

Implementing the Last Planner™ System in Large Public Lump Sum Bidding for Building Projects

Justin M. Reginato, Ph.D., P.E.

California State University, Sacramento
Sacramento, CA

Sterling T. Graham

HMH Builders
Sacramento, CA

The process of assembling and submitting a large, public-sector lump sum bid for buildings is risky for general contractors and subcontractors. For subcontractors, there is considerable risk in understanding their scope of work and assembling a price that accounts for those risks, as well as bid shopping. General contractors also have considerable risks associated with bidding, particularly in the dependence on subcontractors to supply quotes for a majority of the bid value and the fact that many of the personnel involved in assembling the bid temporarily participate in the bid assembly and do not intimately understand the project being bid. These factors conspire to lead to the potential for wildly varying bids which may result in an uncompetitive bid or a bid that will not yield a reasonable economic return on the project for the general contractor. In order to reduce this variability, the Last Planner™ System, a tool used to reduce variability in construction field operations, was applied to the process of assembling a bid. The use of the Last Planner™ System increased preparedness on bid day and reduced the overall variability in the bidding process and mitigated many of the risks associated with lump sum bidding.

Key Words: Last Planner™ System, competitive bids, bidding, planning

Introduction

Bidding large public-sector lump sum projects can be very challenging for general contractors and subcontractors. Lump sum bidding, also referred to as hard bidding, in the public sector is, generally speaking, open to all qualified contractors. Therefore, the amount of competition tends to be greater than in private lump sum bids or negotiated projects where the owner typically prequalifies general contractors. This results in more potential bidders, and thus, more competition.

Another challenge involved with lump sum bidding is that the entire cost of the project, including overhead, must be contained in the submitted bid. That is, after the contract is awarded, the winning general contractor does not have the opportunity to negotiate with the owner regarding items it missed prior to submitting the bid, assuming such items cannot be dealt with as change orders. Therefore, it is important for general contractors to ensure, before the bid is due, that their price covers the entire scope of the project. Scope for lump sum projects can be defined as the description of work relating to the construction documents, including the plans and specifications (Mincks & Johnston, 2004). Both issues, increased competition and the need to adequately cover scope, create a dilemma for general contractors: they must adequately cover scope and overhead costs in order to protect their bottom line, yet they cannot needlessly over cover or duplicate scope items or unnecessarily fill gaps in the scope without their bid becoming uncompetitive in a hard bid environment.

There are other issues directly facing general contractors with regards to completing a timely bid for a building project. First, most general contractors self perform a minority of the work being completed and retain the services of special trade subcontractors to complete the balance of work. This form of organization is preferable for economic reasons (Eccles, 1981), but leaves general contractors highly dependent on subcontractors to help them cover the scope of the project. The reliance for understanding subcontractor costs on bid day can be complicated. General contractors rely on the expertise of their subcontractors for their interpretation of bid documents for a complete determination of the scope of work. Subcontractors have their own concerns when assembling a bid for their desired scope of work. Primarily, subcontractors need to evaluate whether they want to bid the project at all, a decision that is a function of competition, risk, and the need for work (Chua & Li, 2000). Secondly, subcontractors may have questions about the plans and specifications that need to be answered in order to assemble an accurate bid. Thirdly, each subcontractor must plan their own means and methods for completing their scope of work, which may

be dependent upon the general contractor's means and methods. This risk becomes acute in situations where multiple general contractors are bidding the project and proposing varying means and methods. Next, subcontractors must take the time to ensure that they have adequately covered their own particular scope of work and convey that to general contractors in written format, which takes time. Lastly, subcontractors are oftentimes dependent upon suppliers to determine the cost of the materials and equipment necessary to complete their scope of work. Each of these activities takes considerable time, increasing with the degree of project difficulty. These issues, fortunately, can be discussed prior to bid day.

