SUPPORTING DESIGN EDUCATION IN
3D VIRTUAL WORLDS: A CASE STUDY

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ABSTRACT

The higher education sectors of architecture, engineering and construction management are among the first to utilise IT to full advantage with a wide range of CAD and project management software, as well as e-learning technologies. What the future holds for design education is further changes as such technologies loom on the horizon. Within this context, the paper presents a case study in which 3D virtual worlds - a type of virtual reality (VR) and social network technologies - are adopted as a collaborative design and learning environment for architectural education. Based on the outcomes of the course and the students’ collaborative learning experiences, the paper discusses the potential of adopting 3D virtual worlds in design education, in terms of distance learning, collaborative learning and problem-based learning.

Keywords: design education, 3D virtual worlds, distant learning, collaborative learning, problem-based learning.

INTRODUCTION

The higher education sectors of architecture, engineering and construction management are among the first to utilise IT to full advantage with a wide range of CAD and project management software, as well as e-learning technologies. The utilisation of e-learning technologies is both exciting and challenging in design education worldwide. 3D virtual worlds - a type of virtual reality (VR) and social network technology - are the latest form of e-learning environments. They are
networked environments designed using the place metaphor, supporting a wide range of online activities. A 3D virtual world distinguishes itself from other networked technologies by emphasising being in a “place” (Kalay and Marx 2001), where a sense of presence (the awareness of the self, peer and instructor) and a sense of space (the awareness of the learning environment) are supported. Historically, the most common e-learning tools are web-page-based platforms. These platforms are not intended specifically for design education, and generally lack adequate support for synchronised design communications and design actions. The aim of this project is therefore to identify and discuss the beneficial factors of 3D virtual worlds as a design environment for pedagogic purposes. Within this context, the paper presents a case study in which 3D virtual worlds were adopted as a collaborative design and learning environment for architectural education. Students located in two different parts of the world collaborated on a design project via the Second Life virtual world platform (www.secondlife.com). After presenting the outcomes of the course and the students’ collaborative learning experiences, the potential of adopting 3D virtual worlds in design education is discussed against three main pedagogic concepts: distance learning, collaborative learning and problem-based learning.

E-LEARNING TECHNOLOGIES FOR DESIGN EDUCATION

Web-page-based platforms: The most common tools for e-learning are web-page-based platforms such as Blackboard (www.blackboard.com) and WebCT (www.webct.com). These platforms are essentially networked databases that store course materials such as lecture notes and assessments and, in addition, provide asynchronous communication facilities including recordings of lectures and discussion forums. Users access the databases through a graphical interface similar to a web page. They are most useful for recapturing what has happened in physical learning environments. In many scenarios, these traditional e-learning tools often disadvantage learners that are geographically removed from the source because they exclude them from the actual “actions”. This limitation has appeared to be even more critical in design education as the dominant method of design learning and teaching is largely project-based and situated in a design studio. The success of such a method relies on students’ direct interactions with academic
staff - the “masters” - and with their peers through constant discussions and critiques. Traditionally, these interactions are face-to-face and often “hands-on”.

**Virtual design studios:** From the mid 1990s, Virtual design studios (Schnabel 2000; Kvan et al 2000; Maher 1999) have been set up by leading design schools aiming to provide a shared “place” where distance design collaboration including synchronised communications and designing activities can occur. The forms of virtual design studios vary from early approaches of digital design data sharing to the more recent 3D virtual world approach where designs as well as designers (the students, peers and instructors) are simulated and represented in a virtual environment as 3D digital models and avatars (3D animated characters) respectively, allowing for “design within the design”. Commercial 3D virtual world platforms such as Active Worlds (www.activeworlds.com) and Second Life have set up large-scale virtual campuses extending such concept. Researchers meanwhile have taken a strong interest in the potential of these new environments for design education beyond distant learning. Kvan (2001) argues that while design education has traditionally focused on products, virtual design studios allow students to learn more about design processes. Dickey (2005) suggests 3D virtual worlds can provide “experiential” and “situated” learning. Clark and Maher (2005) examine the role of place in 3D virtual worlds that encourages “collaboration and constructivism”. Prasolova-Forland (2004) assesses the use of 3D virtual worlds for supporting social awareness among design students. Wyeld et al (2006) focus on the cultural aspects in 3D virtual worlds where students from different cultural backgrounds design and learn collaboratively. Despite of these attempts, 3D virtual worlds so far have not been widely adopted in design education and further evidence is needed to understand their potential.

