Planning

Lookahead planning typically reviews several upcoming weeks at increasing detail. The horizon should match procurement, design, and field lead times. Teams screen activities, break them into executable assignments, remove constraints, and maintain a backlog of ready work.

6.4 Workable Backlog

The workable backlog protects production when conditions change. It is not a random list of busywork; each item must be safe, valuable, properly sequenced, and ready. Too little backlog creates idle time. Too much can encourage out-of-sequence work.

CONTROL
Authorize fallback work through the same readiness and priority rules as primary work.

Field Assignment · Constraint Burn-Down

1. Build a log for the next six weeks.

2. Categorize every constraint.

3. Assign owners and need-by dates.

4. Review twice during the week.

5. Report opened, closed, overdue, and aging constraints.

Deliverable. A current constraint log and burn-down summary.

KNOWLEDGE CHECK

1. A constraint is closed when:

A. The meeting ends

B. Evidence confirms the prerequisite is satisfied

C. The date passes

D. Someone says it should be fine

2. The workable backlog contains:

A. Ready, sequenced, valuable work

B. Punch work only

C. Unapproved work

D. Any available task

3. A good constraint log needs:

A. A cost code only

B. A trade name only

C. An owner and need-by date

D. A color only

4. Lookahead horizon should reflect:

A. Weather only

B. Payroll week

C. Lead times and project risk

D. A fixed universal number only

Answers in Appendix F.

CHAPTER CLOSEOUT Readiness is a decision, not a hope. Close one aging constraint with real evidence this week and note what made it slow. That pattern is usually the system telling you where to fix it.

Weekly Work Planning

Create promises that crews can keep.

LEARNING OBJECTIVES

- Define sound assignments
- Facilitate weekly commitment planning
- Calculate PPC
- Use reasons for variance

7.1 Sound Assignments

A weekly assignment should be specific, measurable, properly sequenced, sized to capacity, and free of known constraints. Include location and completion condition. “Work on footings” cannot be scored consistently. “Place and finish Footings F1–F8 by Thursday, forms stripped and area clean” can.

7.2 Commitment Conversation

The foreman states what the crew can reliably complete, based on actual capacity and conditions. Management may challenge or negotiate, but should not convert a target into a promise by pressure. Overpromising inflates the plan and destroys learning.

A reliable promise requires more than a yes. The performer must understand what is being asked and the acceptance condition, be competent to do it, have the capacity and prerequisites available, be free of competing commitments, and be willing to report early if the promise becomes at risk. If any of those is missing, the honest answer is *no* — which starts a useful conversation instead of an optimistic guess.

- ▶ Ask what could prevent completion.
- ▶ Confirm crew and equipment capacity.
- ▶ Protect handoffs.
- ▶ Record the person making the promise.
- ▶ Treat an early warning as professionalism, not weakness.

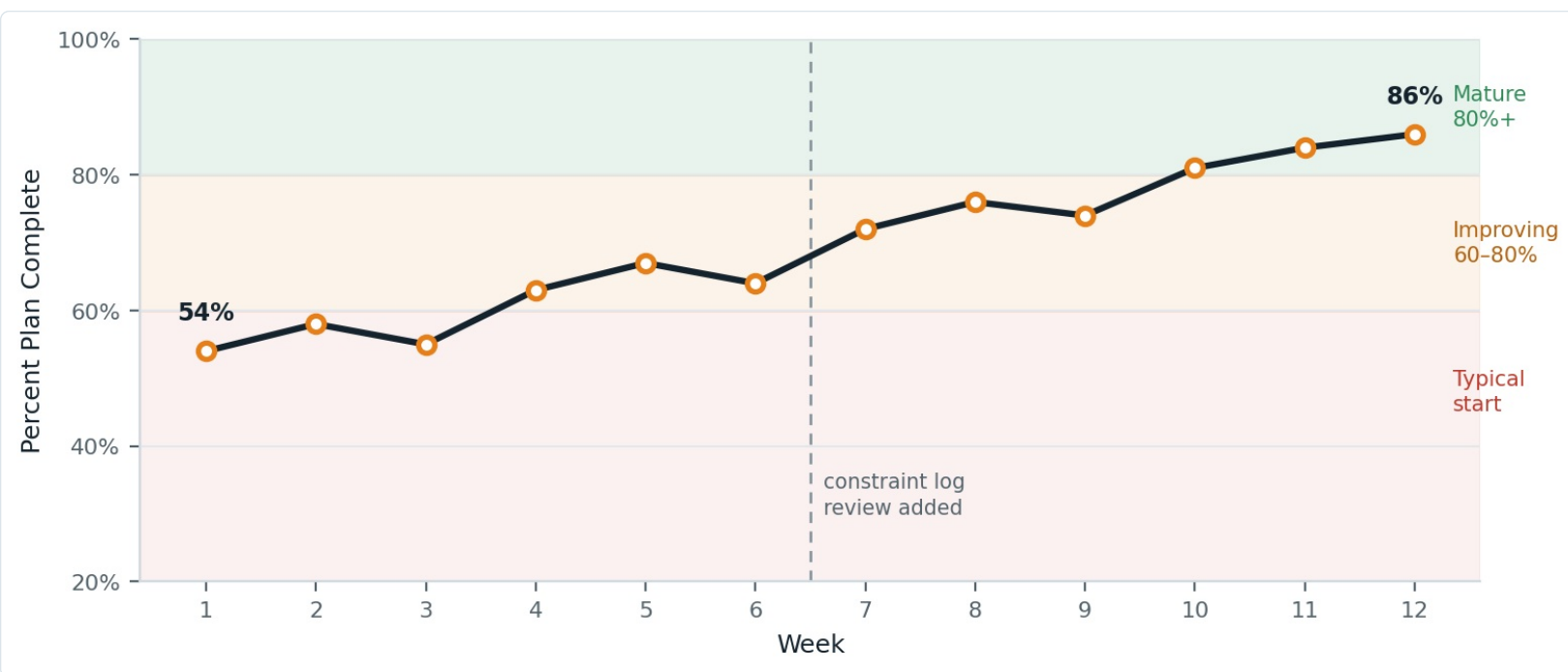
7.3 Percent Plan Complete

PPC = assignments completed as promised ÷ total assignments promised × 100. Score completion against the agreed condition and date. Partial completion is not complete unless the plan explicitly defined a measurable partial handoff.

EXAMPLE

17 completed assignments ÷ 20 promised assignments × 100 = 85% PPC.

Know what a good number looks like before you judge your own. Teams new to weekly work planning commonly start somewhere in the **50-60%** range, which is normal and not a failure — it is the first honest measurement of a system that was never visible before. Teams that work the variance reasons steadily tend to climb into the 60-80% band, and mature teams sustain **80% or higher**. The trend and the reasons behind it matter far more than any single week.



A realistic PPC trend. Reliability climbs in steps, not a straight line, and dips are normal when a team starts scoring honestly or takes on harder work. What moved this team was adding a disciplined constraint review — improvement came from removing causes, not from demanding higher promises.

7.4 Reasons for Variance

Every missed commitment receives a factual reason. Useful categories include prerequisite work, information, material, labor, equipment, weather, inspection, change, overcommitment, quality, safety, and external condition. Analyze recurring causes and assign countermeasures.

CAUTION

Do not game PPC by making tiny promises or hiding difficult work. Reliability and value matter together.

Field Assignment · Weekly Plan Trial

1. Create a one-week plan with 10-25 sound assignments.
2. Confirm each assignment with its Last Planner.
3. Score daily status.
4. Calculate PPC at week end.
5. Complete reasons-for-variance review.

Deliverable. Weekly Work Plan, PPC calculation, and top-three causes chart.

