LEVERAGING SOFTWARE FOR LEARNING-IN-ACTION USING COMMITMENT-BASED PLANNING

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ABSTRACT

The Last Planner® System (LPS) allows teams and individuals to learn and improve their use of language to plan and coordinate production every day on their construction project. This paper will investigates how LPS, when consistently applied, reinforces W. Edwards Deming's Plan-Do-Study-Act. LPS also promotes and requires effective use of key elements of reliable promising and "grammar of action" as put forth by Fernando Flores. These two theories will be explained along with others throughout this paper as a framework and management system for project teams operating in a production setting.

The second half of the paper discusses how technology has been leveraged to achieve high-functioning LPS performance. A cloud-based Last Planner software application exists that helps project teams create learning through the ability to establish reliable promises. By applying Deming's PDSA method for continuous improvement, this collaborative software creates real-time feedback and learning for teams. The commitment-based actions and workflow supported by the software help teams actively engage and appreciate Fernando Flores' language-action perspective. This paper will demonstrate through discussion and examples of three case studies of project teams who have successfully used this production-planning tool to create a network of commitments that are grounded in a learning-in-action approach.

KEYWORDS

Last Planner software, reliable promising, Deming PDSA, language-action perspective

INTRODUCTION

Technology and software if used in the correct context and setting can be leveraged by teams to become more productive and higher performing. More specifically, this paper will show how the theories of Ballard's Last Planner® System (LPS), Deming's Cycle of continuous improvement, and Flores' Language-Action Perspective are connected to support a conversation that is centered around managing commitments and learning through action.

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From the foundational principles theorized above, a cloud-based Last Planner software application was conceived and developed, and these theories were put into practice on project teams. These project teams have successfully used this cloud-based Last Planner software to manage project commitments and create an environment for learning-in-action. Three case studies outline their approach and success on the projects. This paper extends theory based on practice, as opposed to academic research. The "laboratory" was the location where PDSA, language-action, and software tools were taught and effectively used. It expands upon how a commercially available product is currently being used on projects throughout the United States.

THE LAST PLANNER SYSTEM PUTS THE DEMING CYCLE INTO ACTION

W. Edwards Deming is generally credited with developing the Plan-Do-Check-Act (P-D-C-A) cycle, however he gives attribution to Walter A. Shewhart for perceiving the cycle in 1939 (Deming 1986) and always referred to it as the Shewhart Cycle rather than the Deming Cycle. Originally he viewed this cycle as a model to improve products for the market place: Step 1 – Design, Step 2 – Produce, Step 3 – Sell, Step 4 – Redesign through marketing research (Moen 2009). The "Deming wheel," as the Japanese called it, was modified by them into the now familiar Plan-Do-Check-Act (PDCA) cycle (Moen 2009). Deming's last version of the cycle was described by him as a flow diagram for learning and improvement of products or processes (Deming 1994). Deming changed the third step "Check" to "Study" because he said that the "English" word "check" means "to hold back." (Moen 2009).

It is important to understand that the planning step consists of two cognitive tasks. First, it must be clear as to the desired results or outcomes of the process. Only then should one develop a plan in an attempt to obtain these outcomes. Realization of the desired results establishes the "current best way" of planning and executing that process with our current understanding of it. We know that there is a better way and we will seek to discover it in future iterations. Failure to achieve the desired outcomes indicates a lack of complete understanding of the process and guides us in adjusting the plan (Figure 1).

