An e-learning approach to quantity surveying measurement

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Abstract

Quantity surveying measurement adopts prescriptive processes which are underpinned by an understanding of construction technology. The rules for measuring are complex, and are designed for experienced practitioners. Some students struggle to acquire the mix of skills and knowledge within the timeframe allowed. At Newcastle University (Australia) we are preparing high quality teaching and learning materials for both on-campus and on-line distance learning students. We are collaborating with the Department of Civil and Building Engineering at Loughborough University (UK) to develop e-learning measurement packages utilising 3D images. This paper describes and discusses some of the merits and challenges of the approaches we have adopted. The findings of an evaluation survey are also briefly described as well as plans we have for future developments.

Keywords: e-learning, measurement, quantity surveying.

1. The Context

According to the Australian Institute of Quantity Surveying [1] quantity surveyors get their name from the Bill of Quantities, a document which itemises the quantities of materials in a construction project. The quantities contained in bills of quantities are measured from design drawings, to be used by the contractors for tendering and for progress payments, for variations and changes and ultimately for statistics, taxation and valuation. Various dictionaries provide similar definitions including: *cost assessor for building work: somebody who assesses the cost of a construction job based on the amount of labour and materials required to complete it* [2], and *a person whose job is to calculate the cost of the materials and work needed for future building work* [3]. It is clear that quantity surveyors need to measure what goes into a building before they are able to assess costs. Indeed the Australian Institute of Quantity Surveying [4] considers measurement / quantification as a basic quantity surveying ability.

This need for would-be quantity surveyors to develop measurement skills is set in a changing job environment. In Australia, a buoyant construction industry is currently fuelling high student expectations. Job opportunities for graduates as well as for students as part-time employees are attractive. Students embarking on their studies come from a wide variety of backgrounds. Many are of mature age and already have a construction background. Few are female. Many are highly computer literate and expect to engage with their studies using computer systems. An increasing number bring with them financial imperatives of having to work to support their tuition. This latter point is emphasized by Mills and Ashford [5] in their investigation into part-time employment of construction management students. They identify a trend of increasing levels of student engagement in the workplace. More recently an Australian Vice Chancellors' Committee report [6] entitled 'A summary of findings from a national survey of students in public universities' confirmed that increasing financial stress was undermining students' abilities to study effectively.

These financial pressures cannot be ignored. A response that the National Tertiary Education Union Newcastle branch president Bert Groen [7] recently suggested might be occurring is where academics ask students to choose between their work and their studies. This is clearly unsatisfactory, and is obviously not to be advocated. Students require flexible alternatives that respond not only to their pecuniary requirements, but to different ways of learning that many of them engage in.

Barnes, Marateo and Ferris [8] cite Bonamici, Hutto, Smith, and Ward (2005) who claim that the current (Net or 'Internet') generation is unique in that it is the first to grow up with digital and cyber technologies. They observe that not only are NetGeners acculturated to the use of technology, they are saturated with it. By the time s/he has reached 21 years of age, the average NetGener will have:

- (spent) 10,000 hours playing video games,
- (written / responded to) 200,000 e-mails,
- (spent) 20,000 hours watching TV,
- (spent) 10,000 hours on cell phones, and
- (spent) under 5,000 hours reading.

The last point warrants further consideration. Anecdotal evidence suggests that many lecturers teaching quantity surveying courses may have unrealistic expectations of their students' reading skills. If Barnes et al's [8] data are indicative of Australian university students, lecturers need to recognise that the skills students enter University with are evolving and that many prefer to use digital materials rather than paper. Indeed, some staff may be structuring their teaching based on traditional learning preferences rather than those of NetGeners.

To further complicate the issue, quantity surveying students need to be able to 'read' construction drawings. To do this students need an amalgam of skills, knowledge and understanding: they need knowledge and understanding of construction materials and construction technology; they need to be able to visualise how various components fit together; and they need to have an understanding of construction plant and equipment, occupational health and safety issues, relevant legislation and so on. Clearly, measurement might be seen as a 'basic' quantity surveying skill, but it needs to be underpinned in a multitude of different ways.

The approaches to teaching quantity surveying measurement described in this paper are those adopted in the Bachelor of Construction Management (BCM) program in the University of Newcastle, Australia. We have responded to some of the abovementioned challenges in several ways.