KNOWLEDGE CHECK

1. **PPC measures:**
 - A.** Budget accuracy
 - B.** Contract value
 - C.** Reliability of promises
 - D.** Total labor hours
2. **A partial task is complete when:**
 - A.** The superintendent says close enough
 - B.** It meets the agreed completion condition
 - C.** The crew worked hard
 - D.** It is 90% done
3. **A weekly commitment should be based on:**
 - A.** The baseline alone
 - B.** Actual capacity and readiness
 - C.** Pressure
 - D.** Optimism
4. **Reasons for variance are used to:**
 - A.** Hide misses
 - B.** Increase batch size
 - C.** Improve the planning system
 - D.** Assign blame

Answers in Appendix F.

CHAPTER CLOSEOUT Score honestly before you score well. A truthful 58% with reasons attached is worth more than a comfortable 90% built on tiny promises. Reliability is earned by learning, not by rounding.

Daily Huddles and Visual Management

Coordinate rapidly and make abnormal conditions obvious.

LEARNING OBJECTIVES

- Run a focused daily huddle
- Design a useful visual board
- Escalate blockers
- Connect daily management to weekly promises

8.1 Daily Huddle Standard

A strong huddle is brief, standing, and held near the work or visual board. Review safety and weather, yesterday’s commitments, today’s work by location, handoffs, deliveries, inspections, and blockers. Assign actions before people leave.

TARGET

Ten to fifteen minutes for a typical field huddle; longer issues move to a separate problem-solving conversation.

8.2 Visual Boards

A visual board should answer: Where are we? What should happen next? What is abnormal? Who owns recovery? Useful elements include milestones, phase plan, six-week lookahead, weekly plan, PPC trend, constraints, logistics, safety alerts, quality hold points, and decisions.

- ▶ Keep it current.
- ▶ Place it where decisions occur.
- ▶ Use simple status rules.
- ▶ Show owners and due dates.

8.3 Escalation

Teams need a clear escalation path for constraints that exceed the huddle’s authority or time. Define who is contacted, what information is required, and when a response is due. Escalation is not failure; delayed escalation is.

8.4 Digital vs Physical

Physical boards create shared focus and easy participation. Digital systems improve remote access, search, and history. Hybrid systems work when one is defined as the source of truth and updates are disciplined. Duplicate boards with conflicting status create information waste.

STANDARD

One fact, one owner, one current status.

Field Assignment · Huddle Redesign

1. Observe three huddles.
2. Measure duration and participation.
3. List repeated topics and unresolved blockers.
4. Redesign the agenda and board.
5. Pilot for one week and survey the crew.

Deliverable. Before/after huddle standard and results.

KNOWLEDGE CHECK

- 1. **A daily huddle should primarily:**
 - A. Replace the weekly plan
 - B. Coordinate commitments and expose blockers
 - C. Solve every complex issue in the room
 - D. Review payroll
- 2. **A visual board is effective when:**
 - A. It is current and supports decisions
 - B. It is attractive
 - C. It contains every project document
 - D. Only management understands it
- 3. **Complex issues should:**
 - A. Move to a focused follow-up with owners
 - B. Be ignored
 - C. Be assigned without context
 - D. Consume the whole huddle
- 4. **Hybrid systems require:**
 - A. Multiple sources of truth
 - B. A defined source of truth and update discipline
 - C. No physical board
 - D. No digital records

Answers in Appendix F.

CHAPTER CLOSEOUT The board earns its space only if it changes a decision today. Delete anything on it that nobody uses, and put the escalation path where the crew can read it.

Problem Solving and Continuous Improvement

Turn breakdowns into better standard work.

LEARNING OBJECTIVES

- Use PDCA
- Complete a concise A3
- Apply 5 Whys without blame
- Run retrospectives and first-run studies

9.1 PDCA

Plan defines the current condition, target, hypothesis, and experiment. Do performs the test. Check compares actual results to expected results. Act standardizes a successful change or adjusts the hypothesis. PDCA is scientific thinking applied to field management.

9.2 A3 Thinking

An A3 is a structured problem-solving story, usually containing background, current condition, target condition, root-cause analysis, countermeasures, implementation plan, and follow-up. The paper size is less important than the thinking and collaboration.

- ▶ Go see the condition.
- ▶ Use data and diagrams.
- ▶ Involve affected people.
- ▶ Separate causes from symptoms.

9.3 5 Whys

The 5 Whys method follows cause-and-effect beyond the first explanation. Do not force exactly five questions. Stop when the cause is actionable at the appropriate level and supported by evidence. “Worker error” is rarely a sufficient root cause.

EXAMPLE

Missed embed layout → late approved drawing → design decision lacked owner and need-by date → phase plan omitted the decision milestone.

9.4 First-Run Studies

For new or high-risk work, study the first installation as a prototype. Plan the method, observe cycle steps, measure production and quality, collect crew feedback, then revise standard work before scaling. Mockups and first-run studies reduce repeated defects.

Field Assignment · A3 Mini Project

1. Choose one recurring variance.
2. Document the current condition with data.
3. Set a measurable target.
4. Complete cause analysis.
5. Test one countermeasure and report results.

Deliverable. One-page A3 with evidence and next step.

KNOWLEDGE CHECK

1. **PDCA “Check” means:**
 - A.** Compare results to the hypothesis
 - B.** Stop the experiment
 - C.** Approve payment
 - D.** Inspect the worker
2. **An A3 should emphasize:**
 - A.** Formatting
 - B.** Individual blame
 - C.** Structured collaborative thinking
 - D.** Long narrative
3. **5 Whys should stop when:**
 - A.** The foreman is named
 - B.** An evidence-based actionable cause is reached
 - C.** The meeting ends
 - D.** Exactly five are asked
4. **A first-run study occurs:**
 - A.** Only after failure
 - B.** After all work is complete
 - C.** Before scaling repeated work
 - D.** Only during estimating

Answers in Appendix F.

CHAPTER CLOSEOUT Solve one problem to root cause rather than ten to symptom. One completed A3 with a verified countermeasure teaches the team more than a month of status reporting.

Lean Concrete Operations

Build reliable flow from site preparation through curing.

LEARNING OBJECTIVES

- Plan concrete work as a production system
- Match crew, equipment, supply, and placement rates
- Control constraints and hold points
- Adjust for weather and contingency

10.1 Start With the Placement System

Concrete success depends on the entire chain: approved mix, batch capacity, travel time, truck spacing, site access, testing, pump setup, placing rate, consolidation, screeding, finishing, curing, protection, and acceptance. The bottleneck governs the operation. A faster batch plant does not help if finishing capacity is lower.

PRODUCTION EQUATION

Sustainable placement rate = the lowest reliable capacity among supply, access, pump, placing, consolidation, screeding, finishing, testing, and curing.

