

CreateWorld 2011

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Editors
Michael Docherty :: Queensland University of Technology
Matt Hitchcock :: Griffith University, Qld Conservatorium

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Pre-Publication

Proceedings of the CreateWorld11 Conference

*Griffith University, Brisbane
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Proceedings of the CreateWorld10 Conference

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Contents

Submitted Papers

Robert Burrell, Queensland Conservatorium, Griffith University **1**
Zoomusicology, Live Performance and DAW
seas_the_dei@hotmail.com

Presentation Date Tuesday 29th	12:15 pm to 1:00 pm Session: Technology in the Performing Arts S07 1.23 (Graduate Centre)
-----------------------------------	---

Dean Chircop, Griffith Film School (Film and Screen Media Productions) **9**
**The Digital Cinematography Revolution & 35mm Sensors: Arriflex Alexa, Sony
PMW-F3, Panasonic AF100, Sony HDCAM HDW-750 and the Cannon 5D
DSLR.**
d.chircop@griffith.edu.au

Presentation Date Wednesday 30th	12:35 pm to 1:20 pm Session : Film and Animation Griffith Film School Cinema.
-------------------------------------	---

Kim Cunio, Queensland Conservatorium Griffith University **16**
**ISHQ: A collaborative film and music project – art music and image as an installation, joint art as
boundary crossing.**
k.cunio@griffith.edu.au; Louise Harvey, l.harvey@griffith.edu.au

Presentation Date Wednesday 30th	12:35 pm to 1:20 pm Session : Film and Animation Griffith Film School Cinema.
-------------------------------------	---

Helen Farley, Australian Digital Futures Institute, USQ

24

From 'hands up' to 'hands on': harnessing the kinesthetic potential of educational gaming

with Adrian Stagg

Helen.Farley@usq.edu.au

Presentation Date Tuesday 29th	12:15 pm to 1:00 pm Session: Gamification S07 2.16 (Graduate Centre)
-----------------------------------	--

Sue Gregory, UNE

34

Do virtual worlds have a role in increasing student engagement as measured by their higher academic grades?

with Brent Gregory

sue.gregory@une.edu.au and bgregory@une.edu.au

Presentation Date Tuesday 29th	11:15 am to 12:00 pm Session: The Virtual World S07 2.16 (Graduate Centre)
-----------------------------------	--

Marshall Heiser Qld Conservatorium of Music, Gold Coast campus

45

Digital Audio Workstations: Master or Slave?

m.heiser@griffith.edu.au

Presentation Date Tuesday 29th	12:15 pm to 1:00 pm Session: Technology in the Performing Arts S07 1.23 (Graduate Centre)
-----------------------------------	---

Matt Hitchcock

46

Radio IMESD

Queensland Conservatorium Griffith University

M.Hitchcock@griffith.edu.au

Presentation Date Wednesday 30th	12:35 pm to 1:20 pm Session: Technology in the Performing Arts Auditorium S05 2.04
-------------------------------------	--

Kerry Kilner, UQ Research Fellow

56

Define <Colon> Pedagogy: The use of digital research environments in undergraduate teaching

k.kilner@uq.edu.au

Presentation Date Wednesday 30th	11:45 am to 12:30 pm Session: Teaching and Learning Auditorium S05 2.04
-------------------------------------	---

Aengus Martin, UTS
Windtraces: Accessible Sonic Art
With Kirsty Beilharz
aengus.martin@sydney.edu.au

58

Presentation Date	11:15 am to 12:00 pm
Tuesday 29th	Session: Technology in the Performing Arts S07 1.23 (Graduate Centre)

Malcolm Riddoch, Western Australian Academy of Performing Arts (WAAPA)
Spatializing Music at the Academy
m.riddoch@ecu.edu.au

66

Presentation Date	12:15 pm to 1:00 pm
Tuesday 29th	Session: Auditorium S05 2.04

Julia Wren, Edith Cowan University, Western Australia
Using iPad2 to assess students' live performances and actively engage students with tutor and peer feedback
With Alistair Campbell, John Heyworth, Christine Lovering
j.wren@ecu.edu.au

67

Presentation Date	10:05 am to 10:50 am
Tuesday 29th	Session: Technology in the Performing Arts S07 1.23 (Graduate Centre)

