Serious games for integral sustainable design: Level 1

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Abstract

The use of videogames to provide engaging learning contexts known as serious games has emerged over several years and has proved effective in many contexts, but has minimal uptake in sustainable design education. We present a project that explores how serious games may be utilized to introduce Integral Sustainable Design (ISD) which proposes a holistic approach, where there is equal emphasis on quantitative performance and qualitative evaluation. A targeted review of relevant serious games precedent and theory is discussed, which informs the specification of three game levels that provide increasing degrees of challenge, choice, collaboration and context. In conclusion we document the completion of level 1, along with an outline of further work.

1. Introduction

We provide an overview of a project that explores the use of serious games for sustainable design education and document the rationale and features of stage 1 of the project, a 3D simulation game set in a non-realistic landscape. We must emphasize from the start, that our intent is to provide a fun, abstract learning space with ‘rule of thumb’ performance feedback on design decisions and is not intended to provide the accuracy of scientific simulation or the vividness of photo-realism. Another distinguishing principle is that the project is informed by Integral Sustainable Design Theory (ISD), which proposes a holistic approach to sustainable design, integrating qualitative as well as quantitative perspectives [1]. The target audience is first year architecture and design engineering students, with the...
primary learning objective being to provide an engaging introduction to ISD principles. In particular, the integration of performance measures and qualitative evaluation, viewed from individual and collective perspectives. A secondary learning objective is to introduce students to the principles of parametric design, where multiple design iterations can be generated from associative geometry. The aim is to develop serious game environments that enable students to adjust design parameters for typical building configurations, with real-time feedback on design permutations and asynchronous qualitative feedback from their peers. Our proposal can be thought of as a scaffolding application that introduces ISD principles in an engaging way, as a precursor to designing with professional parametric design and environmental simulation software.

The project is grounded in a targeted literature review of serious games, providing a condensed overview of activity, evaluation of their effectiveness and precedent for their use for sustainable development and design education. We then articulate the learning context, introduce ISD and from this determine the learning objectives for the project. From here we introduce the basics of game design, through a discussion of serious game characteristics in relation to integral sustainable design and design pedagogy in general. This overview is complimented by our previous experience with using game engines for collaborate virtual environments and a discussion of flow theory, which is considered within the literature of serious games as an essential requirement for producing an engaging experience for learners. In the next section, we specify three game levels that become increasingly sophisticated. Level one explores a game world that is a balance between non-realistic graphics and a quasi-realistic design scenario, based on designing simple orthogonal buildings in an evocative landscape. The emphasis is on realizing and evaluating a graphic environment, game logic and design interface that meets the essential requirement for a game to ‘flow’. Level two will extend the parametric design tools, introduce more performance measures, and differentiate environments in terms of climate and weather. The emphasis for this second level is on enhancing the range of geometry, materials and environmental feedback in a range of contexts. The ambition for the third level is to extend the single player mode to provide a collaborative learning environment for architectural and engineering students. The aspiration is to have small teams of architectural and engineering students competing against the game logic and each other, and in the process developing their discipline specific skills and ability to collaborate to achieve shared objectives, foregrounding their professional roles. The final section of this paper graphically documents the implementation of level 1. This first working game level enables the design of simple orthogonal buildings set in undulating terrain in a temperate climate; where the design parameters are location, orientation, proportions, fenestration design and material specification.

2. Serious games and precedent within sustainable design education

The original use of the term ‘serious games’ lies with US researcher Clark Abt who designed games with “an explicit and carefully thought-out educational purpose” - in his context the deadly serious simulation and role playing of the cold war scenarios of the 1960’s [2]. Since this generalist definition, there has been a range of activity that aligns ‘learning and play’, which include educational games, edutainment, instructional games, games for learning, and synthetic learning environments. The presumption behind these various takes on combining an educational agenda within a game context, is that learners will be more motivated. However early versions of edutainment and instructional computer games, have been described as combining mere practice and drill with token aspects of play [3]. Charsky argues that just as entertainment games have become more sophisticated, games with an educational agenda have developed substantially [4]. The re-emergence of the term serious games in the last several years is aligned with game environments and interfaces that deliver levels of engagement present in successful entertainment genres. Serious games are now established mechanisms for education and training in public policy, education, business, healthcare and the military. Their production is now a significant part of the games industry and game studies is a burgeoning field of research within academia. This second coming of serious games as it were, is typically based on much more engaging elements that exploit the essential characteristics of play, which include competition and goals, challenging activities, choices and an element of fantasy [5].

Parallel to the increasing sophistication of game production, has being the evaluation of their educational effectiveness. Boyle et al [6] have updated a previous review undertaken in 2012, to analyze the effectiveness of games for learning, which collates research outcomes for the period 2009-2014. Using a rigorous quality assessment matrix they located 71 studies that reported empirical evidence across multiple disciplines with Science,
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