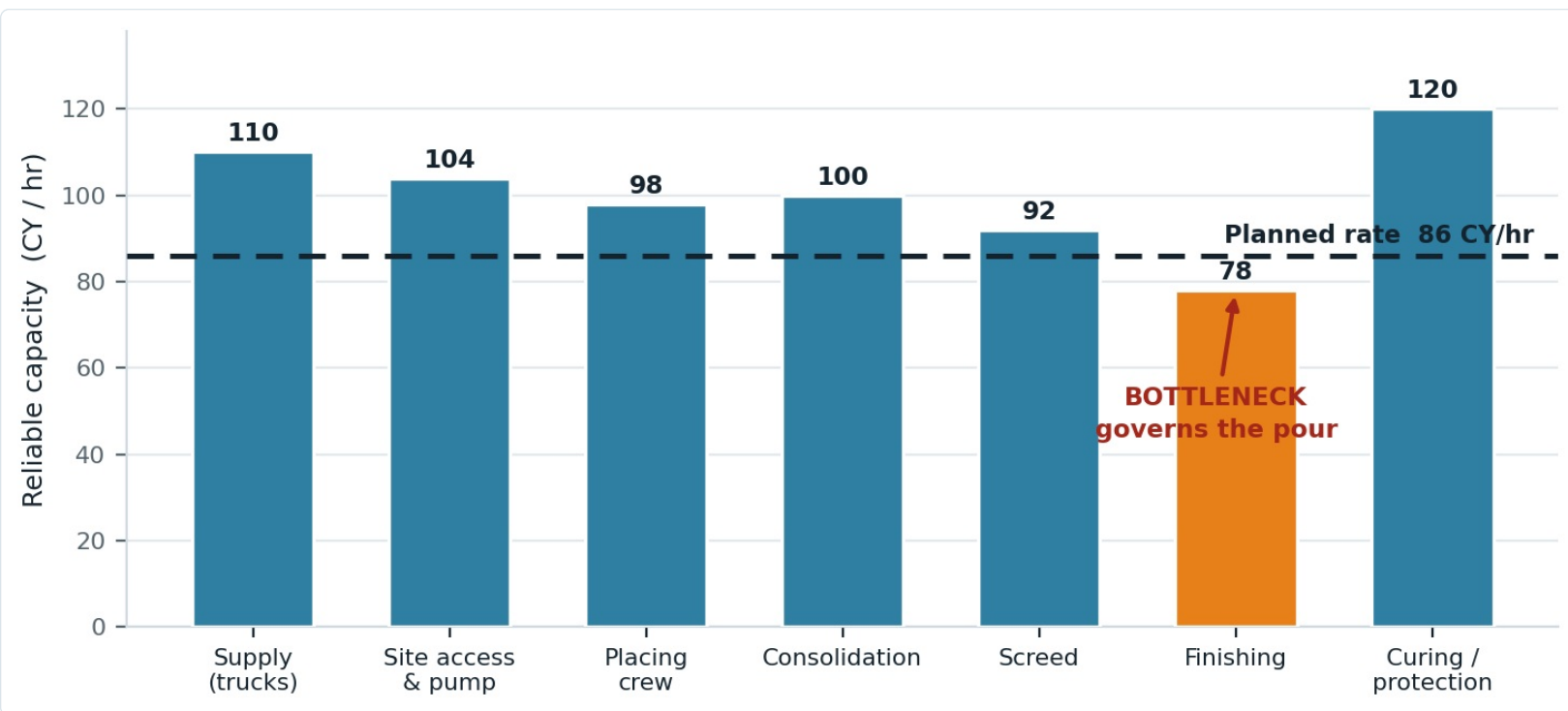
10.2 Pre-Pour Make-Ready

Use a dated pre-pour constraint review rather than a same-day checklist alone. Confirm latest drawings, RFI closure, subgrade and vapor retarder, forms, reinforcing, embeds, sleeves, joints, elevations, access, washout, lighting, weather, testing, inspection, backup equipment, curing materials, and communication.

- ▶ Hold a readiness review 5–10 working days ahead.
- ▶ Conduct final release only after evidence is complete.
- ▶ Assign contingency triggers and decision authority.
- ▶ Verify OSHA-required access, guarding, electrical, silica, and PPE controls.

10.3 Rate and Crew Balance

Convert quantity into required hourly rate, then check every process. A 1,200-cubic-yard mat over 12 placing hours requires 100 cubic yards per hour average, before allowance for ramp-up, interruptions, and cleanup. Truck cycle, load size, pump capacity, crew spread, and finishing windows must support the target.



Crew and capacity balance for a placement. Every process must sustain the planned rate. Here finishing is the constraint at 78 CY/hr, so ordering more trucks or a bigger pump would only build a queue — the pour must be planned to the bottleneck, or finishing capacity increased before the rate is raised.

FIELD CONTROL

Track actual cubic yards per hour, truck interval, placement temperature, slump, air, finishing start, and curing start. Display variance in real time.

10.4 Weather and Curing

Hot weather raises risks of slump loss, rapid setting, plastic shrinkage, and finishing pressure; cold weather raises risks of slow strength gain and freezing. Plan mixture, delivery, placement time, evaporation control, protection, and curing in accordance with project specifications and current ACI guidance — principally the hot-weather guide **ACI PRC-305-20**, the cold-weather guide **ACI 306R-16**, and the curing guidance in **ACI PRC-308** (with external-curing specification **ACI SPEC-308.1-23**).

Know the field thresholds that trigger these procedures, and remember that they are combinations of conditions, not a single thermometer reading:

- ▶ **Cold weather (ACI 306).** Cold-weather protection applies when the air temperature is below **40°F**, or is expected to fall below 40°F during the protection period. Minimum concrete temperature at placement for thin sections is typically around 55°F, and the concrete must reach adequate strength (commonly about 500 psi) before it is allowed to freeze.
- ▶ **Hot weather (ACI 305).** Hot-weather concreting is defined by any combination of high ambient temperature, low relative humidity, high wind, and direct sun that accelerates moisture loss and cement hydration — not by one fixed number. High evaporation rate, more than temperature alone, drives plastic-shrinkage risk.
- ▶ **Delivery temperature (ACI 301).** As a general specification limit, fresh concrete should not exceed **95°F at discharge** (lower for mass concrete). Confirm the project-specific maximum in the specification.
- ▶ **Ideal placement window.** Roughly 65–75°F at placement gives the most predictable set and strength gain; plan mix, timing, and protection to stay near it when practical.
- ▶ Have curing materials on site before placement.
- ▶ Define wind, temperature, and storm triggers.
- ▶ Provide backup lighting and power for extended work.
- ▶ Plan cold-joint response and safe shutdown points.

CURING RULE

Begin curing immediately after finishing on flatwork (and immediately after form removal on vertical surfaces). Even brief early drying can cause plastic-shrinkage cracking and permanently weaken the surface.

10.5 Standard Work by Phase

Break the operation into readiness, layout, formwork, reinforcing/embeds, inspection, placement, consolidation, screed, finish, cure, protection, sawcut, strip, repair, and turnover. Define completion criteria and the customer for each handoff.

QUALITY GATE

Do not cover or place over work until required self-checks and inspections are complete.

Field Assignment · Concrete Production Plan

1. Select an upcoming placement.
2. Calculate target and minimum placement rates.
3. Build a constraint log and pre-pour checklist.
4. Balance supply, pump, placing, and finishing capacity.
5. Define weather, equipment, and material contingencies (with ACI 305/306 triggers).

Deliverable. Complete pour plan with crew chart, rate model, logistics sketch, hold points, and contingency triggers.

KNOWLEDGE CHECK

1. **The sustainable placement rate is controlled by:**
 - A.** The batch plant only
 - B.** The lowest reliable process capacity in the chain
 - C.** The fastest process
 - D.** The pump nameplate only
2. **Curing materials should arrive:**
 - A.** Only if weather changes
 - B.** Before placement
 - C.** After finishing
 - D.** At 7 days
3. **A pre-pour readiness review should occur:**
 - A.** Early enough to remove constraints
 - B.** Only at placement time
 - C.** After trucks dispatch
 - D.** After inspection
4. **Cold-weather concreting procedures per ACI 306 are triggered when air temperature is:**
 - A.** Only when concrete has frozen
 - B.** At or below 40°F, or expected to fall below it during the protection period
 - C.** At or below 60°F under any conditions
 - D.** Only below 32°F

Answers in Appendix F.

CHAPTER CLOSEOUT The chain governs the pour. Find the lowest reliable capacity in your next placement, plan the rate to it, and have curing and weather protection on site before the first truck arrives.

Quality Built In

Prevent defects instead of inspecting them downstream.

LEARNING OBJECTIVES

- Define quality at the handoff
- Use inspection and test plans
- Create standard work and mockups
- Manage nonconformance learning

11.1 Quality at the Source

Quality is created by the process and verified by inspection. Each crew should know the acceptance criteria, self-check the work, and hand off only completed work. Downstream inspection alone detects defects after value has already been lost.

11.2 Hold Points and Evidence

Build an inspection and test plan identifying activity, specification reference, responsible party, hold point, test or inspection method, acceptance criteria, record, and release authority. Coordinate owner, engineer, special inspector, testing agency, and AHJ notice requirements.

