

Collaborative Development of Multimedia Courseware in Geotechnical Engineering Education

S. T. S. Yuen

**Department of Civil and Environmental Engineering,
The University of Melbourne , Australia**

S. Naidu

**Information and Education Services, Information Division,
The University of Melbourne , Australia**

J.K. Kodikara

**Department of Civil Engineering,
Monash University, Australia**

Abstract

This paper reports a collaborative courseware development project in geotechnical engineering, conducted by the University of Melbourne and Monash University in Australia. The project aimed at developing multimedia learning modules to be used by lecturers and students. Specific modules developed included videos in DVD format and self-learning programs in CD or web-based format. The topics included deep excavation (construction of a multi-level basement in the city of Melbourne) and laboratory direct shear test. In a climate where student field excursions are becoming increasingly difficult owing to large class sizes and extensive occupational health and safety requirements, the former provides opportunities for students to gain a detailed understanding of a complex construction activity undertaken in an urban setting. On the other hand, the laboratory module supplements limited hands-on laboratory experiments undertaken by students. The modules have been incorporated in elective subjects in geotechnical engineering and also presented as additional information in some other subjects. This paper describes the basis, project execution, and lessons learnt from the collaborative project. Finally, it gives a summary of an evaluation of the deep excavation module based on feedbacks received from a cohort of students. It is evident that students appreciate the availability of the modules, and perform arguably better in the respective subjects.

Background

A lack of effective linkage to the "real world" is often a criticism received by many tertiary engineering courses. It is important for students in engineering education to relate real case examples to what is being learned in lectures, tutorials and problem-solving exercises. Commonly, this is served to a limited extent by laboratory sessions and field excursions.

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Due to recent fundamental shifts in the higher education sector in Australia, many engineering departments are experiencing a significant increase in class sizes [1]. This, combined with the concurrent reduction in teaching resources, has put a great deal of pressure on the continuation of many beneficial learning activities, i.e. laboratory sessions, and in particular, field excursions. While hands-on experience is hard to replace, it is important that it be supplemented by alternative experiences that take advantage of new technologies that are now available to assist the learning process.

This paper reports a collaborative courseware development project between the University of Melbourne and Monash University in Australia that sought to address the above issues. It also describes the development of the multimedia modules to facilitate teaching and learning in geotechnical engineering.

The Melbourne and Monash Partnership

The University of Melbourne and Monash University in Victoria, Australia, have each established a strong record of excellence in teaching and research. In 1997 both Melbourne and Monash undertook comprehensive reviews of their missions and strategic plans and subsequently established a Melbourne and Monash Protocol (<http://www.unimelb.edu.au/about/melbmonash/>). One of the objectives of the Melbourne and Monash Protocol is to enable both Universities to improve cost effectiveness and efficiency of their operations through collaborative arrangements.

The partnership resulted in the establishment of a Melbourne University and Monash University Teaching and Learning Collaborative Courseware Development Grant Scheme, which is administrated by a joint Melbourne/Monash Committee for Collaboration in Educational Technologies. The purpose of the grant scheme is to encourage staff at both Universities to work together to generate and improve ideas in using educational technologies collaboratively and innovatively.

Twenty-five projects have been recommended for funding in the Melbourne/Monash Scheme from 1999 to 2003. In 2004, each University allocated an additional sum of \$100,000 AUD to the scheme to allow a total pool of \$200,000 AUD for the funding of more projects.

Applications are selected on a competitive basis, using key criteria including excellence in educational design, evaluation and implementation. Applicants must indicate how their proposal is expected to benefit both Universities and provide explicit information about the course/subjects/enrolment numbers to which the project relates in both Universities.

A typical project team is expected to include several academic staff at both Universities as well as a Project Manager (usually a research officer or a senior research student on a part-time appointment). The Project Manager, funded by the project, is the day-to-day contact responsible for managing the tasks assigned by the Project Leaders (academic staff responsible for the educational design, evaluation and implementation), and ensuring efficient communication among members of the team. The Project Manager is also responsible for the project remaining

on-time and on-budget, which requires careful planning and monitoring of milestones and delivery dates. The team may also include specialist staff with expertise in programming or educational design. The two Project Leaders (one each at Melbourne and Monash) have an overall academic and budgetary responsibility for the success of the project.

