A45 ICT & CURRICULUM DESIGN TO BRIDGE THE GAP BETWEEN INDUSTRY AND ACADEMIA

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Building Information Model (BIM) software, collaboration platforms and 5D Construction Management software is now commercially available and presents the opportunity for construction project teams to design more cost effectively, plan construction earlier, manage costs throughout the life cycle of a building project and provide a central asset management register for facilities managers. This paper outlines the merits of taking a holistic view of ICT in curriculum design. The educational barriers to implementation of these models and planning tools are highlighted. Careful choice of computer software can make a significant difference to how quickly students can master skills; how easy it is to study and how much they enjoy learning and be prepared for employment. An argument for BIM and 5D planning tools to be introduced into the curriculum to assist industry increase productivity and efficiencies are outlined by the authors.

Keywords: Building information models, construction modeller, 3D modelling, 4D planning tools, e-learning, visualisation.

INTRODUCTION

Information and Communications Technology (ICT) is rapidly changing the way we look at and participate in education in universities. Innovative approaches and new strategies using ICT to deliver built environment education and training are urgently needed.

Presently the emphasis in teaching is on learning content, teaching materials and resources but there is an urgent need to focus on e-learning and e-teaching to develop workplace skills for the built environment graduate. Industry is demanding that students be work-ready and ICT literate with the relevant software.

INDUSTRY'S VIEW

The wide-spread adoption of computer-based tools automating business processes and supporting activities throughout the life-cycle of facilities planning, design, construction, maintenance and decommissioning supports the reliance on information technologies to deliver efficiency gains.

> "The frenzied race to implement (ICT) across the whole global economy, has all the hallmarks of a 20th century gold rush. Corporations, like miners bitten with gold fever, race to implement ICT's or eCommerce for competitive advantage and improved bottom line results". (Austrade)

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There is a need for an education strategy to prepare students to use integrated ICT systems and technologies and commercial software.

Students who are trained in the above ICT may be called “building modellers” rather than architect, construction manager or quantity surveyor. Very few in industry are currently trained in BIM’s and the shortage of skilled graduates is hindering productivity and improved bottom line results. There is an urgent need for e-learning to be included in curriculum.

E-LEARNING?

There is no definitive agreement on what e-learning is and on terminology used to describe the use of technology in learning (Pailing; 2002, Romiszowski; 2004 and e-learningguru.com accessed 19th June 2004). E-learning can cover a range of activities from supporting learning, a combination of e-learning and traditional learning through to learning that is delivered entirely online (Joint Information Systems Committee; 2004). Romiszowski (2004) found more that 50 different definitions of the term. From this research Romiszowski developed what he terms a “structured definition of e-learning”. The framework developed is as illustrated in table 1.

Table 1 Structured definition of e-learning

	INDIVIDUAL SELF STUDY Computer Based Instruction/Learning/Teaching (CBI/L/T)	**GROUP COLLABORATIVE Computer Mediated Communication (CMC)**
ONLINE STUDY Synchronous Communication (“REAL-TIME”)	Surfing the Internet, accessing websites to obtain information or to learn (knowledge or skill)	Chat rooms with(out) video Audio/Video conferencing
OFFLINE STUDY Asynchronous Communication (“FLEXI-TIME”)	Using stand-alone courseware / Downloading material from the Internet for later local study	Asynchronous communication by email, discussion lists or a Learning Management System

Source: taken from Romiszowski 2004 page 6

This framework emphasises that e-learning may be either a solitary individual activity or a collaborative group activity where both synchronous and asynchronous communication can take place or a combination of all of these. In this paper e-learning is defined as using ICT to learn — collaborating on-line via the internet, using 3D modelling to visualise the virtual building, 4D planning tools to visualise the construction sequence or completing e-quizzes – it all counts as e-learning**.**

It is important at the outset to realise that there are advantages and disadvantages with traditional versus e-learning in delivering learning (Zhang et al; 2004). These are as summarised in table 2.

Table 2 Traditional classroom learning versus e-learning

	Traditional Classroom Learning	E-Learning
Advantages	➢ Immediate feedback ➢ Being familiar to both instructors and students ➢ Motivating students ➢ Cultivation of a social community	➢ Learner-centred and self-paced ➢ Time and location flexibility ➢ Cost-effective for learners ➢ Potentially available to global audience ➢ Unlimited access to knowledge ➢ Archival capability for knowledge reuse and sharing
Disadvantages	➢ Instructor-centred ➢ Time and location constraints ➢ More expensive to deliver	➢ Lack of immediate feedback in asynchronous e-learning ➢ Increased preparation time for the instructor ➢ Not comfortable to some people ➢ Potentially more frustration, anxiety and confusion

Source: Zhang et al. page 76 2004

E-learning can make a significant difference to how quickly students can master skills; how easy it is to study and how much they enjoy learning. E-learning can improve the quality of learning (deep learning); remove barriers to learning, and prepare students for employment. For any type of learning to be effective, whether it is classroom based or computer based, it has to be built on sound pedagogical principles (Wall and Ahmed, 2004). Confucius (450 BC) summarised the importance of understanding the pedagogical processes that take place when learning occurs:

> "Tell me, and I will forget, show me, and I may remember, involve me, and I will understand."