Bid day presents another set of complicating factors for general contractors. Subcontractors (and their suppliers) oftentimes choose to submit their bid as late as possible to reduce the opportunity for general contractors to shop their bids. Bid shopping is the unethical practice of a contractor disclosing the bid price of one subcontractor to another in an attempt to obtain a lower bid price (Degn & Miller, 2003). There is often little recourse for subcontractors for dealing with bid shopping or other risks placed on them by general contractors (Hinze & Tracey, 1994), so delivering bids late in the process is the easiest way for subcontractors to mitigate that risk. Delaying the delivery of a subcontractor bids until the end of the bidding process creates a chaotic environment whereby there is oftentimes not enough time to perform proper buyout, which includes the process of verifying the completeness of the subcontractors' scope of work (Zwick & Miller, 2004), particularly for multiple subcontractor bids covering multiple work packages. In addition to evaluating subcontractors, the general contractor must tally the cost of self performed work, profit and overhead, and any additional information the owner may require, such as bonding information or business qualifications for the general and subcontractors (such as small business enterprises or businesses owned by women, disabled veterans or minorities, etc.).

One last important hurdle to submitting a timely lump sum bid for a large project is supplementing the estimating staff on bid day. Most general contractors do not have large enough estimating departments to fully staff a large bid. It is oftentimes not economical for a contractor to have a large team of estimators from the start of the bidding process to the end for each project. Typically, an individual or small team (estimating team) will prepare for the bid. However, for large projects, the larger number of resources needed to adequately prepare the bid package often exceeds the number available, particularly on bid day. Therefore, as the bid date approaches, the number of people becoming involved in the preparation of the bid escalates, many fielding price quotes from subcontractors and assembling and delivering the final bid package. In this paper, we refer to the people participating only at the end of the bidding period to field the subcontractor quotes as trade specialists. Many of the trade specialists may not be intimately involved with the particular project being bid. They may be estimators that are working on other bids or staff working in the field on active projects. The inclusion of this additional staff, while necessary, may add variability to the bidding process if they do not adequately understand the project for which the bid is being created. It is not uncommon during the pre-bid planning process for bidding team members to have varying degrees of involvement (Laufer et al, 1993).

All of these factors lead to a chaotic setting for both general and subcontractors in the few hours leading up to the time when the bid is due. In this chaotic environment, the opportunity for mistakes is high and mistakes can lead to a non-responsive bid, an uncompetitive bid whose price is unnecessarily high, or a bid that's too low and the general contractor has won the project but failed to do so at a price where sufficient profit, or any profit at all, can be realized. In other words, in order to win the bid and adequately manage risk, general contractors must mitigate significant amounts of risk and variability among their self-perform costs and, more importantly, among the subcontractor quotes they receive.

General contractors employ various techniques to mitigate these potential risks, including meeting with subcontractors before bid day to discuss project scope, prequalifying the subcontractors they will take bids from on bid day, and sending scope definitions to subcontractors prior to bid day clarifying the exact scope they wish for subcontractors to cover with their bids. While these efforts certainly help with the effort to reduce the risks associated with assembling a complete and competitive bid, there are additional tools that general contractors can employ to reduce uncertainty and variability of the subcontractor quotes they receive for the bid. This paper investigates the adoption of parts of the Last PlannerTM system as a tool for further reducing this uncertainty and variability.

The goal of this research is to assess the utility of employing the Last PlannerTM System in public-sector lump sum bids for building projects. Because the Last PlannerTM System has been found to reduce variance and uncertainty during field construction operations, the null hypothesis is that it will also benefit the bidding process.

Last Planner™ System

In the construction industry, risk and variability are commonplace, particularly in field operations. Variability has been found to disrupt the flow of activities, which, as a consequence, challenges project performance (Hamzeh et al, 2007). To combat this variability and uncertainty, many construction companies employ planning and control processes. One of the more recent additions to the contractor's arsenal for managing variability and uncertainty is the Last Planner™ System (LPS).

