

# CONQUERING NEW WORLDS

## *Application and Evaluation of Collaborative Virtual Environments in Design Education*

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**Abstract.** Two Architecture Schools that are geographically separated provided students with a learning experience in Collaborative Virtual Environments (CVEs). Reported in this paper is the experience of the students as well as a commentary on the quality of the outcomes they achieved whilst confronting this new learning experience. A comprehensive questionnaire was developed and used in the end of the collaboration for students to reflect and evaluate their design and collaborative experiences. Based on the questionnaire results, this paper documents the issues that the students experienced in CVEs from the communication aspect, the design support aspect, and the collaboration and teamwork aspect. The paper concludes with insights on how this initiative can inform the way that we can better support design education in CVEs.

**Keywords.** Design Education; Collaborative Virtual Environments; and Student Perception.

## 1. Introduction

Technologies are changing the way design is conducted. Computer Aided Design (CAD) packages and the availability of high bandwidth networks have offered new collaborative environments for design. Despite the impact of the

technologies, there still remain the fundamental skill sets of design, one of which is effective collaborative skills. We must ask ourselves does technological development provide the potential to change the way collaboration occurs. This paper documents the confluence of technology and the design activity in a new learning domain. Two Architecture Schools provided students with a learning experience in Collaborative Virtual Environments (CVEs), which introduced them to designing in the virtual domain and provided a forum with the potential for high levels of collaboration. Students were involved in the collaborative designing and implementation of a “Virtual Home” in Second Life, a commercial 3D virtual world. It allows effective synchronous collaboration activities as well as opening up the opportunity to explore design creativity. Introduced into the learning experience, of confronting design in a virtual domain and new design protocols, are the skills associated with collaboration with design participants of a different culture and differing primary languages.

To facilitate collaboration in design education using CVEs requires further understandings of the technologies as well as understandings of designers’ and learners’ affordance in adopting the technologies. In our previous studies, we have critically evaluated the features in CVEs for supporting collaborative design and learning (Gul et al. 2008). We have also developed and examined the new principles required for designing and teaching in CVEs (Gu et al, 2007). Complimenting these earlier studies that focus on the application and evaluation of the technologies, this paper reports the design and collaborative experience in CVEs from the students’ perspective, with a commentary on the quality of the outcomes they achieved whilst confronting this new learning experience. A comprehensive questionnaire was developed and used in the end of the collaboration for students to reflect and evaluate their design and collaborative experiences. This paper documents the issues experienced by students in using CVEs from the communication aspect, the design support aspect, and the collaboration and teamwork aspect. The paper concludes with insights on how this initiative can inform the way that we better support design education in CVEs.

## **2. Design education in collaborative virtual environments**

CVEs clearly have the potentials to enable innovative and effective education, involving debate, simulation, role play, discussion groups, brainstorming, and project-based group work, etc. While advanced multi-user educational CVEs are still mostly speculation (e.g. Loeffler, 1993), simpler CVEs based on standard technologies have been in existence for some time such as (Eisenstadt

et al., 1995; Hiltz, 1993; Scardamalia et al., 1992). Many researchers of CVEs, stress the importance of collaboration and communication and experiment with currently available communication and information technology.

In design education, web-based tools have been widely used (Craig & Zimring, 2000; Rummel et al., 2005) in particular in the form of online design studios. Broadfoot and Bennet (2003) define online design studio as a web-based studio, which is a “networked studio, distributed across space and time”; such that the participants of an online design studio maybe in different locations handling design communications via computer. Recently, virtual design studios (Maher, 1999; Kvan, 2001; Schnabel et al. 2001) have been set up by architecture and design schools around the globe aiming to provide a shared “place” where distant design collaboration especially synchronous communications and design activities can take place. The forms of virtual design studios vary from the early approach of digital design data sharing to the more recent 3D virtual world approach where the designs as well as the designers and learners are simulated and represented in the virtual worlds allowing the so called “design and learning within the design”. This new phenomenon has caught the attention of many design academics. The effects of CVEs on the learning process, on the creativity and on the quality of the design solutions and design process are currently of heated debate in academia.