**CASE STUDY: NU-GENESIS**

Students in current higher design education such as the ones enrolled in architectural programs will be moving into the workforce in three to five years, and will be confronting changing technologies and skills in their everyday workplace. It is therefore imperative that as educators we look to challenge students with new experiences to better equip them for the workplaces of the future. The following is a description of NU-Genesis, a course where students
were introduced to such experiences. We used the Second Life virtual world platform to enable and support distance design collaboration, to introduce and exercise core skills of teamwork, and to stimulate and challenge design students with new design contexts.

**Course Overview**
The aim of NU-Genesis was for students to understand and develop the essential skills of collaborative design and modelling using 3D virtual worlds; and to develop an understanding and hands-on experience of 3D virtual worlds as an extension of conventional architectural design. For students to develop an understanding of collaborative design in a 3D virtual world, firstly, relevant theories such as the development of core skills for teamwork, as well as design and collaborative cases in 3D virtual worlds were introduced and discussed. The concepts associated with collaboration across cultures were also raised. Secondly, students were guided to inhabit and critically assess a wide variety of design examples in 3D virtual worlds, as well as various design and communication features supported in 3D virtual worlds. For the students to develop and practise these design and collaborative skills, a remote collaborative design project was used as the major assessment item. The weekly studio included a one-hour lecture/instruction and a two-hour design/discussion.

Our first collaboration in 2008 attracted 36 Newcastle students from our second year undergraduate architecture program. They were divided into groups consisting of three to four individuals. Each group was then allocated one to two remote collaborators from Rangsit University, Thailand who were enrolled in the third year of their undergraduate architecture program. Students from both universities collaborated over a period of five weeks in the “Virtual Home” design project using Second Life. The project provided opportunities for students to experience and practice collaborative design in 3D virtual worlds, and to develop and apply design principles and technical skills for virtual world design. The design brief used a virtual world as a new design context to challenge the students, and required them to design and implement a place in Second Life to demonstrate their concept of a “Virtual Home”. The “Virtual Home” was to go beyond the traditional design concept of a conventional home in the built environment, and reflect the unique characteristics and experiences possible in a
Each team was assigned a plot of virtual land in Second Life for the project implementation.

Each student team was required to design its team dynamics and to establish team management protocols. This involved them in defining the roles of their team members, and discussing their plans and protocols with their instructor. These activities occurred during the early weeks of the project. The instructors’ role at this time was to offer advice and assist in facilitating activities. During the course of the project the instructor’s input in these activities diminished, allowing student design groups to take ownership of their decision-making. The groups were formally introduced to each other and additional opportunities were provided for more informal discussions prior to the design collaboration. The objectives of these meetings were to familiarise students with each other and to raise their awareness of cultural differences that might challenge their efforts.

The quality of the communication between the individuals in the groups was critical to the outcomes of the project on both the design level and the team management level. To facilitate communication each design team was required to use Second Life or other electronic communication tools such as Skype, MSN Messenger, email etc. to conduct at least one project meeting per week during the five-week collaboration. The expectation was that at least two of these meetings were to be conducted synchronously in Second Life with full attendance and participation of the whole team in the design activity. Each team was also required to keep weekly project meeting logs with comprehensive communication records so that they could reflect on their experiences at a later date.

**Course Outcomes**

This initiative considers the virtual design project as a design activity that provides students with learning challenges to extend their understanding of the design process and their design skills in a new context.