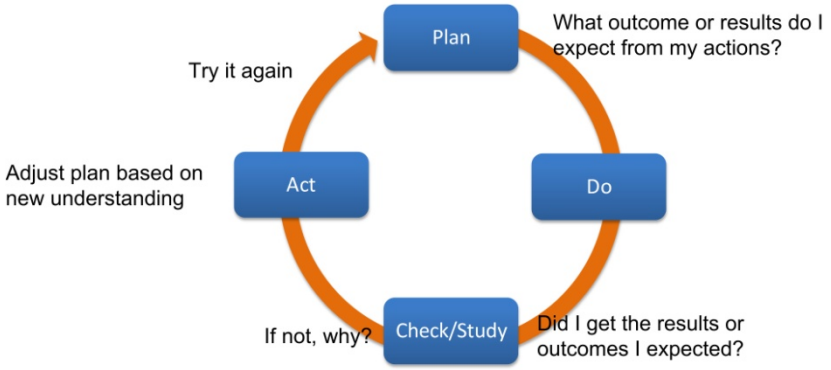

Figure 1: The PDCA Cycle for continuous improvement. (Lean Project Consulting, unpublished internal document, November 2012).

The Last Planner System (Ballard 2000) provides a framework for creating and maintaining reliable workflow on projects. In operation it is a system for planning and executing production work on projects. The weekly production cycle, as depicted in Figure 2, is the embodiment of the PDSA cycle. The Make-Ready Planning process has as its desired outcome constraint-free tasks ready to be placed on the weekly workplan as specified in the phase plan. The project team continuously improves the Make-Ready Planning process by investigating and learning from those instances in which constraints haven't been removed in time. This new understanding is then reflected in a change to the process. Similarly, the PDSA cycle underlies the weekly production process. Before the week begins, the project team determines where they need to be by the end of the plan week and then details, day-by-day, how they are going to get there. Each day during the execution of the plan, the team reflects back on the day's results to compare it to what was planned. The team seeks to learn from variances from planned daily outcomes and adjusts their plan going forward. Members of a disciplined project team continuously improve their planning ability resulting in greater predictability of project workflow.

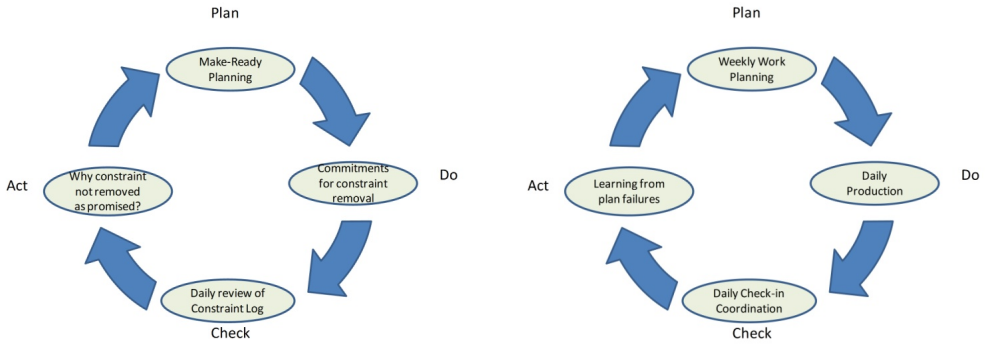

Figure 2: The weekly production cycle - PDSA in action. (Lean Project Consulting, unpublished internal document, March 2014).

GRAMMAR OF ACTION: LANGUAGE-ACTION PERSPECTIVE

We live in a time where it is common to say that we rely on and process information to perform our jobs. We take for granted that there is an "app for that" for seemingly every aspect of our lives. Yet, we fundamentally cope and perform with others through the use of language.

Most of us think of language as descriptive of some aspect of the world. On projects we have "data" that is descriptive of some aspect of the project. However, the world doesn't arise only in descriptive language; the more important aspect is the generative nature of language-action. Language is action with six distinct speech actions which some people call the "grammar of action." Those speech acts are: requests, promises, offers, assessments, assertions and declarations. (Davis, 1998)

Why is this important? "Projects are conceived and completed by autonomous people...acting and learning together through language as they organize the systems

and practices to manage work, information and materiel to serve their needs." (Howell & Macomber, 2006) On Lean projects, Last Planners are the people who do that. They design and manage the network of commitments in conversations for planning, for assessing, for committing action, for making mutual adjustments once physically in action and for learning throughout and post-action. We know those practices as pull planning, make-ready planning, weekly work planning and daily commitment management. All of those practices occur in conversations.