- We offer our BCM program in face-to-face as well as on-line modes. This allows our students to study on-campus or as distance-learners, and provides them with the flexibility to decide at what pace to progress their studies.

- We deliver our courses using problem-based learning approaches.

- We have collaborated with the Department of Civil and Building Engineering at Loughborough University (UK) to develop several on-line measurement tutorials. These respond to students' NetGen skills by harnessing the appeal of information technology, and exploits students' preferences for engaging with e-materials. The tutorials have been developed by industry practitioners and are presented in a professional and engaging manner. They are short and 'punchy' (none are longer than 12 minutes), and can be viewed through Blackboard (the learning management system [LMS] our University uses) and / or downloaded to an iPod or to a Windows based Personal digital assistant (PDA).

This paper briefly describes the skills involved in quantity surveying measurement, illustrates the materials we have developed and then describes how they have been used. Indicative student evaluation data are also presented as well as brief plans we have for future developments.

2. The skills involved in measurement

In their paper on quantification skills in the construction industry, Fortune and Skitmore [9] comprehensively summarise traditional measurement skills and competencies. They cite Fletcher and Bannister (1931) who identified the "essential" attributes of a person quantifying construction work. These include: a thorough knowledge of building construction; acquaintance with the ordinary rules of mensuration; knowledge of the customs of each trade; tact; patience; accuracy; energy; common sense; initiative; and imagination to visualise building design details. Fortune and Skitmore [9] also refer to Willis and Newman (1988) and add to the

aforementioned list the ability to write clearly, take care, think logically and possess a sound knowledge of building materials. Furthermore, Fortune and Skitmore [9] note that many of the qualities Mudd (1984) considered to be associated with contractors' estimators were very similar to Fletcher and Bannister and Willis and Newman but add: a good basic numerate education; experience on site; ability to read and interpret drawings; a neat, methodical and tidy habit; ability to cope with vast amounts of paper work; curiosity; confidence; and the flexibility to pick up useful information. Finally, in this respect, Fortune and Skitmore [9] mention Skitmore's (1985) work with practising quantity surveyors in early design-stage estimating and identify four further perceived characteristics as: good organisational ability; intuition; application; and aptitude.

We acknowledge the traditional skills identified above, but question the relevance of traditional modes of delivery for NetGen students. Many researchers question the efficacy of traditional lectures [10, 11 and 12]. Barnes et al [8] observe that the Net Generation represents nearly 7% of the population today (Bartlett 2005) and with nearly 49.5 million students enrolled in schools in 2003 (Enrollment Management Report 2005), responding to the specific needs of this generation of learners is becoming increasingly important. They go on to observe that the challenge of evolving pedagogy to meet the needs of Net-savvy students is daunting, but say that educators should note that this generation values education. Furthermore they emphasize that these students learn in a different way than their predecessors did, but they do want to learn.

A significant challenge for those teaching measurement is (and always has been) to ensure students have sufficient knowledge and understanding of construction technology to enable them to measure. Measurement (or 'taking off') is a process which requires a technical knowledge and understanding of building or civil engineering technology. However, at the time students are required to learn how to measure, many of them do not yet have this underpinning knowledge and understanding.

Taking-off may be considered analogous to the accounting profession's system of double entry book keeping and requires students to follow a prescriptive set of rules provided by published standard methods of measurement (SMMs). These publications do not explain the taking-off process. They are designed to provide experienced quantity surveyors with rules for taking-off in a standardised manner and rely heavily on readers understanding the 'technology'.

From a teacher's perspective the challenge lies in teaching SMM based taking-off processes to students who have just enough knowledge of construction technology to comprehend the measurement rules. This needs to be done without losing focus on demonstrating taking-off. Traditional lecture based approaches deal with taking-off and technology as two separate topics. Students learning taking-off have to continually refer to technology texts which are generally not compiled in the same order as SMMs (There are very few published construction technology texts that complement SMMs). This is clearly frustrating for students and must hinder their learning. We have adopted a different approach. By judicious use of image capture software and 3D modelling we have blended the necessary construction technology with the teaching of the measurement process as will be seen in the following sections.

