Lean and BIM – A Synergistic Relationship

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Two of the primary drivers of change and transformation in the UK construction industry have been Building Information Modelling (BIM) and Lean Construction. The term BIM describes tools, processes and technologies that are facilitated by digital, machine—readable documentation about a construction project (i.e. buildings, highways, power plants etc.), its performance, its planning, its construction and later its operation. Unlike the conventional Computer Aided Design (CAD) systems, it unifies form, behaviour and functionality in construction visualisation. Lean Construction is an innovative approach to construction management that translates the successful principles of the Toyota Production System (TPS) started to take shape in the 1940s in the car manufacturing industry to the Architecture, Engineering and Construction (AEC) industry.

Recent research on BIM and Lean Construction shows that there is a considerable synergy between the two. Of the many positive interactions, reduction in process variation and cycle-times, increased visualisation of products and processes, automation of some non-value adding activities, increased collaborative working, advanced prefabrication options, and better value capturing and rapid generation of alternatives through the use of BIM come to fore. All those points also constitute some of the important mantras of Lean Construction. It should also be noted that the BIM-Lean synergy is not limited to the design phase and extends over the construction life-cycle with the rapid advent of multidimensional BIM capabilities (nD-BIM).

The design phase in the construction life-cycle is possibly an area where this synergy is most apparent. The Lean Construction related design priorities and concepts of Target Value Design, Set Based Design, Choosing by Advantages, client defined value, collaborative design, rapid evaluation of design alternatives, integrated procurement and supply chain, joint reviews/clash detection, early involvement of stakeholders, simulation/analysis for better value, reduced cycle-times and waste in design activities, and mistake proofing design extensively leverage the BIM capabilities of multi-trade coordination, rapid production of design drawings with fewer errors, better visualisation of the design intent, efficient modelling for constructability evaluations/clash detections, powerful simulation options (e.g. lighting, heating, air flow, energy efficiency, earthquake resistance) providing rapid and correct quantity take-offs, value engineering support and advanced pre-construction analyses (e.g. virtual site planning and logistics, integration of BIM models with schedules and costs or 4D BIM and 5D BIM respectively).

The use of BIM to support Lean Construction techniques and goals has been widening in the construction phase. The increasing integration of multidimensional BIM with existing information systems (i.e. Enterprise Recourse Planning-ERP) and emerging technologies such as Virtual Reality, rapid laser scanning and point cloud generation, Cloud Computing, extensive use of mobile and wearable devices, on-site robotics, sensor networks, image recognition, advanced photogrammetry and indoor/outdoor geolocation adds to the possibilities. Currently, BIM supports visualisation in Collaborative Planning/Last Planner meetings, design briefs and stakeholder engagement. There are also efforts to create state-of-the-art BIM based systems to visualise construction flows and to facilitate on-site visual controls (e.g. KanBIM and VisiLean). The 4D and 5D capabilities of BIM provide constructors with a better understanding of different alternatives and cost/schedule control. 4D/5D simulations for resources, time, safety, space, risk, construction layout and constructability analyses have been used with the outcomes of reduced cycle times, reduced Request for Information (RFIs), reduced wastes and increased safety in some work tasks (e.g. reinforced concrete works). Clash identification at the construction stage is prevalent. BIM models can also support Just-in-Time (JIT) based information, project drawing, material/logistics flows and advanced, model-driven prefabrication (e.g. duct work, MEP, RC panels, cladding, dry wall structures) thanks to their high compatibility with industrial Computer Numerical Control (CNC) units. The combined use of BIM models, BIM servers and emerging technologies enable the automation of some non-value adding activities such as site actual progress and production monitoring, sub-contractor progress payment calculations, production quality control and tolerance checks, checking production against construction codes/requirements, surveying and scanning the existing site/system conditions, stock monitoring and material/plant/equipment tracking.

Although initial design has an effect on every phase in the construction life-cycle, the total cost of a construction project is comprised largely of the costs of facilities and operations management (FM/OM). Thus, efficiency gains in the maintenance/operations phase will have relatively larger impacts on the overall construction life-cycle. Current BIM and Lean discussions revolve mainly around the design and construction phaseses. A more balanced research/practice approach with more emphasis on FM/OM can be expected in the near future. One interesting and challenging area is the use of BIM/Lean in current construction projects within refurbishment, retrofitting and demolition efforts. The integration of emerging technologies with BIM models presents a wide variety of possibilities in the FM/OM phase as well. Also, the fast advent of Big Data may have a fundamental impact on Lean, BIM and FM/OM practices in the near future. BIM and Lean match well in the FM/OM activities of controlling life-cycle cost and environmental data, effectively locating building components and material inventory, asset tracking, facilitating retrieval of real-time integrated building, maintenance and management data (matching those data visually with space), improving maintainability studies, streamlining space management, fostering efficient planning and feasibility studies for non-capital construction (i.e. renovation, retrofit and demolition), enabling personnel training in virtual reality (facility operations), visualised marketing, expediting search, evacuation and rescue (for emergency cases), controlling and monitoring energy (e.g. electricity consumption, CO2 emission) and facilities use. The traditional handover practices from the construction phase to the FM/OM phase should be analysed and redesigned with a Lean/BIM perspective.

Presently, there are also many challenges before the Lean/BIM synergy, and their common dissemination and diffusion in the construction industry. Some of those challenges are technology related such as the diversity of BIM tools and interoperability issues, problems in the integration with other IT systems, the current fragmentation and competition among BIM software vendors and the lack of BIM libraries and established world-wide standards (still). Other issues are mostly management and industry culture related; unclear roles and responsibilities, the lack of effective collaboration between project stakeholders, the inherent problems within the prevalent project delivery systems, cultural barriers towards adopting technologies and mindsets, organisational resistance, the lack of a sufficient legal framework, the lack of educated workforce, the relatively low awareness of both of the concept in the industry (still).