DESIGN AND DEVELOPMENT OF CLINICAL SIMULATIONS IN SECOND LIFE

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ABSTRACT

Physical classrooms in tertiary education have changed little with the introduction of technology. To an extent, the interactive dynamics of teaching have been limited by educational technology, for instance moving around the classroom interacting directly with individual students. Powerpoint based teaching too often ties teachers to a menu-driven podium, and ever-increasing class sizes have cast students into even larger 'seating batteries' where they can be fed. We can do better. The design of physical learning spaces has started to undergo change in recent years (see http://www.jiscinfonet.ac.uk/infokits/learning-space-design), but can we apply these same concepts to virtual spaces such as Second Life?

The Medical faculty at the University of Auckland currently utilises trained actors, called *standardised patients*, to give participants a realistic clinical encounter, including taking a history, discussing the likely differential diagnoses, and making management decisions. A wide range of problems can be presented to the students in this manner, although there is significant cost associated with the development of these real-world simulations.

This paper presents the virtual world pilot environment developed by the Academic and Collaborative Technologies Group and Faculty of Medical and Health Sciences at the University of Auckland within Second Life to explore the potential of bringing the same actors into a very low-cost virtual world. The paper further describes the conceptual design and construction details of the University's Second Life simulation island, which provides an environment for varied clinical and student-oriented simulations.

INTRODUCTION

It is estimated that there are currently over 200 virtual worlds either in development or in production around the globe (http://www.virtualworldsnews.com/). These virtual worlds are mostly browser-based, three-dimensional environments that allow varying levels of customisation, but all rely upon the use of an avatar to represent the user in the environment. By moving the avatar around in the virtual world spaces, the user can engage with other users in real-time. Depending on the system, virtual worlds can be as constrained as a single room with furniture, or as expansive as acres of open virtual space.

In her book, *Designing Learning Spaces*, Diana Oblinger provides a challenging view of what we could accomplish in developing new and exciting physical learning spaces.

> *The key, therefore, is to provide a physical space that supports multidisciplinary, team-taught, highly interactive learning unbound by traditional time constraints within a social setting that engages students and faculty and enables rich learning experiences.*
> <http://www.educause.edu/elements/cdn.asp?id=learningspaces_e-book> Accessed 21.08.08.

But can we apply such creative ideas to develop powerful learning spaces inside of virtual worlds? It appears so, although it is 'early days'. Constructing unique and detailed virtual environments that rival real physical teaching spaces is possible, and in some cases they surpass that which is possible in reality. Virtual worlds allow the construction of learning spaces that are unbound by physical and geographical constraints, presenting to students experiences that would be dangerous and unacceptable in reality. For instance, in virtual learning spaces it is possible to stand inside an active volcano, experience and respond to natural disasters, take a walk through the chambers of a functioning human heart, or practice laparoscopic surgery on simulated patients. We can design collaborative spaces that draw teachers and students together without the limitations of location and travel time, and students can take an active role in the design of their own learning environments. Our only limit seems to be that of imagination.

The virtual world developments at the University of Auckland have primarily centred around the commercial software Second Life (http://www.secondlife.com), a web-accessible virtual world hosted by Linden Labs. This system provides a basic platform (an island or "sim") upon which to build simulations, and the company extends significant discounts to education institutions and groups. The system client software is free to download from the Second Life site, and accounts for users are similarly free. Premium accounts are available that provide expanded services to users. The University's island in Second Life is called Long White Cloud, which is the English translation of the Maori name for New Zealand, Aotearoa. The island is open to the public - http://slurl.com/secondlife/Long%20White%20Cloud/98/66/27.