- ▶ Link hold points to the lookahead.
- ▶ Schedule inspections before weekly commitment.
- ▶ Store evidence where the team can retrieve it.
- ▶ Do not rely on verbal release for concealed work.

11.3 Mockups and Standard Work

Mockups align expectations and expose process issues before production. Standard work captures the safest known method, sequence, staffing, tools, quality checks, and normal cycle time. It should be revised when a better method is proven.

CONCRETE STANDARD

Reference the current ASTM sampling and testing methods — C172/C172M (sampling), C143/C143M (slump), C231/C231M (air, pressure method), C1064/C1064M (temperature), C31/C31M (field cylinders), and C39/C39M (compressive strength) — along with project-specific flatness, finish, joint, curing, and repair criteria.

11.4 Nonconformance

Contain the issue, protect adjacent work, document facts, determine disposition, identify cause, and prevent recurrence. Track repair hours and schedule effect. Repeated “minor” defects indicate a production-system problem.

Field Assignment · Quality-at-Source Plan

1. Choose one high-risk installation.
2. Write its completion and acceptance criteria.
3. Create self-check and hold-point steps.
4. Run a mockup or first-run study.
5. Update the standard based on results.

Deliverable. One-page standard work sheet and inspection plan.

KNOWLEDGE CHECK

1. **Quality at the source means:**
 - A.** Crews build and self-check to defined criteria
 - B.** Defects are repaired later
 - C.** Only the owner checks work
 - D.** No inspection
2. **A hold point must be:**
 - A.** Performed after concealment
 - B.** Known, scheduled, and released by authority
 - C.** Hidden from the weekly plan
 - D.** Informal
3. **Standard work is:**
 - A.** The current best-known safe method
 - B.** A payroll rule
 - C.** A contract amendment
 - D.** Permanent and never changed
4. **Repeated minor defects suggest:**
 - A.** Bad luck only
 - B.** A system or standard-work weakness
 - C.** More inventory is needed
 - D.** PPC is too high

Answers in Appendix F.

CHAPTER CLOSEOUT Build it right at the handoff and inspection becomes confirmation instead of discovery. Write the acceptance criteria for one high-risk installation and let the crew self-check against it.

Safety Through Planning

Design safe work into flow and readiness.

LEARNING OBJECTIVES

- Integrate safety into make-ready
- Use pre-task planning effectively
- Reduce overburden and congestion
- Plan emergency and weather contingencies

12.1 Safety Is a Constraint and a Condition of Satisfaction

Work is not ready if safe access, protection, competent-person coverage, permits, equipment inspection, training, or exposure controls are missing. Safety must be screened during look-ahead planning, not added after crews mobilize.

12.2 Pre-Task Planning

A useful pre-task plan is specific to today's work, location, crew, equipment, interfaces, and changing conditions. The crew identifies steps, hazards, controls, stop-work triggers, and emergency response. Reading a generic form aloud is not engagement.

- ▶ Involve the people performing the task.
- ▶ Update when conditions change.
- ▶ Confirm controls are physically present.
- ▶ Close the loop on near misses.

12.3 Flow and Exposure

Poor flow creates rushed work, stacking of trades, blocked access, material congestion, excessive handling, and fatigue. Lean planning improves safety by reducing instability, but productivity pressure can create overburden if leaders misuse Lean. Balance workloads and protect recovery time.

PRINCIPLE

No production target overrides a required safety control.

12.4 Regulatory Alignment

Use current OSHA construction requirements (29 CFR Part 1926), project safety rules, manufacturer instructions, and competent-person determinations. Common concrete-related planning areas include fall protection, formwork and reshoring, reinforcing impalement protection, silica exposure, concrete pumping, electrical safety, struck-by hazards, and access/egress.

Respirable crystalline silica deserves specific attention on concrete work, because cutting, grinding, drilling, and demolishing concrete are among the highest-exposure tasks on any site:

- ▶ The construction silica standard is **29 CFR 1926.1153**.
- ▶ The permissible exposure limit (PEL) is **50 µg/m³** as an 8-hour time-weighted average; the action level that triggers monitoring and medical surveillance is **25 µg/m³**.
- ▶ **Table 1** lists 18 common construction tasks with specified engineering controls, work practices, and respiratory protection; fully and properly implementing the listed controls exempts the employer from separate air monitoring for that task.
- ▶ For tasks not on Table 1 — or where controls are not fully implemented — the employer must measure exposures and keep them at or below the PEL, and must maintain a written exposure control plan with a designated competent person.

FIELD TAKEAWAY

On concrete cutting, grinding, and coring, plan water or vacuum dust controls into the task before the crew mobilizes — not after the dust is already in the air.

Field Assignment • Safety Make-Ready Review

1. Select work two weeks ahead.
2. List safety prerequisites and permits.
3. Verify training, competent persons, and equipment inspections.
4. Identify interface and congestion risks.
5. Add controls and owners to the constraint log.

Deliverable. Safety constraints integrated into the lookahead plan.

KNOWLEDGE CHECK

1. **Work is ready when:**

- A.** Production materials are present only
- B.** All safety prerequisites are satisfied
- C.** The crew is available
- D.** The schedule says start

2. **A pre-task plan should be:**

- A.** Generic and annual
- B.** Completed by management alone
- C.** Unchanged after conditions shift
- D.** Specific to the work and current conditions

3. **Poor flow can increase:**

- A.** Nothing safety-related
- B.** Only cost
- C.** Congestion and rushed work
- D.** Only quality

4. **Under 29 CFR 1926.1153, the 8-hour TWA permissible exposure limit for respirable silica is:**

- A.** 50 $\mu\text{g}/\text{m}^3$, with a 25 $\mu\text{g}/\text{m}^3$ action level
- B.** 100 $\mu\text{g}/\text{m}^3$
- C.** 250 $\mu\text{g}/\text{m}^3$
- D.** There is no numeric limit

Answers in Appendix F.

CHAPTER CLOSEOUT Safety belongs in make-ready, not in the tailgate meeting afterward. Screen next week's work for access, controls, competent persons, and exposure hazards while there is still time to fix them.

Cost, Productivity, and Forecasting

Connect reliable production to financial control.

LEARNING OBJECTIVES

- Build production-rate models
- Use unit cost and earned hours
- Quantify variance cost
- Forecast from field data

13.1 Production Rate Planning

Production rate = quantity completed ÷ input time. Use consistent units and define completion clearly. Plan rates from crew composition, equipment capacity, work conditions, learning curve, and historical data. Separate target, planned, and actual rates.

EXAMPLE

A 6-person crew places 4,800 square feet in 8 hours: 600 square feet per crew-hour, or 100 square feet per labor-hour.

13.2 Earned Hours and Unit Cost

Earned hours = completed quantity × budgeted labor hours per unit. Compare earned hours with actual hours to see whether production is gaining or losing labor. Unit cost should include direct labor, material, equipment, and appropriate indirect cost.

13.3 Cost of Unreliability

Missed commitments create remobilization, overtime, premium freight, equipment standby, extended supervision, rework, and loss of learning. Track financial effects by cause category. This helps management invest in constraint removal where the return is highest.

13.4 Forecasting

Forecast remaining duration and cost using current production, not hope. Adjust for location, complexity, crew learning, weather, and future constraints. A reliable forecast states assumptions and ranges.

- ▶ Update weekly.
- ▶ Use leading indicators such as constraints and PPC.
- ▶ Separate recoverable variance from permanent loss.
- ▶ Tie corrective actions to owners and dates.

Field Assignment · Production Control Sheet

1. Choose one cost code.
2. Define quantity and completion rule.
3. Record planned and actual labor and production daily.
4. Calculate unit rate and earned hours.
5. Forecast remaining cost and completion.

Deliverable. One-week production report with forecast and action plan.