LPS was developed by Glenn Ballard and Greg Howell as a planning and control system for reducing uncertainty and variability in construction field operations (Ballard & Howell, 1998). In LPS, collaborative scheduling is used to increase predictability and decrease risk. A series of schedules (from least to most detailed schedule, show below in Table 1) are used to manage the project. Project leaders use the most detailed schedule (1 week typically, often referred to as a weekly work plan) to plan actual task completion. Team leaders use the weekly work plan to make tasks ready by ensuring all prerequisite work has been completed. In an effort to create ready-to-perform activities, LPS supports (Ballard & Howell, 1998; Ballard et al, 2007, and adapted from Hamzeh & Bergstrom, 2010):

1. Planning activities in greater detail as the time to execute those activities draws closer,
2. Developing a work plan with the people that are going to perform the work,
3. Increase the reliability of the planned work by removing constraints as a team ahead of time,
4. Driving execution of the activities by coordination and negotiation with the project team and creating accountability, and
5. Learning from past planning failures by finding root causes and preventing them in the future

In order to facilitate the above, LPS breaks the planning process into four levels, with each level corresponding time horizon and level of detail, as depicted in Table 1.

Table 1

Four Levels of Planning in the Last Planner™ System

Time Horizon	Planning Process	Level of Detail
Project	Master schedule: outlines the work to be completed over the entire duration of the project and identifies major milestones	Least
Phase	Phase scheduling: detailed schedule for each project phase that incorporates reverse phase scheduling to identify handoffs between the various teams completing a project and allows them to develop the best way to meet major milestones.	
2 – 6 weeks	Look-ahead planning: specific activities are identified, assigned a responsible party, and are made ready to be executed.	
1 week	Commitment planning: The most detailed level of planning, activities are reviewed at the end of each plan period to determine the reliability of the planning and production system.	Greatest

Taken as a whole, LPS forces detailed thinking in both long- and short-term time frames and builds accountability into project execution. LPS has been determined to increase production and increase the reliability of construction operations (Ballard & Howell, 2004).

Method for Implementing LPS in the Bidding Process

As previously described, the bidding process is burdened with uncertainty and variability stemming from a need to adequately, yet economically, cover project scope, a reliance on subcontractors, and the potential dependence on staff that are not intimately familiar with the project for which the bid is being created. LPS has been demonstrated

to use planning and accountability to decrease uncertainty, reduce variability, and increase output in field operations. Because of the risk and uncertainty involved, LPS lends itself to the bidding of a large, complex, public-sector projects. The primary goals of implementing LPS in bidding was to reduce the uncertainty associated with subcontractor bids and to develop manageable work plans for each member of the bid team that would not have the luxury of spending several days preparing for bid day. Many of the people helping to assemble the bid on bid day were field personnel that were providing help just for bid day. In order to enable them to make informed choices in terms of subcontractor selection, uncertainty and variability surrounding the bid would need to be reduced or removed.

Because this experiment was isolated to a single project and was being implemented largely on an experimental basis by two of the team members, not every element of LPS would be implemented. Therefore, this was a partial implementation of LPS. The authors chose to focus on using LPS to clarify the scope of each subcontractor's work ahead of bid day, preferably a few days prior so that each scope could be reviewed before bid day, and creating a stable of ready activities for trade specialists to perform to be ready for bid day. Measuring percent complete or determining corrective actions during the bidding process were not pursued due to time and inexperience with LPS. The team wanted to focus on the key concepts of LPS that would provide immediate help and would be easy to implement.

This research was performed as action research where the authors were a member of the general contracting team bidding the project (Coghlan, 2001), with one being a full-time employee of the company and the other as a faculty member of a university but working for the general contractor during the bid period. Empirical data was gathered throughout the process of bidding the project and analyzed after the bid was submitted. Methods of improvement were discussed and will be implemented on future bids. Due to the relatively short duration of the project (compared to field construction), improvement alternatives were not employed as they were realized and there were few adjustments made during the project.