The Melbourne and Monash Collaborative Project

The multimedia learning modules described later in this paper were produced under a collaborative project supported by the above joint Melbourne University and Monash University Teaching and Learning Collaborative Courseware Development Grant Scheme. A grant of \$29,500 AUD was awarded in 2001 to the geotechnical groups in the Civil Engineering Departments at both Universities.

A driving force in the formulation of the collaborative project for the two Departments was a challenge brought by increasing large undergraduate enrolments (well over 100 per year at both Departments) and a concurrent reduction in teaching resources caused by a recent fundamental shift in the higher education sector in Australia [1]. This created issues associated with cost and difficulty of conducting field excursions and laboratory activities.

Another important incentive was to promote partnerships in teaching and learning between the two Departments, and also encourage the development of educational materials that could integrate with current in-house teaching and learning resources to enable a coherent program.

The geotechnical engineering project team comprised of 6 academic staff, a Project Manager (in this case a PhD student working on a part-time basis) and a technical staff member with a strong visual and audio production skills.

It was a requirement of the grant that an intellectual property agreement be reached before funding is made available for project commencement. An agreement was signed in May 2001 and the project commenced soon after.

The Deep Excavation Learning Module

Geotechnical engineering is a core area of study in civil engineering. It is concerned with the safe and sensitive transformation of our natural environment, and specifically, it relates to the impact of human activities on soils, rocks and groundwater on the surface of the Earth. It is fundamental that successful teaching in this area involves provision of learning experiences, which visually convey the reality of our geological environment and the human transformation processes to students [2].

In many cases, it would be cost-effective to use currently available tools developed by others [3]; however, there is also a limitation. The direct adoption of these tools may not integrate readily with the current course program. This collaborative project aimed specifically to develop learning

modules that would integrate with the existing course materials to enable a more coherent program in both Departments.

This project produced two geotechnical engineering learning modules, namely, a Shear Box (laboratory) module and a Deep Excavation (construction) module. The former is aimed at second year students while the latter module is to aid later years learning in geotechnical engineering. This paper only describes the Deep Excavation module.

The Deep Excavation module aims to provide students with a visual experience and interpretation of a range of key construction elements and activities involved in deep excavation. This has the potential to enhance students' learning by reinforcing the theory, analysis and design aspects of the subject. The module was based on a real 5-storey basement construction project in the city of Melbourne.

One limitation of field excursions is that students can only see a snapshot of one part of the whole construction activity that occurs on the day of the visit. The main part of the module comprises a 25-minute video in DVD format, which was filmed over a 12-month period and recorded the entire construction sequence right from the commencement of the earthworks to the completion of all basement excavation (see Figure 1).



(a) Commencement of excavation



(b) Excavation in progress



(c) Excavation in Progress



(d) Excavation reached final level

Figure 1 – Images from the Deep Excavation video showing various stages of the documented deep excavation project

Supplementary to the video, there is an interactive self-learning program (in CD or web-based format) providing background information on the project, site geology, selected construction drawings, soil retaining wall and lateral support systems, installation sequences and construction procedures, as well as key design parameters recommended by the project's geotechnical consultant (see Figure 2). The module is supplied in a package containing a CD and a DVD diskette.