KNOWLEDGE CHECK

1. **Earned hours equal:**
 - A.** Actual hours $\times$ wage
 - B.** Completed quantity $\times$ budgeted hours per unit
 - C.** PPC $\times$ headcount
 - D.** Budget $\div$ duration
2. **A forecast should use:**
 - A.** The best single day only
 - B.** The original estimate only
 - C.** Current evidence and stated assumptions
 - D.** Optimism
3. **Missed commitments may cause:**
 - A.** Only material savings
 - B.** No cost effect
 - C.** Only paperwork
 - D.** Premium freight and remobilization
4. **Production rate requires:**
 - A.** Only labor count
 - B.** Only cost
 - C.** Only schedule percent
 - D.** A defined quantity and time basis

Answers in Appendix F.

CHAPTER CLOSEOUT Forecast from evidence. Track one cost code for a week with a defined completion rule, then compare earned hours to actual hours. The gap tells you the truth earlier than the cost report will.

Lean Leadership and Culture

Create a system where truth travels fast.

LEARNING OBJECTIVES

- Lead with respect and accountability
- Coach reliable promises
- Facilitate collaboration
- Deploy Lean with trade partners

14.1 Psychological Safety and Candor

Teams improve when people can report bad news early without humiliation. Leaders must reward truthful status, ask curious questions, and distinguish honest misses from repeated disregard. Hiding problems is more dangerous than having problems.

LEADER PHRASE

“What made the promise unreliable, and what will we change?”

14.2 Coaching Commitments

A coach tests clarity, readiness, capacity, and ownership. When a foreman overcommits, help resize the batch or remove the constraint. When undercommitment becomes chronic, compare capacity data and customer need. Reliability is not comfort; it is disciplined promise management.

14.3 Meeting Behavior

Start and end on time, show current information, invite performers first, capture decisions, assign owners, and separate coordination from problem solving. Eliminate status theater and repeated reporting that does not change decisions.

- ▶ No laptops unless needed for the work.
- ▶ Use visible action logs.
- ▶ Close old actions before creating new ones.
- ▶ Rotate facilitation to build capability.

14.4 Trade Partner Alignment

Introduce Lean expectations during procurement and onboarding. Explain meeting cadence, planning responsibilities, data definitions, and behaviors. Avoid imposing unfamiliar systems without training or time. Contract terms, incentives, and field routines should reinforce collaboration.

Field Assignment · Leadership Experiment

1. Choose one recurring meeting.
2. Measure speaking balance and action closure.
3. Change one facilitation behavior.
4. Collect anonymous feedback.
5. Standardize the improvement for two weeks.

Deliverable. Meeting before/after assessment and leadership reflection.

KNOWLEDGE CHECK

1. **Psychological safety supports:**
 - A.** Lower standards
 - B.** Early truthful reporting
 - C.** No deadlines
 - D.** Avoiding accountability
2. **Reliable commitment coaching checks:**
 - A.** Readiness and capacity
 - B.** Personality only
 - C.** Bid amount
 - D.** Seniority only
3. **A useful meeting produces:**
 - A.** Long minutes only
 - B.** Private status
 - C.** More slides
 - D.** Decisions, owners, and coordinated action
4. **Trade partner Lean expectations should begin:**
 - A.** After the first failure
 - B.** Only in the field
 - C.** At closeout
 - D.** During procurement and onboarding

Answers in Appendix F.

CHAPTER CLOSEOUT Truth travels at the speed the leader allows. Ask what made a promise unreliable before asking who missed it, and watch how much faster problems reach you next week.

Digital and AI-Enabled Lean

Use technology to strengthen decisions, not automate confusion.

LEARNING OBJECTIVES

- Define the decision before selecting the tool
- Build dashboards that trigger action
- Use AI with verified human ownership

15.1 Data Before Software

Digitizing a broken process produces faster confusion. Define the decision, the owner, the review frequency, and the data standard first. Most Lean systems run well on eight fields the team will actually maintain: *assignment, owner, location, need-by date, readiness, status, variance reason*, and *action*. If a field will not be filled in honestly every week, it is not a field — it is decoration.

TEST BEFORE YOU BUY

Run the process on paper or a whiteboard for three weeks first. If it does not work manually, software will only make the failure harder to see.

15.2 Dashboards That Change Behavior

A dashboard should expose abnormal conditions and prompt a decision today. Five views cover most field needs: PPC trend with variance reasons, constraints sorted by need-by date, overdue actions with owners, production rate against plan, and inspection or safety prerequisites for the next two weeks. Anything that would not change what someone does tomorrow is a vanity chart.

- ▶ Use one definition of “complete” across every view.
- ▶ Show the timestamp so users know whether the data is current.
- ▶ Allow drill-down from a number to the owner and the evidence.
- ▶ Retire any view nobody has acted on in a month.

15.3 AI With Human Ownership

Used carefully, AI can draft and summarize the paperwork that surrounds production control: condensing meeting notes into actions, suggesting constraint categories, grouping recurring variance themes across weeks, drafting a lookahead narrative, comparing planned to actual production, and producing a first draft of an A3. Each of those is a draft for a human to verify and own.

What it must not do is decide. Commitments, safety determinations, contract interpretation, competent-person judgments, and acceptance of work belong to accountable people. Train the team to recognize confident wrong answers, stale data, and false precision — a number carried to two decimals is not more true than the field observation behind it.

GUARDRAIL

AI may support the conversation. It must never make an unverified field promise or a safety-critical decision. Control access, preserve source records, and audit any output before it enters project controls.

Field Assignment · Minimum Viable Lean Data System

1. Name three decisions your team makes weekly.
2. Define the minimum data each decision requires.
3. Sketch one dashboard page that serves all three.
4. Assign update responsibility and cadence.
5. Test with two field users and delete whatever they ignore.

Deliverable. Dashboard wireframe, data dictionary, and a list of what you chose not to track.

KNOWLEDGE CHECK

1. **Software should be selected after:**
 - A.** The decision process and data definitions are clear
 - B.** All paper is banned
 - C.** A vendor demo only
 - D.** The project ends
2. **A dashboard should primarily:**
 - A.** Look impressive
 - B.** Replace meetings
 - C.** Show every metric
 - D.** Expose abnormal conditions and trigger action
3. **AI outputs should be:**
 - A.** Used for safety decisions
 - B.** Verified and owned by an accountable person
 - C.** Hidden from users
 - D.** Trusted automatically
4. **Data governance includes:**
 - A.** Access control, source records, and auditability
 - B.** No human review
 - C.** Only passwords
 - D.** Only charts

Answers in Appendix F.

CHAPTER CLOSEOUT Define the decision before you buy the tool. If a chart would not change what anyone does tomorrow, it does not belong on the dashboard.

Capstone Implementation

Deploy Lean on a live project in 90 days.

LEARNING OBJECTIVES

- Assess current state
- Create a phased rollout
- Define measures and governance
- Complete a Lean project execution plan

16.1 Start With Purpose

Define the business and project problem: unreliable handoffs, low schedule confidence, excess rework, congestion, weak coordination, or poor forecast accuracy. Select a pilot area with meaningful pain, engaged leadership, and enough repetition to learn.

16.2 30-60-90 Day Plan

Days 1-30: assess, train, define standards, and pilot daily huddles plus constraints. Days 31-60: run pull planning, weekly commitments, PPC, and variance learning. Days 61-90: stabilize, integrate production/cost/quality data, coach leaders, and expand selectively.

DEPLOYMENT RULE

Depth in one pilot beats shallow compliance across the whole company.

16.3 Measures

Use a balanced scorecard: safety leading indicators, quality first-pass acceptance, PPC, constraint closure, production rate, labor variance, rework, milestone reliability, and team engagement. Avoid treating any single metric as the goal.

16.4 Governance and Sustainability

Assign an executive sponsor, project Lean lead, meeting owners, data steward, and coaches. Establish standard work, audit cadence, training path, and lessons-learned transfer. Sustainment depends on line leadership, not a separate improvement department.

