Interaction of Lean Construction and BIM

Development of a 4D Project Planning Software to Increase Construction Productivity

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Introduction

The AEC Industry has been developing very slow over the last decades. Thanks to the development of Building Information Modeling (BIM) and the implementation of Lean Construction the AEC Industry is currently undergoing major changes. BIM and Lean Construction are approaches with quite different initiatives, but both have a profound impact on the AEC Industry and are applied to improve productivity and efficiency with outstanding effects.

Lean Construction

Lean construction is defined as a "way to design production systems to minimize waste of materials, time, and effort in order to generate the maximum possible amount of value." [1] The Last Planner System (LPS), a comprehensive "pull" system for optimized planning and execution, represents a key element in the project production control in Lean Construction and is applied to reduce variability, improve planning dependability, and increase construction productivity. The LPS divides the project into two different planning stages – the long-term planning (Master Schedule and Phase Schedule) and the short-term planning (Lookahead Plan, Commitment Plan, and Learning) (Figure 1).
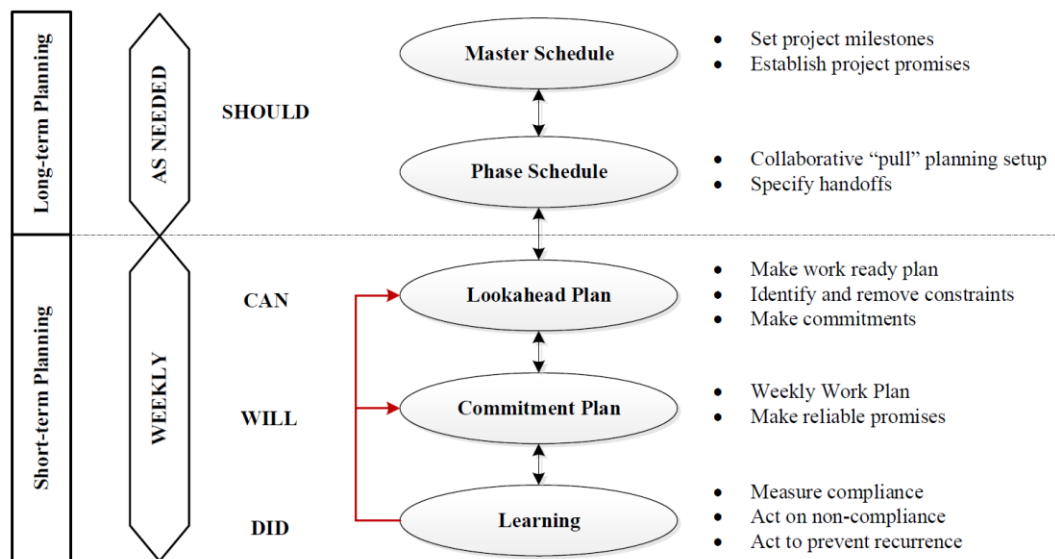

Figure 1: The planning stages in the Last Planner System of Production Control [1]

[1] Ballard, G. & Tommelein, I., 2016. Current Process Benchmark for the Last Planner System. *available at p2sl.berkeley.edu,* pp. 01-42.

BIM-based LPS tool

Realizing that Lean Construction and BIM have significant synergies, which bring benefits to the overall productivity and efficiency of construction, a BIM-based prototype tool has been developed. The software supports the LPS and enables construction managers to plan more reliably, eliminate construction waste and improve the use of Lean Construction through 3D visualization of the construction project. Key features of the software are a fully automated quantity take-off, a color-coded 4D construction planning simulation with respect to the short-term planning process of the LPS (Figure 3), and an evaluation tool to achieve a continuous improvement of the planning process in terms of productivity (Figure 4), manpower allocation, and waste quantity.
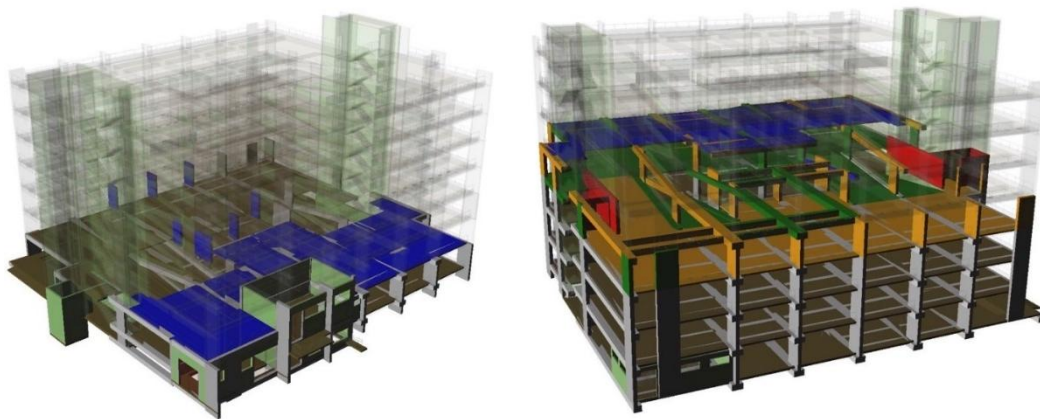

Figure 2: 4D visualization of the a) Learning construction progress and b) Short-term planning construction process – completed tasks (blocked), tasks currently under construction (blue), tasks ready (green), tasks can be made ready (orange), and tasks cannot be made ready (red)

BIM provides the opportunity for an improved analysis and control of time-dependent spatial conflicts through 4D construction planning simulation, which can extensively be used as a visualization and communication tool and typically results in a more efficient planning and execution of the construction work.
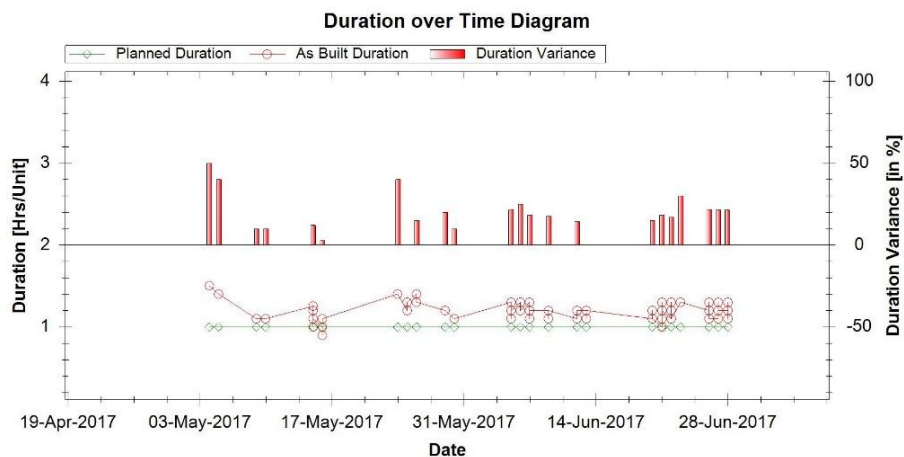

Figure 3: Evaluation of the planned vs. as-built duration of prefabricated column elements with an element length between two and three meters