Few systems or practices put our attention on those conversations, let alone directly support being effective in those conversations. We ask for "reliable promises" from various project performers with a background expectation that people can promise reliably and deliver impeccably. Doing so results in value accumulation (flow), far less waste and positive moods among project participants.

"The distinction reliable promise provides a basis for assessing the quality of the promise at the moment of promising. The distinction provides the promissor and others in a promising conversation a shared basis for exploring the promise and for making contingent promises. That we characterize a promise as made reliably doesn't guarantee that the promise will be fulfilled just as promised. There remains the possibility of misunderstanding and that the future is different from what was anticipated." (Macomber, et al 2005).

Declaring complete and the timely acceptance of completed work are two key actions for maintaining flow. Project teams have historically had difficulty getting one let alone both. Not finding out that someone finished early with their work does the project no good. There is no acceptance of the work, nor is there a handoff of that work area from one performer to the next. Flow is broken.

There are three other project events happening in language that often go unnoticed: commitments to ad hoc (emergent) work, the re-promising of work due to missed commitments and any necessary mutual adjustments made by others in a work flow. One can imagine the tedious updating necessary to have the schedule represent the all these everyday changes in a project. People just don't (or won't) do it. Yet, it is easy to imagine missing how one performer's adjustment to another performer's early or late completion can inadvertently throw the work out of sequence. Computer systems and software applications in the field could help with this.

LEVERAGE SOFTWARE TO CREATE HIGH PERFORMING TEAMS

The inspiration for a Last Planner software application came from the desired ability to effectively capture planning conversations and reinforce behaviors and actions of commitment. The collaboration software was designed to support not only those people new to Lean, specifically PDSA and the Last Planner System, but also those planners in the AEC industry who already are implementing some of these tools and techniques. It is meant to apply both methods in practice with a disciplined approach.

By encouraging learning-in-action, foremen and superintendents in the field gain exposure and understanding to the theory without having to read a paper or listen to a presentation on abstract concepts. Individuals and teams are able to take action in the field with real time commitments and metrics being tracked. By building in a lean workflow through its commitment-based approach, teams are guided into a certain behavior when interacting with the software to encourage lean behavior.

Over time the discipline of committing to tasks, marking items complete and incomplete (with a reason for failure), helps foster an environment where reliable promising becomes the way teams interact on a daily basis. The figure below shows the workflow of items that are incorporated into the system.