- ▶ Publish roles.
- ▶ Review metrics at a fixed cadence.
- ▶ Coach behavior at the point of work.
- ▶ Retire tools that do not support decisions.

Field Assignment · Capstone Lean Execution Plan

1. Choose a real or simulated project.
2. Write Conditions of Satisfaction.
3. Create milestone and phase pull plans.
4. Develop a six-week lookahead and constraint log.
5. Build one Weekly Work Plan, huddle standard, PPC method, quality/safety gates, concrete production plan, dashboard, and 90-day rollout.

Deliverable. A complete Lean Project Execution Plan suitable for leadership review.

KNOWLEDGE CHECK

1. **A strong pilot has:**
 - A.** No repeatable work
 - B.** No measures
 - C.** Meaningful need and engaged leadership
 - D.** No operational pain
2. **The first 30 days emphasize:**
 - A.** Enterprise automation
 - B.** Assessment, training, standards, and pilot routines
 - C.** Certification exam only
 - D.** Closeout only
3. **A balanced scorecard uses:**
 - A.** Cost only
 - B.** One metric only
 - C.** Safety, quality, flow, cost, and people measures
 - D.** PPC only
4. **Lean sustainment depends primarily on:**
 - A.** A poster
 - B.** An annual kickoff
 - C.** A software vendor
 - D.** Line leadership and standard work

Answers in Appendix F.

CHAPTER CLOSEOUT Depth beats breadth. Run the full system in one pilot area with real coaching, prove it with data, and let the results do the persuading for the next workstream.

Field Templates

Copy, simplify, and use only what the crew will maintain.

A1 • Conditions of Satisfaction

Stakeholder	Need / Value	Measure	Target	Due	Owner

A2 • Constraint Log

Activity	Constraint	Category	Owner	Need-by	Status	Evidence

A3 • Weekly Work Plan

Day	Location	Assignment / Completion Condition	Last Planner	Crew	Status	Variance

A4 • Daily Huddle Board

Area	Yesterday	Today	Handoff	Safety / Quality	Blocker	Owner

A5 • Reasons for Variance

Missed Assignment	Category	Immediate Cause	System Cause	Countermeasure	Owner	Due

A6 • A3 Problem Solving

Section	Notes
Background	
Current condition	
Target condition	
Root-cause analysis	
Countermeasures	
Implementation	

Follow-up	
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A7 · Production Control

Date	Location	Quantity Plan	Quantity Actual	Labor Hours	Rate	Issue / Action

A8 · Pre-Pour Constraint Register

Item	Requirement / Evidence	Owner	Need-by	Verified	Comments

Concrete Pre-Pour Checklist

Verify with evidence and an owner — not from memory.

Documents and Approvals

- ☐ Issued-for-construction drawings confirmed
- ☐ RFIs and submittals closed
- ☐ Concrete mix approved
- ☐ Placement plan reviewed
- ☐ Inspection / testing notifications confirmed
- ☐ Permits and lane / road restrictions confirmed

Subgrade, Forms, and Reinforcement

- ☐ Subgrade proof / acceptance complete
- ☐ Vapor retarder and insulation complete
- ☐ Forms braced, treated, and dimensionally checked
- ☐ Reinforcing size, spacing, support, cover, laps, and cleanliness checked
- ☐ Embeds, sleeves, anchors, blockouts, and joints checked
- ☐ Elevation benchmarks and screed rails verified

Logistics and Equipment

- ☐ Batch plant and truck spacing confirmed
- ☐ Pump size, hose, setup, and backup confirmed
- ☐ Access, traffic control, lighting, and washout ready
- ☐ Vibrators, screed, finishing machines, saws, generators, and spare parts checked
- ☐ Fuel, cords, hoses, hand tools, and radios ready

People, Safety, and Quality

- ☐ Crew chart and shift relief confirmed
- ☐ Competent persons and operators confirmed
- ☐ Pre-task plan complete
- ☐ Fall, impalement, electrical, silica (1926.1153 controls), struck-by, and access controls ready
- ☐ Testing agency and cylinders / curing box ready (ASTM C172, C31)
- ☐ Inspection hold points released

Weather, Curing, and Contingency

- ☐ Forecast and evaporation / freeze risk reviewed
- ☐ Hot / cold weather plan triggered as required (ACI 305 above ~95°F discharge; ACI 306 below 40°F air)
- ☐ Curing compound, wet coverings, blankets, enclosure, heaters, or fogging ready
- ☐ Rain and wind protection staged
- ☐ Cold-joint and emergency shutdown locations defined
- ☐ Decision authority and communication tree confirmed

Crew and Production Planning

Balance every process against the bottleneck.

C1 • Crew Balance Worksheet

Process	Quantity	Target Rate	Crew	Equipment	Cycle Time	Capacity / Risk
Supply						
Site access						
Pump / placing						
Consolidation						
Screed						
Finishing						
Curing / protection						
Sawcut / joints						

C2 • Example Rate Calculation

Planned quantity: 600 cubic yards. Available placement window: 8 hours. Base average rate: 75 cubic yards / hour. With a 15% allowance for startup, testing, truck variation, and cleanup, plan the production system for approximately **86 cubic yards / hour** during steady-state placement. Confirm that the plant, truck cycle, site access, pump, placing crew, and finishing capacity can each sustain the planned rate.

Worked Example: 600 CY Slab Pour

One placement carried end to end — rate model, constraints, weekly plan, PPC, and what the team learned.

Blank templates show the format. This appendix shows the *thinking*. It follows a single realistic placement from readiness review through variance learning, using the same forms provided in Appendix A. Numbers are illustrative but internally consistent; use it as a pattern, not as a standard.

THE SCENARIO

Zone B interior slab-on-grade, **600 cubic yards**, 8-hour placement window, pumped placement, hard-troweled finish. Ambient forecast 88°F with 12 mph wind — hot-weather conditions under ACI 305 because of the evaporation rate, even though the temperature alone is unremarkable. Placement is Thursday; the readiness review is held the prior Friday, seven working days ahead.

STEP 1 — RATE MODEL (APPENDIX C)

Convert quantity into a required rate, then add a realistic allowance for startup, testing, truck variation, and cleanup. Only then check whether every process can sustain it.

Line	Basis	Value
Planned quantity	Takeoff, Zone B	600 CY
Placement window	06:00–14:00	8.0 hr
Base average rate	$600 \div 8$	75 CY/hr
Allowance	15% for startup, testing, truck variation, cleanup	+11 CY/hr
Planned steady-state rate	Design the system to this	86 CY/hr
Governing constraint	Finishing capacity (see crew balance)	78 CY/hr
Decision	Add two finishers and one power trowel, or extend window to 9.5 hr	Rate held at 86

WHAT THIS CAUGHT

The original plan was one finishing crew. The rate model exposed a 78 CY/hr finishing ceiling against an 86 CY/hr placement plan — a mismatch that would have shown up as a cold joint or a burned finish at hour six, not as a planning error.

STEP 2 — PRE-POUR CONSTRAINT LOG (APPENDIX A2)

Every item has a named owner, a need-by date ahead of placement, and closure by evidence rather than assurance. Two items below did not close on time, which is exactly what a log is for.