Case Study

The case study involved the bidding of a project that entailed the renovation of a large historical state government building located in northern California. The project's budget for both design and construction was over \$65 million. The scope of the improvements included upgrades to the interior and exterior of the building to recapture its historic character; a complete fire, life and safety upgrade; abatement of hazardous materials; and interior upgrades including the establishment of vertical stacking electrical and telecom spaces, restoration of the historic elevators, installation of new wheelchair lifts, enhancement of security, and improved accessibility. Additionally, there was extensive architectural renovation required, including cleaning, repair, and restoration of historic ceilings, light fixtures, and works of art. Two mechanical penthouses were also to be demolished and rebuilt on the roof to re-open the historic light wells. The project was registered for consideration as a Leadership in Energy and Environmental Design (LEED) project and is seeking a rating of Silver.

The main purpose of experimentally applying LPS to the bidding process was to reduce the variability introduced to the bidding process by fielding multiple subcontractor quotes in a short period of time and utilizing trade specialists on bid day to receive and process subcontractor quotes that may not be familiar with the project, with both issues possibly compounding one-another. In order to clearly identify those sources of variability, the estimating team first identified a number of potential subcontractors for each trade or bid package (scopes of work to be performed by subcontractors). The list of subcontractors came from a listing of subcontractors that had attended job site visits and subcontractors that the general contractor had worked with successfully in the past. At about the same time, the trade specialists for each bid package were identified. Once many potential subcontractors and trade specialists were identified, LPS could be initiated for the bidding process. The general contractor's core bidding team could identify a series of activities that should be done and turn those into activities that could be done. The aim of the output of these activities was to provide each trade specialist a set of subcontractors that had already been contacted and their scope of work for the package they intended to bid on clearly understood. Therefore, the trade specialist could focus solely on comparing subcontractors on the basis of price and selecting the one that had adequately covered the proper scope of work at the lowest price.

Schedules and plans were developed to facilitate the conversion of "should" work to "could" work. The estimating team, due to the short duration of the bidding process (approximately one month) combined the master and phase

schedules into a single schedule with a single discreet phase. The major milestones for the project included the dates of the site visits, the date that requests for bidding information were due, and the bid date itself. Two other milestones were added. The first was for handing the subcontractor information to the trade specialists before bid day. That milestone, set at two days before bid day, was key because the trade specialist that were not a part of the full-time estimating team would have only a short period of time to get familiar with the project and the specific scope package they were responsible for. The second milestone was for an “all hands” meeting with as many of the trade specialists that could attend. This meeting was important because the bidding team was able to get buy-in from each trade specialist that they would come to bid day prepared to manage the bidding of their specific trade package. Trade packages were given to the specialists that understood the technical issues involved with the package, as well as had relationships with many of the subcontractors bidding the scope package.

Once the bidding schedule was established and a general understanding of the work required for a successful bid understood, specific plans were put into place. In performing look-ahead planning, specific activities were identified. These activities included, but were not limited to, determining the Small Business/Disabled Veteran Business Enterprise (SB/DVBE) status of each identified potential subcontractor (there was a requirement that a certain percentage of the project be completed by firms with this designation), development of scope letters defining the work the general contractor was accepting bids for and many of the specific items entailed in each of those packages (along with drawing and specification references), communication with identified subcontractors to ensure that they intended to bid the project and that they were familiar with the scope(s) highlighted in the scope letters and to discuss means and methods, and quantity take-offs performed by the general contractor as a check against the quantities generated by the subcontractors. It was important to clearly define the scope of work so that subcontractors could evaluate and mitigate as much as the risk associated with their scope packages as best they could, as well as remove any price redundancies with the general contractor or other subcontractors. These are issues that traditionally problematic for subcontractors (Hinze and Tracey, 1994), so great effort was used to alleviate them as best as possible under the circumstances. Each of these activities needed to be performed for each bid package. Because many of the trade specialists would not be involved until bid day or just before, much of this work needed to be performed by the core estimating team assigned to the bid.

