Last Planner®

5 + 1 crucial & collaborative conversations for predictable design & construction delivery

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[1] Significant changes from the September 2012 version are marked with a vertical green line in the left margin as here.
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Introduction

On the basis of research they did to improve construction productivity in the 1980s, Glenn Ballard and Greg Howell created The Last Planner[2] System (LPS) to improve the predictability and reliability of construction production.

Last Planner manages the relationships, conversations and commitments that together enable program & production planning decisions to be made collaboratively at the lowest possible level in a whole range of one-off production settings — software development, ship-building, yacht fit-out, construction and other examples of one-off production. With adaptations, LPS works in new product development and design too.

Last Planner is a short-term project planning system first used in engineering construction 20 years ago. It continues to create significant improvements in project & program safety, predictability, productivity, speed of delivery, profit and feelings of wellbeing among project staff. LPS offers a realistic way to collaboratively manage project-based production, enables issues to be identified and resolved before they become problems on-site and increases the chances that work will flow and projects be completed on time. It is a vital link between logistics and building assembly teams. That's why more and more companies are making it part of their standard procedure for project delivery.

In construction, for example, Last Planner promotes conversations between trade foremen and site-management at appropriate levels of detail, and before issues become critical. These conversations increase the chances that work flows and recognises that personal relationships and peer pressure are critical to that process.

Over the last two decades Last Planner has evolved. It has become associated with new theory, some details have changed and others clarified. This process will and should continue. As when making any supposed improvement, the change should be benchmarked against pre-change performance so as to be able to answer the question "is this change an improvement".

"Results show a **30% improvement in the rebuilding times for runways** since Last Planner was introduced and predictability is greatly improved."

Gerry Chick, formerly Supply Chain Development Manager, BAA, *UK*

Why do construction people choose to use Last Planner?

Last Planner was one of the few tools to be mentioned explicitly in the UK *Rethinking Construction* (Egan) report in 1998. The many advocates of Last Planner include BAA, the UK Airport operator, for whom LPS became required practice for all projects from 1999, Waitrose in UK and Sutter Health, UHS and others in the US.

There are many reasons why organisations (including owners, designers and constructors) and projects adopt Last Planner[3]:

- To deliver projects more safely, faster or at reduced cost
- To create a more predictable production program
- To reduce stress on project management staff
- To help improve the overall production process

[2] Last Planner is a registered trademark of the Lean Construction Institute www.leanconstruction.org LPS is sometimes referred to as Collaborative Planning, Lean Planning, Workface Planning among other labels. What is offered under these alternative names is not always the full Last Planner System.

[3] Most were reported by Prof Glenn Ballard at the 2011 International Group for Lean Construction Industry Day in Lima, Peru

- To make projects a reliable customer for just-in-time deliveries
- Because traditional Critical Path Methods don't work

Any company with schedule slip as a standard part of its business is a candidate for LPS

All our senior and then our middle management were schooled and subsequently coached by a [lean manufacturing] group from Detroit MI. We were in shipbuilding which is not a widget game and so I had a prolonged and distracting struggle getting "Toyota" out of my thoughts. When we were introduced to the *Last Planner* (by John Meecham, one of our managers) the lights came on and we started finding our way past the blockage.

Owen H Howell, formerly Vice President Operations, **Burger Boat Company, USA.**

A recent meta-analysis of 26 LPS case studies in peer reviewed papers[4] noted nine benefits reported in two or more of the cases (left in Table 1) and reported six benefits that emerged from additional research by the authors (right in Table 1):

Table 1: benefits of using LPS (source: Solis et al 2012)

From the 26 case studies	From authors' own research
Increased work flow reliability (9)	Smooth work flow
Improved supply chain integration (3)	Predictable work plan
Reduced project delivery or production time (5)	Reduced cost
Improved communication among project participants (3)	Reduced delivery time
Less *firefighting* or fewer day to day problems (3)	Improved productivity
Improvement in quality of work practice at construction site (2)	Greater collaboration with field personnel and subcontractors
Enhancement of managerial practices in construction projects (2)	
Knowledge expansion and learning among project teams (2)	
Reduced stress levels on construction sites (2)	

Additional research by the authors highlighted some concerns, a number of which chime with my own experience, that can influence the success of LPS deployment:

- Lack of leadership
- Organizational inertia
- Resistance to change
- Lack of training [in LPS]
- Contractual issues
- Lack of experience and knowledge [of LPS, particularly at senior management level]

Last Planner increases safety

Even with all the improvements in recent years, construction is a high-risk industry. Worldwide accident rates are three times those for most other occupations. Last Planner is helping bring accident and incident rates down still further. Danish research on like-for-like project comparisons within a single company showed **65% fewer accidents** and up to **70% less sickness absence** on Last Planner managed construction sites[5]. A similar and more recent Chilean like-for-like study showed **75% fewer accidents** where LPS was used compared to projects in the same company where it wasn't[6].

[4] Solis Rybkowski Lavy Porwal Lagoo Son Shafaat 2012 Survey of motivations, benefits and implementation challenges of LPS users J Construction Engineering & Management

[5] Thomassen Sander Barnes Nielsen (2003) Experience and results from implementing lean construction in a large Danish contracting firm. IGLC

[6] Leal & Alarcon (2010) Quantifying impacts of Last Planner implementation in industrial mining projects. IGLC

Last Planner helps stabilise project-based production systems

Stabilising your systems is the first step to making a lean transformation. In project-based production LPS is a great way to do that. It was developed specifically to improve the planning and predictability of increasingly rapid, complex and uncertain construction projects.

Stability and predictability support more than lean. When projects are more predictable it becomes easier to integrate sub-assemblies created off-site. This in turn reduces the number of personnel required on-site and speeds the construction process. Fewer people on site yields fewer opportunities for accidents and incidents which in turn creates a safer site.

As the second quote from Owen Howell on the previous page makes clear, LPS will help you make sense of lean ideas from automotive and elsewhere.

Last Planner makes 'control' *proactive*

In traditional project management production control is generally about catching things after they have gone wrong, i.e. reactive, for example when the project team have missed deadlines in the project program. With last Planner the focus is on making things happen by being sure things can be done when we have planned them. Control becomes pro-active rather than reactive. Planning and control system performance are measured and improved with a view to managing and improving total project performance. Overall project performance is more important than reducing the cost or increasing the speed of any single activity, particularly as the latter may make it more difficult to make overall improvements.

Last Planner reduces waiting

By systematically ensuring that everything necessary is in place before a task is due to start, LPS reduces waiting. Waiting for access, design information, materials, plant; waiting for the previous trade or design team to complete work; these are major sources of uncertainty, frustration and waste in projects. When one team is late delivering, follow-on teams are prevented from starting when they planned to and work ceases to *flow*.

Last Planner supports effective relationships

Construction is a social process. Last Planner manages construction flow by building relationships, creating conversations and securing promises to act at the right level at the right time throughout the process. Work is managed through a network of production relationships and promises that enable delivery of quality projects on-time. Whatever the plan says, work is generally done, and value created after individuals and teams make a promise to do it. Last Planner is a production *and promise* management system.

"MT Højgaard - the largest construction company in Denmark - has applied the Last Planner System on more than 25 building projects during the last two years. No matter what the size or type of project, **the Last Planner System improves the building process and hence the overall result — reduction in costs, projects that are on or ahead of schedule, and a shorter [defects] list**. The most significant improvement is the **lower accident frequency & severity."**

Mikkel Thomassen, Project Manager, MT Højgaard, *Denmark*

Last Planner works on small & large projects

LPS is a simple tool suited to both smaller and larger projects. It was used on large-scale projects such as the £4.2bn (€5bn, $6.5bn) London Heathrow Terminal 5 and £400m (€480m, $600m) North Staffordshire Hospital PFI[7][8]. All that is required for smaller projects (>3 trades. >8weeks) is coloured stickies, paper, pencil, eraser & photocopier. As projects grow, generic software such as MS Excel and then bespoke LPS software such as ProjectFlow (SPS) and OurPlan (DPR Construction) can be helpful.

