The Lean Transformation: A Framework for Successful Implementation of the Last Planner^{TM} System in Construction

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The Last Planner^{TM} system for production planning and control has been successfully implemented on construction projects to increase the reliability of planning, increase production performance, and improve workflow in design and construction operations. However, research has shown that many organizations face significant hurdles when implementing the new system. The hurdles are multifaceted and tied to organizational, cultural, and technical factors. This paper reports implementation challenges and failures experienced on three construction projects. Using action-based research the paper presents a framework for implementing the Last Planner^{TM} system on construction projects drawing on previous research in change management and lean implementation. The implementation guidelines suggested in this paper are further tested on an ongoing construction project as an experiment in change management.

Key Words: Lean Construction, The Last Planner System, Production Planning and Control, and Change Management.

Introduction

Architecture, Engineering, and Construction (AEC) processes are inherently variable and uncertain. Variability undermines project performance and disrupts workflow leading to detrimental project consequences on cost, duration, quality, flow, sequencing, etc. (Hamzeh et al., 2007; Hopp & Spearman, 2008). Organizations, under norms of rationality, strive to maintain consistency in production flow and shield production from uncertainty in business processes and in their environment (Thompson, 1967).

Accordingly, these companies employ production planning and control methods to manage uncertainty and reduce variations in production systems. A production system can be defined as a collection of people and resources (e.g. machinery, equipment, information) arranged to design and make a good or service of value to customers (Ballard et al., 2007). An example of a production planning and control system is the Last Planner^{TM} system (LPS) which has been successfully implemented on construction projects to increase the reliability of planning, increase production performance, and improve workflow in design and construction operations (Ballard & Howell, 2004).

The Last Planner^{TM} system embodies the principles and human values of lean thinking. Lean is a business philosophy and a system for organizing and managing corporate processes including product development, design, production, operations, supply chain, and customer relationships to increase value and minimize waste. Lean is a perpetual quest for perfection pertinent to organizational purpose, business processes, and developing people (Liker, 2004; Womack & Jones, 2003).

Despite the advantages of the LPS, research has shown that many organizations face significant hurdles when implementing the new system (Hamzeh, 2009). An implementation framework may help such organizations develop a better implementation plan, foresee implementation hurdles, and invest resources into the change process.

There is a common misconception that LPS is a stand-alone tool that can be picked up and put into operation as needed. However when embedded in a lean culture, the LPS offers a framework for enabling a much more radical transformation in the way an organization functions, and communicates with its partners. The Last Planner^{TM} system offers a systematic process for construction planning, given that the organizations involved have embraced a "lean" philosophy. Without requisite commitment, LPS may be viewed by all those employees upon whom its success is determined, as another empty management initiative that will soon pass. Successful implementation of LPS is contingent upon a deeper organizational shift in mindset, cultural change, and a willingness to depart from the status-quo.

This paper reports implementation challenges and failures experienced on construction projects when implementing lean and lean tools such as LPS. Organizations planning to implement the LPS on their construction projects can benefit from the framework presented in this paper. The guidelines suggested in this paper will be further tested on an ongoing construction project where an experiment in change management involving the implementation of LPS is taking place.

The Last Planner ™ System

The Last Planner™ system was developed by Glenn Ballard and Greg Howell as a production planning and control system to assist in smoothing variations in construction work flow, developing planning foresight, and reducing uncertainty in construction operations. The system originally tackled variations in workflow at the weekly work plan level but soon expanded to cover the full planning and schedule development process from master scheduling to phase scheduling through lookahead planning and weekly work planning.

Percent plan complete (PPC) is a metric used to track the performance of reliable promising at the weekly work plan level by measuring the percentage of tasks completed relative to those planned. It thus helps assess the reliability of work plans and initiates preparations to perform work as planned. Previous research has found that implementing the Last Planner™ system has a positive impact on workflow and labor productivity. Secondary impacts include possible improvements in work safety and quality (Ballard and Howell, 1998; Ballard et al., 2007; Liu and Ballard, 2008).

As a lean tool, LPS advocates: (1) planning in greater detail as time gets closer to executing the work, (2) developing the work plan with those who are going to perform the work, (3) Identifying and removing work constraints ahead of time as a team to make work ready and increase reliability of work plans (4) making reliable promises and driving work execution based on coordination and active negotiation with trade partners and project participants, and (5) learning from planning failures by finding the root causes and taking preventive actions (Ballard, 2000; Ballard et al., 2007). Figure 1 shows the LPS comprising four levels of planning processes with different chronological spans: master scheduling, phase scheduling, lookahead planning, and commitment planning.