*Exploring creative design:* Students demonstrated formidable abilities in adopting various approaches to design development. They also explored the potential of 3D virtual worlds as an alternative means or context for exploring creative design. The design outcomes saw the island used to its full capacity and, because of the
flexibility of the virtual space, the designs were able to utilise three different layers: under the “water”, on the “ground”, and in the “sky”. This provided many unusual sites, which in turn stimulated the emergence of a range of interesting design solutions. Many groups were motivated to develop their designs on unusual sites, for example, an “underwater” site or a floating site in the “sky”, which would often be beyond the scope of a conventional architectural studio.

Selected designs of a “Virtual Home” are displayed in Figure 1, each of which represents a different interpretation of a “Virtual Home”. Two different design approaches emerged from NU-Genesis. The first is the form-based approach where students start with an exploration of interesting forms, and then adopt or sometimes even “make up” a concept afterwards. These groups often reach design solutions quickly and then move on to detailed design and documentation, as their design collaboration begins with form making and detailed modelling. The second approach is the concept-based approach, where students firstly explore, develop and agree on concepts with more in-depth, and then realise the concepts through 3D models. They often progress slowly especially in the early stages compared to the groups that adopt the form-based approach. However, their design outcomes often become more sophisticated. This demonstrates that students were provided with unique opportunities for design in a very different context from the normal experiences of design students. These experiences extended to the requirements as well as the potential for exploration of creative design.

Figure 1. Six selected “Virtual Home” designs.
Supporting collaborative design development: As well as having a unique experience with an opportunity to apply their design skills to a new context, students were able to explore and adopt a wide range of communication and visual aids from 3D virtual worlds, as shown in Figure 2, to assist their design collaboration.

In Figure 2, the left image shows a “group photo” captured directly from Second Life. The identity of individuals in 3D virtual worlds appears to be an essential factor during collaboration. Students spend considerable amounts of time customising their avatars to reinforce their virtual identities. Functionally they often used avatars as reference points when referring to design elements and 3D models during collaboration. For example, they often made statements such as “the floor above ME” or “the box next to YOU” and etc. In some designs, avatars also became an important part of the “Virtual Home”. In most of the design presentations, avatars have been used to help present experiences of inhabiting the “Virtual Homes”. In addition, students import 2D scanned sketches, as shown in the middle of Figure 2, into 3D virtual worlds for synchronous communication. They also export screen shots, as shown on the right of Figure 2, from 3D virtual worlds for asynchronous communication such as email attachments.

Some groups demonstrated a high level of competency in applying and adopting 3D virtual world features for different design phases. For example, in the “Archi-Bio” project, students successfully demonstrated how a group can strategically use different features in 3D virtual worlds to develop from an initial concept in the form of a scanned image that inspires the design (Figure 3 left) to abstract 3D
volumes that assist the conceptual development (Figure 3 middle) to the final detailed implementation of the “Virtual Home” (Figure 3 right).

Figure 3. The development of the “Archi-Bio” project.

Evaluation and Discussion
Upon the completion of the collaboration, a student survey on their perceptions of adopting 3D virtual worlds for design and collaboration as well as a comprehensive evaluation of the effectiveness of various technical features in 3D virtual worlds for collaborative design and learning were conducted. The results have been documented in Gul et al (2008) and Gu et al (2009) respectively, which indicate that there are both opportunities and challenges when adopting the technologies. This paper however focuses on discussing the potential of 3D virtual worlds in relation to the following three main pedagogic concepts.