Last Planner helps create value in projects

Value is what the customer/client/end-user system wants[9]. It is defined by the client system and often involves the end-user in some way. Rarely if ever does the client system speak with one voice and, even if it did today, it would probably say something different tomorrow. Thus value is an emergent concept that requires continual updating and adjustment on the part of the production team.

Some value statements are based on good research. For example in the case of a hospital or school there is research that shows which building attributes are associated with faster patient recovery or improved student behaviour and results[10].

In production, *value* is reinterpreted down the line so that each trade knows what they have to do to create what the succeeding trades need to deliver a quality job. LPS supports this.

Last Planner helps manage conflicting objectives

Within projects there are conflicting objectives. For each trade contractor (and often each design team member too) there is a clear desire to optimise the use of personnel across a number of projects. The same is true for the lead constructor and, in addition, the lead constructor's project team are seeking to optimise their project's delivery process.

Managing this level of complexity requires a high level of collaboration, communication and commitment. Project management tools that only use *Critical Path Methods* (CPM) are inadequate to the task as they only focus on one of the flows – prior work[11].

Location based planning methods such as *Line of balance* see *safe space* as the major constraint – and base planning on that. Line of Balance and LPS can work well together[12].

Ignoring trade contractors' legitimate objectives doesn't help as that makes it difficult to have conversations about issues that inevitably arise.

> "LPS is an effective set of tools for leveraging the shared knowledge of all members of the project team. Without LPS a project manager is guessing at what can be accomplished versus knowing how the job will get done."
>
> **Tom Richert, Program Manager, Linbeck Construction, *USA***

7 PFI = Private Finance Initiative, a form of Public Private Partnership (PPP)

8 Reported in detail in Court, Peter 2009 Transforming Traditional Mechanical and Electrical Construction into a Modern Process of Assembly EngD Loughborough University UK

9 Womack & Jones (2003, 1996) Lean Thinking p.

10 see e.g. Rybkowski (2009) The Application of Root Cause Analysis and Target Value Design to Evidence-Based Design in Healthcare PhD

11 See Koskela & Howell's critique of CPM project management methods http://galbarello.googlepages.com/ObsoleteTheory.pdf

12 Seppanen Ballard Pesonen 2010 The Combination of Last Planner System and Location-Based Management System LCJ & IGLC

Last Planner is part of a new business strategy for construction

Last Planner is part of a new *production management system* for one-off project-based production such as that in construction and design. This business strategy allows project managers to significantly improve productivity and client/end-user satisfaction when compared to the equally consistent old way of doing business.

Together with a focus on collaboration and relational commercial terms, LPS creates this powerful new business strategy that is central to two related collaborative approaches the **Lean Project Delivery System**[13] (LPDS) and **Integrated Project Delivery** (IPD)[14], that:

- align people, systems, business processes & practices to
- harness the talents & insights of all participants so that they can
- optimise value for the client (while creating an appropriate return for all stakeholders),
- reduce waste & maximise effectiveness
- throughout all phases of design, fabrication & construction.

The lean business strategy

Using LPS to plan & manage production commitments
collaborative organisation
relational commercial terms

The old way

Critical Path (CPM) push planning
Command & control organisation
adversarial & transactional commercial terms

Figure 2: The new business strategy (left) for project-based production (Mossman after Lean Construction Institute)

Integrated projects are led by a highly effective collaboration between client, lead designer & lead constructor from early in design through to project handover. This teamwork is often defined within a multi-party collaborative agreement and uses lean thinking throughout the process. LPDS and IPD differ from both Design & Build and from historic Design-Bid-Build.

Last Planner decentralises decision making

Construction projects are increasingly complex, fast and uncertain. As Don Reinertsen made clear in a May 2012 presentation *Decentralizing Control: How Aligned Initiative Conquers Uncertainty*[15] decentralisation is a valuable strategy if you want to make rapid progress in conditions of complexity and uncertainty.

Last Planner provides the *last planners,* trade foremen and design-team leaders, with the authority, information and physical & social space they need to make decisions collaboratively about the use of resources to deliver the project. At the same time LPS helps each of them develop their skills as decision makers.

Even though he doesn't mention Last Planner and draws his examples from organisations like the US Marines, US Forest Service Fire teams and Boeing, Reinertsen's 90 minute talk is excellent background for thinking about why you might want to use LPS on your projects.

Reinertsen is not advocating decentralising everything. He shows how decentralisation needs to be balanced with what he calls *soft-centralising,* a process with a clear *doctrine* to

[13] For more information see http://www.leanconstruction.org/lpds.htm
[14] For more information see http://www.thechangebusiness.co.uk and click on Integrated Project Delivery and read Thomsen (ed) (2009) Managing Integrated Project Delivery CMAA
[15] http://vimeo.com/45947817

drive mindful behaviour, clarity about the project manager's intent (what is to be done & ***why*** – a goal beyond the immediate task), training to help build the culture as well as specific skills, teamwork, communications to develop familiarity & trust within the team[16] and simple, modular & flexible planning. You will find most, if not all, of these on well-run projects using LPS.

Leadership is key to managing the balance between soft-centralisation and decentralisation.

Last Planner reduces specialty constructor costs

Image Decorations Ltd, a Sheffield UK based decorating company, found that using LPS improved the managerial skills of site foremen (→ decentralisation) and led to a freeing up of senior management time. MD Nick Wain told a *Construction Productivity Network* meeting[17]:

> *"The Last Planner System [enables] our site supervisors to **plan their workload on a weekly basis** and assess their team's performance on a daily basis [and] to make an accurate prediction of the labour required on a weekly/daily basis. **This plan is based on facts, not a site manager's wish list**… Once supervisors understand … Last Planner, and are confident in using the documentation, it can reduce the frequency of senior management visits to site. The foremen are capable of handling situations as they arise as their decisions are based on facts that are documented weekly."*

Last Planner delivers bad news early

At the same meeting Gerry Chick, then Supply Chain Manager at BAA, dramatically underlined one of the benefits of LPS. ***Bad news***, he said, ***provides good information. Bad news early is even better.*** Why? Because the earlier you know about something going wrong the easier it is to reduce the impact and to take corrective action.

Last Planner enables bad news to surface quickly before it becomes a major issue. It can also provide signals of immanent bad news that may enable the team to head it off.

Last Planner helps reduce stress on project management staff

Messer Construction in the US adopted LPS in part because it had the potential to reduce the stress on project management staff[18]. Engaging the brains of all management and supervisory staff on a project gives everyone a sense of the vision and direction of the project and gets everyone thinking about the risks and involved in managing them.

Last Planner cuts "*fire-fighting*" on projects

Much of construction management is *fire-fighting*[19] — dealing with things that have gone wrong in an effort to get back on track. Continuing that metaphor, the Last Planner System is an *integrated fire prevention system*.

Collaborative programming anticipates problems and helps the team develop countermeasures; **MakeReady** identifies problems before they impact on production;

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[16] The US Marine Corps guidance includes the following: "Relations among all leaders—from corporal to general— should be based on honesty and frankness regardless of disparity between grades. Until a commander has reached and stated a decision, subordinates should consider it their duty to provide honest, professional opinions even though these may be in disagreement with the senior's opinions." http://www.clausewitz.com/readings/mcdp1.pdf p 58

[17] 17 September 2003 in London. For a copy of the meeting report see: http://tinyurl.com/3eh9an for other CPN Last Planner reports see: http://tinyurl.com/4kc9s3 My emphasis.

[18] Reported by Prof Glenn Ballard at the 2011 International Group for Lean Construction Industry Day in Lima, Peru

[19] Those of you that watch Reinartsen's video http://vimeo.com/45947817 will understand that this metaphor is based on an outmoded view of fire fighting!

collaborative production planning reduces potential problems still further. **Learning** is the basis for **improvement** that helps the team avoid repeating mistakes and working more effectively together as new problems emerge. There is more on each of these elements of the Last Planner System in the next section.

Bad news early means that project managers and last planners have time to think through options to mitigate the risks that do manifest and consider what action to take, instead of diving into firefighting mode.

