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ScienceDirect

Procedia Engineering 118 (2015) 774 – 780

Procedia Engineering

www.elsevier.com/locate/procedia

International Conference on Sustainable Design, Engineering and Construction

Evaluation of performance modelling: optimizing simulation tools to stages of architectural design

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Abstract

Given the necessity of resilience architecture is vital, the most effective decisions on building performance are made at design stages. Simulation represents a possible solution to the complex problem of enabling comprehensive and integrated appraisals of design options under realistic operation conditions [1]. Building Energy Performance Simulation tools (BEPS) provide an opportunity for architects to assess their design strategies in order to reach a high performance building. According to the current developments of Building Information Modeling (BIM) as an Integrated Project Delivery (IPD) tool this study tries to define a logical relation between level of development in different stages of architectural design and BEPS tools in order to fill the gap between architects and engineers in earlier stages of building design. In order to assess the current capability of the simulation tools and evaluate their platforms as an Integration of tools in building design decision making by defined criteria of Input data required for simulation, Usability and graphical visualization of the interface, Interoperability of building modelling, Accuracy and ability to simulate detailed and complex building components. In order to have a market assessment of these types of building performance tools, a survey was conducted of architectural and engineering firms of diverse size.

Peer-review under responsibility of organizing committee of the International Conference on Sustainable Design, Engineering and Construction 2015

Keywords: Building energy performance simulation; Building information modeling; Level of development; Design decision support

Peer-review under responsibility of organizing committee of the International Conference on Sustainable Design, Engineering and Construction 2015
doi:10.1016/j.proeng.2015.08.513

1. Introduction

Buildings account for approximately 50% of total U.S. energy consumption and CO_2 emissions, and as such represent a key target for efficiency improvements [2]. To reduce the total energy consumption and CO_2 emissions, industry and governments initiatives have catalyzed the energy efficient building design with different rating systems and high energy performance regulations such as the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) rating system [3], the Centre for Energy and the Environment in the UK, where develop an environmental assessment and rating system for building (BREEAM) [4], ASHRAE Standard 189.1 for the Design of Green, High Performance Buildings [5], and the International Code Council developed the International Green Construction Code (IgCC) [6]. Although these standards and rating systems have reduced energy consumption and CO_2 emission in construction sector, architects and engineers can design more efficient buildings via current enhancements of building project delivery method and building performance simulation tools.

New improvements of building energy modelling platforms and capabilities of Building Information Modelling (BIM) actuate architects and engineers to assess their design, however, building energy performance simulation still has a low impact in the building design sector, especially in design decision making in earlier stages of design.

The aim of this paper is to support architects and engineers to design energy efficient buildings by implementing appropriate building energy performance analysis platforms in different stages of architectural design to make proper design decisions.

2. Building Information Modeling (BIM) and Level of Development (LOD)

The American Institute of Architects (AIA) developed definitions for LOD specification in *AIA G202-2013 Building Information Modelling Protocol Form* [7]. The document describes and illustrates characteristics of model elements of different building systems at different Levels of Development. This clear articulation allows model authors to define standards for development, and allows downstream users to clearly understand the usability and the limitations of models they are receiving. The specification will help AEC industry to have a standardized framework as a more useful communication tool and aid individual project stakeholders in digital workflow.

2.1. Fundamental LOD definitions

AIA defines Level of Development as the description of the minimum dimensional, spatial, quantitative, qualitative, and other data included in a model element to support the authorized uses associated with such LOD [7]. Each model element develops at a different rate. The Level of Development (LOD) framework allows the project participants to understand the progression of a model element from conceptual idea to precise definition and description. Table 1. charts specifications of different LODs based on AIA definitions of design stages by numerical codes.