Distance Learning: The traditional distance learning tools such as Blackboard and WebCT are essentially networked databases that store course materials and assessments as well as provide limited communications. They are most useful for recapturing what happened on a physical campus. This limitation is especially critical in design education as the dominant method of design learning is largely project-based, and often situated in a studio environment, which requires direct design interactions. 3D virtual worlds, as the latest technologies for distance learning, have the potential to better accommodate such needs because they provide an integrated environment and support design and communication across different phases of a project life-cycle from early conceptual design to detailed design, to final documentation. In terms of engagement, 3D virtual worlds provide a shared “place” supporting a sense of presence (the awareness of the self, peer and instructor) and a sense of space (an awareness of the design and learning environment), to allow remotely located design teams to collaborate effectively.
**Collaborative Learning:** Virtual environments used for educational purposes are often called learning virtual environments (LVEs), educational virtual environments (EVEs) or collaborative virtual environments (CVE). NU-Genesis shows that 3D virtual worlds clearly have the potential to enable innovative and effective design education, involving discussion, role-play, simulation, stimulation, problem-solving and decision-making in a group context. This has been echoed by other researchers, who have emphasised the importance of communication and collaboration in education in general, through experiments with various current technologies. For example, The DeskTOP CVE (Portugal et al. 2000) was developed to support and promote collaborative learning in universities. The project aimed at creating new possibilities for communication between users and increasing the awareness that users have of each other. The DigitalEE (Okada et al. 2003) project aimed at using a CVE in environmental education. The system was meant to support discussions and information exchange between different users, create a place where knowledge can be recorded as well as make experiences of certain natural environments and processes possible through virtual reality. Our experience in NU-Genesis demonstrates the success in introducing design students to CVE, encouraging them to learn and interact in a group environment, and engaging them in collaborative design across geographic locations and cultures. We have provided our students with a collaborative learning experience by bringing them together in a design project that requires them to plan and manage a design team remotely.

**Problem-based Learning:** Problem-Based Learning (PBL) has been a significant force in higher education for more than thirty years. PBL has been controversial since its earliest beginnings, but has initiated change in higher education, for the most part in professional education including architecture, engineering, construction management, law, medicine etc. PBL was introduced in the late 1960s as an innovative educational approach to undergraduate engineering education (Woods 1985). Impetus was given to PBL by its adoption, more or less simultaneously in the early 1970s, by undergraduate programmes in medicine at McMaster (Canada) and at Maastricht (Netherlands) (Norman 1988), followed in the late 1970s by medicine at Newcastle (Australia). The PBL approach provides an effective educational framework for the development of a learning
environment that encourages risk taking and engages students in high levels of collaboration. This means that it is eminently suited to the introduction of new learning experiences without the fear of failure traditionally experienced by students when a more traditional approach to learning and particularly assessing is employed. The following are characteristics of successful PBL experiences:

- The learners should have active learning roles rather than passive roles.
- It permits learners to make informed choices in conducting learning activities and to reflect on the consequences of their decisions.
- Learners engage in enquiry into the application of intellectual processes and current problems.
- Learners engage with real problems with appropriate resources.
- Learners reapply learned intellectual processes into a new context.
- Learners are provided with opportunities and skills to refine their work following reflection.
- It involves learners in the application and mastery of skills to standards appropriate to their profession.
- It engages learners in working collaboratively to reach learning outcomes.

As shown in NU-Genesis, these indicators are particularly pertinent to 3D virtual worlds. Research on virtual reality technologies provides compelling evidence of the potential of these emerging technologies to facilitate learning activities as constructive platforms (Dede et al 1996, Winn 1993). These new constructive learning platforms facilitate the activities, which are required for PBL experiences. Dede (1995) points out that 3D virtual worlds offer many benefits including opportunities for experimentation without real-world repercussions, opportunities to “learn by doing”, or “experiential learning” and ability to personalise a learning environment. These provide compelling evidence of the potential of adopting virtual reality technologies such as 3D virtual worlds to facilitate learning activities as constructive platforms.
CONCLUSION

Although to extend the use of 3D virtual worlds in design education requires further investigation, this paper presents NU-Genesis, a successful case study in which 3D virtual worlds were adopted as a collaborative design and learning environment to support architectural students from two different parts of the world in collaborative design and learning. Our early experiences of NU-Genesis for collaborative architectural design have shown a wide range of opportunities for enhanced student learning. Students have successfully collaborated across geographical and cultural boundaries, demonstrated strategic approaches in adopting various design and communication features supported in 3D virtual worlds for collaborative design development, and widely explored new design opportunities inherent in 3D virtual worlds. The potential of 3D virtual worlds for design education can be realised through the support for distance learning, collaborative learning and problem-based learning.

REFERENCES


Winn, W., 1993. “A conceptual basis for educational applications of virtual reality”, Human Interface Technology Laboratory, University of Washington.