Critical Path Method (CPM) is no use for managing projects

In a recent conversation a senior manager in a large international construction company described critical path programs as a wish list. Critical Path Programs offer a great way for designers and constructors to test the feasibility of completing a program in a given time frame. That is where the utility stops. CPM is no way to manage a program.

Prof Friedrich Hayek, an economic philosopher beloved of both Ronald Regan and Margaret Thatcher, described the dilemma for planners as long ago as 1945. Planning, he argued, is concerned with the complex set of decisions about the optimal allocation of available resources. In construction resources includes time, money, productive capacity and equipment (such as cranes & hoists), The problem, Hayek suggested, is to secure the best use of resources when "practically every individual … possesses unique information of which beneficial use might be made … *if* the decisions depending on it are … made with his active cooperation." [20] Views about what is optimal change as the situation changes and new information becomes available. There is no way that a central "planner" (or planning team) can access all this distributed information, let alone keep it up to date.

With every pair of hands comes a free brain.

As Koskela and Howell made clear in *"The underlying theory of project management is obsolete"*, a brave paper presented to the Project Management Institute in 2002, considering projects only in terms of **transformation** (as described in the PMBoK) is to ignore:

- uncertainty and many of the interdependencies that interrupt the smooth **flow** of work in projects.
- **value** generation from the point of view of the customer.

Last Planner supports value, flow *and* transformation

Creation of **value** in construction, as in manufacturing, requires the **transformation** of materials. Unlike manufacturing, there are seven streams required to come together at the workface to enable construction transformations to **flow**. If any one of the seven is interrupted or out of sequence value cannot be created[21]. The seven are summarised in Figure 1.

Figure 1: the seven construction streams (after Koskela 2000)

[20] FA Hayek (1945) "The Use of Knowledge in Society" *The American Economic Review* 35(4) pp.519-530 (my emphasis)

[21] The flow, transformation, value (TFV) theory and the identification of the seven streams is due to Prof Lauri Koskela of Salford U, UK. See e.g. Koskela (2000) An Exploration towards a Production Theory and its Application to Construction PhD

This still applies on projects where sub-assemblies are manufactured off-site. Value is only created when the sub-assemblies are added to the structure on-site.

Last Planner helps move from push to pull

The historic Critical Path planning system is a push system — it pushes work into production based on pre-determined start and completion dates in the CPM schedule. It does this without regard to whether the work is ready to be done, the progress made by prior trades — or the readiness of the producers. If this system worked, there would be a high coincidence between what **should** be done and what is **done**.

This traditional *push* approach leads to *nonsenses* such as ceiling contractors installing ceilings before the M&E contractor has finished working above them. In software engineering it can lead one programmer to make assumptions about what another is doing or will do, resulting in rework; in design, one designer will make an educated guess about what will be required and proceed on that basis — sometimes they'll be spot on, but more often, they'll have to do a load of rework too. When building luxury yachts, installing fitted furniture in the wrong sequence can lead to problems for the plumbing, electrical or mechanical teams.

LPS changes the way the program is arrived at and adds a critical step, designed to ensure that *only work that **can** be done is scheduled for production*.

The origins of Last Planner – by constructors for constructors

Some talk as if Last Planner is a Toyota tool. It is not. **Last Planner was developed by construction people for construction people** and the research on which it is based began well before "lean", let alone *lean construction,* became part of the management vocabulary. The first experiments were conducted in 1981 and Ballard's unpublished report of those experiments in 1991 showed that on well managed sites run by respected engineering and building companies only 54%, one in two, of tasks planned for delivery the following week were delivered in that week[22].

Others believe that *just* using Last Planner *is* lean. It is not. **There is much more to being lean than Last Planner.** Lean is a way of thinking common in Toyota. Like most of the "tools" used in lean transformations, Last Planner supports lean thinking about a very specific problem. In this case that problem is unreliable and unpredictable production in project-based environments.

How do you do on your weekly programmes?

What percentage of tasks planned for a given week are completed in that week? This is a critical question worthy of some research.

Unreliable production discourages planning and poor or no planning leads to poor performance and makes the use of prefabrication and other time saving activities much more difficult. LPS is, first and foremost, a way to make work-in-projects more reliable so that it is worthwhile planning and, in that way, improving productivity.

If, after reading this note, you decide you would like to have LPS working in your organisation a good place to start is by gathering data from a number of projects over 3-4 weeks about the

[22] Ballard only measured task completion to the week. Greg Howell suggests that this equates to a PPC score (see p 18) of around 30% - remember that LPS and PPC did not exist when Ballard did this research so no-one was making promises (work was pushed into production) and that PPC is measured to the day.

percentage of tasks planned for a given week that are delivered in that week. That data is more likely to convince senior managers that action is required than stories about what other companies have done and the results they have seen.

If they still need convincing, get someone to run the *Parade of Trades* simulation with them. It will take about 90 mins with debrief[23].

The next section describes the key elements of LPS. Points to ponder as you read on:

- why are Last Planner projects safer?
- how does Last Planner mobilise social pressure?
- what is different about Last Planner?
- why is work in projects so unpredictable?
- what is the cost of that unpredictability? What does it stop us doing?

Last Planner in practice

In construction LPS is used[24]:

- to help manage the design process
- on its own in a conventional Design-Bid-Build or Design-Build setting during the construction phase
- as part of a wider lean project transformation at site level
- in the context of integrated project delivery to help manage both design and construction production
- to plan and manage tender processes[25]

In a *Last Planner Masterclass* in May 2012 at Nottingham Trent University in UK, Glenn Ballard reported that LPS has been used in projects in these fields:

construction	**work order systems**	**aircraft and shipbuilding**
job shop	**product development**	**software engineering**
healthcare	**oil & gas development**	**performing arts**

He went on to state his belief that *LPS works in all kinds of situations that require coordination between humans*.

5 + 1 crucial conversations - building trust among key performers

LPS creates planning and evaluation conversations at the right level and at the right time to build trust between key project performers — the *last* planners [i.e. trade foremen on site, design team leaders] and overall project managers. These conversations increase the chances that work flows and recognises that personal relationships and peer pressure are critical to that process.

[23] For details see http://www.leanconstruction.org/training/lean-simulation-games/

[24] Reported at various Lean Construction Institute Annual Congresses and LCI/P2SL Design Fora: http://www.leanconstruction.org/training/lci-past-events/ and in IGLC papers http://www.iglc.net

[25] reported at a Lean Construction Institute UK meeting 28 April 2008.

Five key conversations make up the Last Planner System (see Figures 3 & 13). Each brings its own benefits. When all are working together they reinforce each other and the overall benefits are greater. The *conversations* are:

1. **Collaborative Programming**[26] —creating and agreeing the production sequence (and compressing it if required)
2. **MakeReady**[27] — Making tasks in the *LookAhead* period ready (i.e. constraint free) so that they can be done when we want to do them.
3. **Production Planning**— collaboratively agreeing production tasks for the next day or week
4. **Production Management** —collaboratively monitoring production to keep activities on track
5. **Measurement, learning and continual improvement** — learning together about and improving project, planning and production processes.

The additional set of crucial conversations are **First Run Studies** (FRS). FRS doesn't fit neatly into the sequence of conversations above as they might occur at almost any time in the process as shown in Figure 3. As you will see in the section on FRS below they are nevertheless an important way to learn as the basis for improvement.

Last Planner enables a project team to focus on keeping all seven critical streams moving so that they come together at the workface where materials are transformed and value is created. It creates a structured series of conversations that enable projects to progress and provides the basis for relationships within the team so that when *things go wrong* it is easier for the team to pull together and find ways to move beyond the crisis. By making it possible for team members to share bad news early some crises can be avoided and others mitigated.

Last planners and project management collaboratively plan the sequence of the work for each phase of the project so they understand the overall process before work begins. *Last* planners systematically and rigorously ensure that tasks are ready to be done when planned and then collaboratively plan and manage production of those activities that can be done week by week. They learn so that they can continually improve both planning and production.

