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# Understanding the role of “tasks anticipated” in lookahead planning through simulation

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ABSTRACT

Construction planning takes place at many levels. This paper pertains to the level called lookahead planning, during which planners make their plan more realistic as construction tasks approach execution. To improve the quality of lookahead planning, the construction industry has benefited from implementing the Last Planner® System (LPS) that emphasizes creating reliable workflow. Successful lookahead planning relies on task anticipation by breaking down tasks to the level of operations, designing those operations, and making tasks ready by identifying and removing their constraints so that tasks can become executable assignments. This paper presents a study, using computer simulation, of the relationship between improving Task Anticipated (TA) in lookahead planning and overall project duration. The results indicate that increasing TA can have a positive influence on reducing project duration. The authors recommend that industry practitioners use the TA metric to gauge their planning performance and then to improve on it.



## 1. Introduction

Construction planning helps teams achieve successful project performance in meeting the objectives of time, cost, quality, and safety [1]. However, it is hard to execute work when planners push plans to frontline crews without preparing tasks for proper and timely execution. The complex preparation process involves many organizations and requires a planning system that fosters collaboration at various levels of planning. In this regard, the Last Planner® System (LPS) has been used on construction projects as a production planning and control system, bringing several organizations together, sharing a common production planning platform, and enabling them to improve workflow reliability by reducing the difference between tasks that SHOULD be done and those that CAN be done [2,3].

Lookahead planning is an important process in the LPS as it links front-end planning (master- and phase scheduling) with execution of the work. It goes beyond the simple interpretation (i.e., what ought to be done in order to complete the project) of the project schedule, to breaking down tasks from the master- and phase schedule into the level of operations (i.e., matching the level of detail required for commitment planning and execution by individual work crews), designing operations, identifying constraints, assigning responsibilities, and then making assignments ready by removing constraints [2–4].

Lookahead planning involves making work ready so that the ‘work’ flows in the sequence and at the rate needed to complete the project within the available time. Allowing into commitment plans only tasks assessed as ‘ready’ increases plan reliability, which in turn enables better matching of capacity to load because load is more predictable. The LPS measures this reliability in terms of percent plan complete (PPC) which is the percentage of tasks completed at the end of a certain time period—typically a week but it can be any time period—relative to those tasks promised to be completed at the end of that time period (i.e., PPC compares DID to WILL). Lookahead planning also includes producing a backlog of work available to absorb excess capacity when it arises and for contingency planning purposes [2,5] (e.g., in case committed tasks are completed faster or more slowly than expected).

When employing lookahead planning, a project team can identify and remove constraints by using a combination of pulling and screening. Pulling aims at making tasks ready by removing constraints and ensuring that all prerequisites are available. Tasks that cannot be made ready to be performed when scheduled are ineligible for inclusion in the week's work plan. Screening assesses the status of scheduled tasks against the quality criteria shown in Table 1 to determine eligibility for inclusion in ‘commitment’ plans; i.e., daily or weekly work plans.

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**Table 1**
Quality criteria for evaluating tasks for commitment [2].

| Quality criterion | Question to answer |
|---|---|
| Definition | Is the task defined so that workers understand what, when, where, and with what? |
| Soundness | Have all constraints been removed that can be removed prior to the plan period? |
| Sequence | Is the task properly sequenced? |
| Size | Does workload, the amount of work to be accomplished, match the capability of those who are to perform the task? |
| Learning | Are metrics traced to track and improve performance? |

Tasks Anticipated (TA) [2,4–6] is a metric used to measure successful performance of the lookahead planning process in anticipating tasks that will take place, e.g., two or three weeks in the future. In this study TA measures the percentage of tasks on the commitment plan that were anticipated two weeks prior to the execution week. The goal of the study is to investigate the impact an increase in TA may have on overall project duration. The hypothesis is that "increasing TA will reduce project duration."

TA gauges the ability of the planning team to gain foresight (better anticipation of tasks) through task breakdown and operations design, and hence the ability to turn work that SHOULD be done into work that CAN be done. This 'making ready' is measured by a metric called Tasks Made Ready (TMR). TMR measures the ability of lookahead planning to identify and remove constraints, and to make tasks ready for execution [4]. In this study, TMR refers to the ratio of tasks having all their constraints removed in the two weeks preceding execution to the tasks that were anticipated on the lookahead plan. It is apparent that TMR will vary to some degree with TA, since it is only a matter of chance that tasks will be ready to be performed when scheduled if they have not previously been anticipated.

