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The application of virtual reality in construction management education and training – a case study in Australia

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Background

- The construction sector and its practitioners have been changing its understanding about productivity and creativity.

Examples:

- Greater reliance on offsite modulation – more design and operations determined in advance and the on-site work carried out by laborers is considerably reduced

- The construction sector invested remarkably in Building Information Modelling (BIM) that facilitates project stakeholders to better link the designs to their operations and coordination. This foster better project planning to reduce design and operational errors, minimize waste, optimise schedule, rationalise budgeting and subcontracting (Wong, Wang, Li, Chan, & Li, 2014).

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Background

- Undergraduate students in construction engineering and management are literally **not work ready** if they are not capable of applying building technologies in practice.

- Effective learning of building technologies is stemming from persistent practices in transforming information from construction drawings to appropriate responses in compliance with the industry standards and the government requirements.

- This type of training has been delivered in a conventional fashion involving formal lectures and studios-based practice sessions.

- Common approaches higher education and professional bodies has been adopting – call for upskilling students, life-long learning for practitioners. Rarely review the effectiveness of the mode of course delivery.

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Challenges

- Students/Junior staff usually lack site experience and demand for more intensive guidance to understand the learning content.
- Professional trainers or academics with sufficient site and project management experience are not many.
- Student numbers, safety, disruption of site progress, relevance of sites, timing of work constrain the value and frequency of site visits.
- Not possible to hundreds of students to sites even RMIT has been blessed to receive immense support from the industry.
- Devising more effective training in construction technologies, operational practice and project monitoring skills shall be invaluable for the students, professional bodies, academia and the construction industry.

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Can BIM helps address the challenges?

- Both industry and the academia invested remarkably in Building Information Modelling (BIM)

- BIM enables visualisation of end-products in three-dimensional forms before physical construction work commence. This facilitates project stakeholders to better link the designs to their operations and coordination.

- BIM fosters better project planning to reduce design and opeartional errors, minimize waste, optimise schedule, rationalise budgeting and subcontracting (Wong, Wang, Li, Chan, & Li, 2014).

- Information abstracted from BIM is merely 3-dimentional computerized models in a virtual environment that cannot help individuals to develop spatial skills as much as site visits guided by experts with hands-on experience sharing.

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Can BIM helps address the challenges?

- Future developments of BIM into multiple dimensions - enable more preliminary planning. Make use of information visualization techniques, designers are able to combine drawings with simulations of 3-dimensional graphics. This also enables entire virtual planning in site layouts, construction, schedules and cost before the development commence in reality.

- However, human experts and their real site experience are difficult to be modeled (Herr, et al., 2018).

- Nonetheless, such real experience is not only complementary to the constraints of BIM simulated virtual design, but also a key to rationalize future BIM models.

- Furthermore, the greater reliance of BIM may reduce chances of inexperienced professionals/ students to understand building methods and gain hands-on site experience during the project construction stage.

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Virtual Reality – how is it being implemented in construction management education and training?

- Some advocates that Virtual reality has great potential in leading changes in construction education and training.
- ‘VR represents effort in creating a virtual environment with visual and immersive aids to let users feeling a “real” sensation. (Fogarty, McCormick, & El-Tawil, 2018)’
- When users wear proper equipment, they can access a range from totally computerized virtual to immersive real environments, thereby experiencing the size and extent of important features in a natural and intelligible way.
- ‘However, it can only provide a limited level of ‘realism’ due to a lack of sensory feedback to accommodate for perceptual and cognitive viewpoints’. (Fogarty, McCormick, & El-Tawil, 2018)’

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Current use of VR in construction management education and training

- Construction safety: ‘as a complement to digital modeling, leading to better communication in vocational construction safety education to enhance the students' safety awareness’ (Li, Chi, Wang, & Chan, 2018)
- Scenario-based close to reality 3D dynamics environment for on-the-job safety training.
- Defects checking
- Some uses in manufacturing pre-fabricated units

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Not all VR applications are effective

- Previous use in VR – usually combines drawings with simulations of 3-dimensional graphics.
- VR with headsets and handheld device – costly, space, limitation in teaching large classes
- VR simulations helps in pre-construction stages to reduce cost and errors. However, cannot relate real physical environment. Learners find difficult to understand the concepts. No feedback loop, no instance response
- Augmented Reality (AR) - integrates images of virtual objects into a real world. Good for tagging permanent structure not good for construction management

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Applying VR in construction management education - case study in Australia

- The lower costs and improved quality of hardware and software make VR approaches more feasible to be applied in higher education than before
- The VR technology we adopted has been successfully implemented in entertainment, medical science, military training, heritage and archaeology as well as in some the manufacturing fields. It's not a new concept but it's a brand new approach to construction management professional training.
- We collaborate with the Centre for Learning Sciences and Technologies (CLST), Chinese University of HK. http://vr.ev-cuhk.net/
- We conducted a pilot VR for construction education project and collaborate with RMIT Property Services and Concept Build Pty. Ltd.
- Combine 4K Spherical Virtual Reality (VR) techniques with mobile apps development for construction education and research.