Each part of Last Planner brings its own benefits. Used together they help deliver quality projects more safely, on-time and within budget

A mature implementation of Last Planner will probably begin with a collaborative programming workshop for the first phase, but if this is your first implementation it could well start part way through a project. Just the implementation of daily or weekly work planning can help to stabilise a project so that other elements can be progressively introduced. This is particularly useful where an existing project is running behind schedule.

A school extension project in Scotland was running 4 weeks late. Collaboratively planning the remaining 42 weeks of the contract and then managing activity on site with a weekly production evaluation and planning meeting enabled project delivery 13 weeks early.

Problems arise at handovers

Problems arise and breakdowns often occur at the interfaces between contracts and trades. There are good communications within companies and trades but communications between trades, even trades within the same company, are not as good. That is where things often go wrong.

[26] sometimes called *pull scheduling, pull planning, reverse phase scheduling, collaborative mapping, sticky-note planning*
[27] sometimes called *LookAhead planning* [all plans look ahead!]

The 5+1 LPS conversations are designed to enable trade foremen & design team leaders to make reliable promises & keep them:

- **collaborative programming** helps the project team get to know each other, identify issues with the project and agree how to resolve them and design and plan handovers
- **MakeReady** helps them ensure that the work can be done when they want to do it
- **First Run Studies** are an opportunity to rehearse critical handovers and understand where failures might occur so that they can be planned for
- **weekly or daily production planning** meetings lets them check for interdependencies before they promise
- **production management** helps them adjust plans in the light of new information, &
- the **learning** element encourages learning from success & reduces repeated failures.

Regular conversations give teams early warning when aspects of the project are not going well and allow them to take action before they get worse – *bad news early is good information.*

Figure 3 shows the Last Planner System as a flowchart – start bottom left. Moving bottom to top we go from plans that set out what **should** happen, the MakeReady process that establishes what **can** be done to production planning when the last planners agree what **will** be done – this is where promises are made. At the same time moving left to right and closer to the point of production, tasks are broken down from big chunks (boulders) to small details (sand).

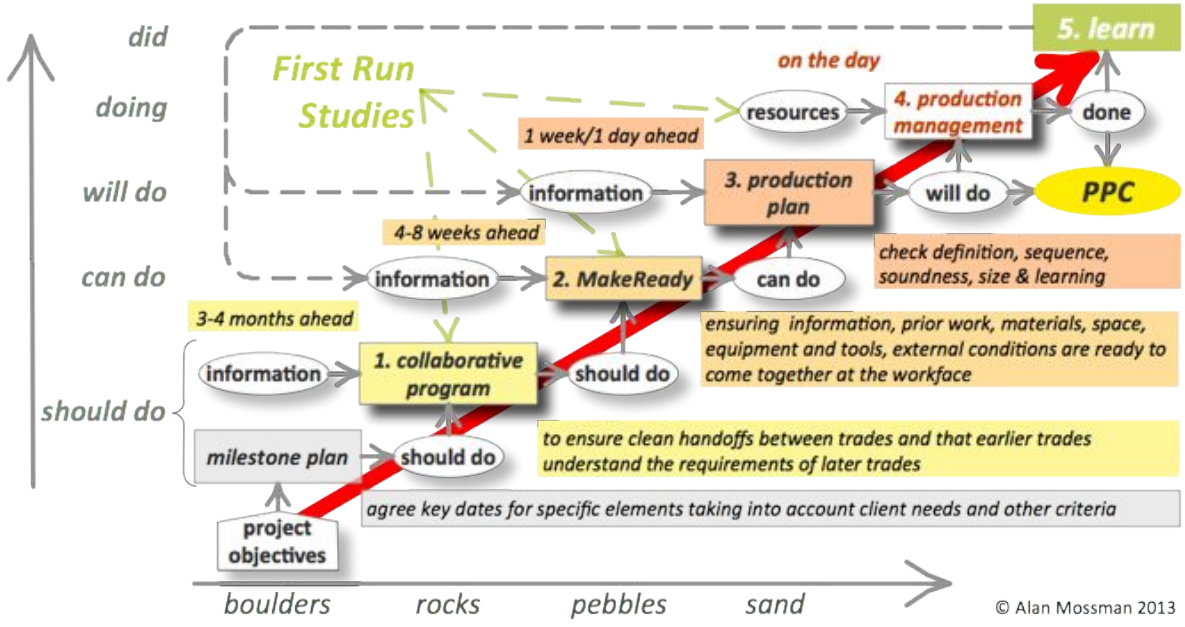

Figure 3: the Last Planner System as a flowchart (Mossman).

1. Collaborative programming

Traditionally programs are prepared by professional planners and project managers – *first planners*. To do this they make many assumptions – and build slack (buffer, float, padding) into the program to compensate for these uncertainties. First planners may consult members of the delivery team if the packages have been let, but delivery team members will not easily give up buffer when they are uncertain about whom they will be working with or what the project involves. The first planner program is generally *imposed* on the project. Projects are then managed in terms of what the program says *should* happen. It often requires work to be done that cannot be completed as programmed because one or more of the flows is broken.

LPS is a program coordination and production control system designed to ensure the achievement of *agreed* goals. Those goals are set in a *collaborative programming process* so that all the main suppliers and specialist contractors are engaged right from the start in developing and signing up to the master program and to the program for each phase.

A number of UK constructors *only* use collaborative programming. They get significant benefits from doing so but miss many others by failing to support their collaborative programming with collaborative production planning, management and systematic learning from experience quite apart from systematic MakeReady.

When all major players meet early in the process it's possible to discuss critical interdependencies and risks, test assumptions and agree on good practice.

It is generally accepted that there are two classes of customer: the end user and the 'next trade in line'. A key task for design teams is to discover and validate end-users' requirements. But what about the requirements of the next trade (or design team) in the process? Making time in collaborative programming to be clear about what team(s) want from those who precede them so that they can work more safely, faster, etc. is generally time well spent. Planning from right to left, i.e. from the future, helps build later trades' needs into the plans of earlier trades.

Systematic risk analysis is integral to collaborative programming. Float is used strategically to protect program predictability (unlike *Critical Chain* which creates program *un*certainty by moving *all* float to the end of the program and then allowing the program to drift to the right).

Figure 4: Review of construction sequence (front) while others continue to create the program for a student-housing scheme on the wall behind. (photo Alan Mossman)

Sven Bertelsen, a Danish Engineer and lean construction consultant, has listed the range of uses and benefits of a collaboratively produced program:

- a **workplan** of what *should* be done
- an **organisation chart** - who does what?
- an **agreement between trades** (or design teams) about when to start and finish
- a **logistics plan** defining when we need materials, trade teams, drawings etc.
- a tool for **workflow control** - when we want to do which tasks
- a basis for monitoring progress

Benefits of collaborative programming[28]:

- *prepares team members for action together*
- *team members discuss details much sooner*
- *sorts out sequencing & other issues that would be difficult to change later; issues sorted on paper rather than at the workface*

[28] The benefits *in italics like this* are from a variety of LPS users in the UK and US, both managers and operatives.

- *enables team to test options to improve work flow, buildability and program reduction*
- *identifies unclear design details*
- *builds commitment to program and reduces overall program period.*

Programme compression

With an agreed programme it is possible to explore ways to compress it. With a supply team that had worked together on a number of similar projects previously, one UK constructor took 6 weeks out of a 20-week programme using this approach (Fig 5). This clearly has enormous benefits for their client, an hotelier: the building is earning significantly earlier. It also has benefits for the main contractor and their suppliers, they are more competitive as reducing the programme itself reduces cost and they all stand to make a larger margin.

Some claim that it is generally possible to **reduce programmes by about 20%** using collaborative programming and I have certainly seen that done on supermarket fit out programmes (twice) in addition to the examples cited here.

One constructor showed an airport upgrade project could be delivered in 16 weeks instead of the 22 weeks that *first planners* thought it would take. In a subsequent workshop they managed to get that down to 12 weeks[29].