Integration of the communication and information technologies into design curricula may offer many possibilities to design schools that should recognise the significance of designing in new environments, leading the research and development of new teaching and learning theories. There are approaches that occupy the emerging fields of digital design into design education, such as employing parametric design, interaction design, experience design, graphic design, product design, etc. Despite those studies, there is still a general lack of understanding of the student perception on the application of CVEs in design education.

### **3. A collaborative design studio in Second Life**

The collaborative design studio was the result of an international collaboration between the University of Newcastle, Australia, and Rangsit University, Thailand. “NU Genesis”, a virtual island in Second Life was set up as the virtual site for collaborative design and learning. Students from both universities collaborated over the period of 5 weeks on a design project titled “Virtual Home”. The weekly format included a one-hour lecture and a two-hour design studio. In 2008, the course attracted 36 Newcastle students from the 2<sup>nd</sup> year undergraduate architecture program. They were divided into groups of three-

four students and each group was allocated with a remote collaborator from Rangsit University.

**Course aim and structure:** the aim of this course was for students (1) to understand and develop the essential skills of collaborative design and modelling using CVEs, and (2) to develop the understanding and hands-on experience of CVEs as a new kind of environment design. The course content was structure included two major components: *understanding* and *practising* collaborative design in CVEs. In order for students to develop the understanding of collaborative design in CVEs, firstly, relevant theories and design case studies of CVEs were introduced and discussed. Secondly, students were instructed to inhabit and critically assess a wide variety of designs in CVEs. In order for the students to practise and demonstrate the design and collaborative knowledge and skills learnt from the course, a collaborative design project was used as the major assessment item.

**Collaborative design project:** With structured design supervision and technical tutorials, the collaborative design project titled “Virtual Home” provided opportunities for students to (1) experience and practice collaborative design in CVEs, and (2) develop and apply design principles and technical skills for virtual design in CVEs. Each group designed and implemented *a place* in Second Life which demonstrated their concept of a “Virtual Home” and this extended the boundaries of a physical home (developed by students in an earlier conventional design studio). Through interactions between the avatars and the “Virtual Home”, the group’s understanding of experience in the “Virtual Home” would need to be demonstrated. The “Virtual Home” and the collaborative experience in CVEs of each group were documented in a slide presentation.

**Design collaboration:** Besides the use of Second Life as the main collaborative design and learning platform, students were introduced to a wide range of synchronous and asynchronous tools, and were encouraged to adopt and apply these in supporting their group collaboration. Each group was required to maintain a weekly group log, which served in monitoring group collaboration and provided a forum for student self-reflection.

#### 4. Perceptions of students to collaborative design and learning

Following the completion of the course, students in both institutions were asked to complete a questionnaire covering the following aspects:

- evaluating the effectiveness of the tools for communication and design (10 questions - on a five-point Likert scale statements),
- identifying likes and dislikes on the collaboration process (10 open-ended questions),
- evaluating the collaborative design and learning process (10 questions - on a

- five-point Likert scale statements), and
- providing background information of the students.

The sample size is good with, 32 of a class of 36 responding. 56% of the students were male. 70% of the students have 2-3 years design experience. 22% of them have only 1 year design experience. 100% of the students have a personal computer, only 17% of them do not have internet connection at home. 96% of the students experienced Second Life for the first time during this course. The students are considered both as novice designers and CVEs users. We summarise the students' questionnaire answers indicating their preferences and perceptions as follow:

**Communication:** 42% of the students stayed as neutral when comparing email correspondence with Second Life communication. 32% of the students thought Second Life as a communication tool was "effective/very effective".

- Students were divided about comparing Second Life and other asynchronous communication technology such as blogs and wikis. 35% of the students rated as "effective/very effective", the chat channel in Second Life, as a tool to communicate and share ideas whilst 33% of the students rated "not effective/not very effective".
- 45% of the students thought that MSN messenger is more effective synchronous communication tool than Second Life is. 42% of the students rated as neutral.

**Design support:** Students were divided about how satisfied they are with the decisions and solutions developed in the collaboration task. 39% of the students rated as neutral, another 39% were "dissatisfied/ very dissatisfied".

**Teamwork:** Some students found it difficult to work together citing inability to meet face-to-face. 51% of the students "agreed/strongly agreed" with that statement, and 25% of the students "disagreed/strongly disagreed".