What has changed considerably in more recent times is the evolution of ICT and how technology can be configured to incorporate the "tell", "show" and "involve" that are prerequisites of effective learning (Sit; 2001)

E-LEARNING VISION

There are many aspects to the e-learning vision for curriculum design -

- Develop digital e-teaching and e-learning resources by improving education-industry partnerships
- Develop an educational ICT framework throughout all degree studies to enhance project innovation
- Develop innovative ways of exploiting e-learning alongside other teaching methods
- Mix e-learning with more traditional methods, offering more active and creative ways of learning in construction
- Develop assessment to keep pace with new kinds of e-learning
- Maximise the benefits of ICT technologies across each asset life phase
- Devise strategies to reduce life cycle costs and enhance the competitiveness of ACE enterprises in a global market.

- E-learning resources and software is shareable and affordable
- Provide guidance on organising design teams and supply chains to work collaboratively on 3D models (Nanetti's virtual building)
- Capturing and utilising the information for the life of the project and future projects.
- Incorporate the common data environment concept into curriculum design.

As new technologies emerge ICT needs to be introduced into the curriculum to e-learning is relevant. Lecturers need training to engage in e-teaching and need to be able to innovate and take the lead in pedagogical developments using, creating and sharing e-learning resources to offer more active and creative ways of learning. E-learning could incorporate Nanetti's "Virtual Building" and Avanti's Common Data Environment.

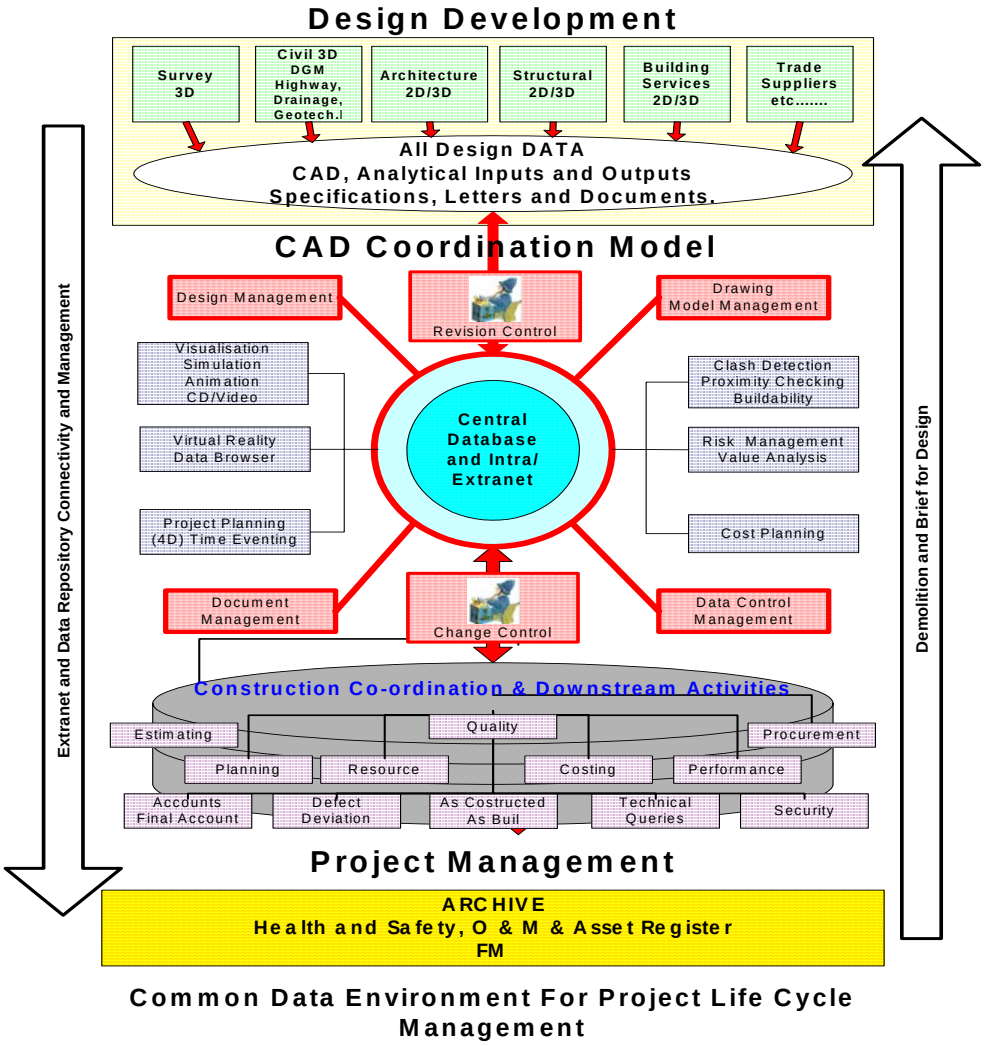
VIRTUAL BUILDING CONCEPT

Nanetti's virtual building is a digital building holding all project information similar to a hard copy system today. Nanetti states that "efficiency can only be reached when we replace a mountain of electronic papers with a project model central database". The virtual building will use 3D Building information models (BIM), 4D planning tools and 5D reports in the common data environment.

