

# Developing and Teaching Information Systems for Construction Management Students: A Perspective in Deakin University

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## Abstract

*A new unit named Information Systems in Construction was developed and taught for the first time in the School of Architecture and Building at Deakin University in Semester 1 2003 for first-year construction management students. This paper reports on key issues that arose during the unit development process and the implementation of teaching activities. Special consideration is given to the learners (first year students), the teaching environment (online teaching and learning), the unit background (information technology and information system), and the discipline (international construction). Several suggestions are outlined for improving the unit development and delivery in the next round.*

## Keywords

Construction Management, First-year Students, Information Systems, Online Teaching and Learning, Unit Development

## INTRODUCTION

The construction industry has been affected by the revolution of information systems in various ways. For a few decades, computers and computer-based information systems have been a common working environment in all levels of construction management including operational, tactical and strategic management areas. Higher education institutions are responsible for educating their graduates to pursue and lead the development of information systems in industries. The development of new units is necessary to facilitate university students' understanding of the latest information systems so that they will have more opportunities in their future career development.

The environment of new unit development has been drastically changed with the expanding application of networking technologies and the increasing globalisation of diverse industries. Online teaching and learning has been considered to be the future of tertiary education not only for distance learning students, but also for full-time on-campus students. Online environments can support the face-to-face teaching and learning activities in various ways even though fully online teaching and learning cannot replace all traditional face-to-face education in some course modules. On the other hand, higher education institutions must also envisage the changes of working environments of their graduates, which is towards globalisation with international competition and collaboration.

In response to this environment, a new unit titled *Information Systems in Construction* for construction management students at Deakin University was approved by the university's academic board and scheduled for offer in semester 1, 2003. The unit was offered to first year students, which required some special considerations to be taken to stimulate the interests and thoughts of students to set them up for their future university studies. The success to date in all teaching and learning activities of this unit in semester 1 2003 is based on some considerable endeavours that are summarised in this paper. The next section briefly describes the background for developing the new unit. In the section titled 'unit development', the unit structure model, the content, and teaching environment preparation are outlined. The subsequent section details the implementation of teaching and learning activities in semester 1 2003. Further development needs are outlined based on feedback from students and the identification of modifications for offering the unit in the next year. Finally, discussion and conclusions are drawn in terms of the unit development and unit implementation.

## **BACKGROUND**

### **Information Systems Related Units in Construction Management Course**

The construction management course in Deakin University was first launched in 1991 under the course name of Bachelor of Building. In 1997, the course name was changed to the current title, Bachelor of Construction Management. According to the university undergraduate studies handbook in 2002, in order to qualify for the Bachelor of Construction Management degree, a student must complete a total of thirty-two credit points (units) satisfactorily. Among them, 8, 10, 6 and 2 units fall the discipline areas of technology, management, environment and research respectively, and another six units are from the elective pool. No construction information systems related units were offered as either a core or an elective unit. In Australia and worldwide, many universities have incorporated a diverse range of information systems related modules into their construction courses (Clarke 2002). Due to the amount of time available, most of these information system related modules only cover the very basic and fundamental applications of information systems, which is not dissimilar to the various discreet short courses offered as continuing education for adults (Too *et al.* 2002). As mentioned in this reference, higher education institutions limit their delivery of information systems related units to basic low-level hardware skills and industry specific software tools such as CAD, planning software, and the Internet together with the more general word processing and spreadsheet packages.

Education is recognised to be fundamental to maintain and develop Australia's competitiveness in the global information economy (NOIC 2002). In order to prepare the construction management students in Deakin University with the relevant knowledge and skills on information systems for the construction sector, the Information Systems in Construction unit was introduced as a core unit. To avoid the mode barriers in existing information systems related units in which specific information system application modules are developed to suit specific information system skills, a spiral unit structure derived by the information is developed to formulate the taught content of information fundamental, application, and implementation in terms of the basics of information systems, information technologies, information management, and information system management. The information system skills are mainly covered in tutorials.

### **Online Teaching and Learning**

Online teaching and learning has been a trend worldwide. All Australian education and training institutions are simultaneously addressing the need to promote a strong market for online education content (NOIE 2002). Correspondingly, a number of software packages have been developed and distributed commercially or freely to facilitate the development and delivery of course materials using the Internet-based courseware management tools, sometimes called learning management systems, or distance education systems. Many studies have been carried out on the analyses and comparisons of online education environments from various perspectives such as the content expert, the web development, the student, the teaching assistant, and the system administrator. For example, Zaina *et al.* (2001) analysed and compared some of these systems taking into account lists of important features, and Tront *et al.* (2001) undertook a study to find out how courseware management tools are used in engineering education.

Deakin University has a long history and reputable profile in online teaching and learning. Progressively introducing online resources and learning experiences has been a university strategy for campus based programs as well as distance education to ensure that students have appropriate information technologies and learning skills that make them competent in the use of online environments and facilities (Walker 2003). Development of new units must be aligned with Deakin's teaching and learning strategies. Deakin has a long history of using online communication, collaboration and content delivery tools that include FirstClass, TopClass, and versions of WebCT, and WebCT Vista. Deakin Studies Online (powered through WebCT Vista) will be available for all units from semester 1, 2004 after an implementation phase during 2002, 2003. For the development of this unit, which commenced in 2002, no learning management tool was available. Therefore, the web-based communication platform temporarily used in this unit was personally developed and maintained by the lecturer.