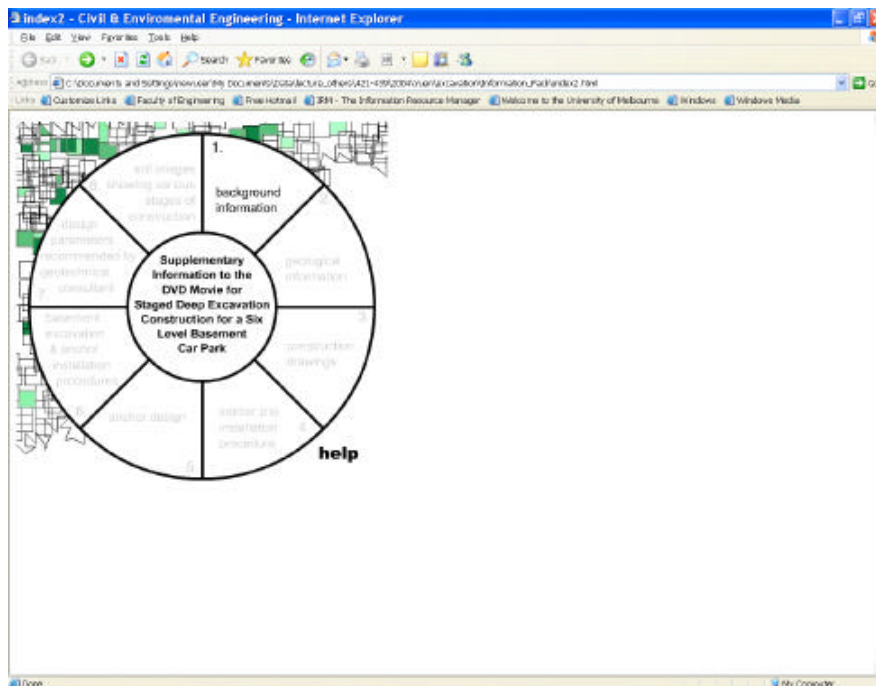


Figure 2 – Main menu of interactive program showing various learning materials aiming to supplement the Deep Excavation video.

The module was used for the first time in 2004 in a final year geotechnical elective subject at the University of Melbourne called “Geotechnical Applications”. Deep excavation is one of six major topics covered in the subject. The mode and sequence of delivery of this deep excavation component includes 2 background lectures to provide an introduction to the topic and to integrate relevant materials learned previously in the course; viewing of the 25 minute video; a follow-up class discussion session with a list of pre-selected items and questions provided to the class prior to the session; a problem-based learning assignment using the interactive self-learning pack described above and other recommended references; and assessment based on the above assignment and a question in the end-of-semester examination. The module was used in a similar fashion at Monash University in a final year geotechnical elective subject called “Foundation Engineering”.

Development experience: Opportunities and challenges

While a strong research collaboration has already existed between the two Departments at Monash and Melbourne (e.g. the CRC in Catchment Hydrology), the project team believes that this joint grant has most importantly provided an unprecedented opportunity for teaching and learning collaboration between two of the top civil engineering departments in Australia. An obvious major advantage of the collaboration is the sharing of expertise and resources between the two Departments. Limited opportunities in this regard existed prior to this project.

This joint effort has also allowed the project to enjoy the overwhelming support from the industry in providing the relevant engineering sites and activities for the module development – an arrangement that would be difficult to achieve by a single department.

The original project timetable had changed substantially due to an unexpected personnel change in the project team. Three of the original 6 academic staff listed in the agreement left the Universities at different times before the completion of the project. The project had to also replace the Project Manager at a late stage of the project. Extension of time was granted by the joint Universities Committee to May 2004.

Difficulties also existed due to the extra communication required among all the staff involved between the two departments. However, this problem has been addressed partly by frequent group meetings and partly helped by a committed Project Manager. It is fair to say that the team had underestimated the amount of time in achieving the desired communication, which had taken a considerable proportion of the project time. The departure of 3 out of the 6 original team members as described above had also added further challenges to the project.

A major lesson learnt from this project is the procedural and material requirements for producing a video for teaching purposes. This was new to most members in the project team. The Deep Excavation video in DVD format was produced at the Monash University Teaching Services Unit. They required all figures and video clips to be produced in specific formats and sizes. Early and better communication with this unit would have saved time and reduced duplication of certain tasks.

Evaluation of the impacts on learning

The evaluation of the impacts of the Deep Excavation module on students' understanding of key concepts as well as their perceptions of understanding of relevant concepts is reported in details in a separate paper [4]. It is described briefly in the following.

The evaluation process included an initial design evaluation by content experts. Then a prototype version of the video and the self-learning pack were first produced, and a small group of students and tutors were invited to provide feedback on it. During the first full-scale use of the module in a real teaching and learning situation, a survey was used to collect data about students' understanding of the subject matter content. The goal of the survey was to ascertain students'

self-assessment of their understanding of the subject content before and after viewing the multimedia module.