BRIEF DESIGN AND CONSTRUCTION ISSUES

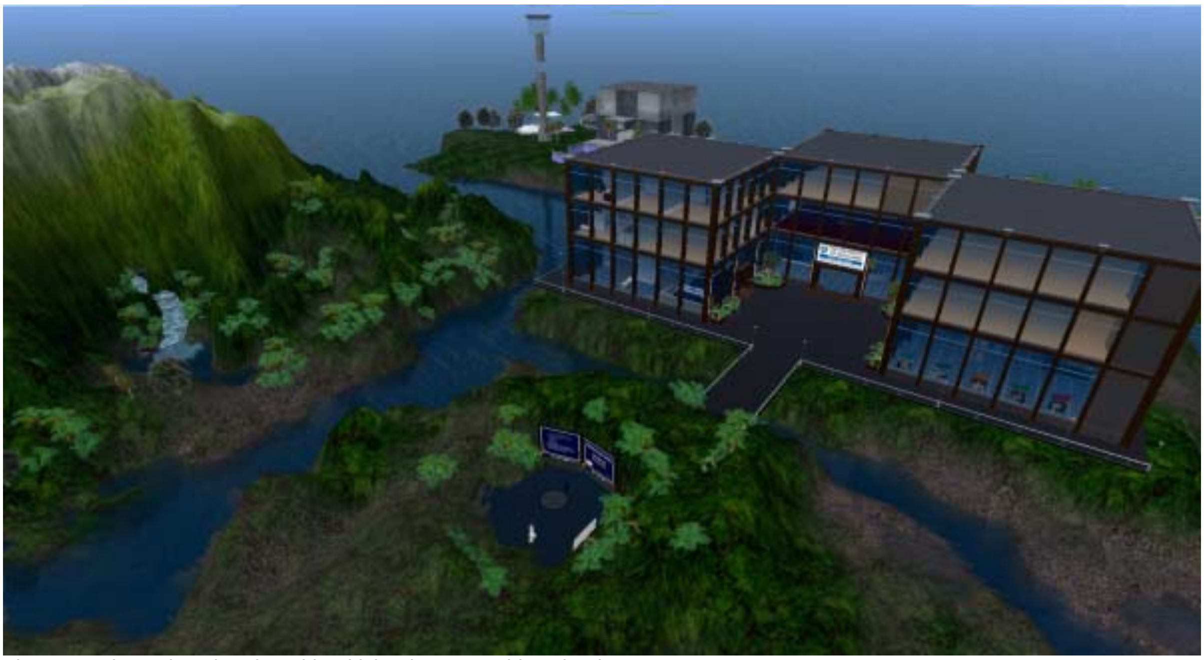

Figure 1. The University of Auckland island, “Long White Cloud”

Initial development on the University sim was done by the lead author, and consisted of nothing more detailed than ‘quartering’ of the island into distinct parcels of land. The entire island consists of roughly 95,000 square metres of flat space. Linden Labs does initially mold the surface of the simulated land (known as terraforming) to include basic coastlines surrounded by water, but in the initial design phase no other forming was attempted.

Parcel allocation

Each sim can be subdivided into quite small sections, just a few meters square if desired, and assigned to specific ‘owners’ who have exclusive building rights on the parcel. It is important to carefully consider the overall sizes of these subdivisions, since each parcel is given a finite number of ‘prims’ (primitive objects – basic 3D building blocks). The entire island supports only 15,000 prims, so allocating these to specific projects is crucial to successful outcomes for sim designers.

Audio/video

It is also important to note that by subdividing, designers can expand the number of audio/video channels available to projects. Initially there is only one channel for the island, but by subdividing, each parcel enjoys a private channel. This is crucial where, for instance, multiple classrooms requiring isolated streaming video/audio are developed.

Terraforming

Creating mountains, rivers and other land features is easily accomplished using the tools that are native to Second Life. Careful conceptual design in the initial stages of sim development can save considerable effort later. It is quite difficult to move large developments (eg. an office building complex) once they are in place. Initial development of the University sim focused on the creation of buildings and other physical structures, with little emphasis placed upon land formations. In retrospect, it would have saved considerable time and labour on redesign if greater initial design efforts had been made on the island. However during the early stages most of the portions of the island were allocated to experimentation, and the more sophisticated design elements were not a priority.

Governance and Management

Although we established the University sim as open to the public, we carefully control who can build or modify objects. A tiered access strategy was established that now provides flexibility and security for projects. For instance, only two top-tier administrators can build or terraform land in the general areas, while individual parcel (project) owners can build and terraform their local areas. Ongoing strategic design of the sim and expansions now falls under a four person governance group. As the site becomes more in demand, we anticipate expansion of this group.