3. Description of the QS materials

We have developed digital learning materials in a manner that enables them be used in a variety of ways including lectures, tutorials, or as reference materials. The range is due, in part, to the concise and focussed presentation we have adopted, and represents a continuation of our earlier work into Integrated Learning Objects [13 and 14].

The materials comprise:

- Video presentations which describe relevant measurement procedures and incorporate relevant documents such as selections from the Australian SMM [15], dimension paper, construction drawings, site layout plans and site photographs

- Supporting documentation including drawings and specifications (in hard as well as softcopy)

Materials for the following topics have been developed:

- Taking off and the Australian SMM

- Siteworks

- Excavations

- Concrete, formwork and reinforcement

Further materials for the structural steelwork, masonry and roofing are to be developed for delivery in Semester One, 2008.

4. Development of the QS materials

The QS materials were developed using two software packages, Camtasia Studio [16] and Google SketchUp [17]. Camtasia is a fourth generation screen capture program that provides a timeline which accepts video, images and audio. Video and images are arranged on a timeline and finally a voice-over is added. Figure 1 shows a developer's view of how these media are combined on screen. In addition, Camtasia provides a number of tools that enhance useability from an end-user's perspective. It is possible to 'zoom' and 'pan' to explore aspects of interest, and to access additional information / explanation by clicking on symbols which are available at various locations.

