Virtual Design and Construction in Support of Construction Engineering

Martin Fischer, Professor of Civil and Environmental Engineering, Stanford University, fischer@stanford.edu
Roberto Arbulu, Director of Technical Services, Strategic Project Solutions, San Francisco, CA rarbulu@spsinc.net

Virtual Design and Construction (VDC) is the use of multi-disciplinary performance models of construction projects, including their products (facilities), organizations, and work processes for business objectives. VDC methods combine technologies, typically based on building information models (BIM), with social collaboration methods and formal process models in the context of project performance metrics and client business objectives. Like every other engineering task construction engineering depends critically on the effective communication of project data and construction and engineering concepts and knowledge.

VDC technologies support this communication through data-driven and visual modeling of construction projects across spatial, organizational, and temporal scales. Single-worker-single-task visualizations support the training and instruction of and communication with single workers. Crew-task visualizations enable crews to carry out virtual first run studies before going into the field, improving safety and productivity. Multi-crew-multi-tasks visualizations support the effective allocation of resources in the context of the project goals, schedule milestones, available resources, and the current project context. Simply put, these visualization are allowing project teams to achieve WYSIWYG (what you see is what you get) performance with greater conformance to schedules than is typically seen. Data-driven models for construction engineering are now emerging. Such models can provide performance data about the engineered construction processes and enable more timely and accurate feedback loops than typical today. Eventually, such modeling methods will enable reliable WYMIWYG (what you model is what you get – in the sense of performance modeling) performance of construction crews.

VDC collaboration methods enable the rapid exploration of possible construction engineering options. By facilitating (or requiring) real-time collaboration of all job functions required to engineer a particular construction aspect provide input about the most appropriate performance criteria and construction engineering solutions simultaneously. The resulting 3D and 4D models then support the communications outlined above.

VDC process modeling enables the project team members related to the engineering of a particular construction aspect to align the construction engineering and actual construction work, information, and material flows for maximum efficiency, making clear, e.g., the material and information buffers required for pull-scheduling given the time required by the project team and the designed construction engineering workflow to produce the necessary information and materials for the workforce.

Focusing on only one of the three VDC methods – technology, collaboration, process modeling – yields some construction engineering benefits. The maximum improvements in safety, productivity, and other performance goals are reached when all involved job functions collaborate effectively using timely and appropriate visual and data models in the context of a workflow that maximizes each participant’s contributions. While this may sound obvious, few projects have achieved this combination and therefore embedded construction engineering in the increasingly model-based design practice.