THE UNIVERSITY MEDICAL CENTRE

Figure 2. Main University building and Medical Centre

Within the main University building we built a Medical Centre (fig. 2) that houses several isolated areas for specific medical simulations. Each of these simulations was developed to mimic a real life environment, however the size and spatial relationships of objects was frequently tailored to allow for better engagement from the myriad “camera” views that a user can employ. Because users are able to zoom and rotate their view at any time - from close up to panorama- dimensions of rooms were made substantially larger to help eliminate confusing camera views that can suddenly become blocked by walls and other objects.

Reception Area

Figure 3. Medical Centre reception area

Upon entering the main building, there is a Reception that would normally be found in any medical centre or doctor's office (fig.3). By adding to the overall amenity and realistic nature of the Centre, this area was designed to give students simulated experience in managing a reception room setting. Although there are no immediate plans to engage this portion of the development, there is no reason why not. It does, however, add to the overall amenity and realistic nature of the Centre. Adjacent to the reception area are two Examination rooms (fig.4) that provide space for simulated patient interviews and potentially for other problem-based learning scenarios.

Figure 4. Medical Examination room

Emergency Room

From the rear of the building there is a driveway that services the Emergency Room entrance (fig.5). The simulation includes functional emergency vehicles that can carry patients and be driven by users. Although the learning simulations presently developed do not utilise the ambulance or police vehicles, they do rely upon their visual effect for creating a realistic environment. However, we do envision the development of disaster preparedness simulations in the future that would, for instance, require the real-time transport of a patient from a distant location to a treatment facility.

Figure 5. Emergency entrance

The Emergency Room (fig.6) houses a resuscitation simulation that can be tailored to provide a variety of team training situations. In this simulation, the instructor acts as the patient lying on the emergency room table, while students act as the attending team. There is a large wall display behind the patient table that provides student teams with the vital information about the patient's physiological status, including heart rate, blood pressure and cardiac rhythm. This display is under complete control of the instructor, who by using a Heads Up Display (HUD) not visible to students (fig.7), can manipulate the physiological variables, as well as generate other sounds, facial expressions and vocalisations of the avatar patient. Based upon the clinical presentation of the patient, students must respond appropriately and as a team.

Figure 6. Emergency room

The room is populated with a number of medical equipment objects, and these are under control of the student teams via a Student HUD (fig.7). Utilising this HUD, teams can interact with the patient to consent them for what needs to be done. The students are able to make a decision to commence intravenous fluids, choose the insertion site, and determine the flow rate. Furthermore the students are able to take a blood pressure, listen to heart and bowel sounds through a stethoscope, select and administer medications (including dosage), and in the event of a cardiac arrest apply paddles to the avatar and administer shock treatment defibrillation.