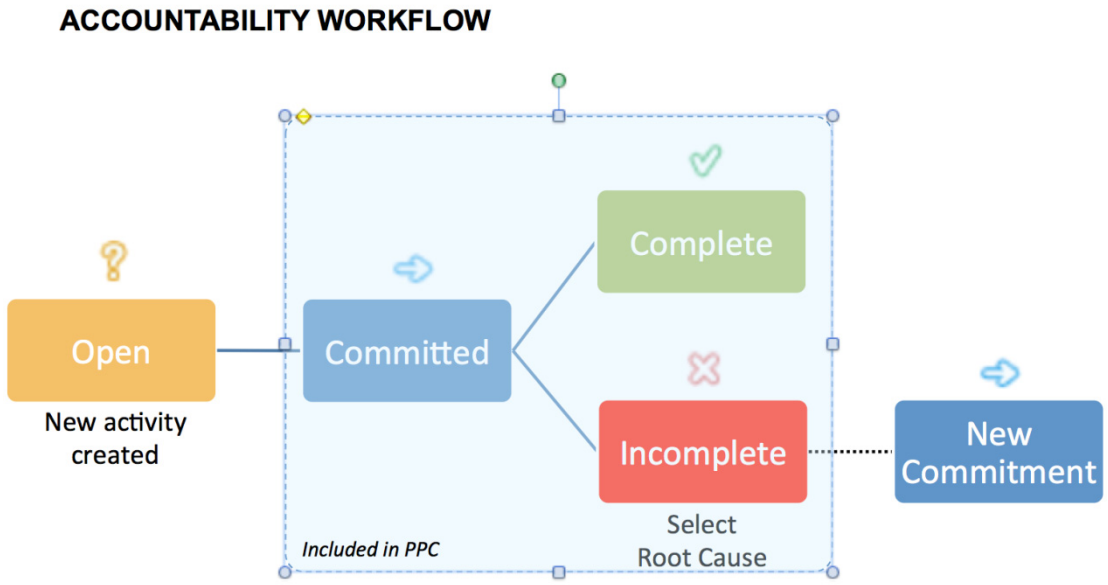

Figure 3: Accountability Workflow. (courtesy of ourPlan, LLC 2014)

COLLABORATIVE SOFTWARE TECHNOLOGY EMERGES

The idea for the cloud-based Last Planner software was conceived within a leading general contractor in the United States. Dean Reed and Atul Khanzode, responsible for Lean Construction and BIM respectively for DPR Construction, had both worked very closely with the project team that had used BIM extensively in combination with the Last Planner System to deliver the PAMF (Palo Alto Medical Foundation) Mountain View Medical Center. Reed acted as the secretary to operate the Excel workbook to save money. This fact put hiring Strategic Project Solutions to facilitate using their powerful web-based software for production planning out of consideration. Only the MEP trade foremen were consistently able to fill out a worksheet designed for them to create their own work plan and bring it to the weekly planning meeting. In spite of this, and the unwillingness of the assistant superintendent tasked with using Last Planner to hold daily check-ins, the planning conversations were much better than in typical "Sub Meetings." Plan Percent Complete was high and the project was completed very successfully in February of 2007 (Khanzode et al 2005).

By August of that year, DPR LPS advocates had developed and begun using special sticky notes they called "I Get | I Give cards." They were divided into halves; the top was for listing what the planner needed from one or more suppliers; the bottom half was where the Last Planners listed what they promised to deliver. While visiting projects near Washington D.C., a DPR Project Executive showed Reed a long whiteboard covered with "planning boards", which were large sheets of laminated

paper printed with columns for each day of the week and rows for trade contractors or work areas. Last Planners had created a work plan by placing standard sticky notes on the days they thought they could complete work. At the very next project he visited that day, Reed witnessed the most interactive planning session he had ever seen. The Project Superintendent was leading a daily planning meeting, placing I Get | I Give "tags," cards filled out by the Last Planners, on the promised completion day on set planning boards identical to those Reed had just seen. The project, a data center build-out in a warehouse shell space, was working two shifts. The Last Planners were making commitments to deliver work with each "tag."

Reed realized immediately that this was the best technique for the Last Planner System. The Weekly Work Plan was being created by all the planners together each day in a give-and-take conversation. Everyone heard constraints being described and plans to remove or work around them. Everyone saw and heard commitments being made by other Last Planners. The only downside Reed saw was that while the Superintendent called attention to which tasks had been completed as promised and the reasons why others hadn't been, it was almost impossible to capture this information so that PPC and failure reasons could be logged and charted for learning over time. After the meeting, the Project Manager noted that the only record of the plan was what was on the board and the photos his Project Engineer took of the planning boards.

Two months later, in June of 2008, Reed and Khanzode began talking about creating a simple and visual Internet based solution with a well-designed interface. Their model was an airline kiosk, simple enough that any one could use it. Last Planners could enter tasks on digital "I Get / I Give" sticky notes at any time from wherever they had access to a computer connected to the Web. Every project would have a computer with a touch-screen for the Last Planners to use. The Last Planners would come together to create the Weekly Work Plan by moving task notes for work to be completed on the "right" days on a digital planning board, thereby committing to accomplish these "ready" tasks. They would do the same with new tasks added in the lookahead window. Last Planners would also identify tasks that could not be started or completed as scheduled because of unresolved constraints.