- 51% of the students found managing team activities difficult in remote designing.
- 40% of the students "agreed/strongly agreed" that teamwork tasks encouraged collaborative learning. 42% of the students were not sure as they rated neutral.
- 55% of the students did not establish a plan or procedure for teamwork.
- 48% of the students thought that they gained knowledge and skills from their group members during the collaboration project.

Students also commented on communication mode, design support and teamwork during the design project. Some comments include:

**Communication:** "[...] Synchronous (communication) was (the) most effective when meeting however asynchronous (communication was the most effective) when organising meetings and giving group information".

"Text-based chat was the most appropriate. Audio can be a helpful tool but depends on the connection".

**Design Support:** "[...] 3D collaborative modelling - instantaneous and easy

to relay. [...] I like that the group could see objects being made instantaneously - could discuss. [...] dislike that it was hard to meet at the same time”.

“Second Life is not compatible with other rendering software and has basic modelling technologies. But application of textures and lighting is excellent. [...] (Second Life is) very easy and quick for modelling”.

“3D is easier to understand the concept of the design and gives an impression of how it looks/behaves. [...] Second Life was an entertaining, novel mode of communication, but was not often helpful, as it required every group member to be online”.

**Teamwork:** “[...] Face-to-face meeting was the most productive”.

“[...] Email was good because we did not need to co-ordinate meeting times. Second Life face-to-face and phone call were good to get fast responses. [...] Coordination of both emails and messages are useful to coordinate a meeting on Second Life”.

“[...] (I dislike emails because) people don’t regularly check their emails and therefore it slowed down (the) progress”.

“[...] (I like that) Second Life - could communicate instantly whilst exploring options and activities”.

The results of the questionnaire indicate polarisation among students over the tools used during the collaboration project. The results and our observation and discussion with the students indicate some major collaboration management problems, which impacted on the overall satisfaction on their design decisions. The design outcomes clearly indicate that the students are able to design and implement their ideas and concepts in Second Life to a satisfactory level. However, the students in both universities were frustrated with several problems including: collaboration management, monitoring tasks and responsibilities of each member, delay in responses, language barriers, cultural differences, the lack of shared understanding of the design concepts and ideas, and lack of common goal in collaboration. The students identified the following features of CVEs as requiring future development:

**Support for 3D design development:** the 3D representation of design allows clearer and more effective design communication among group members, compared to 2D sketches. The 3D representation provides an instant visual feedback of design creation and modification.

**Support for team collaboration:** collaboration support tools are necessary for keeping track of design ideas and development in a group chat situation. Effective monitoring of group activities would encourage participation. There is a need for better support of collaborative 3D modelling, including: referencing and pointing objects, more complex modelling and object sharing, including: version control, compatibility and compliance with professional CAD standards and etc. Possible add-ons to customise the platform for design collaboration for specific design disciplines and import and export more varieties of resources

for collaboration (for example, direct information flow with conventional CAD systems) would enhance collaborative 3D modelling.

## 6. Group design outcomes

Based on the results of the questionnaire, CVEs as potential platform for collaborative design and learning remain a challenge to design students. To further adopt CVEs in design education will require improvement in design supports provided in CVEs and more importantly the careful planning and development of curriculum. These issues will be discussed in the following concluding remarks section. Nevertheless, our early trial of the collaborative design experience proved to be fruitful. Students demonstrate formidable abilities in adopting various communication and collaboration technologies in design development. They also widely explore new design potentials in CVEs as demonstrated in the outcomes of the collaborative project.

As shown in Figure 1, students explored and adopted a wide range of visual aids from CVEs in assisting their group communication. The left-hand-side of Figure 1 shows one particular “group photo”. The individual identity in CVEs during collaboration appears to be an essential factor. Students spent considerable amount of time in “pampering” the avatars by customising the figures and purchasing new clothes in order to reinforce their virtual identity. Functionally, students used avatars as the reference points when referring to design models and objects during collaboration, for example, they often made statements such as “the red cube next to me” and so on. Avatars also become a part of the “Virtual Home” design. In most of the design documents produced, avatars were important elements that help to illustrate the experience in the designed places. In addition, students also imported 2D scanned sketches (Figure 1 middle) into CVEs for synchronous communication, and exported screen shots (Figure 1 right) from CVEs for asynchronous communication such as email attachments (Figure 1 right).