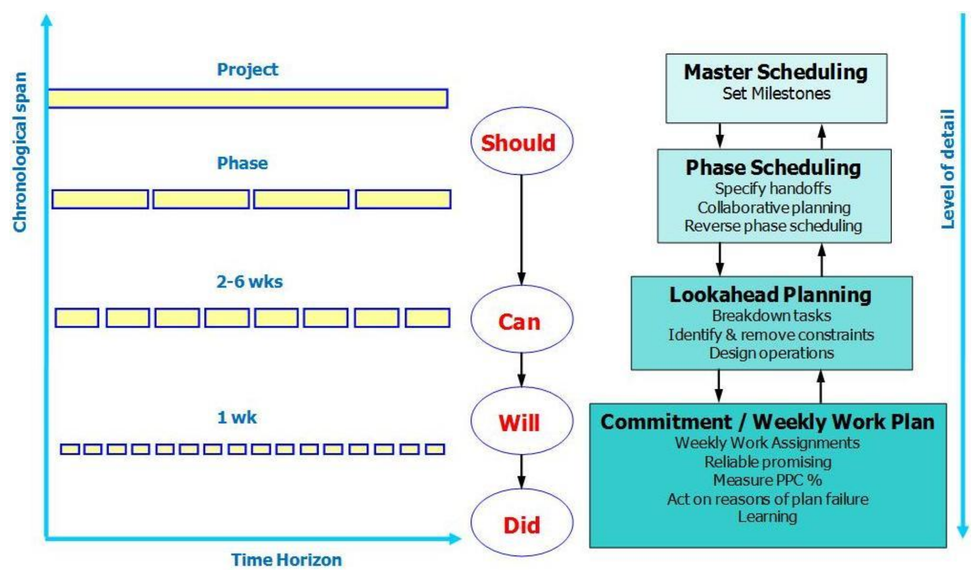

Figure 1: Planning stages/levels in the Last Planner ™ system (Adjusted from Ballard, 2000).

1- The *master schedule* is the output of front-end planning describing work to be carried out over the entire duration of a project. It identifies major milestone dates and incorporates critical path method (CPM) logic to determine overall project duration (Tommelein & Ballard, 1997).

2- *Phase scheduling* generates a detailed schedule covering each project phase such as foundations, structural frame, and finishing. In a collaborative planning setup, the phase or pull schedule employs reverse phase scheduling and identifies handoffs between the various specialty organizations to find the best way to meet milestones stated in the master schedule (Ballard & Howell, 2004).

3- *Lookahead planning* signifies the first step of production planning with a time frame usually spanning between two to six weeks. At this stage, activities are broken down into the level of processes/operations, constraints are identified, responsibilities are assigned, and assignments are made ready (Ballard, 1997; Hamzeh et al., 2008).

4- *Commitment planning* represents the most detailed plan in the system showing interdependence between the work of various specialist organizations. It directly drives the production process. At the end of each plan period, assignments are reviewed to measure the reliability of planning and the production system. Analyzing reasons for plan failures and acting on these reasons is used as the basis of learning and continuous improvement (Ballard, 2000).

However, a question remains unanswered: how can the AEC industry successfully implement LPS and incorporate it into day-to-day production planning and control? This paper explores the current implementation of the Last Planner™ system in construction, reports implementation issues, highlights concerns with the current implementation, and lays out a recommended implementation framework for further testing and improvement.

Method

This paper presents results from previous research highlighting industry challenges related to implementing LPS. It also reports research results from three construction project case-studies implementing LPS. The case studies include a health care project, a research facility, and an administration building. The first project has been employing LPS for two years during the design phase and has invested heavily in employee training in different aspects of lean construction. The owner is a strong advocate of lean and integrated project delivery systems. The first author performed research on this project for 18 months assisting the project team in developing a standardized planning process and implementing LPS.

The second project implemented LPS in a hurry at the beginning of the construction phase in response to the owner's request. The first author was asked to audit the implementation process for 8 months, assist in employee training, and provide improvement suggestions.