Once the specific activities previously mentioned were identified and assigned, commitment planning was initiated. The activities were assembled into work packages and assigned to a responsible party within the core estimating team and time frames for their delivery set. Regular planning meetings, while informal, were conducted to measure performance. It should be mentioned that this is where the estimating team departed dramatically from a traditional LPS arrangement. A core principle of LPS is to continuously measure percent complete of each activity and introduce corrective measures if the requisite percent complete is not being met (Ballard, 2000). The estimating team for this project did not measure percent complete or any other metrics during the course of completing the specific commitments made by the team members. This was done primarily because of the introductory and experimental nature of introducing LPS to this bid and also due to the lack of time needed to collect that data. Also, it would have been very difficult to monitor any work being performed for the bid by the trade specialists that were working off site on other projects until they were need for the bid. Instead, the work packages were tacitly created to build focused scopes that would not lead to overly detailed plans for work that would lead to micromanagement, which can be an issue in creating work plans (Choo et al, 2001). Instead plans were built so that they were manageable within the LPS (Ballard, 1997) and could have their status qualitatively verified. The lead estimator and the designated project manager for the bid continuously queried the estimating team to ensure that they would have the necessary make ready work completed by the time the trade specialists became involved in the bid. Also, plans and specifications were delivered to project trailers for trade specialists to review prior to bid day so that they would better understand the project as bid day commenced. LPS, as adapted for this project, is graphically represented below in Figure 1.

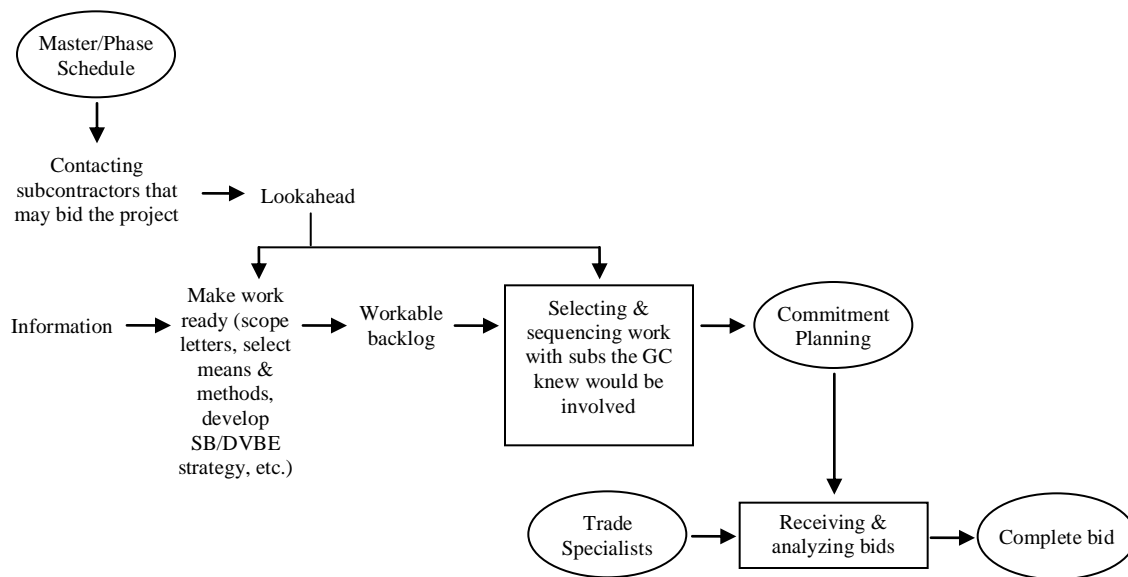


Figure 1: Last PlannerTM System Adapted for a Lump Sum Bid

Results and Discussion

By employing LPS, the goal was to reduce variance and uncertainty in the bidding process in order to produce a bid that adequately yet economically covered the project's scope. Some of the issues that add to the variance and uncertainty of the bids received by subcontractors include the issues associated with subcontractors bidding to multiple general contractors, each possibly employing differing means and methods; subcontractors submitting bids just before the bid is due, not leaving general contractors much opportunity to analyze them; and having little time to evaluate a subcontractor's business and bonding qualifications. It should be noted that all subcontractor bids for this project were submitted on bid day, with most arriving within two hours of the bid deadline. There are also issues internal to the general contractor with respect to assembling a lump sum bid, including a dependence on subcontractors to fully understand the plans and specification (and hence scope) of the project and supplementing bidding staff. LPS was able to alleviate or eliminate many of these problems in the project chronicled in the case study.