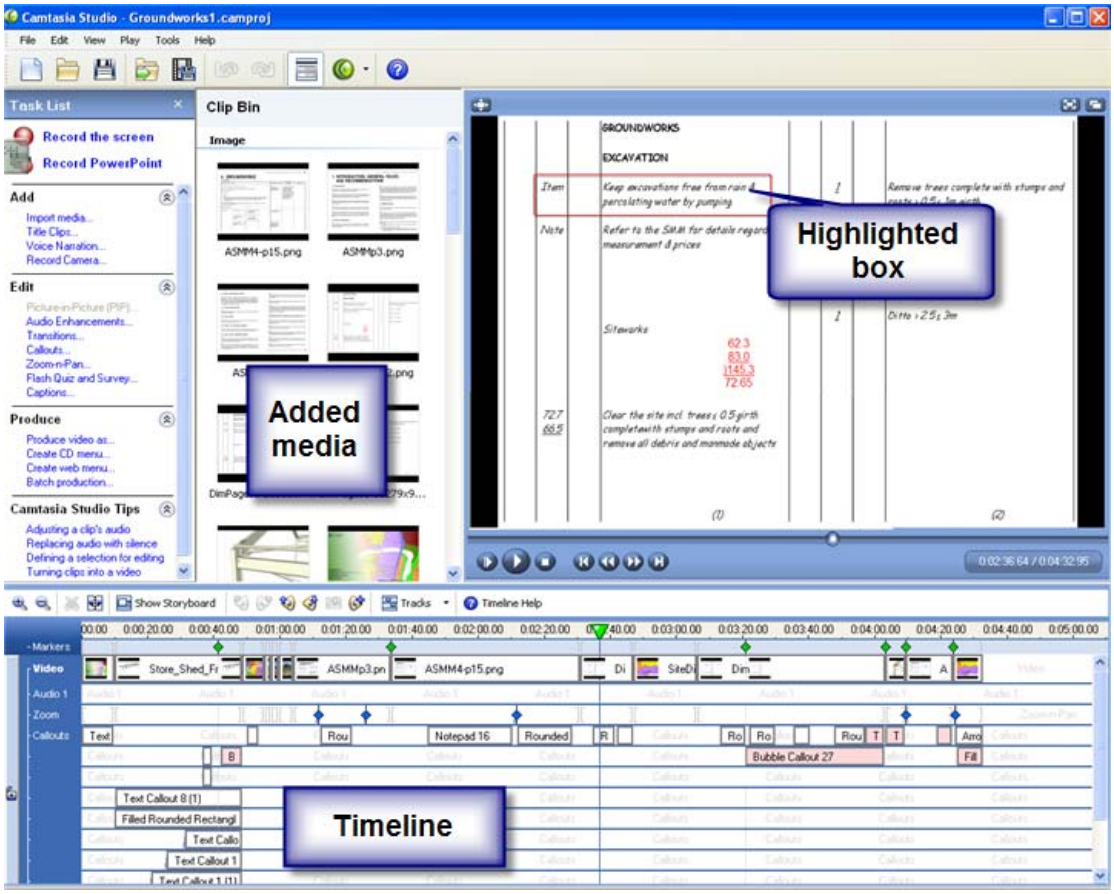

Figure 1: Camtasia workflow with media, images/video inserted on a timeline

Camtasia provides output in several formats including AVI, Flash, WMV, QuickTime, RealMedia, iPod video and mp3 audio. The Flash format has significant advantages; it streams particularly well without dedicated streaming software and allows interactivity via hot spots (which, when invoked, take users to another image, video or URL).

5. How we have used the QS materials

The digital measurement materials may used in a number of different ways.

- When used in lectures the materials may be presented as a discrete element around which discussions ensue.

- To service our distance learning students we use Lectopia, a system which gives distance learners access to lectures delivered on-campus. Lectopia allows lecturers to record their lectures from suitably enabled venues. Staff present their lectures as normal, and what they say and display (from their computer or visualiser) is recorded in a digital format. Once a lecture is over it is automatically processed and is ready for students to access through Blackboard within a short space of time. Distance learners are thus able to engage with the measurement materials in a similar manner to on-campus students.

- Our student population is dispersed over a wide geographic area. Some students work on remote construction sites without Internet access, and in these cases we make CD versions of the measurement materials available to them.

- Self paced learning is also possible. Students can work through the materials at a time and pace that suits them. When used in this way the materials are delivered through BlackBoard. iPod and Windows PDA versions are also available.

- We have also used the measurement tools during tutorials. Students are shown the materials and discuss various aspects face-to-face with tutors (for on-campus students) or via electronic discussion boards on our BlackBoard LMS (for distance learners).

We have explored a range of delivery routes. The measurement materials have proved to be versatile, and provide benefit to students as well as to staff.

6. Student evaluation

A representative sample of students (28 out of 76 students, 37%) responded to an on-line survey. They were split almost evenly between on-campus and distance learners ensuring that the views of both cohorts were represented. The majority (76%) used the measurement materials on-line from home (two students used iPods and two used PDAs), while 12% accessed the Internet from work and a similar percentage gained access from University. Three students experienced technical difficulties using the materials. The problems they encountered included the font size displayed on the iPod version, sound quality and old hardware. Our intention was to keep the materials short and 80% of students said that the length of the tutorials was about the right length of time. The remaining 20% felt that the materials were too short. We also anticipated that students would access the materials several times. This was indeed the case, with 64% of respondents saying that they had accessed each tutorial 2 to 4 times. Virtually all students found the materials easy to use. When asked whether they thought the materials would help them with their assignments, 88% of students said yes, and a similar percentage said that they would like to see more tutorials prepared in this way. Some free format questions were also asked. Students were asked how the materials had helped them. They said:

- It was explained in a straight forward manner and if I wasn't quite sure about something I could listen to it again and understand how the example works. Sometimes when you read something its not always as straightforward as hearing it explained.

- It has provided a basic starting point and simplified each step involved in the assignments. It was easy to refer back to when I got stuck.

- It was helpful in that it put into practice what we had learnt in class. It also made some of the more difficult concepts clearer.

- You can go back to sections you don't understand, and listen again. Easy to follow and outlines the areas the tutorials is talking about. The ability to click for more information in some sections is very good.

We wondered whether students would prefer on-line tutorials to face to face ones. Their response was ambiguous: 56% wanted on-line as well as face to face tutorials, 40% wanted only on-line tutorials and 4% wanted only face-to-face tutorials. When asked whether they would like to be quizzed about what they had learned from each tutorial, 82% of students said that this would be useful, but did not want these quizzes to count for marks. All students saw 24/7 access as being useful or very useful.

Whilst the above views are acknowledged to be those of a small sample of students, they support our hopes and expectations, and encourage us to continue our developments.