Dr Jason Zagami
Dynamic EEG Mapping as artistic expression
School of Education and Professional Studies, Griffith University
j.zagami@gmail.com

78

Presentation Date	11:15 am to 12:00 pm
Tuesday 29th	Session: Technology in the Performing Arts S07 1.23 (Graduate Centre)

From ‘hands up’ to ‘hands on’: harnessing the kinaesthetic potential of educational gaming

By Dr Helen Farley & Adrian Stagg, Australian Digital Futures Institute, University of Southern Queensland

Abstract: Traditional approaches to distance learning and the student learning journey have focused on closing the gap between the experience of off-campus students and their on-campus peers. While many initiatives have sought to embed a sense of community, create virtual learning environments and even build collaborative spaces for team-based assessment and presentations, they are limited by technological innovation in terms of the types of learning styles they support and develop. Mainstream gaming development – such as with the Xbox Kinect and Nintendo Wii – have a strong element of kinaesthetic learning from early attempts to simulate impact, recoil, velocity and other environmental factors to the more sophisticated movement-based games which create a sense of almost total immersion and allow untethered (in a technical sense) interaction with the games’ objects, characters and other players. Likewise, gamification of learning has become a critical focus for the engagement of learners and its commercialisation, especially through products such as the Wii Fit.

As this technology matures, there are strong opportunities for universities to leverage the use of gaming consoles to embed levels of kinaesthetic learning into the student experience – a learning style which has been largely neglected in the distance education sector. This paper will explore the potential impact of these technologies, to broadly imagine the possibilities for future innovation in higher education.

Introduction

Universities have a vested interest in leveraging technology to improve student learning through engagement. This is especially true of distance learning institutions as this mode can often be more challenging than with a purely face-to-face cohort. In a traditional on-campus lecture, it is easier to engage students by presenting material which appeals to multiple learning styles, but this becomes more difficult when trying to encourage deeper learning in off-campus students. Some lecturers have addressed auditory learning styles through the use of cassette tapes and later via podcasting; whilst others have utilised video or screencasting to engage with those who prefer visual learning experiences. By combining these with social learning tools such as forums embedded in the Learning Management System (LMS), lecturers can provide students with a range of resources which empower the learner to select the 'best fit' between their learning style and the content of the course.

One learning style which technology has thus far been unable to fully address has been kinaesthetic learning. Some disciplines, such as performing arts and medicine, require kinaesthetic elements to support authentic learning. With the advent of commercialised, consumer-driven advances in gaming consoles, educators can access a range of tools which could be effectively utilised to facilitate kinaesthetic learning. This is provided that certain shortcomings are understood and that a basic understanding of subjects such as social learning and immersion underpin pedagogical decisions for their use. This paper aims to address these issues in relation to the Nintendo Wii and Microsoft Kinect (in particular Avatar Kinect) and highlight some existing projects for educational consideration.

Doing, Playing, Learning

There is evidence to suggest that the game technology employed in many virtual environments may improve learner motivation and engagement via immersion (Fassbender & Richards, 2008: p. 1). Engaged students who are responsible for their own learning through an active approach tend to experience a deeper level of learning compared to those who are merely passive recipients of information. Problem-solving, authentic learning experiences, virtual learning, online collaboration and other active methods, will usurp more conventional didactic approaches to learning. Further, Curtis Bonk and Ke Zang (2006) also flag a greater emphasis on reflection for students to 'internalize and expand upon their learning pursuits' (Bonk & Zhang, 2006; Sanders & McKeown, 2008: p. 51) and this can be readily facilitated through interaction in and with an immersive virtual environment.

Persistent online worlds such as the one in which World of Warcraft (WoW) players are immersed, often have a learning curve due to the inherent complexities of the world. As the virtual geography, player options, and social interactivity (such as WoW's Guild structure) mature there needs to be a process through which new players are inducted and achieve the threshold concepts of the game. In this context, players will learn the social complexities of the game (such as forming alliances or strategically integrating their characters' abilities into a larger group), search for information related to specific

quests and character advancement (and then apply that knowledge in a range of circumstances), and discuss the game via in-game chat or forums. In essence, players create their own learning communities akin to communities of practice aimed towards inculturating new players, information seeking and social learning (Oliver & Carr, 2009; Galarneau, 2005). What has just been described is a community of engaged, self-directed, location-independent learners; equivalent to a cohort of students from any distance learning institution. The point of differentiation is that WoW players may not acknowledge the 'gamified' learning which is occurring (and in which they actively participate).

