Degree Project Proposal

Building Information Modeling (BIM) can be used to visualize the design at any stage of the processes within the *Architecture, Engineering, and Construction* (AEC) industries (Eastman, et al., 2011, p. 198). It can allow stakeholders to receive essential information before the project is completed (Azhar, 2011, p. 251). Furthermore, BIM can be implemented as a part of a *"hybrid practice"* and be used in conjunction with additional tools (Miettinen & Paavola, 2014, p. 86). For example, BIM can be incorporated in *Building Performance Simulations* (BPS) for design evaluation (Hemsath & Timothy, 2014, p. 96). However, existing tools may not be preferred by architects due to their complexity and non-intuitive user interfaces (Paryudi & Iman, 2015, p. 81). One contributing factor is the lack of integration between design models and performance-and-simulation tools (Arayici, et al., 2018, p. 180).

According to Sampaio & Martins (2014), *Virtual Reality* (VR) can be used to reduce the aforementioned obstacles. They have shown that VR can be used within AEC. In addition, Hilfert & König (2016) demonstrates how *Head Mounted Devices* (HMD) can be used to visualize the design at a low cost. They show the implementation of *Industry Foundation Classes* (IFC) with game engines. Conclusively, Natephra, et al. (2017) have developed a performance-and-simulation tool that utilizes HMD in a VR environment. Their own prototype system, *BIM-based Lighting Design Feedback* (BLDF), simulates daylight and the illumination of artificial lights in virtual buildings. However, the authors have not used any open data exchange format, such as IFC, and suggest further research in this area to be made.

Therefore, the aim of this paper is to evaluate how the open source data exchange format IFC can be used to exchange information between BIM and a game engine for indoor lightning design. The proposed method will heavily rely on the works of Natephra, et al (2017). For the end user to visualize the proposed design, interdisciplinary mechanics need to be configured. The methods include data interoperability between two different systems - a BIM software and a game engine – as mentioned previously. Within each system, several steps are carried out as depicted in Figure 1. The goal of the present study is to develop a system for visualizing lighting design that allows users to experience, analyze, and assess the lighting quality of their designed space in an immersive environment.

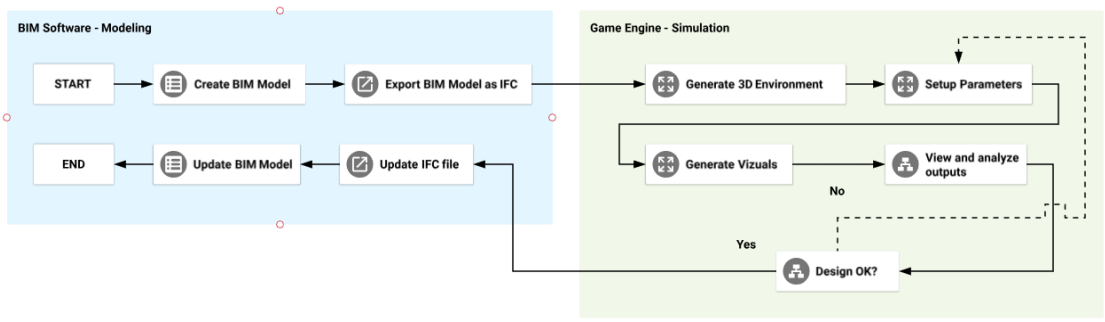

Figure 1. Overview of the proposed method (Amended from Natephra, et al., 2017).

Since Natephra, et al (2017), have already conclude that the system allows design stakeholders to better perceive and optimize lighting conditions, there's no need to redo that part. Instead, this paper will focus on collecting quantitative data similar to how Sorger, et al. (2016, p. 292) did. The collected data should be real life sensors readings – a case study - of illuminance levels (lux) paired with values from the virtual environment. The method for collecting data from the virtual environment have been explained in previous studies. Hosokawa, et al. (2016, pp. 113) shows the basis for the experiment setup.

The expected findings are close to Natephra, et al. (2017). The system should allow for realistic indoor lightning visualization and energy consumption calculation. However, the main finding should be how data exchange format work (or don't work). Thus, the implications of this study are to aid future researches who want to use IFC files. Especially, those researches who want to use IFC models and Virtual Reality for indoor lighting design. However, there are several possible limitations. Chief among them being related to hardware, software and development tools. Further limitations in the game engine's physics – how it renders light might be troublesome. Also, the level of development might limit the scene geometry in ways that are undesirable.

Due to many technical uncertainties regarding this thesis, a more optimized schedule has yet to be produced. Instead, the development of the software uses a Kanban method. For those who are technically inclined, the development can be monitored on GitHub and via the Kanban board.

Title	Start date	Deadline
Final Thesis	2019-05-27	2019-06-03
Thesis Draft	2019-05-13	2019-05-27
Analyze Data	2019-04-29	2019-05-10
Set up IFC exhange script	2019-04-12	2019-04-26
Set up VR HMD	2019-03-28	2019-04-19
Set up BLDF process	2019-02-14	2019-03-14
Set up development tools	2019-02-11	2019-02-14
Acquire development tools	2019-01-01	2019-01-11
Draft literature review	2019-02-04	2019-02-08
Finalise objectives	2019-01-28	2019-02-01

Figure 2. Outline of work schedule.

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