The third project is in the nearing completion of the construction stage. The authors were asked to assist the construction project initiate a second attempt at implementing LPS after a previous failed attempt. The authors have been assisting the project team develop the planning process, train project parties, and develop a handbook for implementing the LPS by construction professionals.

Research was performed in an "action research" environment where the authors joined each project as a team member or insider (Coghlan, 2001), gathered empirical data, analyzed and evaluated the data with the team, searched for patterns or variations, developed various improvement alternatives, and tested these improvements empirically. The research process follows an inductive reasoning scheme adjusted to the specific situation. Accordingly, the research process comprised multiple steps of evaluating and assessing the current practice, developing guidelines for improvements, and testing these suggested guidelines.

Implementation Challenges

Implementing LPS and lean thinking should be viewed as a first step towards creating a higher-performing, more competitive lean enterprise. The critical distinction to be made is that LPS is only one tool to facilitate a new more effective way of performing production planning. And in order for the system to translate into measurable performance, the implementing organization must be committed to learning, changing, and focusing on people and philosophy and not only focusing on tools and methods (Liker, 2004).

The implementation process usually faces various obstacles common to organizational change. Researchers in the field of change management and lean have reported attempts of many organizations to implement lean practices. However, most companies either failed or only partially achieved lean production in its true form (Liker, 2004; Kotter, 1996; Ballard et al., 2007; Hamzeh, 2009).

The core philosophy of lean production revolves around teamwork and continuous improvement. Many organizations fail to operate with much of either. This is often the case for the construction industry, which involves multiple self-interested parties, with little motivation to improve. In his book the *Toyota Way*, a leading source for understanding lean production, the author emphasizes that the secret of the Toyota Way is that it creates bonds among individuals and partners so that they can work collaboratively toward a common goal. This is in contrast to most companies which can be seen as made up of individuals who are disorganized, do not know each other, and do not trust anybody. "*The question is how to get to there from here*."(Liker, 2004)

Lean thinking requires employees to change the way they view and execute their work (Liker, 2004). This often results in some loss of independence as the focus shifts from the individual tasks to the larger integrated team goals. Changing the status-quo can not only be seen as cumbersome, but even threatening to people who have operated relatively successfully for years within a somewhat dysfunctional system. The key is preparing them to be willing to learn, to work better, and strive for continuous improvement. Since the success of LPS is contingent upon active meaningful participation by all parties involved, it is critical that proper consideration is given to the scope and scale of the required transformation. Implementing LPS is not simply applying a tool to a project, but changing the way people think, work, and execute tasks. In moving forward with a new opportunity to implement LPS, the question must be asked: *how to implement the process better?* The root of failed implementations of LPS is not that the new system is too complicated; the core problem lies in the lack of implementation planning (just like poor planning on the projects that LPS is indented to aid), and the failure to realize that LPS requires fundamental organizational change which is always incredibly difficult to achieve, especially in the long-term.

Ballard et al. (2007) studied the implementation of LPS on many construction projects and reported various implementation obstacles. Projects in the study experienced strong resistance to change on the part of project team and members within the organization. In some cases, implementation challenges were the result of a lack of leadership during the process. In other cases, there was a lack of commitment by upper management or top down mandates without active support.

Hamzeh (2009) highlighted two sets of factors, local and general, impacting the implementation of new methods, in general, and the LPS, in particular. Local factors are potential challenges attributed to project circumstances and the team including: fairly new experience in lean methods, traditional project management methods, novelty of LPS to team members, fragmented leadership, and team chemistry. General factors impacting the implementation of a new process include: human capital, organizational inertia, resistance to change, technological barriers, and climate. Human capital is associated with human skills and experience required on a project. It addresses the need to continuously develop new skills as new technologies, processes, and policies are implemented. Inertia increases the resistance to change in organizations. Inertia is attributed to both internal structural arrangement and external environment. Internal factors include: (1) investments that are sunk in plant, equipment, and personnel, (2) incomplete information reaching decision makers, (3) internal political constraints such as fear that change may disrupt internal political equilibrium, and (4) constraints generated by an organization's history such as standard procedures and normative agreements. External factors are equally significant and include: (1) barriers to entry and exit from markets, (2) incomplete information about external environment (demands, threats, and opportunities), (3) legitimacy constraints arising when a new norm challenges the established norms, and (4) collective rationality problems (e.g. a strategy found rational for a certain decision maker may not necessarily be rational for a large number of decision makers) (Hannan & Freeman, 1977).