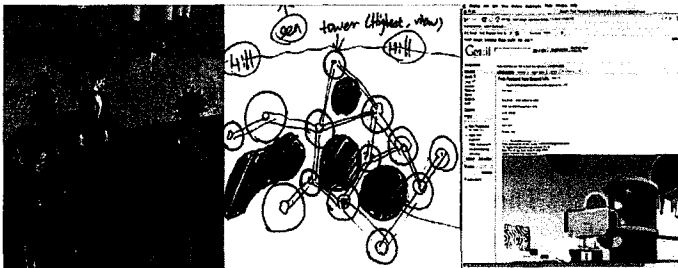


Figure 1. Varieties of visual aids used during design collaboration.

Some students demonstrated a very high level of competency in applying and adopting CVEs for different design stages. For example, in the “Archi - Bio” project, students demonstrated how the group strategically used CVEs to develop from the initial concept in the form of an image that inspired their design (Figure 2 left) to the abstract volumes that assisted their conceptual development (Figure 2 middle) and to the final implemented “Virtual Home” (Figure 2 right).



Figure 2. The development of “Archi - Bio” in three different stages.

The student submissions prove the potential of CVEs as alternative means for exploring design creativity. Among various interesting submissions, Figure 3 demonstrates three different approaches in exploring the design of a “Virtual Home”: (non) gravity as the design trigger for home design (left); home as series of portals that shift the occupants from one mind set to another and from one activity to another; home as a place for communication inspired by poetry.

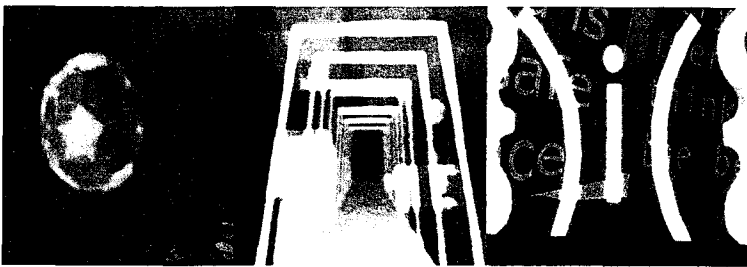


Figure 3. Various new design ideas for a “Virtual Home” in CVEs as explored by students.

Some students explicitly focused on the creation of different experiences in the “Virtual Home”. They made use of the interaction between the design representations of the avatar and the designed environments to explore and document different experiences. Figure 4 shows three different ambient environments that imply three different “emotions” in the “Virtual Home”.





Figure 4. Three different ambient environments implying three different “emotions” in the “Virtual Home” that form parts of the “Metamorphosis” project.

## 7. Concluding remarks

This paper presents our experience in a studio project developed by the University of Newcastle, Australia and Rangsit University as a novel collaboration attempt between design institutions, and reflection and evaluation from students on their collaborative design and learning experience. Our observations show that the course provides students with opportunity for design collaboration in remote locations and new experiences of virtual design. Students learn collectively during the design processes experiencing both asynchronous and synchronous collaboration. Besides the above findings of student perceptions on collaborative design and learning in CVEs, we highlight the following issues that need to be considered when implementing collaborative design and learning in CVEs.

**Degree of collaboration:** Teamwork and group discussions should lead to developing a participatory environment that is essential to increase a shared understanding of design. The groups should include students with different background and interests. Students should distribute the task according to the interests and skills and gain experience of working in a design team situation. As a group, students should have the same goal which is successfully achieving the given design problem. Based on this shared goal, the key aspect of collaborative learning is *consensus through cooperation* by group members.

**Management of collaboration:** Management of design collaboration is essential for the successful completion of the tasks. Students are to be encouraged to use a web-based management system which may be used for collaboration management purposes that may include: task management (allocation and monitoring), meeting scheduling and minutes, design and communication document sharing, and etc. With the use of this tool the students would develop understanding and gain hands-on experience of collaboration and information sharing in a design situation. This also enables students learning through experiencing and reflecting on their own design process.

**The nature of collaborative design tasks:** The nature and complexity of collaborative tasks to be used as the triggers for designing and learning in

CVEs should be carefully considered. The design tasks should be complex enough to grasp students' attention and yet be challenging, requiring employment of cognitive skills.

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