Figure 5: intense concentration & discussion during a compression workshop reduced a 20-week program to 14 weeks. (photos Alan Mossman)

For another constructor, collaborative programming and compression rescued a 70-week programme that was running about six weeks late after 30 weeks. From the time of that workshop, involving all the major suppliers on the project, Last Planner was used to help keep the project on the agreed new track so that it came in on time.

Three important words

There are three important words in Last Planner. They are important in all of the conversations and sometimes people will do anything to avoid saying them:

I don't know

It takes courage to be vulnerable like this. Please think of "I don't know" as an example of "*bad news early is good information*". When you admit you don't know you allow other people to help you be successful. When you fail to use these three words, you can fail on your own.

[29] I participated in the workshop when this was done

Reducing activity durations: SMED for construction

SMED (Single Minute Exchange of Die) is a manufacturing technique[30]. The problem it was developed to address was the lengthy changeovers on machines switching from producing A to producing B. The process involves identifying anything that can be done while A is still being produced and doing it then; identifying anything that can be done once B is in production and doing that then; finally working out how to do what is left in the shortest possible time. In this way and over many years manufacturing folks have learnt how to manage changeovers that originally took 16 hours in 4 minutes. Results like this take dedication and perseverance.

The process has applications in construction too and needs to be thought through in a different way. The problem to be addressed is how can we reduce the time required at the workface to complete a particular task. Good questions to ask are:

- what can we do before we get to the workface that will make work at the point of assembly safer, faster, cheaper, etc.?
- what can we do while subsequent teams are at the workface?
- How can we reduce the time we spend at the workface?

In the next section we look at MakeReady, a critical part of LPS, that will help with this too.

2. MakeReady

Earlier I referred to seven streams – all of which are essential to creating value in construction. There is no point in putting a task into production if any one of the streams is broken. Using a simple tick sheet like that in Figure 6, the MakeReady process systematically checks that everything is in place for each of the tasks in the LookAhead[31] window. At least a weekly activity, this *constraint* removal process continues throughout the project.

Benefits of the MakeReady process:

- *tasks are ready for production when required*
- *safer working — planning involves hazard analysis and method statements*
- *greater certainty of time, materials and equipment — less waste*

MakeReady: Assembly

company: M-hill Groundworks Ltd
project: Waitrose Droitwich — contracts manager: Ted Foster 0121 796 8485; 07731 252730
phase: foundations & shell — prepared by: Jim Jones 07968 485 627
area — date prepared: Weds 8 October 2008

				Information				Pre-req		Resources					
ref	task description	program start date	responsible party	contract/ instr.	design	RFIs	mthd stmt	wea-ther	tasks	plant	labour	space	materials	can do	notes
1	drainage - exg foul manhole to FMH11	28 Oct	M-hill	✔	✔	✔		✔	✔	✔	✔	✔	✔		method statement - induction
2	reinforcement to toe D2-F2 (incl DL & DLB)	28 Oct	M-hill	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	
3	drainage access MH & stanchion base deepening & ducts	29 Oct	M-hill	✔	✔	97	✔	✔	✔	✔	✔	✔	✔		RFI97

Figure 6: MakeReady form for guiding and documenting the process of making tasks ready (part) note: MakeReady for design is simpler – generally only four flows. (Alan Mossman)

Information (e.g. drawings, method statements, standard work) enables tradespeople to recognise whether they are doing a quality job in a safe way and supports self-inspection. Pre-requisite work is necessary prior work done by other trades and resources covers the remaining flows that are required to complete the task.

[30] See e.g. http://en.wikipedia.org/wiki/Single-Minute_Exchange_of_Die

[31] The length of the LookAhead period varies – usually between four and eight weeks. Any activity with a longer leadtime than the chosen LookAhead period becomes an item in the program so that it is not forgotten.

Together the PEP meeting (next section) and MakeReady go a long way to improve the way that work works in a project. They are even more effective within the framework of an agreed, collaboratively produced project program – see previous section.

3. Production evaluation & planning

Throughout the project there is a regular production evaluation & planning (PEP) meeting involving all *last planners*. It generally lasts less than an hour. In very tight projects shorter daily work planning may be necessary, but generally the PEP meeting is weekly [for that reason this meeting is often known as the Weekly Work Planning WWP meeting]. The purpose of the PEP meeting is to *review and learn from* the work done in the previous and current periods - we will discuss this aspect later - *and* to plan the work that **will** be done in the next period, bearing in mind the work that **is** being done now and in the knowledge of work that **can** be done.

Proposed production plan — Week commencing: Monday 16 January 2012

project	ABC project
phase	fitout
area	turbine hall
Company	TCB Ltd t: +44 1453 765611
Prepared by	Jim L Fixit t: +44 1453 765611 alanmossman@mac.com
Date prepared	Wednesday 11 January 2012

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Plan A ref	Task description (Criteria for release of assignments: defined, sound, ordered, sized)	Final MakeReady needs (Work that must and can be performed prior to the release of this task)	who will do the work?	when will the work be done? M	T	W	T	F	S	S	complete	PPC analysis: on time	Reasons for late delivery*
10765	SM1 pipework		pipe1	5	5								
10770	Non destructive test of SM1 pipework	complete pipework	pipe1			3							
10835	SM2 pipework		pipe2	5	5	5							
Plan B work we could do if we have the time				M	T	W	T	F	S	S			
10925	assemble final piping for overspeed												
10935	begin preparation work for turbine 2												

* Reasons: 1 Late or defective materials • 2 MakeReady items not in place • 3 Interface with other packages • 4 Prerequisite activity not recognised by resp party • 5

Figure 7: part of a Production Plan form used by trade foremen & design team leaders to propose the work they and their team will do next week at a PEP meeting. (Alan Mossman)

Each last planner/team leader proposes a production program for her or his team (Figure 7). In the PEP meeting, team leaders explore any inter-dependencies between their proposals – e.g. conflicts of space, resources, access or equipment. As team leaders get used to the discipline of Last Planner, they will negotiate prior to the meeting. Even then, nothing is finally agreed until the end of the PEP meeting.

One cause of late delivery at this stage is team leaders over-committing. It is in everyone's interest to prevent this happening. There are two rules for collaborative production planning:

- **If you promise to do it, get it done**
- **If it cannot be done, don't promise to do it**

you cannot trust a promise from someone who feels unable to say "No".

Figure 8: Production & Evaluation Planning Meetings weekly left, daily stand-up right – if no digital projector you can use photocopied proposals (fig 7) or stickies on the wall (right). (Photos: Boldt Construction, Alan Mossman)

In the next section we will look at how you might know that a task cannot be done. First let us look at some of the benefits of systematic and collaborative production planning:

Benefits of PEP meeting in the context of Last Planner:

- *maintains commitment to the intention of the project and current client concerns*
- *suppliers prepare better because they know what's expected of them*
- *builds relationships with & between supplier team leaders*
- *focuses attention on what can really be done*
- *facilitates learning from experience – together we get better every week*

The PEP meeting alone will not realise these benefits week-in week-out. Trade foremen can only reasonably commit their teams to deliver a particular piece of work if the work **can** be done. Just because a task is on the project program doesn't mean it can be done — there may be inadequate design information, pre-requisite tasks incomplete, resources or materials not available or any of the other seven flows broken. The *MakeReady* process exists to ensure that when work is programmed for production it **can** be done.

Securing reliable promises, making reliable commitments

A contract is a very formal promise to the client to deliver the project by a certain date in a specified condition. Within the project it is helpful to think about the production plan as a record of promises made to the wider project team.

The agreed program defines when tasks *should* be done and acts as a request to the supplier to do that task. *Last planners* only promise once they have clarified the *conditions of satisfaction,* including the due date, and are clear that the task *can* be done — i.e. they have the capability, materials, labour, information, etc. to do the work (Figure 1).

Once the task is complete the *last planner* responsible *declares delivery* so that site management or the team responsible for the next task can make an assessment as to whether it meets the Conditions of Satisfaction or not (Figure 9).