Resistance to change, which is closely related to inertia, is high in an organization when individuals believe that they will do tomorrow the same thing they are doing today (Zammuto & Krackower, 1991). Technological barriers may have a substantial impact on the success of a novel process. The apparent influences include: lack of experience with new technologies, the instability and breakdowns in using these technologies, incompatibility with current systems, and investment in the form of time, cost, quality of processes, and human capital. Climate is an organizational characteristic that employees live through and experience while working for an organization. The climate shapes their behavior, performance, and the way they perceive the organization. Climate thus influences an organization's ability to change and the change process. Two overlapping types of climate considered in the literature are psychological and organizational. Several dimensions contribute to the perception of psychological climate in an organization such as: autonomy, cohesion, trust, pressure, support, recognition, fairness, and innovation (Koys & Decotiis, 1991).

Implementing the Last Planner ™ System: Case Studies

Case Study 1

The first case study is a proposed 555-bed hospital and medical campus in San Francisco, California. The $1.7 billion project includes a 16-story hospital including two below grade floors. This is a unique case study since the project is: (1) implementing integrated project delivery (IPD) and integrated form of agreement (IFOA), (2) engaging project partners who are interested in experimenting with lean practices, (3) applying LPS for production control, (4) utilizing target value design (TVD) to steer design towards meeting the owner's value proposition, (5) and using building information modeling (BIM) extensively.

A transition team was selected on this project and entrusted with developing a new planning process, identifying training needs, developing training programs, and studying deployment models. The team involved cluster leaders and managers from the architect/engineer and the construction manager / general contractor. The transition team composed a training program to teach various aspects of lean theory, methods, and tools. This program included four main sections: (1) introduction to lean history, concepts, and methods, (2) basic training modules, (3) lean project delivery, and (4) lean management. Coaches from the project were later assigned to produce and teach the basic training. These modules include: (1) value stream mapping, (2) 5 S (sort, set in-order, shine, standardize, sustain), (3) reliable promising, (4) learning from experiments, (5) learning from breakdowns, (6) Choosing by Advantages, and (7) A3 reports.

The collaborative implementation process on the project is the foundation for the implementation framework presented in this paper. By establishing transition teams the project management team was able to effectively generate buy-in for the process and relate the value of LPS. The training program was instrumental in aligning project team members around lean goals and developing a collaborative planning environment. Despite the success of these efforts, the project team faced many common barriers to change which limit the effectiveness of LPS. These include organizational inertia, human capital constraints, technological barriers and general resistance to change (Hamzeh, 2009). These factors are not unique to LPS implementation and will likely be obstacles to any change effort. Establishing a framework for LPS implementation will aid project teams attempting the change effort.

Case Study 2

The second case study is a 232,000 square foot research center in San Francisco, California. The five story building is scheduled to open in 2011 with an estimated cost of $181 Million (Rudolph & Sletten, 2009). Although the project's contractual structure is bound by design-bid-build agreements, the owner has been creative in looking for ways to enhance collaboration, information flow, and management processes on the project. Accordingly, the owner advocated the applications of several lean methods including LPS for production planning and control. To insure timely completion of the project, the owner offered a monetary incentive plan for the general contractor and major subcontractors.

The General Contractor (GC) started applying LPS at the beginning of the construction phase involving all subcontractors on the project. Because most of the project parties were not conversant in LPS, the GC organized training sessions to familiarize the team with lean principles and production planning using LPS. Spurred by the owner's interest in lean methods, the GC took on the challenge of implementing a new planning process and involving all project parties in phase / pull planning sessions, the open use of collaborative scheduling tool called TOKMO, and in weekly work planning meetings.

Although the inexperience of most project parties in lean methods and LPS was an impediment to collaborative planning, the general contractor took the lead in changing the traditional methods of project management. These traditional methods relied heavily on contractual structure and functional silos inhibiting coordination and collaboration. The training sessions and the general contractor's conduct during collaborative planning meetings helped send the right message and bring the rest of the team on board.

In addition to challenges related to implementing a new planning process, introducing a new scheduling tool and resistance to change created additional complications. To mitigate this challenge, the general contractor had to work meticulously with TOKMO developers to customize the software to match user expectations and project needs.