COMMON DATA ENVIRONMENT

Avanti's Common Data Enviornment (CDE) for project life cycle management illustrates how the design process can be managed to include functions such as cost planning, estimating, scheduling, clash detection and value analysis through using the BIM. CDE facilitates project team collaboration and asset lifecycle management from a project management perspective

A strategic approach to education in ICT is needed right across the built environment university curriculum. ICT software across all phases of an asset life cycle creates the potential to integrate design, construction, and operational information processes. Figure 1 illustrates this integration.



Source: ***http://www.avanti-construction.org/***

DIFFICULTIES IN IMPLEMENTING IN THE CURRICULUM

Some educational leaders take the view that precious time in lectures and tutorials should not be used for teaching ICT but should be used to pass on learning content — they say students must learn ICT tools independently. Others blend ICT training into lectures and tutorials. The ICT chosen is often based on what's popular in industry at the time of writing the unit outline, bedded into the official curriculum document and purchased by the university for its labs. These are often not updated and no partnerships are formed with industry or software suppliers for upgrades. Changes are needed.

Lecturers are best placed to understand and discover how to use e-learning in teaching but they need the flexibility and tools and the means to discover and innovate. Analytical IFC compliant software used in conjunction with 3D modelling tools should be considered for e-teaching in universities.

ANALYTICAL IFC COMPLIANT SOFTWARE

A suite of analytical software tools are now commercially available to the construction industry and these should be included into curriculum design:

1. Model-based Estimating.
2. 4D visualization of construction schedules.
3. Code Checking
4. Environmental controls
5. Clash detection software

Application and software distributors are outlined below.

Estimating

Model-based Estimating provides that the quantities from the BIM produces an estimate. Software suppliers include Graphisoft. Some systems have added features such as 5D Reporting and uses the construction model as the link between cost and time. The ICT produces cost loaded schedules for financial analysis. An example is Graphisoft Estimator 2005.

4D visualization of construction schedules

4D Sequencer automatically linking the BIM to the project schedule. Once linked, schedule alternatives can be analyzed and communicated. Graphisoft's Constructor 2005 has connectivity to Primavera's Engineering and Construction and Primavera's Contractor. An alternative is Navisworks TimeLiner JS which similarly enables 3D model data to be linked with project software for fast 4D visualization of construction schedules.

Code Checking

Code checking is currently being developed by the CRC CI. The BIM is checked by the Code Checker to the Building Code of Australia and Australian Standard 1468.1 to comply with the Disability Discrimination Act.

Environmental controls

Environmental control software has been developed by the CRC Construction Innovation. The software assesses the BIM for automated eco-efficiency assessment.

Clash detection software

Clash detection software is necessary to detect any errors in the BIM. Commercially available software includes Navisworks Clash detective enabling identification, inspection and reporting

The building modeller understands and uses Industry foundation classes to ensure interoperability.

INDUSTRY FOUNDATION CLASSES (IFC)

It is time consuming to draw plans, compile schedules and write specifications. Traditionally, lines on drawings represented building elements such as walls, roofs, windows, doors but

there was no information on the materials used or exactly what the lines represented. A legend, schedule and a specification was then compiled detailing the materials, type of product and performance required. Any updates required changes in a number of places. This has all changed with 3D models where IFC's are used.

Industry foundation class (IFC) are used to encode the specification of each building element into the 3D model drawing. The IFC allows each component of a building and its relationship with other components to be identified.

CLASSES

Classes include building elements such as slabs, roofs, walls, windows, doors. Window information embedded into the window lines include type (eg casement), dimensions, type of frame and various settings specifying all components for the window). A separate technology exists for manufacturer's and suppliers.

GEOMETRIC DESCRIPTION LANGUAGE (GDL)

Building material manufacturers now provide on their websites 2D CAD symbols and 3D models for use in drawings and quantity calculations. These are real-world objects using GDL which contains all the information necessary to describe the building element.
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CONCLUSIONS

E-learning can make a significant difference to how quickly students can master skills; how easy it is to study and how much they enjoy learning. E-learning can improve the quality of learning; remove barriers to learning, and prepare for employment. Universities should consider analytically compliant IFC software for inclusion into curricula including, (i) 3D Visualisation and Simulation tools showcasing the benefits of IFC compliance, (ii) 3D Building information model Environments, (iii) 4D planning tools to visualise construction schedules, (iv) Automated estimating packages to produce cost estimates, (vi) automated of bill of quantities, code checking and clash detection. Construction modellers who are trained in these digital e-learning resources through improved education-industry partnerships can contribute to industry's competitive advantage and improved bottom line results. The new graduate of the future may be called a construction modeller rather than a construction manager, architect, hydraulics designer or quantity surveyor.

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The list of references should be laid out as detailed in these guidance notes, using the style References, and with one reference per paragraph (no blank paragraphs are needed between them).

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