A framework for Virtual Interactive Construction Education (VICE)

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ABSTRACT

Training and process analysis in the construction industry has not taken full advantage of new technologies in simulation, modeling, and semantic web and software engineering. The purpose of this research is to develop a framework for a virtual interactive construction education system taking full advantage of these technologies. The modules will simulate the construction process for a facility from start to finish using information drawn from domain experts using real projects in the built environment. These modules can be used as training tools for new employees where they attempt to optimize time and cost in a virtual environment given a limited number of equipment, time and employee options. They can also be used as a process analysis tool before, during and after construction where a number of situational variables could be analyzed for exposure of potential risk. These modules would be particularly useful for repetitive construction where the initial project or task is analyzed for optimization and risk mitigation. This paper describes the framework using a residential construction example that is a 900 square foot (about 85 m²) wood frame single family house designed for the United States.

1. Introduction

The annual gross output of the United States construction industry is over a trillion dollars per year which comprises nearly five percent of the total output of all industries. There is currently a need to improve construction education and training by incorporating advances in simulation, modeling and semantic web and software engineering. Contextually rich interactive simulations have proven effective at improving the educational experience in fields like health care and military operations. Simulations were shown to improve skills and safety in surgical skills [1,2], training anesthesiology [3] and laparoscopic and cardiovascular techniques [4]. The U.S. Army claims that this new generation learns more efficiently using simulation games [5].

Betts et al. [6] found that active project-based learning will more likely meet educational objectives than traditional lectures in construction education. Construction simulations can provide project-based experiential learning leading to better prepared graduates entering the workforce. This type of learning also has the potential to eliminate some of the risks associated with the learning curve phenomenon and on-the-job training.

Simulation-based learning modules address the fundamental need to reinvigorate instructional methods and approaches in engineering education, which have changed little in over a century. The expectation is that students need to adapt to traditional delivery methods instead of delivery adapting to the students. This problem is particularly acute with Generation Y students, the so-called “Internet generation,” and succeeding generations. Gen Ys frequently play online games for socializing and entertainment [7]. Students will stay up all night with an exciting video game but have difficulty maintaining enthusiasm for some traditional learning methods. Simulation-based learning tools are increasingly being used in the classroom to engage and motivate students, and assist in recruitment of students to meet the demand for qualified personnel in technology-related fields such as information technology (IT), architecture, engineering and construction [8].

This paper introduces the framework for a virtual interactive construction education (VICE) system which is an on-going research project at the University of Nebraska. The framework for the VICE system and the software user interface using 3D technologies are described.

2. Literature reviews

Early construction education simulation can be traced back to over half a century with the development of the Critical Path Methods and the Program Evaluation and Review Technique (PERT). Computer availability in the 1980s allowed these simple simulation programs to find their way into construction education and training throughout the country. Other construction simulation programs were also being introduced around that time. Halpin [9] developed CONSTRUCTO as an educational simulation tool for training on-site construction management using real projects. Harris and Evans [10] focused their