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Virtual Environments for Access Design: Bringing together multidisciplinary teaching and learning for real world outcomes

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ABSTRACT

Developing digital design skills appropriate for analysing and accommodating issues of design accessibility is critical to better: housing; interior architecture; landscape architecture; industrial design and urban planning. This is a critical response to greater human rights expectations and a key government response to population ageing. The area of inclusive or universal design is a response to global design education initiatives including the United Nations Convention on the Rights of Persons with Disabilities, which stipulates the implementation of programs of action to make physical social and virtual environments more equitable and accessible. In response to these imperatives, an innovative 6 unit credit summer course was designed and developed as a multidisciplinary elective and run for the first time in January 2009 as part of a research project to investigate the use of an open access home modelling application known as MyVirtualHome. From a course learning perspective, students engaged with established digital modelling applications within cutting edge virtual technologies and cultures. Parametric design was used in conjunction with 3D modelling to create customisable components that could be used by naive users within a virtual world to test accessibility solutions. As well as learning technical skills, students' learning addressed attitudinal barriers. The evaluation method used for this project is action-based and draws on a range of evidence including student and tutor learning outcomes, as captured via the learning wiki developed especially for the course and the student satisfaction scores. The paper will discuss outcomes drawing from the Virtual Accessible Design wiki http://vead-2009.wetpaint.com/ which students used as the collaborative vehicle to communicate with each other and their tutors. Finally, the authors will reflect on the future potential of other inclusive design collaborations that enhance both teaching and learning outcomes across design disciplines as well as provide real-world outcomes and scholarship in both learning and enabling environments research.

WHY TEACH UNIVERSAL DESIGN?

A design education paradigm shift is occurring in Europe and the United States as a result of rapid population ageing. The traditional approach to teaching accessible design is changing as designing for the full range of users and understanding the concept of human difference underpins equity and social sustainability. Universal design as a tool for creating greater equity has been around nearly 20 years (Welch & Jones, 2001). However the dream of universal design education being embedded in the core curricula for all design professions is yet to be fully realized in most countries. The slowness to implement or to integrate universal design education into professional built environment curricula is partly because disability access is still seen as a specialised subdiscipline, design for them, not us (Tahkokallio, & Koivusilta, 2004).

The built environment, and housing in particular, has a powerful impact on health, mobility, independence, autonomy and wellbeing for older persons and those with disabilities (Krieger & Higgins, 2002; Lowe, 2002; Thomson, Petticrew, & Morrison, 2002). Unfortunately, residential housing generally assumes average adult dimensions and reach ranges as a design baseline based on healthy and fit adults (Imrie 1996). As a consequence, inaccessibility in the form of stairs, doors, corridors, bathroom, etc., makes remaining in the community difficult if not impossible (Stark 2001). Achieving the independence and autonomy required often results in substantial and costly retrofitting which because it was not a part of the original design might not be aesthetically unappealing, further stigmatising the occupants. Also, traditional housing design outcomes do not consider disability as part of a lifecourse so are likely to require renovation and modification in order to adapt to the needs of its human occupants over its lifespan. On the other hand, including features, such as level entry, wider corridors and walls that can support handrails facilitates independence in daily living. Further, universally designed housing can significantly increase the number of occupants who can use a home with minimal home modification cost.

Unfortunately, understanding human ability has not been the prime organising principle of either homes or product design (i.e. furniture, fittings and tools of daily life). As a result much of what is currently available in the form of intervention solutions (often sold as assistive devices) have been created for small niche markets. Indeed they often look unattractive or even worse carry connotations of hospitals, institutions or disability, so are likely to confront the potential user with their disability status. Further, knowledge about what constitutes good solutions must be interpreted in context (Harrison & Parker, 1998).

Universal design is a reframing intended to better address the accessible design inertia. Universal design means design for people of all ages and abilities to the greatest extent possible without the need for adaptation or specialised design (Connell et al. 1997) Thus, universally designed housing is intended to better cater for the range of physical dimensions and capacities as people move through life. Universal housing is designed to improve housing sustainability by increasing durability of the home over its lifespan. Other terms often used interchangeably to mean much the same thing include 'lifetime housing', 'barrier-free', 'accessible', 'visitable' or 'adaptable' home designs are.

While Universal Housing Design is rarely a 'one size fits all' outcome, considering the full range of users is important when starting to develop more useable, flexible and adaptable designs. The development process is extremely important in this regard, both in terms of training future design and construction professionals but also in enabling end user testing and feedback. An essential part of this process is ensuring that existing commercially available products designed to improve accessibility are available to end users in a format that they can identify, easily manipulate and critique. Throughout this interaction process, it is possible to create better quality housing outcomes and better Universal Design products by accumulating and reflecting on what is available to the designer during the design process.