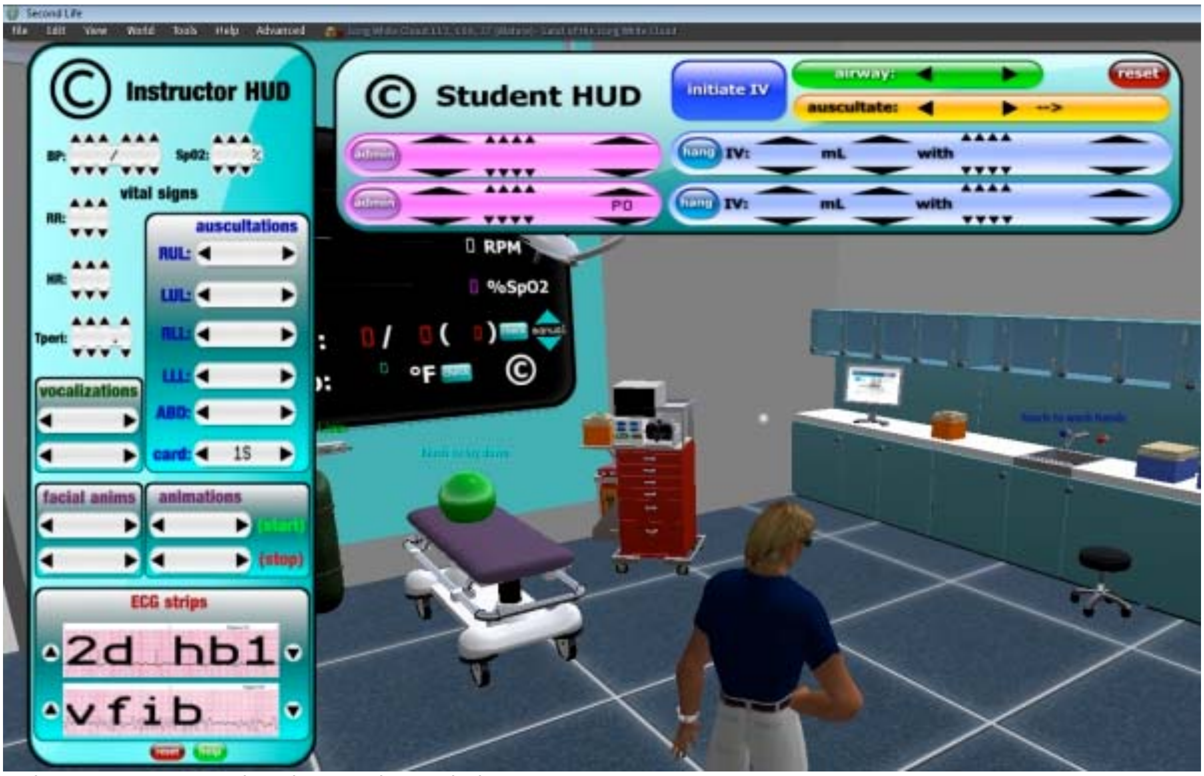

Figure 7. Instructor and Student Heads-Up-Displays

Intensive Care Unit

The ICU is on the second level of the Medical Centre, accessed via a lift (elevator) just adjacent to the emergency room. The ICU has been designed to provide a wide range of problem-based scenarios for training doctors, medical students and nursing students. The ICU contains five cubicles with beds and appropriate monitoring equipment (fig.8). The nursing station comprises a large desk, computer screens, storage for medical supplies, and a computerised medications dispenser.


Figure 8. Intensive Care Unit (ICU)

The Medical faculty at the University currently utilises trained actors, called *standardised patients*, to give participants a realistic clinical encounter, including taking a history, discussing the likely differential diagnoses and making management decisions. A ward round can be simulated, taking in a sequence of patients. A wide range of problems can be presented to the students in this manner, although there is significant cost associated with the development of these simulations. The ICU project is a pilot environment to explore the potential of bringing the same actors into a very low-cost virtual world.

A key element for success in this simulation will be the development of a comprehensive patient records database that will provide students with patient history, symptoms, clinical test results and interview notes. We have started to develop a wide range of clinical scenarios, based upon real-life examples (e.g. severe infection). Preliminary work on a HUD for this has been undertaken (fig.9) and a working database within Second Life has been developed. Further work to externalise this database and create links into Second Life is presently being scoped.