The "kiosk" software application would make tracking and reporting PPC and reasons for failure to complete tasks much easier. Last Planners would choose from a list of reasons defined for that particular project. PPC and failure reasons would be calculated and charted instantly. The PPC metric and "reasons" list would be shown for the team as a whole and also for the companies the Last Planners represented.

The Internet based solution would put people who had never heard of the Last Planner System into action right away. They could learn-by-doing, so long as there was someone to explain the "why" to the Last Planners. Projects would not flounder while people went through formal Last Planner training. Project Managers would stop complaining that they didn't have money in their budgets to pay a first-year Project Engineer to spend two days a week on Last Planner data entry.

APPLYING A3 THINKING TO SOFTWARE DEVELOPMENT

Reed and Khanzode partnered with a software developer in September of 2008 to develop a prototype. In mid-October 2008 they wrote the first draft of a proposal A3 to argue for investment by their employer, DPR Construction, and completed a final

draft six weeks later. While doing this, Reed organized a group of advisors composed of 28 people in the company who had either applied or were interested in using the Last Planner System on their projects.

Reed and Khanzode surveyed available Last Planner System software in the Current State section. They identified three applications from Strategic Project Solutions, Tokmo and ADePT, giving them a "plus" for their scope. Of those three, only the SPS tool was web-based, which Reed and Khanzode thought was critical for direct, transparent planning by Last Planners. Although the DPR prototype would also be deployed over the Web, they gave it a "minus" for scope and reporting capabilities. Its big advantages over the SPS application would be simplicity and lower cost. (Reed and Khanzode)

Simplicity would come through a straightforward graphical interface. Planning would be "stochastic" as opposed to "deterministic." Last Planners would simply note the date they thought they could complete a task by creating a digital card and placing it in a calendar view. The digital "card" could be moved backwards and forwards in time based on the agreement of other others in the weekly planning meeting. In this way the new web-based application remained true to the freedom granted to Last Planners when they used the LCI Excel template. They would not be expected to create the finish-to-start links in a tabular entry screen, which allowed the SPS application to calculate expected start and finish dates along with the "Last Responsible Moment" for starting and completing a task. Reed argued that this "deterministic" approach unnecessarily replicated the complexity found in all Critical Path Method software where planners are required to designate the dependency relationship between tasks. This extra step required time and skills many Last Planners did not have. Nor did it account for the reciprocal dependence between trades that occurs when they are more productive working on an installation together. Reed wanted to encourage Last Planners to show relationships, but argued against requiring this in order to plan production. Completion dates should not be calculated based on dependencies, which make production planning more difficult and less accurate than it should be. The Last Planners, individually and as a team, would be responsible for designating completion dates, not software.

The DPR Management Committee (MC) discussed and accepted the proposal and funded the project in early January 2009. Shortly afterwards, the third-party software developer began work. DPR developed the first version and used it on over 60 projects across the company. In November 2010, DPR brought on a software product manager with 30 years of software experience on a variety of products to form a subsidiary to develop version 2 and began licensing it for use throughout the construction industry at the end of 2012.

EMPOWERMENT OF TRADES

The action of commitment comes from an empowerment and accountability at the individual level on the project team. Allowing Last Planners to enter their own tasks and make commitments to complete these promises throughout the week develops a sense of responsibility by those planning and executing the work. The cloud-based software allows for rapid learning and implementation across the entire integrated team to include all of the stakeholders that need to make commitments on the project. Even though the general contractor plays a key role in the facilitation of "making and

keeping commitments" (Flores 1982), project success ultimately lies with the person that is making and delivering on reliable promises to the rest of the project team. This cloud-based software becomes a virtual forum where trade partners can enter and update their commitments resulting in a dynamic and up to date production plan.

LEVERAGING SOFTWARE: CASE STUDIES OF LEARNING-IN-ACTION WITH RELIABLE PROMISING

Last Planners have continuously improved their performance because of their use of this cloud-based software in a project-based setting. The next sections will discuss three projects that were able to incorporate the practices of learning-in-action and reliable promising through their ability to leverage this powerful Last Planner tool.