The universal housing design leaning objectives were as follows:

- To develop an awareness and understanding of universal design principles, and its significance in the built environment.
- To test, analyse and develop the application of digital technology in universal design.

I. DIGITAL DESIGN LEARNING

The learning opportunities afforded by simulated and virtual environments have prompted their exploration as learning modalities (Breen, Nottrot, & Stellingwerff, 2003; Plume & Mitchell, 2007). A classic genre of virtual reality applications that strive to save money and reduce time is virtual prototyping. These can range from something small such as a more accessible tap assembly to the review of the whole home. Simulation is frequently used in educational environments and appears to be a universally accepted mode of learning as it allows users to explore and communicate complex ideas (Rieber, 1996).

Virtual prototyping facilitates product evaluation from a variety of perspectives: accessibility; ergonomics; constructability and aesthetics. This advance is underpinned by innovation and growth in virtual reality, visualization, and simulation technologies useful for building information management and housing design. Further, authors like Whyte, Bouchlaghem, & Thorpe (1999) state that improving residential design quality using virtual reality as a design and visualisation tool offers both greater transparency and efficiencies in communication. The students enrolled in the VEAD course appear to agree with this notion as the following excerpt demonstrates.

"*I think that virtual environments will become a great aspect of design someday. its true that most clients will feel at ease if they were to see a final result of their 'plan' without having to risk making huge mistakes and risk losing mone*y" (VEAD student 1, blog).

These types of student responses are unsurprising as simulations using virtual reality techniques are held to reduce uncertainty and allow for quick and easy concept assembly and component checking. This is critical because without the final product, only "intermediate design objects" (drawings, CAD images, prototypes, etc.) are capable of embodying intended outcomes (Marc, Belkacem & Marsot. 2007). Further, as circulation space, lighting and product design and selection account for the major part of a building's accessibility and usability to its end users, it is vital that the performance of these systems be well understood and optimized in order that better house building and interior architecture outcomes can be achieved.

There are several reasons why students have difficulty understanding the requirements of a building for a particular user's accessibility as this depends not only on the performance of the envelope components (walls, windows and roofs); fixtures, fittings and lighting systems, but also on their overall performance as an integrated system within the room and home as a whole. The complex and dynamic interactions that the building has with its users and its systems need to be modeled and simulated for analysis. However, to be effective, it is important to take account of the tools employed, as well as their limitations.

In this course, the digital software employed was an innovative on-line gaming type of software (i.e. MyVirtualHome) combined with the more conventional 3D Studio Max from AutoDesk. Most built environment students are expected to be familiar with 3D Studio Max software or similar as a part of digital architecture education and it is typically introduced as a part of a suite of building information management tools. Mastery of 3D Studio max involves the ability to create new object primitives; materials; parameterisation; lighting and rendering.

II. MyVirtual Home

MyVirtualHome software was created as an alternative to traditional 3D modelling software with ease of use and affordability as its key criteria. Traditional modelling software typically demands many hours of training and sufficient opportunities to practice to achieve mastery. Further, developers assume an understanding of architectural drawing conventions and coordinates. MyVirtualHome software unlike traditional tools uses a computer games software platform a little like the SIM software series popular amongst teenagers and therefore already familiar to many younger people.

The rationale given by the MyVirtualHome developers for its creation was the need for innovative Australian software aimed at end-users not just design professionals. They believe that resultant opportunity for visualisation and improved communication has the potential to address the significant amount of new construction and renovation currently underway in Australia. For instance, it aims to improve customisation, renovation and maintenance within the home building industry.

This is significant since over "150,000 new dwellings are built every year. Further, nearly 450,000 of Australia's 7.7million homes undergo a renovation, 1.3 million home owners move to another address, millions purchase furniture, electronic or decorator items and most households will require some maintenance or upkeep via contractors" (My Virtual Home, 2009). Additionally, there is a growing awareness of how design decisions impact satisfaction and usability outcomes. The digital design learning objectives were as follows:

- To give the students a conceptual framework within which to understand the nature of virtual technology, its application within their wider learning context and its impact on the present and future state of built environment professions; and

- To establish a basic level of confidence and capability in the use and manipulation of virtual technology for design purposes.

III. STUDENT EVALUATIONS

Students had a number of tasks that they tackled to achieve the learning objectives as they moved through the course. These tasks included: case studies of people and designs; design and modelling of an accessible prototype that addressed functional limitation of a person known to the student. This prototype was then placed into their home that was remodelled for accessibility. The design prototypes designed by students varied from innovative task lighting solutions for people with visual impairment to integrated accessible shower units for people with mobility issues. This section reports on feedback obtained via the end of semester unit evaluations or the Course and Teaching Evaluation and Improvement (CATEI) scores.