Although there is great fanfare about the potential of these three-dimensional immersive spaces for application to higher education, there are still significant shortcomings in the available technologies that need to be addressed to reliably harness that potential. An obvious example is the constraint of natural movement in these spaces due to the limited flexibility afforded by the conventional mouse and QWERTY keyboard. A further constraint is the lack of haptic (tactile) feedback when interacting with virtual objects. For many reasons, achieving more natural motion, tactile precision and haptic interaction remains a largely unrealised dream for human computer interface designers across disciplines as diverse as gaming, IT, engineering, health sciences and education.

Propelled by the lucrative consumer market, gaming developers are at the forefront in the quest to radically change the way users interact with 3D immersive spaces. Speed, responsiveness and dimensional motion are generally not facilitated by most user interfaces, diminishing the participant's experience (Champy, 2007). Further, gaming developers are focused on how to best exploit intuitive skills through tangible user interfaces (TUIs) and intuitive tangible controls. Xin and colleagues (Xin, Watts, & Sharlin, 2007) have reinforced the value of this research, discovering that sensory immersion is enhanced in games using such controls. The provision of haptic feedback further enhances the immersive experience, leading to heightened believability through interaction with 3D objects (Butler & Neave, 2008).

Persistent multi-player virtual environments are so appealing to students and educators because the senses are artificially stimulated to evoke emotional responses, introduce new ideas and entertain in new and exciting ways. These computer-mediated environments provide sensory information including visual, audio and haptic information so that a multi-modal understanding of the environment can be constructed (Butler & Neave, 2008: p. 140). The simple presentation of information is arguably not as valid as engaging students in interacting with that information as becomes possible in an immersive virtual environment (Tashner, Riedl, & Bronack, 2005). From a pedagogical standpoint, therefore, it makes sense to examine the elements of persistent virtual worlds, and the options available via the advances in commercial, consumer-driven console gaming in the context of providing alternative, yet sound, methods of teaching and student engagement (Dalgarno & Lee, 2010).

Although the velocity of growth in IT-related development continues to be exponential, there has only been limited success in exploiting human spatiality, senses, innate human physical movements and tactile precision in interfacing with computer-generated environments. In fact, as stated by Xu (2005), 'It is commonly believed that physical action is important in learning, and tangible objects are thought to

provide different kinds of opportunities for reasoning about the world. Arguably, many classic computer interactions offer very limited stimuli, little freedom to behave and low ecological validity (that is, little relevance to normal, everyday human behaviour in the real world)' (p.1). In searching for technologies that offer potential to be adapted to learning tasks in virtual 3D spaces, we were particularly interested in those that could support the application of theory-to-practice and would be enhanced by more tactile precision, natural movement and haptic feedback.

Kinaesthetic learners are frequently insufficiently catered for and authentic movement in 3D worlds may help to meet this need. Kinaesthetic learning activities compel students to move, sometimes requiring significant exertion (Begel, Garcia, & Wolfman, 2004, pp. 183-184). This exploits what Jean Piaget called 'sensori-motor learning,' in which physical activity transforms into representative mental symbols (Piaget, 1999, pp. 37-38). The increasing importance of hands-on learning has already been glimpsed in the rising prevalence of realistic and complex simulations, interactive scenarios and commutative news stories (Bonk & Zhang, 2006, p. 251). Given the diversity of students attending university, it seems prudent to seek out an environment where all learning styles can be accommodated. As such, the Nintendo Wii and Microsoft Kinect bear closer examination within educational settings.

Nintendo Wii: old folk and young folk and all inbetween

'Of course, when playing a game, the nearest thing to the player is the controller. The controller should therefore be regarded as an extension of the player rather than as part of the console. I always bear in mind the importance of the fact that the player will have far more contact with the controller and UI [user interface] than the console itself.'