KAISER HEALTHCARE PROJECT: SHAPING BEHAVIOR THROUGH OWNERSHIP

John Wiegand, a project superintendent for 29 years, was interviewed to discuss his experience with securing reliable promises using the Last Planner System and more specifically the role of software in the ability to do that. He mentions "…inevitably it started out as this tool that we thought could enhance and develop the way we did our work. And it became this exercise in behavior shaping." (Wiegand 2012) It was a challenge getting the project kicked off with all the stakeholders in the same room getting them to really "commit in a profound way that didn't impact the path forward." (ibid.)

The project team started to use the cloud-based software with just the General Contractor "driving" the process for the first few weeks before the trade partners got "the hang of data entry themselves." (Wiegand 2014) The team was "provided a kiosk in the planning room" (ibid) and entered their own tasks, committed to activities as well as reviewed PPC. After awhile, each of the trade contractors would take turns to "drive" the weekly work plan meeting and daily huddles by discussing their own commitments collaboratively in these meetings. The make-ready and phase planning process were done using white dry erase planning boards and sticky notes. Through this process, Wiegand was able to get "Everybody in the same place and everybody had to commit to their promises directly to the people they were impacting." (Wiegend 2012) It became an exercise in education and building awareness through a disciplined approach to the process. The project team began meeting daily to check what was complete and not complete from the day before. Weekly coordination and make-ready planning meetings were held using the short-interval planning software tool for support.

The team at this healthcare project made it a standard practice during the weekly coordination meetings for the foremen to "stand and deliver" their plan for not only next week but the following three weeks. He made it a point to mention that:

> *If you are not the last responsible person to plan an activity that makes us successful, don't show up here tomorrow. Send me the guys who are, because if you can't stand out in the field and honor your commitment physically you have no business being in this room* (ibid.).

The key to this project team's success was the ability for the trades to take ownership of the plan. Through their ability to make commitments on their own without

someone telling them what to do, the trades were compelled to a higher level of accountability. The electrician took it one step further and "set up his own Last Planner board in his office" to plan his commitments (ibid.). In the end, it was about getting the right level of detail with the right people to secure those reliable promises. This project team went from "140 activities a week with a PPC of 44% to averaging 250 commitments a week with a PPC of 69%" over the course of the project. (Wiegand 2014). Wiegand noted that by capturing the data real time "[The Software] has made the process much more reliable in the sense that the information is shared so much more quickly and easily." (ibid.)

FACEBOOK DATA CENTER PROJECT: BUILDING TRUST THROUGH CONSISTENCY

Lance Wafler was interviewed to discuss his experience with implementing the Last Planner software on two large-scale data center projects for Facebook. He "wanted to create an environment where everybody was trusted." (Wafler 2012) The only way to really build that "two way, mutual level of trust" on the project was through what he calls "consistency." (ibid.) Having team members really be committed to the process and make a disciplined effort to deliver on commitments every day on the project was the key ingredient to success on these projects.

This project team introduced the software halfway through the project. The team was already engaged in using spreadsheets and hand-written commitments in a three-week rolling format submitted by the trade partners. The General Contractor would then assemble all of this information into a master spreadsheet to distribute to the team. Wafler mentioned that they "spent most of the time figuring out the information in front of them and how to organize it, and less time on actual planning and coordinating the work." (Wafler 2014). He mentioned that this process was really time consuming and didn't allow for a good system to track reasons for variance and PPC.

With the introduction of the software, the team was really able to engage the subcontractors to put in their own activities, saving time on data entry for the General Contractor. Now the time in the meeting was "spent focusing on the commitments." (ibid.) Similar to the method used on the Hospital project, the "(S)ubcontractors get up in front of the room and make promises: very specific promises, very specific commitments to the team." (Walfer 2012.) The team would then record the commitments in the software application. By going through this routine the team was able to build good behaviors that were further reinforced by the software application when they were not in the planning meetings.