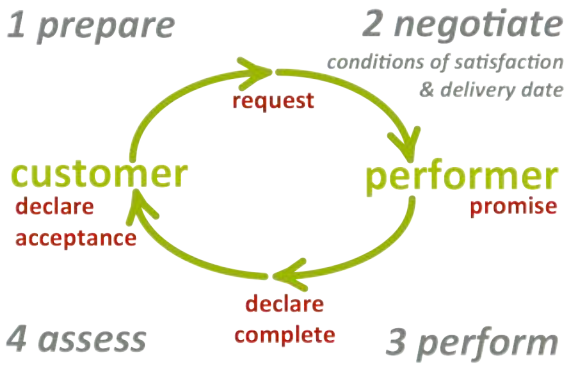

Figure 9: the promise conversation cycle (after Flores[32])

For this to work it is important that *last planners* have the freedom to say *no* to a request whenever that is appropriate. You cannot trust a promise from someone who feels unable to say NO.

The discipline of managing promises improves the way foremen and operatives engage in the project. They become members of a *team* intent on fulfilling the overall promise to the client. Foremen feel the effect of peer pressure following their public commitment to deliver and that encourages them to demonstrate initiative in keeping promises and adjusting to the changing performance of others so that the overall project is a success.

[32] See e.g. Denning & Medina-Mora 1995 Completing the Loops *Interfaces* 25:3 42-57 or Macomber & Howell (2003) Linguistic Action- contributing to the theory of lean construction IGLC

Collaborative programming, **MakeReady** & negotiation in and around the **PEP meeting** all help trade foremen promise reliably. **Learning** & Continual Improvement, the fifth conversation in LPS — helps improve promise reliability and the predictability of production plans.

4. Production Management

Construction is a social process. Peer pressure works so long as there is a shared sense of responsibility for project delivery. The Collaborative Programming and Production Planning conversations particularly help to develop that. A daily stand-up meeting on site or a brief morning telephone conference of design team leaders lets everyone know what was completed yesterday, allows early warning of any late deliveries and enables the team to renew or adjust promises based on last minute adjustments.

This is a vital conversation. A key role for project managers is to manage the mood of the project. This brief meeting, generally no more than 15 minutes, is an opportunity for senior project staff to *take the temperature* of the project so that when necessary they can act quickly to maintain project morale as well as enabling the team to keep the project on track.

On some projects, production planning and production management are combined in a daily meeting. This is generally essential in design and can often be helpful during assembly.

5. Measurement, learning & continual improvement

This is the basis for the evaluation process in a PEP meeting. All these continual improvement elements together contribute to more predictable and reliable workflow. It is only by adding continual improvement processes that we systematically learn how to work more effectively together, to make the work program ever more predictable. They also contribute to the quality of the finished product as the process significantly reduces hurry-and-wait and contributes to smoother workflow.

Within Last Planner there is a measure of predictability of work delivery – **PPC -** the **P**ercentage of **P**romises **C**ompleted[33] on time. At the end of the PEP meeting, each team leader promises to complete one or more activities so that it meets the agreed *Conditions of Satisfaction* by a given day of the next week. Used to improve production reliability, PPC measures the proportion of promises made that are delivered *on time*.

A study for a 2004 US Construction Industry Institute report showed a statistically significant correlation between PPC and productivity on engineering construction projects[34]. Anecdotal reports from both the US and the UK suggest that this may be true in building construction too and seem to show that there are step changes in productivity and profitability with a PPC around 75% and 90% – Figure 10.

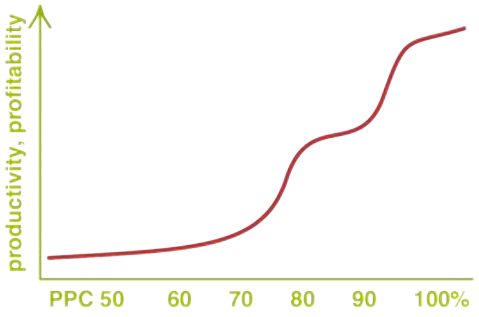

Figure 10: productivity, profits increase with PPC (Mossman)

[33] sometimes called *Plan Percent Complete* – I choose not to use this term as it is not always clear what plan is referred to.
[34] Reported in Liu & Ballard (2008) Improving labor productivity through production control IGLC16

Tasks Made Ready[35] (TMR), another metric, is a great predictor of PPC and a good measure of the quality of the MakeReady process. Measurements are only indicators of improvement. *Tasks Anticipated*[36] (TA) is an excellent measure of the effectiveness of the planning process.

Part of the **continual improvement** of TMR & PPC scores and program predictability is a study of the reasons why tasks promised in the production plan are delivered late[37] and why tasks are not made ready on time. Recording reasons in a Pareto chart (Figure 11) shows where attention is most likely to yield the most results.

Part of the learning conversation is to understand thoroughly the *root cause(s)* of the more common reasons for delay. This is not something you can do for a class of reasons. It is something that needs to be done one reason at a time. Material X may be late because Chris didn't order it; material Y because of a fire at Supplier Y. Both are examples of 'late delivery of materials'. Using tools like *5 Why* and *cause-effect diagrams* helps a team understand what needs to be done to improve[38].

Reason	occurrence
Unclear information	X X X X X X X X X X X X X X
Too few operatives	X X X X X X X X X X X X X
No promise to deliver	X X X X X X X X
Client/design change	X X X X X
Overrated capacity	X X X X X
Late request	X X X X
Unclear requirement/CoS	X X X
Pre-requisite work	X X X
Failure to request	X X
CoS not made clear	X X
Rework	X X
Other	X
Absent operatives	X
Unplanned work	

Figure 11: example of a reasons Pareto chart – the standard reasons you use will depend on the type of project you are working on – this was for a supermarket fit-out.

Some organisations are using Process Failure Mode Effect Analysis [PFMEA] to gain further insight into the patterns of failure on their projects.

Construction logistics

LPS supports logistics planning. Logistics involves more than just materials. **Last Planner** ensures that all seven flows — information, plant, equipment, materials, people etc. — are flowing to the workface so that tasks can be done when required.

For more on this see "More than materials: managing what's needed to create value in construction" – downloadable from http://bit.ly/morethanmaterials

[35] the number of tasks that can be done divided by the total number of tasks that were planned to be done in the given week

[36] the number of tasks made ready divided by the total number of tasks done in a given week including any tasks that were added to the weekly work plan that were not included in the collaborative plan or in the look ahead window.

[37] Rebecca Bettler, National Director of Lean Construction at JE Dunn Construction, encourages her teams to study reasons for *early* delivery too, noting that early delivery means lost opportunities for other trades to get work done sooner and that such losses can never be recovered. She does allow teams that deliver early to count the tasks towards their PPC score.

[38] For an excellent guide to root cause analysis read Bettler Macomber 2011 No Fault Problem Solving http://bit.ly/5why-LPC

+1 First Run Studies

First Run Studies (FRS) are an integral part of LPS[39]. FRS is used to learn about a process so that it can be improved, that is done more safely, completed more quickly and/or completed to the required quality. FRS are based around the PDCA (Plan-Do-Check-Act) cycle. The key steps are shown in Figure 12.

The label *First Run* Studies suggests that this is something you do for things that are repeated but that is not their only application. You can use FRS to prepare for the first time you do anything, even if it is the only time you do it! So use FRS when you do something that will be repeated, when you do anything that is time critical, safety critical or where quality could be an issue.

FRS can be done digitally (Virtual FRS or VFRS[40]). On one of the UK Channel Tunnel Rail Link contracts at London's St Pancras Station a VFRS of a time critical activity using the building information model (BIM) revealed that the parts could not be assembled as designed. A simple redesign enabled the work to be completed in 36 hours instead of the 51 hours allowed[41].