Case Study 3

The third case study is a 218,000 square foot administration building in Denver, Colorado. The $64 million dollar design-build project is scheduled for completion in June 2010. The GC attempted to implement LPS at an earlier stage of the project as a test case for the system. The implementation team fell short in gaining the support and buy-in of leaders in the field. The implementation team reported common implementation barriers such as: resistance to change, lack of leadership, limited buy in from superintends and project managers. As a result the system was abandoned after only a few months and deemed ineffective by many involved.

Following the unsuccessful initial implementation of LPS, the project team is in the process of using the implementation framework presented in this paper (next section) for a second attempt. The process is currently lead by the GC's superintendent involving all last planners (superintendents, foremen, project engineers) from various disciplines and subcontractors. The team can use more support from upper management to implement LPS and can benefit from further training on its use. Implementing LPS towards the end of the project might reduce the chances of success.

However, this case study will be beneficial in calibrating the implementation process. Feedback from the implementation team and lessons learned on this project will help assess implementation barriers, identify possible enabling methods, and develop possible adjustments to the process steps.

Suggested Framework for Implementing the Last Planner™ System

The Last Planner™ system challenges the old practices of developing schedules and pushing them from top management down to frontline people to execute. It advocates collaborative planning, performing collaborative constraint analysis, and learning from plan failures. The Last Planner™ system is not only a system for production planning and control but also an enabler for social exchange on construction projects. It institutionalizes coordination and communication by incorporating them into everyday activities and into a managerial structure for project planning and control, team building, and continuous improvement.

Researchers in the field of lean construction identify common implementation barriers to lean construction and the LPS including: lack of leadership, resistance to change, and poor implementation planning. However, as the case studies indicate, little attention seems to be paid to developing a thoughtful plan for integrating LPS into a project. There is commonly an effort to train people in the system as a tool, but implementation plans seem to fall short in regard to philosophical and social considerations.

Applying LPS on a project is a lengthy process and requires strong commitment from the owner, top management, and all others involved. The framework presented in this paper is a suggested method that should be tailored to project circumstances and conditions. It draws on experience from previous implementations and research in change management (Kotter, 1996; Ballard et al., 2007; Hamzeh, 2009). It is recommended to adopt the following steps when implementing the LPS:

- **Harness the support of the project's owner and your organization's top management**. Change is next to impossible without strong commitment from the head of each organization, the division managers, and even middle level managers.

- **Establish a cross-functional nucleus team and develop goals to accomplish**. The nucleus team should be entrusted with the implementation process before it starts and during the implementation life. Thus the team should develop goals, identify training needs, recognize implementation hurdles, develop implementation steps, and perform necessary adjustments. The team should involve front line managers and last planners, such as superintendents and foremen. The team should also put the opinion leaders in charge and work on involving as many individuals in the organization as possible. Without the momentum of many individuals, little meaningful change will occur. Team incentives for reaching the stated goals may also be formulated by the team after securing buy-in from top management.

- **Evaluate and map the current planning process.** Use process mapping to highlight both deficiencies and valuable steps in the current process.

- **Develop a go-to process**. Customize LPS to the current project/organization building on the existing valuable steps and eliminating wasteful steps. The nucleus team embeds into the go-to process goals and vision of the future.

- **Identify challenges and opportunities for implementing the new process**. In developing the vision for the future the nucleus team identifies possible challenges and communicates them to the organization. The team also highlights the opportunities and ways to seize them.

- **Develop and perform a train-the-trainer program**. The nucleus team indentifies training needs, develops a training program, and trains the future trainers who are mostly last planners (superintendents and foremen), and communicate the goals to the organization. People won't help and the change process unless they believe it is both useful and possible.

- **Create a positive team experience during initial implementation and regularly evaluate achievements**. People need to see compelling evidence of success during initial implementation stages so that they can build on these successes. However, improvement should not stop when reaching interim goals. Therefore, the team needs to introduce regular incremental adjustments and improvements to the process in order to meet the end goals. The new process should become part of standardized project/organizational procedures. However, these standardized procedures are there for people to improve on.

Identifying and managing these recurring issues in advance should lead to a more successful and less painful transition for a project team. This framework realizes the significant organizational change is required to successfully implement LPS. The process steps aim at achieving buy-in from managers and workers of all project parties and ensuring a smooth transition into the new production planning and control system.

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