The software enabled this project team to capture those commitments in a way that created an environment of accountability. By having the trades plan their work and enter their tasks individually, the team was able to realize higher PPC during the project. Even though this project was based in a rural setting where technology was not easily accepted, Wafler mentioned that the team's open and positive attitude along with effective lean leadership helped drive the disciplined process to allow this project to be successful. The team made the process a part of the job like "wearing safety glasses and hard hats" (Wafler 2014). There just wasn't an option to perform in any other way.

TEMECULA VALLEY HOSPITAL PROJECT: PLANNING ANYWHERE, ANYTIME AND TOGETHER

Using an Integrated Project Delivery approach, Universal Health Services engaged in a project in Temecula, CA employing lean planning in preconstruction using a full wall of boards to capture commitments. As they transitioned into construction, the team realized that they could not manage the project using just whiteboards and sticky notes. They explored a few software applications to help. Strategic Project Solutions was used to record the data at first, but this option proved to be "too cost prohibitive and cumbersome" for the team (O'Dwyer 2014). Next the IPD team introduced software called "SIPLink", but this software did not allow for collaboration as all the tasks were entered into a database by one individual and distributed via email in PDF format to the rest of the team, the process taking one to two days.

The cloud-based software referenced earlier in this paper was the final LPS software used on the project. Each foreman entered their own tasks into the software. O'Dwyer noted that it was "(U)ser-friendly enough for each of the trades to pick up in 30 minutes" (O'Dwyer 2014). The General Foremen were very positive about the benefits of sticky note planning at the whiteboard and using Last Planner software on laptops and iPads to plan work on their own outside of the "Big Room." Steve Bragia, a drywall foreman on the hospital project, remarked, "[The Software] is definitely a big help as far as getting people (to make) reliable commitments and then moving on to the other day's activities" (Bragia 2012). Even though there is some inherent value in planning side-by-side with the sticky note process, the foreman noted that "[The Software] allows us basically to do the same thing, but we don't literally have to all be in the same room" (ibid).

The process of daily check-ins was facilitated by having kiosks with internet connections stationed in the field, which allowed for real-time updating where the work was occurring. A "culture of accountability and collaboration" was created on the jobsite as the team used this "dynamic" and "live" plan interactively (O'Dwyer 2014). The millwork subcontractor used the software in their fabrication plant more than 300 miles away to help schedule deliveries and make commitments, involving their whole supply chain in this process.

O'Dwyer noted that staying true to the process and creating "automatic behavior" and "conditioned response" allowed for the team to operate with reliability even under stressful deadlines and situations (ibid). Even when the team was planning the most simple of sequences and tasks, they pulled their work and committed to activities using the same disciplined approach. The team did not become complacent with how they planned their work and kept an energy level and mood that allowed for learning and continuous improvement through reviewing their root cause and PPC reports.

The project was notable for quality, safety and achieving the target cost which was the lowest per bed for a California hospital in the last 10 years. The hospital came in two weeks ahead of an aggressive schedule at an astounding $1.1 million per bed. The IPD partners earned additional profit by intentionally applying PDSA to improve their implementation of Lean Construction throughout the project.

A CAUTIONARY NOTE

In this age of electronic gadgetry it is easy to fall into the trap of thinking that face-to-face interactions with team members are unnecessary. We simply need to text, tweet or email them. This same undesirable behaviour will develop with the use of any computer application that supports LPS unless definite steps are taken by project leadership to prevent it. As Eisenhower said, "Plans are worthless, but planning is everything." (Eisenhower 1957) The most important thing to realize is that the value from LPS is not in the tools, techniques or artifacts of the system, but from the face-to-face collaborative planning. The tools, techniques and artifacts provide a framework and support for this required collaboration but should never be allowed to replace it.

CONCLUSION

Last Planner software, if used with the right behavior and leadership, creates commitment and accountability at the foreman level. Case studies have shown how teams have been able to implement and leverage software effectively to create a culture of learning in action that is grounded in reliable promising.

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