During the survey, students in the class were asked to fill in a questionnaire on a voluntarily basis. There were 10 questions in the questionnaire; each was targeting student's understanding of a particular key element or activity related to the topic of deep excavation. The questions were designed in such a way that 5 of the 10 questions were on design (i.e. more on theory and analysis aspects) and 5 were related to construction (i.e. more on practical and application aspects of the subject). The students were asked to score their understanding on a scale of 1-4.

The students were asked the same 10 questions before and after using the learning module. This aimed to gauge students' perception of their understanding of design and construction related concepts. There were 35 students enrolled in this final year elective subject; 22 valid questionnaire forms were collected in the survey.

Results of the survey indicate that the students who filled in the questionnaire reported a higher level of understanding after the use of the module, in the 5 design-related questions as well as the 5 construction-related questions. The differences in group means for design and construction-related questions (on a scale of 1-4) are 0.8500 and 0.9681 respectively. These numbers suggest a statistically significant difference for the groups on the pre and post-tests ($p = .000$).

The above suggests that the use of the module may have helped students' understanding of design and construction related content. While there is some variation in students' perceptions of their understanding of design related concepts, their assessment of their understanding of construction related content is consistent across the 5 question areas [4].

In terms of students' actual performance, their marks on this Deep Excavation topic were excellent (in both assignment and examination question), in comparison to their marks on the other 5 topics on which they were assessed in the same subject. This may also suggest that the multimedia module is likely to have had an impact on students' understanding.

Conclusion

This collaborative project between the University of Melbourne and Monash University has achieved a successful outcome. The same result would have been more difficult to attain by a single institution. The project benefited from the expertise, resources and industrial contacts of the two Departments. Most importantly, the project has avoided duplication and enhanced collaboration opportunities between the two Departments.

The evaluation was conducted to ascertain the impacts of the multimedia courseware on students' learning and their perceptions of their understanding of key concepts, by collecting data from a live implementation and *in situ*. This was not an experiment within which variables and factors such as random sampling, sample size and a control group could be incorporated. As such, no direct causal links between the multimedia materials and student understanding and achievement can be established.

Nevertheless, it is possible to suggest from this experience, that after using the multimedia module, students in this course seemed to have an enhanced understanding of design and construction related content.

Unarguably, first-hand experience is hard to replace. This study demonstrates that multimedia, if used appropriately in conjunction with other modes of delivery (e.g. lectures, class discussions, assignments and assessment tasks), could play an effective role in bringing in the practical component of engineering education into the classroom.

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SAMUEL T S YUEN

Samuel Yuen is a Senior Lecturer in the Department of Civil and Environmental Engineering at the University of Melbourne, where he coordinates all geotechnical engineering related subjects. He worked as the Melbourne Team Leader for this project. His research focuses on bioreactor landfills, landfill containment systems, leachate recirculation management, landfill hydrology and groundwater modelling. Dr Yuen was the recipient of the 2002 University of Melbourne Engineering Faculty Teaching Excellent Award.

SOM NAIDU

Som Naidu is an Associate Professor in *Educational Technology* at the University of Melbourne. Dr. Naidu is also Adjunct Associate Professor in the *Master of Distance Education* program, in the Graduate School of Management

& Technology, University of Maryland University College, USA. Dr. Naidu serves as Editor of *Distance Education*. He is also Series Editor of the Open and Flexible Learning Book Series published by Routledge.

JAYANTHA K. KODIKARA

Jayantha Kodikara is a Senior Lecturer in the Department of Civil Engineering at Monash University, and specializes on Geoengineering, Geo-environmental Engineering and Pavement Engineering. He worked as the Monash Team Leader for this project. He has developed and has taught subjects in all these disciplinary areas. His current research topics include behaviour of unsaturated soil and liquid flow, behaviour of cemented geomaterials, modelling of soil/climate interaction, pavement deterioration modelling, and analysis of piled foundations in soils and rocks.