7. What improvements / changes will we implement?

As previously mentioned, many novice quantity surveying students are not familiar with how to read and interpret construction drawings. A discussion of whether or not these students need to be able to prepare technical drawings before they can fully understand them is outside the scope of this paper. However, many software packages are currently available to help students overcome the limitations of 2D drawings. We have trialled 3D models developed using Google SketchUp and have been encouraged by the ease with which these have been created, and by the verbal feedback students have provided. Google SketchUp [17] is a powerful yet easy-to-learn 3D software tool that combines a simple, yet robust tool-set with an intelligent drawing system that streamlines and simplifies 3D design. From simple to complex, conceptual to realistic, Google SketchUp enables you to build and modify 3D models quickly and easily.

An example of a 3D model for a reinforced concrete pumping station is shown in Figure 2. Students are able to rotate, pan and zoom in on the model to gain an overall appreciation of the manner in which components fit together.

We intend to develop quizzes for students to use in conjunction with the measurement materials. These will be aimed at facilitating reflection and are likely to be non (or minimally) weighted assessment tasks. The questions we ask will provide a focus for students and will provide feedback that they have understood key aspects presented in the materials. Formative assessment, such as the quizzes, are important for giving regular feedback, providing opportunities for revision and for improving reflection and understanding [18].

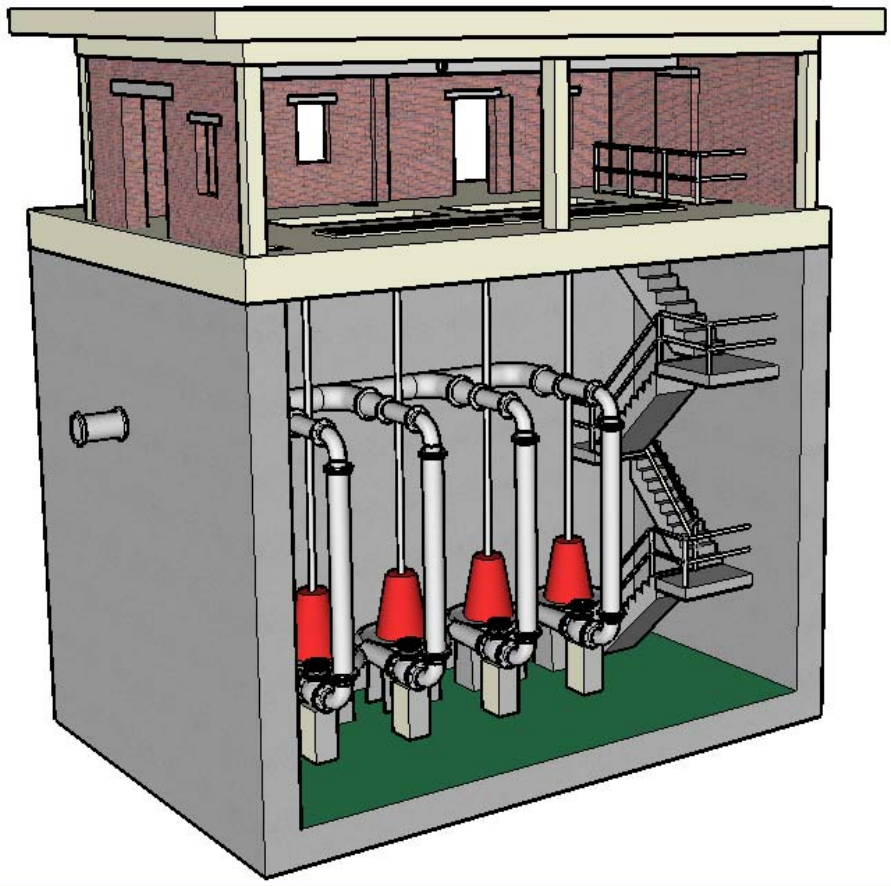

Figure 2: Various views of a pumping station, prepared using Google Sketchup

8. Concluding comments

This paper describes a modest step in harnessing the power of high performance processors now standard in all personal computers. 3D imaging and graphics have come of age and are no longer solely in the domain of design studios and TV stations. We have demonstrated what can be done on a relatively small budget with mature software and imagination. The scope for future development is constrained only by the foresight and imagination of developers. These tools are not intended as a replacement for traditional course delivery. They complement conventional approaches by providing students with convenient access to repositories of knowledge and procedures.

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