

Further, in addition to traditional base of mathematics and engineering technology, future mining engineers require a new set of skills [20] such as to undertake identification, formulation and solution of problems; utilise a systems approach to design and operational performance; function effectively as individuals and as part of a multi-disciplinary team in roles of both leader and team member; understand and achieve responsibilities socially and environmentally; apply the principles of sustainable design and development; and undertake life-long learning. These skills represent several of the core professional engineering competencies required by Engineers Australia. They require the ability to make technical specialist decisions and at the same time take into account the wider implications of being in a complex dynamic, often messy and unpredictable, socio-political and environmental context, often referred to as 'systems thinking' [21].

2. DEVELOPING VIRTUAL REALITY AT THE SCHOOL OF MINING ENGINEERING, UNSW

UNSW in collaboration with the industry has progressively built simulators for the mining industry. A project commenced in 1999 with seed funding from UNSW and Coal Services Pty Ltd. Subsequently, funding was provided from industry in 2002 through Australian Coal Association Research Program (ACARP). A flat screen 'proof of concept' system was deployed at Newcastle Mines Rescue Station in Argenton, NSW. Stothard et al. [22] described the development, deployment and implementation of a VR simulation capability by the School to address the specific needs of the Australian coal mining industry. The simulation capability developed is a hybrid system designed to provide simulation technology to operators, both large and small. They were deployed at Mines Rescue Stations in NSW and are currently in daily use for training in areas such as Unaided Self Escape, Rib and Roof Stability, Hazard Awareness and Isolation. Further, The School has been involved in UNSW's award-winning iCinema Advanced Visualisation and Interaction Environment (AVIE) project – a 3D 360° VR facility and iDOME (a 2D version of the AVIE) [10]. The School has constructed an AVIE and an iDOME, funded partly by a Federal Capital Development grant in 2007, for developing mine safety-training simulations (Fig. 2). Currently, the School has developed a total of 18 modules, some of which have also been developed as part of specific industry demand.

3. MODULES DEVELOPED FOR LEARNING AND TEACHING AT THE UNSW EN MINERIA

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South Wales established the Mining Education Australia (MEA) in 2006 in Australia with the purpose of undertaking an innovative approach to educate undergraduate mining engineers that meets the demands of the industry in terms of quality and quantity of mining graduates, with the financial support from the Minerals Council of Australia. The University of Adelaide became a member of MEA in 2008 [23]. As part of this collaboration, various innovative teaching techniques and effective instructional materials were developed. Numerous VR modules were developed for betterment of teaching and learning for mining engineering education and these are being used currently amongst majority of the courses, both in undergraduate and postgraduate teaching. All these modules are capable of running in the AVIE at the School and also on a standalone PC. Some of these modules are currently being made to run on the internet so that students can access them at their leisure [24]. The following sub-sections will discuss the modules that have been developed for improvement of learning and teaching developed in the UNSW.



Fig. 2. (a) AVIE and (b) iDOME at the School of Mining Engineering, UNSW.