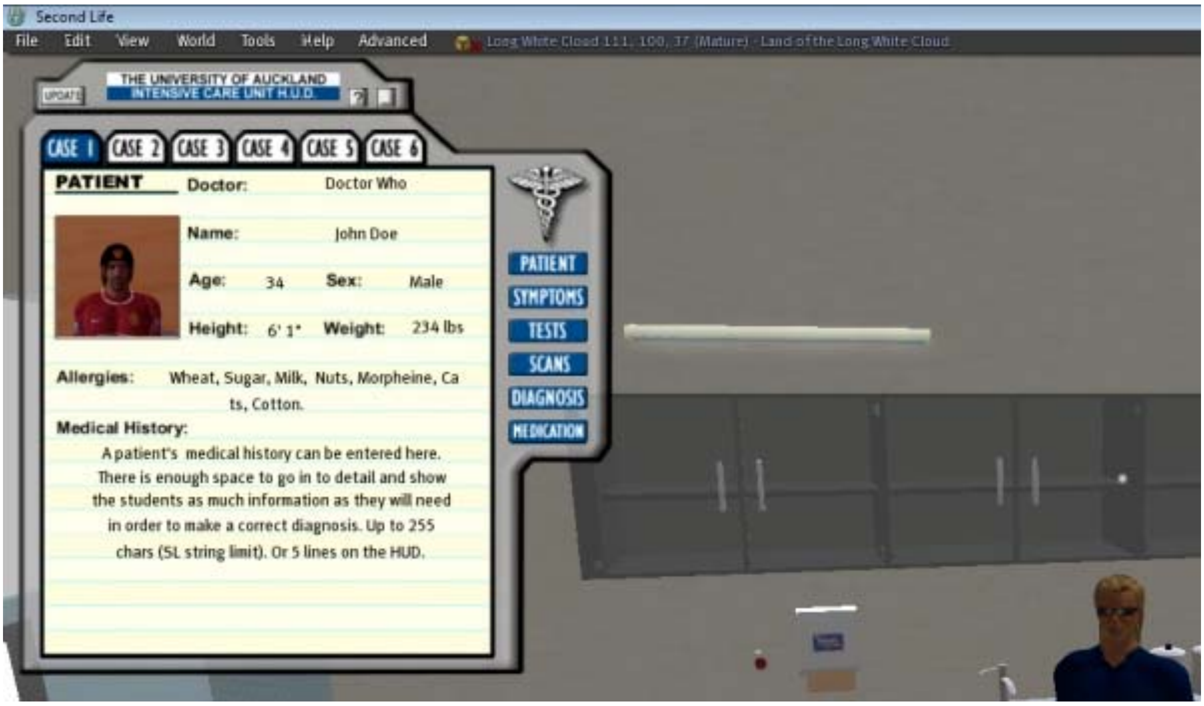

Figure 9. Patient Information Heads-Up-Display (HUD)

Nursing Simulation

Across from the ICU we have developed a task-specific research simulation area, again based on a problem-based learning model. The postpartum haemorrhage scenario was developed by teaching staff in the Department of Nursing at Boise State University in the United States, and has been utilised for nurse training in their real-world simulation environment. A formal evaluatin of this Second Life simulation will involve a comparison with real-world teaching.

Figure 10. Nursing Simulation lecture area

The entire floor of the central building has been dedicated to the simulation, and includes a lecture area complete with whiteboard, a round-table discussion area for debriefing, and the medical simulation itself (fig.10). The simulation comprises a single hospital room, but it is surrounded by a one-way curtain (see in, but not out) that prevents participants from seeing people in the observation seating area. The simulation requires student nurses to interview a patient in the bed (played by the instructor) and to make appropriate clinical decisions following the discovery of profuse bleeding (fig. 11).

Figure 11. Postpartum Haemorrhage nursing simulation room

DISCUSSION

During the process of developing the University's clinical simulations, several questions have emerged around the capability of the Second Life platform to accurately mirror the detail found in real world environments. Key among these is the question of whether the virtual world is sufficiently immersive for users to willingly suspend disbelief and engage with the simulation to the extent that real learning can occur. In Second Life, users can move their avatars around in a variety of ways, including walking, running, flying and "teleporting"- where a click can take the user instantly from one location to another distant location. However, complex avatar movements (eg dancing) are simulated programmatically and can limit user control of the avatar. Moreover, users must initially grant permission for this programmed control, which compromises the level of user immersion.

In the simulations that we have been developing we have several animations that are intended to add realism to the experience. For instance, when a student makes the decision to initiate intravenous access on a patient, a programmed avatar animation is asserted to represent the actual task. The student does not have control over the animation, and there is certainly no practice of the bedside procedure itself. Specific procedural training can be provided by other means, and this includes web-based training. An example of this is the Integrated Cognitive Simulator (www.govirtualmedical.com) which students can be directed to train on within Second Life as a part of the learning experience.

While it is reasonable to assume that some elements of simulations can be distractions, and therefore omitted, we are at present uncertain as to what levels of abstraction this might apply to within a clinical simulation. It is a logical assumption that interruptions of the scenario by user permission dialogues and other discontinuous activities associated with the system itself might detract from learning.