(Akio Ikeda, responsible for accelerometer hardware in the Nintendo Wii™, in an interview with Satoru Iwata, Wiilaunch website, Summer 2006)

A controller that holds more promise in this context currently is the Nintendo Wiimote that comes with the Nintendo Wii console. Haptic feedback is simulated via the onboard vibration-producing motor (Brindza & Szweda, 2008). The Wiimote is the device with the most potential for educational use due to its low cost, adaptability and its popularity as a gaming controller. For example, some enterprising gamers are using the Wiimote to interact with the MUVE, Second Life to provide many exciting possibilities (Boulos, Hetherington, & Wheeler, 2007; Sreedharan, Zurita, & Plimmer, 2007).

The Nintendo Wii also incorporates a number of innovative features that enable more tactile precision. Its most unique feature is the Wiimote (Wii remote) which can detect motion and rotation in three dimensions via three accelerometers and an infrared sensor (Brindza & Szweda, 2008). This is intended to make motion sensitivity more intuitive and natural. The Wiimote is designed to be easy to grasp and point, and makes the device seem more familiar to the non-gaming public. This broadens its use to nontraditional audiences such as the elderly and disabled people. Users control the movements of their avatars (or Miis) in the games by moving their arms while holding the Wiimote (Pearson & Baily, 2007).

For example, Wii Sports contains a tennis game and participants play by using the Wiimote as they would a tennis racquet, swinging it as the tennis ball approaches their avatar.

The Wiimote is wireless and communicates with the Nintendo Wii console via Bluetooth. The Wiimote has been reverse engineered, through the contributions of several individuals to the WiLi and WiiBrew projects (programming libraries), making it possible to both send data to the Wiimote and interpret most of the data received from it. Transmission is through a standard Bluetooth signal, enabling communication between the Wiimote and any computer with a compatible Bluetooth adapter (Brindza & Szveda, 2008). The Wiimote's unique features will facilitate such tasks as motion capture and gesture recognition, ensuring that the device will be used beyond the gaming industry (Brindza & Szveda, 2008). It has already been used successfully for teaching CPR techniques at the University of Alabama in Birmingham to track hand precision and give students feedback on their depth and rate of compression (Coldewey, 2009). The release of the Wii MotionPlus has boosted precision and motion-sensing capabilities compared to the original Wiimote, as it can more accurately track the user's arm position and orientation in real time on the screen (Hearn, 2009).

Even with the Wiimote's obvious advantages there are still significant hurdles that need to be overcome before the Wiimote can be used in a wide range of virtual educational contexts. There are very few options for customizing the Nintendo Wii console without buying the expensive official Game Development kit. The kit is intended for use by professional development companies only. In addition, there are very few software tools available to assist development (Morgan, Butler, & Power, 2007). And although the Wiimote has been successfully reverse engineered, there are some aspects that are poorly understood. For example, the speaker embedded in the Wiimote is not yet functional outside of Nintendo authorized games and will not emit any meaningful audio in any Wiimote library (Brindza & Szveda, 2008). Finally, they are only sensitive to motion in the hand in which they are being held. The addition of a 'nunchuck' which also contains an accelerometer and is attached to the main Wiimote by a cord about one metre long, overcomes this to a certain extent. The nunchuk attachment does lack the inbuilt motor of the Wiimote, so is not able to simulate haptic feedback. Technologies utilizing depth-sensing cameras offer some advantage over the Wiimote (Naone, 2008).

Another floor device recruited from gaming is the Wii Balance Board. The Wii Balance Board is available for use with the Nintendo Wii console and Wiimotes. Within the gaming context, it is used to play a number of games many of which simulate snowboarding (such as Shaun White Snowboarding: Roadtrip and Snowboard Riot) and skateboarding (such as Skate City Heroes and Skate It) (see Hudson Soft, 2009; Ubisoft, 2009). It is also used for balance, aerobic and yoga activities in Nintendo's Wii Fit and Wii Fit Plus games. The Wii balance board itself is a sturdy, rectangular panel that rests on four feet each of which contains a pressure sensor. The pressure values are conveyed to the Wii console via Bluetooth (de Haan, Griffith, & Post, 2008).