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Our outputs

- We designed the curriculum and capture VR picture in multiple construction sites on regular basis.
- We conducted field trips in Melbourne, Singapore and Hong Kong capturing relevant VR images for app development.
- We developed six Apps to be used in the following courses:
  - BUIL1226 Introduction to Buildings
  - BUIL1227 Introduction to Construction Process
  - BUIL1144 Cost Planning and Tendering
  - BUIL1260 Construction Contract Administration.

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Authentic VR apps for RMIT construction management students

- EduVenture VR is an online platform developed by the CLST to carry our VR learning. This platform enables designers to develop and distribute VR content and conduct VR site visits for users. EduVenture VR enables designer to add interactive elements to enhance learning motivation. “With mobile devices and tray glasses on hand, students can experience outdoor learning in VR world, a more flexible and interesting environment” (CLST, CUHK 2018)

- Engender learners to make more references to critical thinking and higher-order cognition in compare to conventional teaching methods. In engineering education context, VR improves learners’ understanding about spatial arrangements and the link between two-dimensional and three-dimensional environment.

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Features

- Combine 4K Spherical Virtual Reality (4KSVR) techniques with mobile apps development – among the first in construction education world.
- Create an interactive VR learning environment with tags, portal journeys and multiple choices functions. Future functions: voice answers, videos and teleports.
- Capitalizes on the rapid smartphone hardware and software advancement and development – learners can download the apps from AppleStore and Google Play. They use their phones, we provide headsets.
- Minimise technical glitch and on-line data congestion. Minimise reliance on wifi and mobile network in classroom environment.
- More immersive high resolution 360 degree photographic images complete with augmented labels/details.
- Demonstration – Oxford Scholar Project, Construction Design Economics

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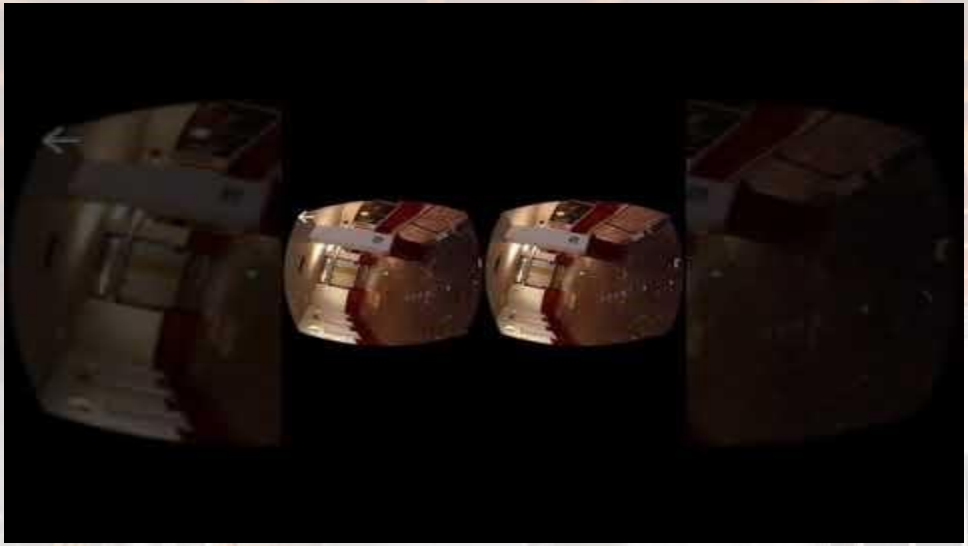
Demonstrations



- Oxford Scholar Project – VR app to study construction technology. VR pictures captured on regular basis to understand construction sequence and progress,

- VR for use in teaching design economics. VR pictures captured from different countries. Learn the best sides of professional practices of different countries. Enable critical thinking.

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Features

- By using 4KSVR technique, information from 2-D and 3-D drawings can be better conveyed by more immersive high resolution 360 degree photographic images complete with augmented labels/details. These images can then be further used for apps development.

- The lower costs and improved quality of hardware and software make VR approaches more feasible to be applied in higher education than before (Herr, et al., 2018). The equipment needed for developing 4KSVR based learning materials is not extensive. This includes:

  - A high resolution 4K VR camera
  - A high internal storage capacity smartphone that can accommodate VR images and videos
  - Camera Mount
  - Camera Tripod
  - Laptop/Desktop computer
  - Computer software for image editing and apps development

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Industry support does matter!

- Needs industry support in site visits, suggesting topics that relevant to the industry needs, show case.
- Scholars have experts and skills that can lead changes in construction education and training.
- Researchers have the skills that can extend the use of VR in managing construction projects. We are ready and capable of working with industry partners in VR R&D.

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Expected Results and benefits

- Will benefit the construction industry by developing a new approach in enhancing the industry-based professional training through the use of VR technology.

- Capitalizes on the rapid smartphone hardware and software advancement and development, designers are able to convert their virtual reality images to an education app that can be download by the learner anywhere and anytime.

- The virtual reality experience to be gained by the users of the proposed App will be different from those conceivable on BIM and cave automatic virtual environment (CAVE). To access to the VR learning materials, users only need to download the app to their own smartphone and mount it to a simple headset. The whole operation is cordless and no laboratory space is required.

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End of presentation

Thank you

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