While "increasing TA reduces project duration" may seem intuitively true, in light of numerous sources of uncertainty that may challenge a schedule, a detailed study with testing of multiple project scenarios is in order. In other words, under what conditions is that hypothesis true? The presented study examines changes in TA and analyzes their impact on project duration under various project settings that contribute to uncertainty in planning. Undertaking the proposed study on a real-life project is impossible because in real life only one scenario is followed, making it impossible to gauge the range of alternative futures. Moreover, whereas tracking PPC occurs on most real-life projects that implement the LPS, tracking TA is still rare. Some studies of real-life projects have shown an ad-hoc correlation between certain parameters in LPS (e.g., [8]). However, they did not answer the hypothesis proposed in this paper.

This study presents an original model to simulate lookahead planning. Its contributions to knowledge in the domain of planning include conceptualizing the lookahead planning process, characterizing a number of uncertainties that may hamper the execution of plans, modeling lookahead planning decisions, and demonstrating how in-process performance of a planning system can be measured, not just end outcomes.

## 2. Literature review

### 2.1. Lookahead planning in the Last Planner® System (LPS)

The LPS comprises planning processes at four levels: 1) *Master scheduling* that identifies major milestone dates on a project (tasks that SHOULD be done), 2) *Phase scheduling* that produces schedules specifying the processes performed by the various organizations working in each phase, and the handoffs between those organizations, 3) *Lookahead planning* that breaks down processes into operations, designs those operations, and makes them ready to be executed (making ready what SHOULD be done so it CAN be done), and 4) *Commitment planning* that results in coordinated commitments (creating a list of promises by selecting from tasks that CAN be done those that WILL be done) by frontline supervisors and their work groups to execute tasks within a time period ranging from one shift to one week or more (the period used in this study is one week, so the commitment plans are weekly work plans (WWP)) [2,4–6].

The foundation of the LPS is reliable promising and the criteria for making promises, also called commitments (Table 1). Simply trying to commit to execute only tasks that are well defined, sound, sequenced, and sized increases the percentage of commitments kept and the willingness of front line supervisors to invest in planning and preparation, including lookahead planning.

Several studies have investigated the implementation of the LPS on construction projects (e.g., [3,5]). Results show that implementing the LPS can strengthen the social network among the project participants including frontline supervisors and direct workers [7], shield production units from work flow uncertainty [8,9], reduce workflow variation in reducing the difference between tasks that are predicted to be executed and those actually executed [10], improve the reliability of planning [11], and enhance productivity [12].

### 2.2. Background of simulation in construction and project management

Computer simulation is effective in supporting decisions during design and implementation of construction processes (e.g., Halpin and Woodhead [16]). Martinez and Ioannou [17] examined several simulation programs and reported their fit for a range of applications in construction. Computer models can be built to simulate a construction process with its tasks, resources, and specific environmental constraints to aid in optimizing resource use, reducing cost and risk, project planning, and overall delivering a better project for the customer [15,18].

Simulation has been used to study constructability and construction logistics. Vanegas et al. [19] used it to plan construction processes on heavy civil projects and to analyze workflow at a relatively low implementation cost. Huang et al. [20] used it to optimize the planning of formwork operations for building construction. Cho et al. [21] built a simulation model to verify an algorithm for smart multi-lifting operations for high-rise buildings. Hamzeh et al. [22] used simulation to study the supply chain for consumables on construction projects and reported benefits from using logistics' centers to reduce site storage and material shortages.

Simulation has also been used for risk assessment and management on construction projects. Cho and Kim [23] used it to evaluate risks during construction phases of a suspension bridge. Kang et al. [24] simulated a system to analyze the degree of risk in construction projects by visualizing numerical risk information linked to a four-dimensional (4D) CAD system.

In the area of construction scheduling, a number of programs were developed in the late 1980s and early 1990s to automate the scheduling process (e.g., Hendrickson et al. [25]). Tommelein et al. [26] programmed an object-oriented simulation system to instantiate discrete-event simulation models based on a project's design, its CPM schedule, and construction methods captured as elemental simulation networks. Wang et al. [27] combined simulation with Building Information Modeling (BIM) to measure quantities of required materials and generate more realistic project schedules. In an effort to improve the accuracy of lookahead planning, Song and Eldin [28] used adaptive real-time tracking and simulation of heavy construction operations to dynamically incorporate new project data and adapt to changes in field operations.

Despite extensive application of discrete-event simulation in construction, simulation modeling of the mechanics of a schedule's execution and means to recover from failures due to the manifestation of uncertainties is relatively rare. Tommelein [29,30] simulated the