There are numerous possibilities for movement in three-dimensional space. The most obvious use would be to control first person travel using natural proprioception and kinaesthetic senses. The user would step onto the centre of the balance board and then move to the rim to indicate movement in any

direction (de Haan et al., 2008). Engineer David Philip Oster created some software for Bluetooth-enabled Apple computers that enables users to 'surf' Google Earth (Oster, 2009a, 2009b). This software is easy to download, install and use and within minutes it is possible to be exploring the three-dimensional features of the Amazon or the Himalayas. A lesson in geography becomes much more interesting if the student can learn about the Grand Canyon by surfing the Colorado River. Matthieu Deru and Simon Bergweiler also hacked the Wii Balance Board so that it could be used to surf Google Earth. In addition, they used it as a means of moving avatars in the MUVE of Second Life (Deru & Bergweiler, 2009). It would also be possible to use the balance board while sitting down and in that way could simulate pedal control (de Haan et al., 2008). The board can also be used as rotational input device whereby the user can rotate a particular object. Further, it would be useful in those contexts when the user's hands are already occupied with another task (de Haan et al., 2008).

Xbox Kinect

Launched in November 2010, the Xbox360 upgrade known as Kinect creates the environment for a deeper level of immersion and as such has interesting educational implications. The major difference between the Kinect and the Nintendo Wii is that it allows users to interact with Xbox 360 games by moving their hands and bodies in front of a screen, in a manner reminiscent of how people play games on Nintendo Wii consoles. The significant difference is that players will not need any sort of controller. All that is required is a camera bar and a microphone which sits above or below the screen to record a player's movements.

The Kinect offers educators the opportunity to utilise kinaesthetic learning within a broad range of environments, and not only in those where there could be a potential risk to participants (such as in chemistry or any situation involving potentially hazardous substances or environments). Already there have been a range of applications for the Kinect which have educational value. Medical researchers have begun to use the Kinect to assess motor skills development in children with developmental coordination disorders (Straker, et al, 2011); and to view patient MRIs during cancer surgery (Moretti, 2011). The latter is especially useful as it allows surgeons to view data in a sterile environment, without the need to leave the operating theatre or change their surgical garb. In the language classroom, a Kinect application has already been designed to teach American Sign Language. The software is able to match the learners gestures with those of the virtual teachers to ascertain if the learner is signing correctly (Kissko, 2011).

Avatar Kinect (Microsoft Corporation, 2011) has implications for distance learning as it can allow groups of geographically dispersed learners to meet in a virtual space and interact through their motion-driven avatars. The same software allows for the users to create presentations, performances or interviews within a virtual environment which capture body movement, gesture, and facial expression as well as voice. Used as a medium for assessment this offers applications for almost all disciplines - from a project management team comprised of business students, to a groups of nursing students performing a diagnosis, or pre-service teachers interacting with mock students in a classroom. It is theoretically

possible to teach even performing arts via distance education and assess students within this environment.

Lastly, in the field of religious studies, the Avatar Kinect could offer tools for greater immersion and understanding of ritual and body language. Most religions have a strong kinaesthetic element for adherents, from the Catholic genuflecting to the use of dance as a celebratory or ritual tool (Sautter, 2005) and neopagan religion is heavily reliant on ritual yet at the same time has small numbers of geographically isolated adherents. The use of Kinect aligned with virtual worlds such as Second Life, would allow studies in religion learners a greater level of immersion and appreciation for the movement-based nuances of religious observances.

Conclusion

User interfaces from gaming consoles such as the Nintendo Wii and Xbox Kinect confer numerous advantages for education over traditional input devices: the keyboard and mouse. Creative arts students can dance or perform at a distance for their peers or lecturers by exploiting the affordances of Avatar Kinect for the Xbox. A more natural way of interacting with a virtual environment can reduce the learning curve of navigating for the elderly or the very young and it is precisely this element that contributed to the enormous sales of the Nintendo Wii through the recruitment of players in non-traditional markets. This natural interaction coupled with haptic feedback (in the case of the Wii) helps facilitate immersion in a virtual environment such that players feel like they are really there. Already, a number of applications have been developed for both the Kinect and the Wii, which facilitates kinaesthetic learning. This is a boon for distance learning that has struggled to provide authentic learning at a distance for students enrolled in action-based programs such as nursing or for those students identified as being primarily kinaesthetic learners.

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