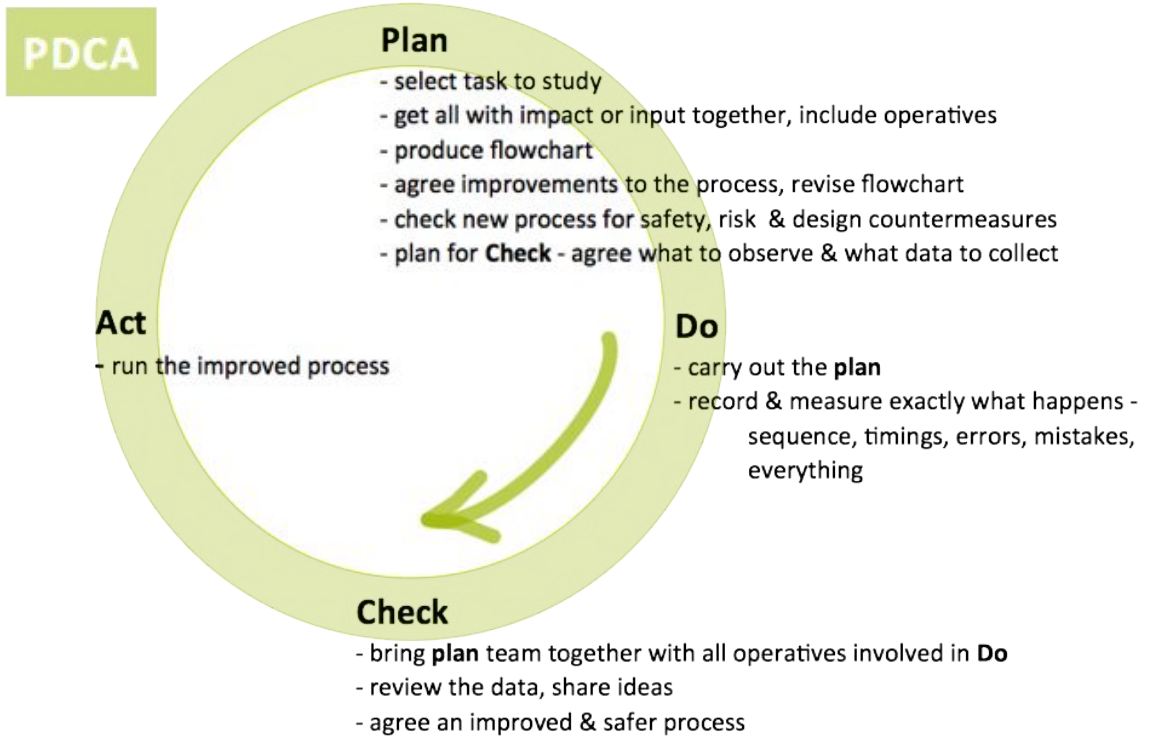

Figure 12: basic First Run Study process (Mossman after Ballard)

Note: you need all those involved in the task and those who can affect the task to be involved at plan stage. If the task will be repeated, it helps to have time-lapse photography and other ways to record exactly what happens.

[39] For more on FRS read Ballard & Howell (1998) First Run Studies & Howell & Ballard (1999) Design of Construction Operations LCI White Paper-4 (both downloaded from http://www.leanconstruction.org in 2003)

[40] see e.g. Nguyen Lostuvali Tommelein (2010) A3- Decision Analysis Using Virtual First-Run Study of a Viscous Damping Wall System. *Lean Construction Journal*

[41] reported in Koerckel A (2005) Moving beyond the Network of Commitments: CTRL – A case study in Lean Construction LCI Annual Congress, San Francisco http://www.leanconstruction.org (24 jun 2006)

Constructing Excellence New Zealand notes: … many projects [using LPS] have reported a range of benefits, not least the Manukau Harbour Crossing project completing 7 months ahead of schedule & one large contractor reporting a 30% increase in profitability since using Last Planner.

http://www.constructing.co.nz/Services/Constructing-Excellence/Last-Planner 29sep12

Figure 13: collaboratively planning the production of detail design drawings for a factory (photo: Albert Kahn Family of Companies)

Last Planner in design and pre-construction

In the design process there are more uncertainties, and design as a process is more iterative, than in on-site assembly so planning horizons are shorter than in construction. Before and during conceptual design they are very short and as the design progresses they tend to extend so that time horizons during the production of construction drawings are much closer to those seen in the planning and management of construction production.[42]

LPS is helping constructors manage their tendering processes in Design-Bid-Build procurement as well as to manage design production in PFI/PPP procurement.

Is Last Planner right for our project?

Its not for us … our projects are too small/big/simple/complex/low margin. I hear many reasons for not using LPS:

- **we only do small projects** – LPS was deigned to be relevant to projects with more than three suppliers and more than 8 weeks long. (I know of one complex *15 minute* project where it was used!)
- **our projects are too big/complex** – LPS was used on the largest project in Europe – the £4.5bn (US$7bn) Heathrow Terminal 5

[42] For a useful introduction to the adaptation of LPS to design read http://bit.ly/RbPD-LPC

- **the subbies will never agree** – yet they do *and* they generally prefer this way once they know it; some subbies use it even when the lead constructor isn't.
- **its going to cost more** – while you are learning perhaps, as is often the case when learning something new. Yet many pilot projects have realised significant savings.
- **we are rewarded for *firefighting*[43] and LPS reduces the number of fires to be fought** – I've no answer to that, just a question: *do you really want to continue working that way?*

LPS is part of a new business strategy[44] and a much more rigorous planning and commitment management process than is generally used in construction. Planning reduces problems on site and in the design office so that more of your energy goes into creating value for your customer.

We do it already

Many project managers do some or all of these things already, to a degree. Last Planner creates a more formal and rigorous discipline. It consists of a system of inter-related elements and it is only when *the full set* is systematically implemented over time by the whole project team that the major benefits will be appreciated. Greatest benefit is likely when an integrated team use Last Planner consistently over a number of projects.

Signals that you are not yet *doing it* include:
- *work done out of sequence*
- *sub-contractors with no sense of ownership of the programme*
- *operatives with no idea of what work there is for them the day after tomorrow.*
- *projects dominated by fire-fighting*
- *work pushed into production by the programme*

Be aware

- If members of your supply chain are using LPS and you are not, be careful. If you make a claim against them they may have superior information.
- If Last Planner is not carried out in a systematic manner, it will fail. Complete the conversations in full week-by-week.
- Part of the job of project managers is to police the Last Planner System effectively. There may still be a need for sanctions against poorly performing companies and teams and companies that don't fully engage with LPS. Because of the inter-dependencies, getting ahead of the agreed program can be just as much of a problem as falling behind.
- Last Planner will highlight teams that don't perform well. If project managers don't use the data to help those teams improve their performance, Last Planner may be discredited and the benefits lost.
- Last Planner can show up poor project managers.
- Last Planner is part of a new way of thinking about the management of production in a construction environment (see p.5). It is difficult, but not impossible, to manage projects using LPS in a context where senior managers use old modes of thinking.

[43] Those of you that watch Reinartsen's video http://vimeo.com/45947817 will understand that this metaphor is based on an outmoded view of fire fighting.

[44] See page 5 Last Planner is part of a new business strategy for construction for more about this.

LPS works best when new ways of thinking come from the very top of the organisations involved.

- The system only works effectively in the context of whole system thinking and a learning culture. *Command and Control* thinking or a blame culture will quickly destroy any benefits.

There *is* more to lean construction than Last Planner

Much more. LPS is just a starting point, a way to stabilise your processes so that you can see the problems more clearly, define those problems, create good metrics, learn from studying what happens and then design yet more improvements to your processes.

Using Last Planner to kick-off a corporate lean transformation

In a recent book review[45] Greg Howell noted that a lean transformation in construction involves at least two significant shifts:

- improving systems and
- encouraging learning as a basis for further improvement.

In this approach successful transformations begin with action and study using Last Planner. Concepts and practices in action are tested in one or more pilot projects, and a study group, usually made up of a diagonal slice of company leadership and participants from the pilots, learn more about lean and how it has transformed other organizations.

Figure 14 illustrates this two-path approach. Efforts to improve systems (dotted line C) begin with the implementation of LPS. Pilot projects reveal opportunities hidden in current practice and bring sufficient stability to make visible the deeper issues that must be faced in any larger initiative. Study (line B) combined with simultaneous engagement with the real world opens new possibilities. Strategy and new capability develop together. In Howell's experience, trying to drive directly to lean (line A) doesn't work.