Activity	Constraint	Category	Owner	Need-by	Status	Evidence
Slab placement	Mix design 4000 psi w/ mid-range WR not yet approved	Information	J. Ruiz (PM)	Mon 06/08	Closed	Submittal 03-12 stamped approved
Rebar top mat	Bar list revision pending RFI 214 response	Information	T. Alvarez (GC)	Mon 06/08	Closed	RFI 214 returned, bar list rev B issued
Subgrade	Proof-roll and density acceptance	Predecessor	M. Doyle (Site)	Tue 06/09	Closed	Density reports, 4 of 4 passing
Vapor retarder	10 mil sheet quantity short by 2 rolls	Material	S. Kane (Supt)	Tue 06/09	Closed	Delivery ticket 88431
Embeds	Elevator pit sleeves not coordinated with MEP	Predecessor	D. Pham (MEP)	Wed 06/10	Closed	Signed embed walk checklist
Placement	Pump backup not confirmed with supplier	Equipment	S. Kane (Supt)	Tue 06/09	Closed	Supplier email, standby unit committed

Finishing	Two additional finishers for 86 CY/hr rate	Labor	R. Boyd (Foreman)	Wed 06/10	LATE — closed Wed PM	Crew roster revised, confirmed verbally then in writing
Hot weather	Evaporation-retarder and fogging equipment on site	Material	R. Boyd (Foreman)	Wed 06/10	OPEN at release	Partial — one fogger, retarder not delivered
Curing	Curing compound staged at Zone B	Material	S. Kane (Supt)	Wed 06/10	Closed	Verified on site, 12 pails
Testing	Agency notified, cylinders and curing box ready	Inspection	J. Ruiz (PM)	Wed 06/10	Closed	Agency confirmation, ASTM C31 box on site

STEP 3 — WEEKLY WORK PLAN AND PPC (APPENDIX A3)

Eight sound assignments were promised for the placement week. Each names a location, a performer, and a completion condition that can be scored without argument.

Day	Location	Assignment / Completion Condition	Last Planner	Status
Mon	Zone B	Fine grade and vapor retarder complete, seams taped, ready for rebar	M. Doyle	Complete
Tue	Zone B	Bottom mat placed on chairs, cover verified, self-checked	R. Boyd	Complete
Tue	Zone B	Perimeter forms set, braced, elevations shot to benchmark	R. Boyd	Complete
Wed	Zone B	Top mat tied and embeds set, ready for MEP verification	R. Boyd	Complete
Wed	Zone B	MEP verification walk signed off, hold point released	D. Pham	Complete
Wed	Zone B	Hot-weather materials staged: retarder, fogging, blankets	R. Boyd	MISSED
Thu	Zone B	Place, screed, and finish 600 CY; curing started same shift	R. Boyd	MISSED
Fri	Zone B	Sawcut control joints per plan, no random cracking	R. Boyd	Complete

PPC CALCULATION

6 assignments completed as promised ÷ 8 assignments promised × 100 = **75% PPC**. The placement is scored as a miss even though concrete was placed, because the promised condition — 600 CY finished with curing started in the same shift — was not met. Partial completion is not completion.

STEP 4 — REASONS FOR VARIANCE (APPENDIX A5)

The two misses are traced past the obvious answer. Note that neither system cause is “the crew was slow.”

Missed Assignment	Category	Immediate Cause	System Cause	Countermeasure	Owner
Hot-weather materials staged	Material	Evaporation retarder was never ordered; only one fogger on site	Hot-weather materials were treated as a same-day checklist item, not as a dated constraint with an owner	Add weather-response materials to the pre-pour register with a need-by 3 days ahead; verify by photo	S. Kane
Place, finish, cure 600 CY	Prerequisite / weather	Finishing fell behind at hour 5 as surface set accelerated; last 70 CY finished after curing window	Rate model was corrected for crew size but the hot-weather effect on the finishing window was never re-run	Re-run the rate model whenever forecast triggers ACI 305 conditions; plan a reduced rate or earlier start	J. Ruiz

STEP 5 — PRODUCTION CONTROL (APPENDIX A7)

Hour	Quantity Plan (CY)	Quantity Actual (CY)	Cumulative Actual	Note
1	70	62	62	Startup, first-load testing (slump 4.5 in, air 5.2%, temp 84°F)
2	86	88	150	Steady state achieved
3	86	90	240	Best hour; truck interval 7 min
4	86	84	324	One truck late from plant
5	86	72	396	Surface setting fast; finishers falling behind

6	86	64	460	Rate reduced deliberately to protect finish
7	86	78	538	Second trowel added
8	14	62	600	Placement complete 14:40; curing started 15:20 on last panel

Average actual rate: **75 CY/hr** against a planned 86 — the finishing constraint governed the operation exactly as the crew balance chart predicted, and the hot-weather effect made it worse than modeled.

STEP 6 — WHAT THE TEAM LEARNED

- ▶ A 75% PPC week with two honest, well-analyzed misses is more valuable than a 100% week built on vague assignments. The team now knows exactly which two system causes to fix.
- ▶ The rate model caught the finishing bottleneck; it did not catch the interaction between hot weather and the finishing window. Rate models need to be re-run when conditions change, not just when quantities do.
- ▶ Both misses trace back to the same root pattern: weather response was managed as a checklist rather than as dated constraints with owners. One countermeasure addresses both.
- ▶ The constraint log worked. It flagged the finishing labor gap and the missing retarder before placement — the failure was releasing the pour with one constraint still open.

THE REAL LESSON
 The system did its job by making the problem visible five days early. The breakdown was a release decision made with an open constraint, not a field-execution failure. That distinction is the entire point of Lean production control.

90-Day Deployment Checklist

Depth in one pilot beats shallow compliance everywhere.

Days 1-30 — Stabilize

- ☐ Name sponsor and project Lean lead
- ☐ Define Conditions of Satisfaction
- ☐ Map current meetings and planning system
- ☐ Train Last Planners
- ☐ Launch daily huddle and visual board
- ☐ Build six-week constraint log
- ☐ Baseline PPC, rework, production, and safety indicators

Days 31-60 — Integrate

- ☐ Facilitate milestone / phase pull plan
- ☐ Launch Weekly Work Planning
- ☐ Record reasons for variance
- ☐ Run first A3 improvement
- ☐ Integrate quality and safety hold points
- ☐ Pilot production-rate tracking
- ☐ Coach meeting behavior

Days 61-90 — Sustain

- ☐ Standardize successful routines
- ☐ Create dashboard and data dictionary
- ☐ Audit constraint closure and assignment quality
- ☐ Integrate cost forecast
- ☐ Complete leadership review
- ☐ Expand to next workstream
- ☐ Publish lessons learned

Mock Examination

Select the best answer. Target 80% or higher. This is not an official CM-Lean exam.

1. A crew begins framing an area before coordinated MEP information is released. Which Lean problem is most direct?

- A.** Pull
- B.** Takt balance
- C.** Value confirmation
- D.** Overproduction and constraint failure

2. Which assignment is most sound?

- A.** Set, brace, and self-check Forms W1-W8 by Tuesday noon, ready for inspection
- B.** Work on walls
- C.** Keep the crew busy
- D.** Complete something in Area A

3. A project has 24 weekly assignments and completes 18 as promised. PPC is:

- A.** 67%
- B.** 80%
- C.** 133%
- D.** 75%

4. The main purpose of reasons-for-variance tracking is to:

- A.** Improve the production system
- B.** Renegotiate the contract
- C.** Increase paperwork
- D.** Evaluate personalities

5. Which item belongs in a constraint log?

- A.** Only material deliveries
- B.** Only RFIs
- C.** Only safety permits
- D.** Any prerequisite that can prevent planned work

6. Pull planning is performed primarily:

- A.** After the phase ends
- B.** Forward from today
- C.** Backward from a milestone
- D.** By the scheduler alone

7. A visual board is stale for two weeks. Its main Lean failure is:

- A.** Color selection
- B.** It no longer supports current decisions
- C.** It is physical
- D.** It lacks cost codes

8. Which is the best root-cause statement?

- A.** The approved layout was unavailable because the decision milestone had no owner or need-by date
- B.** Bad attitude
- C.** The crew failed
- D.** Careless worker

9. The sustainable concrete placement rate is controlled by:

- A.** The pump maximum only
- B.** The fastest truck
- C.** The lowest reliable capacity in the connected production chain
- D.** The largest crew

10. Work is “ready” when:

- A.** All necessary prerequisites are satisfied or reliably scheduled before need
- B.** Material is somewhere on site
- C.** It appears on the baseline
- D.** Labor is available