The estimating team was able to generate very detailed scope letters that were sent to multiple subcontractors in each trade division. These scope letters opened many conversations between subcontractors and the general contractor that was beneficial for both sides. Subcontractors were able to better understand how the general contractor had planned to manage the project and were assured that certain means would be in place for them to use (rigging, scaffolding, etc.). This allowed the subcontractors to remove those items from their bids and also allowed them to reduce contingencies that they had intended to add. Importantly, many subs returned a completed scope checklist stating which items they intended to perform. Knowing this ahead of time would allow the trade specialists to focus on selecting the subcontractor that had covered the requisite scope at the lowest price. Many subcontractors expressed comfort in bidding to the general contractor because they felt that both sides had adequately vetted risks and allocated them to the party that was best equipped to manage them.

The general contractor realized additional benefits from these exchanges as well. Discussions with subcontractors allowed the general contractor to better understand the scope of the entire project and were alerted to potential issues by individual subcontractors that would impact the entire project, such as staging and selective demolition. Also, in building confidence between the general contractor and subcontractors, many subcontractors elected to send their bids a few hours or more before the close of the bid, allowing the general contractor more time to assess them. This helped alleviate the last minute rush of subcontractor bid evaluations. These benefits were the result of identifying risks early and creating a plan as a team to proactively mitigate them, as prescribed by LPS.

The trade specialists also benefited from the concerted effort to create a stock of make ready work for them. By bid day, many trade specialists had a bid comparison sheet that was populated with each subcontractor's contact information, a summary of the work they intended to bid, a completed or semi-completed checklist of their qualifications (acknowledgement of addenda, DVBE qualification, etc.). The majority of the subcontractors had been previously contacted by a member of the core estimating team and had expressed that they would indeed supply the general contractor with a bid. All that was left for the trade specialist to do was to wait for the subcontractor to send their bid or call a subcontractor if a bid was not received.

In discussing the bid with trade specialists after the bid, many expressed that the bid was much better managed than others in the past and they felt more prepared to discuss the project with subcontractors that had called with questions, despite not having put considerable time into preparing for bid day. With the core estimating team having identified which work could be done ahead of time and creating a stable of make ready work (receive bids and make calls if necessary), the trade specialists were able to focus on obtaining a complete bid with the lowest price, which is the key to assembling the proper value for subcontracted work on a large public sector lump sum bid.

Not everything worked according to plan, and LPS would not have likely mitigated these issues. The general contractor received many bids from subcontractors that had not been previously contacted and had not provided a scope check list. Therefore, trade specialists were forced to analyze those bids while receiving other bids from subcontractors. This only created an issue if the unforeseen subcontractor quote was low (if it was not the lowest, it was not analyzed). If it was low, the entire scope needed to be quickly analyzed to ensure completeness. If such a determination could not be made quickly, the trade specialist would have to call the subcontractor in question. This diverted their efforts away from receiving other quotes. However, having been briefed and armed with information provided by the core estimating team as part of the make ready work, most trade specialists understood the scope well enough to make a judgment call as to the validity of the unexpected subcontractor quotes.

Another issue was subcontractors submitting bids for multiple work packages. If the work packages included work being covered by multiple trade specialists, then those trade specialists had to communicate during the bidding process to make sure that if one trade specialist was going to list the subcontractor for multiple packages that the other trade specialist did not also list the subcontractor, thus effectively double counting the subcontractor's bid. While this happened in a few instances, it ultimately was not an issue for this particular bid.

Ultimately, the uncertainty and variability in the bidding process were not eliminated in their entirety, but they were sufficiently mitigated to the point where the general contractor was pleased with the final bid it submitted. In all, the contractor, from both the point of view of the core estimating team and the trade specialists, was happy with how the bidding process went for that particular bid and will continue to improve and refine the practices borrowed from LPS on future bids. In returning to the original purpose of the research, it was empirically determined that LPS does improve the bidding process for public-sector lump sum building bids.

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