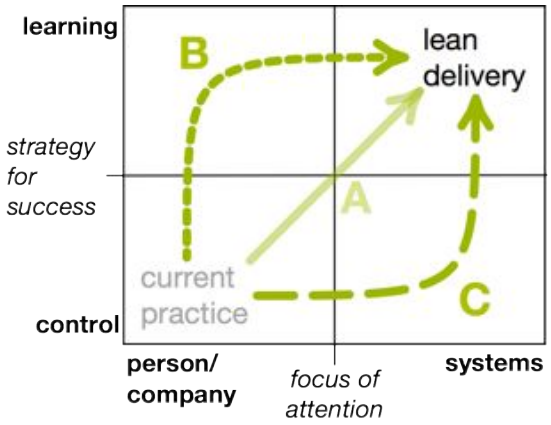

Figure 14: Paths to implementation (Mossman after Howell)

This is markedly different from the predominant approach in traditional practice of motivating and training individuals and subbies coupled with control in an attempt to improve project performance.

[45] Howell, Greg (2011) Book Review: ***Build Lean: Transforming construction using Lean Thinking*** by Adrian Terry & Stuart Smith. Lean Construction Journal pp 3-8 http://www.leanconstruction.org/lcj/2011/LCJ_11_011.pdf

How can my team and I learn Last Planner?

Last planner requires skills and judgement. Judgement [for example: how long will my team take to do that work in these conditions?] comes with practice. So do skills.

Managing a Last Planner process requires inter-personal, group, facilitative and developmental skills and skills require practice. It seems to me that the best place to learn those skills is on the job with a good coach to support you.

There are a number of learning pathways for those who want to implement LPS including:

- A generic introductory workshop with a good LPS simulation backed up by coaching.
- An Action Learning development program based on a live project.

Learning LPS is a very challenging task. A handful of individuals have successfully implemented Last Planner after attending a simple introductory workshop or by reading (you will need to read a lot more than this document). Workshops don't cover everything and are rarely geared to developing skills. There is nothing written covering the whole system or the skills needed.

Integrated action learning on a project supported with just-in-time instruction and coaching gets Last Planner up and running in the project team without interrupting the flow of work. If you choose this method read http://bit.ly/rn0GKX, ask around and/or consult the LCI website www.leanconstruction.org before you select your coach.

Greg Howell cautions those involved in their first implementation. LPS will provide you with data about your project management systems that makes uncomfortable reading. **Don't panic**. Pilot LPS in your organisation carefully with project teams that welcome a more collaborative approach. Gather data systematically and make improvements then invite others to inspect what the pilot project or projects have done and learn from them.

Most companies that successfully implement LPS have done so incrementally as a strategic learning and improvement intervention. Many companies that are on a lean journey have started by introducing LPS to help stabilise their systems and to allow their project managers to see and understand what is going on.

Villego: a Last Planner simulation

Colleagues in the Netherlands developed an excellent Last Planner simulation called *Villego*® [pronounced *vill-egg-o*]. As part of a day-long workshop that includes LCI's *Parade of Trades*[46], Villego helps develop awareness and some experience of the five main LPS conversations which can then be followed up with coaching on the project.

My first experience of this simulation was in collaborative programming sessions a week after the training when I noticed a much greater willingness among trade foremen to engage in the process than I had experienced previously. I translated it into English and now use the simulation when introducing Last Planner to a new project team. A French client is insisting that it is used to introduce LPS on all its projects.

The simulation is now available in English, French, Spanish, German, Brazilian/Portuguese. Other languages are possible[47].

[46] For details see http://www.leanconstruction.org/training/lean-simulation-games/

[47] More information at http://www.villego.com. *Note:* I have a small financial interest in Villego.

Summary

There are many reasons why organisations and projects adopt Last Planner:

- To identify & address potential problems before they become obstacles in the project
- To help improve the overall production process & flow on small and large projects
- To reduce the incidence of bad news & to get what bad news there is early
- To create projects that are a reliable customer for just-in-time deliveries
- To develop supervisory skills and reduce the load on management
- To mobilise social pressure through commitment management
- To create a more predictable & reliable production program
- To deliver projects more safely, faster & at reduced cost
- To become the customer of choice in a tight market
- To stabilise projects & support other lean actions
- To improve construction logistics on projects
- To improve predictions of labour required
- To reduce the risk of catastrophic loss
- To reduce the cost of public projects
- To complete projects on schedule
- To reduce fire-fighting & stress

There are 5 + 1 key conversations in the Last Planner System, the top five "eggs" + FRS in Figure 15:

Figure 15: the 5 + 1 key conversations – another view (Mossman after LCI)

Last Planner enables a project team to focus on keeping all seven critical streams moving so that they come together at the workface where materials are transformed and value is created. It creates a structured series of conversations that enable projects to progress and provides the basis for relationships within the team so that when *things go wrong* it is easier for the team to pull together and find ways to move beyond the crisis. By making it possible for team members to share bad news early some crises can be avoided and others mitigated.

Each element of the Last Planner System brings its own benefits.
Together they help deliver quality projects on-time *and* within budget

Comments about previous versions of this note:

this may be the best introduction to Last Planner® System ever done. I'll make sure it is well read. Hal Macomber, Lean Project Consulting on *Linkedin* March 2012

Alan, …. You've developed a very clear and concise paper that does a wonderful job presenting [LPS] - the why, how and who of what LPS is all about. Thank you for posting this. It should be required reading for all who are new to Lean and LPS and want to learn why they should start LPS and what it is all about. Mike Kotubey, President, MMC Contractors on Linkedin, March 2012

I'm asked frequently "what can I read up on to better understand this lean stuff?". Alan's paper … is an outstanding summary for us to recommend. John Strickland, CH2MHill on *Linkedin* June 2012

… this is a superb resource. Prof Eric Johansen, University Northumbria on Linkedin, Sept 2012

NOTE: **There is much more to Last Planner than is possible to cover here.**
There is much more to lean construction than Last Planner.

Dr Glenn Ballard & Greg Howell developed LPS. Last Planner is a registered trademark of Lean Construction Institute (LCI) http://www.leanconstruction.org. LCI, Ballard & Howell are happy for organisations to use LPS to support project delivery and would appreciate it if they joined LCI. For more info see "*The Last Planner System*" page on the LCI website. **Trainers and consultants are asked to read the final paragraph of** http://www.leanconstruction.org/lastplanner.htm **if they want to teach LPS to people in organisations other than their own.**

For a Last Planner discussion group on the web
join the LPS User group on LinkedIn http://linkd.in/lastplanner
[note: you will first need to join the Lean Construction Network (LCN) http://linkd.in/LCNetwork as the LPS User group is a sub-group of LCN]

Links to and notices of updates to this note will be posted in the **LPS User Group**.

Joe Dager of **Business901.com** interviewed Alan about this note. Listen to it at http://bit.ly/lps-podcast
This note is adopted as a course document by **Centre for Lean Projects, Nottingham Trent University**

Alan Mossman is a lean design and lean construction consultant, trainer and author. He trained as an architect and worked for many years in management and organisation development. He only returned to construction in 2000 building on his knowledge and understanding of collaboration, systems thinking, quality and lean. An accredited UK based Last Planner trainer, he has coached teams implementing Lean and Last Planner for a wide range of clients in Europe, Africa and Australasia. From 2004 to 2010 Alan was a founding Director of The Lean Construction Institute UK. He helped set up the *Lean Construction Journal* www.leanconstructionjournal.org and was co-editor from 2003 to 2012. A member of the Lean Construction Institute, he has supported the formation of Communities of Practice in a number of European countries and moderates the Lean Construction Network http://linkd.in/LCNetwork, Lean Design Forum http://linkd.in/leandesign & Last Planner User groups on Linkedin. Alan is a member of the LCI (US) Education Committee developing training materials and guidance for those involved in teaching LPS.

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For info about where to find the global lean construction community on the web go to http://bit.ly/LCweb-global