It should be noted that while scores were very positive, only 7 of the 35 enrolled students completed the CATEI assessment. Figure 1 indicates that students valued the level of course challenge and found the material interesting. This is not surprising as it was an elective unit and it could be argued that students may have self-selected according to existing interests.

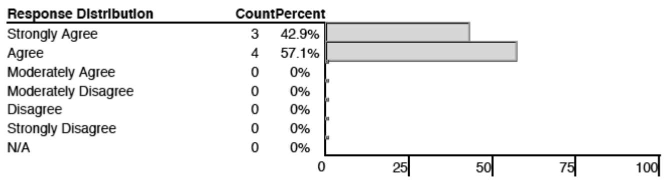

Fig. 1. Level of course challenge and interest.

A key objective of any teaching and learning interaction in terms of professional development is the ability to take material and develop it into the future. It was therefore pleasing to see that students strongly agreed with the fact that the course had enabled this (Figure 2).

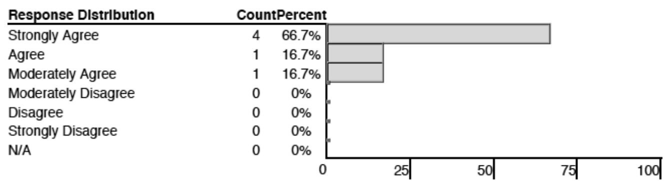

Fig. 2. Degree of learning independently in the future.

Last and probably the most pleasing outcome was that students rated the level of improvement of their understanding and skills so highly see Figure 3.

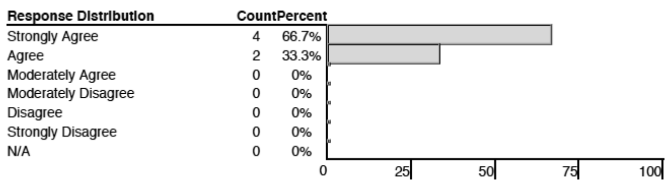

Fig. 3 Level improvement of understanding and skills in accessible modelling.

Student blogs entered during the course provided a greater degree of insight into the factors that shaped this type of rating. For instance, "*overall I have learnt a lot on what universal design is, and its importance to the world. Before this course I had little to no idea on this field. Also learning to use my virtual home is pretty useful, I'll use it when trying to draw up something quickly to get an idea, before drawing it on AutoCAD etc.*" (VEAD student 2, blog). It appears that they valued the speed and ease of modelling, seeing it as an intermediary step in the more detailed modelling expected of design profession. Another student made clear that exposure to and reflection on peer-discussion assisted them to develop much more understanding and a greater degree of insight into Universal Design. This is illustrated by the following excerpt "*the universal design concepts will probably make designing in the future somewhat easier as there's a much stronger conscience about Universal Design and that it should be implemented*" (VEAD student 3, blog).

Probably most pleasing of all was that students enjoyed the unit as illustrated, "*I also found this course very enjoyable. For me it was very interesting, fun, an eye opener and not just to universal design but also to a liking for industrial design. This course was very beneficial to me as it expanded my knowledge of 3Dmax such as unwrapping and gave me a taste of designing with a specific purpose on a small scale.*" (VEAD student 4, blog). As can be seen from this excerpt, student enjoyment was also linked to exposure to other design disciplines and a degree of specialisation combined with opportunities to practice and become competent with industry relevant computational tools. However, a key limitation of the course was the technical difficulties experienced that prevented the students from being able to share their 3Dmax accessible prototypes, via the MyVirtual Home menu system.

IV. CONCLUSIONS

In this paper we presented a learning approach using simulation and 3D modelling software designed to enhance spatial thinking by exercising certain abilities that influence the process of creating a spatial image and manipulating it. Additionally, we used the VEAD course wiki to assist enrolled students to collaborate and to share their insights and awareness of both Universal design for ability impairment and the potential and possibilities inherent in 3D modelling. The main research question concerned whether this approach would be valued by students and was workable as a means of advancing universal design thinking. Results reveal that students valued the creation of 3D spatial images and manipulating them at both large and small scale to create more accessible housing outcomes. Therefore we may conclude that a virtual reality learning approach was valuable in focusing attention and increasing motivation. Student feedback both during the course and in their Course and Teaching Evaluation and Improvement (CATEI) feedback has shown clearly that they valued the learning opportunity. However, further research is needed to find the best method to use for a core design unit for universal design learning. Our future research will investigate how this could be achieved and implemented.

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