11. A good daily huddle should:

- A.** Resolve every issue fully
- B.** Replace the weekly plan
- C.** Coordinate today’s work and assign blockers
- D.** Last at least one hour

12. Respect for people most directly requires:

- A.** Removing schedules
- B.** Allowing unsafe methods
- C.** Including performers in planning and improvement
- D.** Avoiding accountability

13. Which is a leading indicator?

- A.** Final project profit
- B.** Open constraints due within seven days
- C.** Completed warranty claims
- D.** Total closeout cost

14. A first-run study should occur:

- A.** Only after a defect
- B.** After all repeated work is complete
- C.** Only in design
- D.** On the first representative installation before scaling

15. Which buffer is most defensible?

- A.** A backup pump for a critical pour after risk / cost review
- B.** Unlimited queued trucks
- C.** Excess material in every work area
- D.** Opening many zones early

16. A3 thinking begins with:

- A.** Buying software
- B.** Countermeasure selection
- C.** Understanding the current condition and purpose
- D.** Blaming a trade

17. Takt planning is mainly concerned with:

- A.** Concrete testing only
- B.** A location-based rhythm and balanced handoffs
- C.** Contract payment
- D.** Safety citations

18. Which action best reduces information waste?

- A.** Verbal updates only
- B.** More email chains
- C.** Duplicate spreadsheets
- D.** One source of truth with named update ownership

19. An activity is partially complete. For PPC it should be scored complete when:

- A.** It meets the promised completion condition
- B.** The week ended
- C.** The crew made effort
- D.** It is over 50%

20. Under 29 CFR 1926.1153, the permissible exposure limit for respirable silica (8-hour TWA) is:

- A.** 50 $\mu\text{g}/\text{m}^3$
- B.** There is no numeric PEL
- C.** 250 $\mu\text{g}/\text{m}^3$
- D.** 100 $\mu\text{g}/\text{m}^3$

Answer Keys

Check your applied understanding, then revisit any chapter behind a missed item.

Mock Examination Key

- 1. D
- 2. A
- 3. D
- 4. A
- 5. D
- 6. C
- 7. B
- 8. A
- 9. C
- 10. A
- 11. C
- 12. C
- 13. B
- 14. D
- 15. A
- 16. C
- 17. B
- 18. D
- 19. A
- 20. A

Chapter Knowledge-Check Keys

- | | |
|------------|------------|
| Chapter 1 | C, C, A, B |
| Chapter 2 | B, C, D, D |
| Chapter 3 | C, A, B, B |
| Chapter 4 | A, C, B, A |
| Chapter 5 | D, D, D, A |
| Chapter 6 | B, A, C, C |
| Chapter 7 | C, B, B, C |
| Chapter 8 | B, A, A, B |
| Chapter 9 | A, C, B, C |
| Chapter 10 | B, B, A, B |
| Chapter 11 | A, B, A, B |
| Chapter 12 | B, D, C, A |
| Chapter 13 | B, C, D, D |
| Chapter 14 | B, A, D, D |
| Chapter 15 | A, D, B, A |
| Chapter 16 | C, B, C, D |

Glossary and References

Glossary

Term	Definition
A3 Thinking	A structured, collaborative PDCA problem-solving approach summarized on a concise report.
Batch Size	The quantity of work released or transferred at one time.
Conditions of Satisfaction	Measurable statements describing stakeholder success and acceptance.
Constraint	A prerequisite or condition that can prevent an activity from starting or finishing as planned.
Cycle Time	Elapsed time required to complete one work cycle or unit.
DOWNTIME	Defects, overproduction, waiting, non-utilized talent, transportation, inventory, motion, extra-processing.
Flow	Steady movement of value through connected processes and handoffs.
Last Planner	Person closest to the work with authority and knowledge to make a reliable commitment.
Lookahead Planning	Near-term planning that breaks down work, screens readiness, and removes constraints.
Make-Ready	Actions that turn planned work into executable work.
PPC	Percent Plan Complete: assignments completed as promised divided by assignments promised.
Pull Planning	Collaborative backward planning from a milestone or downstream need.
Reason for Variance	Factual explanation for why a promise was not completed as agreed.
Reliable Promise	A clear commitment made by the performer based on capacity, readiness, and sequence.
Standard Work	The current best-known safe, quality method for performing repeatable work.
Takt	A planned production rhythm across locations or work zones.
Value	Outcome the customer or stakeholder needs and is willing to support.
Work-in-Process	Started but not yet completed and handed-off work.

References and Further Study

- ▶ **Lean Construction Institute.** Lean Construction, Lean Project Delivery, Last Planner System®, Lean in Design, and related public learning resources. leanconstruction.org.
- ▶ **Associated General Contractors of America.** Lean Construction Education Program and CM-Lean credential information. agc.org.
- ▶ **American Concrete Institute.** Verify the current edition of each document before use (ACI periodically rennumbers guides with the PRC / SPEC / CODE prefixes): hot-weather concreting *ACI PRC-305-20*; cold-weather concreting *ACI 306R-16*; curing *ACI PRC-308* and external-curing specification *ACI SPEC-308.1-23*; structural concrete specification *ACI 301*; and other project-applicable publications. concrete.org.
- ▶ **ASTM International.** Current project-applicable standards for sampling and testing fresh and hardened concrete, including C31/C31M, C39/C39M, C94/C94M, C143/C143M, C172/C172M, C231/C231M, and C1064/C1064M. astm.org.
- ▶ **Occupational Safety and Health Administration.** 29 CFR Part 1926, including the respirable crystalline silica standard 29 CFR 1926.1153 (PEL 50 µg/m³ 8-hr TWA; action level 25 µg/m³; Table 1 task-based controls) and applicable construction safety guidance. osha.gov.
- ▶ **Project documents.** Contract, specifications, approved submittals, manufacturer instructions, authority-having-jurisdiction requirements, and company safety / quality procedures.

Final Reminder. The purpose of Lean is not to make people run faster. It is to create a production system in which promises are reliable, problems surface early, work flows safely, quality is built in, and every cycle teaches the team how to improve.

ABOUT THE AUTHOR

London Wulfe

Three decades of concrete construction — written from the field, not from a classroom.

London Wulfe has spent more than thirty years in concrete construction, working through project management, superintendent, and construction management roles across commercial, industrial, and civil concrete work. That experience spans the full arc of a placement — estimating and takeoff, subgrade and formwork, reinforcing and embeds, placement and finishing, curing and turnover — and the planning systems that determine whether any of it goes well.

He is also the author of *14 Laws: After Heart Break* and writes on discipline, resilience, and men’s mentorship. The through-line across the construction work and the writing is the same conviction that runs through this book: systems and standards make people effective, and people are the point of the system.

WHY THIS BOOK EXISTS

Most Lean construction material is written for conference rooms. It explains the theory well and then leaves the reader to figure out what to do at 6:00 a.m. with trucks rolling and a finishing crew waiting. This book was written the other way around — starting from the pour, the constraint log, and the conversation with the foreman, then connecting those back to the principles that explain them.

It is given away free because the people who most need reliable planning — foremen, general foremen, young superintendents, and trade partners running their first Lean project — are usually the last ones sent to training. If one crew stops waiting on a pump, one pour gets cured on time, or one foreman learns that an honest *no* is worth more than an optimistic yes, the book has paid for itself many times over.

SHARE IT

- ▶ Pass this book to anyone in the field who can use it. It is free, and it is meant to circulate.
- ▶ Use the templates in Appendix A on a live project this week. Start with one crew and one board.
- ▶ Work through Appendix D with your team before your next significant placement — it is the fastest way to see how the pieces connect.
- ▶ More writing and resources: <https://wulfecon.life/authy>

A closing note. Lean does not ask people to work harder. It asks leaders to build a system in which good work is possible — where promises are reliable, problems surface early, quality is built in at the handoff, and nobody gets hurt because the plan was rushed. Everything in this book serves that one idea.