Another key question arises from the approaches that are currently used to give instructors and students control over the simulation equipment. As discussed earlier, control is through a heads-up-display (HUD) that looks much like a remote control device, with buttons for specific actions/functions. While this approach is standard across Second Life generally, we feel it adds another barrier to accomplishing an authentic experience. Our current strategy is to imbed these functions within the equipment or on the avatars themselves, thus requiring more representative actions on the part of students. For instance, we can attach the auscultations (heart sounds, lung sounds, gut sounds) directly to the appropriate location on the patient avatar, rather than on the button of a remote. Touching an area on the patient, then, would activate the appropriate sound for the student. Similarly, touching a piece of equipment should itself begin an animation or activate a function.

We have also received frequent questions from academic staff (and administrators) about the level of automated teaching that can be accomplished in these simulations. While there are excellent examples of automated/sequenced learning materials in Second Life simulations (eg the Heart Murmur Sim at *http://slurl.com/secondlife/waterhead/124/56/32),* we think their applications are limited. Our present simulations provide students with experiential and contextual learning in a team setting, rather than as remote individual learners.

While it is possible to create objects called “bots” that automate sequence of activities and mimic avatars, these are presently quite limited in their ability to convince even the most naive student that they are a real patient. By contrast, a trained actor is capable of delivering a convincing performance via their avatar. Importantly, our goals are to engage students in analysis, decision making and problem solving within a real-time team context. It is the interactions, collaborations, and post-simulation debriefings that form the basis for a sound pedagogy (Maudsley & Stivens, 2008). These are quite labour intensive for teaching staff, and would not scale well in the context of increasing training throughput.

There are some areas where savings can be made, however. First, where students can take responsibility for scheduling a required interview with a standardised patient, or for meeting with other students to collaborate, we can give them 24hr access to the facility without involving teaching staff or administrative staff. Moreover, if facility use is high we can simply duplicate the entire simulation and expand at the click of a button. We are presently experimenting with a “holodeck” strategy that would allow us to instantly build or remove entire simulations or components based upon user demand. Secondly, by developing virtual spaces where students can meet we conserve physical space (overhead) at the University and at the same time reduce travel, parking and other expenses. This is especially true for students who must travel long distances for clinical training.

Thirdly, through increasing collaborations with other medical educators and institutions we believe we can reduce the cost of simulation development, considerably expand the base of cases and scenarios, and improve the international exposure our students receive in the process.

SUMMARY

Hundreds of educational institutions currently have a presence in the Second Life community (see http://www.simteach.com/wiki/), providing a wide variety of resources and experiences for students. As this resource base expands it is reasonable to assume that new and exciting approaches to clinical simulation in an interactive, real-time environment will be developed. At the University of Auckland we are continuing these developments, and welcome collaborations with other institutions/educators. Interested parties should contact:

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REFERENCES

Boulous, Maged N. Karmel, Hetherington, Lee and Wheeler, Steve (2007). *Second Life: an overview of the potential of 3-D virtual worlds in medical and health education*. Health Information and Libraries Journal, 24, pp233-245. Retrieved 14 December 2008 from http://www.wiley.com/bw/journal.asp?ref=1471-1834

Heinrich, William LeRoy, Youngblood, Patricia, Harter, Phillip M. and Dev, Parvati (2008). *Simulation for Team Training and Assessment: Case Studies of Online Training with Virtual Worlds*. World Journal of Surgery. 32:161-170. Retrieved 11 December 2008 from http://www.springerlink.com/content/101185/

Maudsley, Gillian and Strivens, Janet (2000). *Promoting professional knowledge, experiential learning and critical thinking for medical students*. Medical Education, 34: 535-544. Blackwell Science Ltd.

New Media Consortium and EDUCAUSE Learning Initiative. (2007). *The Horizon Report, 2007 Edition*. Austin, TX, and Boulder, CO: Authors. Retrieved September 8 2008, from http://www.nmc.org/pdf/2007_Horizon_Report.pdf

Second Life. *Heart Murmur Sim. Cardiac Auscultation Training Concept*. Retrieved 20 January 2009 from http://slurl.com/secondlife/waterhead/124/56/32 .