### **Challenges of Internationalism to Construction Management Education**

With the globalisation of economics, culture, politics and techniques, international construction is becoming an important part in the education and practice of construction management (Mawhinney 2001). Individual construction firms are no longer competing with a limited number of domestic product and service providers, but other firms in the world economy. The challenges of internationalism to construction management education are purposely taken into account while preparing the lecture and tutorial materials and assignments. There is no doubt that the international students in construction management courses have the need to understand the construction industries, enterprises, markets, and management strategies in other countries. For the local students, there are also increasing opportunities after graduation to work on overseas construction projects or meet a

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foreign construction contractor in the Australian construction market with rapidly developed globalisation of the construction sector.

On the other hand, the nature of large-scale international construction projects, using resources from different countries and continents, necessitates a high degree of information systems (Howes and Tah 2003). Information systems as a global technology may enable the students to understand construction management under the international environment. Under such a consideration, in this unit, the implementations of information systems in both teaching and assignments are purposely connected to international construction. For example, the top 225 international construction contractors published by the Engineering News Record (2002) are used as the base to develop an assignment in data analysis. In addition, in an assignment, the students are also required to study the specific data collection and analysis characters of an international construction project under the current globalisation circumstance by referring to the common data collection and analysis procedures. Therefore, the construction management students are trained to have an awareness of international construction in their future studies and career.

### **First Year Teaching and Learning**

First year teaching and learning is given special consideration at Deakin University, and a very positive step called the First Year Initiative has been implemented from 2002 to cater for the specific needs of first year students. Specially designed activities commence during orientation week before the teaching begins (Emmitt *et al.* 2002). There are many needs to be extensively considered by academic lecturers during the teaching period to ensure the ongoing development and survival of the First Year Initiative. The unit *Information Systems in Construction* was scheduled for first year construction management students in semester 1 2003. Therefore, the lecturer was challenged to find effective ways of motivating and stimulating the students to set them up for their university studies into the future. During the preparation and implementation of all lectures, tutorials, and assignments, it was always in the lecturer's mind that the learners were new to higher education, and both the content and format were designed to be interesting and easily understood. For example, a number of pictures and hyperlinks used in the lecture slides attracted the students' attention and enabled them to understand the content better and more easily.

## **UNIT DEVELOPMENT**

### **Unit Structure and Content Development**

In recent years, the scope of information systems has developed a lot, no matter whether this development is in information system theories, information system application and information system skills. A huge number of topics related to information systems benefit the construction management students in their future studies and careers. However, due to the limitation of contact hours as well as the knowledge backgrounds of students, the content in both lectures and tutorials have to be screened carefully and organised well. After a long time consideration and wide discussion, it was determined that this unit should provide the students with an understanding of the process, technology, management and system of information in construction management. Teaching and learning are based on the lectures, tutorials, assignments, and individual discussions. Furthermore, this unit is purposely developed to be taught and learned by computers in an online environment. All materials from the lecturer are made available to access through the university Intranet, and all practices and assignments are also required to be prepared and submitted by computers and through networks.

Except the first lecture, which mainly introduces this unit and the information systems in the university, the lecture contents in this unit are broadly organised into four sections or stages, Section I: basics of information and systems (Lectures 2-4); Section II: information technologies (Lecture 5-7); Section III: information management (Lecture 8-10) and Section IV: system management (Lecture 11-13). The objectives in each section will enable the students to understand the nature and process of information in construction project, construction enterprise, construction industry, construction market, and construction sector in Section I; the development and applications of information technologies in Section II; the methods and tools of information management in Section III; and the implementation and future of information systems management in Section IV. A spiral course structure model is used to drive the unit content from section I to section IV, and each section covers the fundamental, through application to implementation. The topic and brief descriptions in each lecture are listed in Appendix 1 on the basic of sections. Beside the first lecture, three lectures are allocated to teach the fundamental, application and implementations at each of four stages. Generally speaking, in the fundamental lecture, the basic definitions, principles and knowledge are explained to the students. No doubt, it is hard for the construction management students in their first year to understand the theories in computer science. But, it is quite useful for them to have a brief background before studying the potential applications of specific information technologies or information systems, and the practical implementations in construction. The application lectures detail one or more particular

technique or methodology. The implementation lectures teach the students to understand the state of art of information systems in construction management by practices.

### **Preparation of Teaching for Semester 1 2003**

Online teaching and learning is considered as a strategy to bring Deakin forward. As mentioned above, a couple of commercial software packages have been widely used in Deakin and other Australian universities. Because of the lack of licence in utilising these packages in the School of Architecture and Building, email and Intranet are chosen as the platforms for the information delivery from the lecturer, the assignment submission by students and the interactions in semester 1, 2003. An Intranet web page was developed and maintained by the lecturer for the communication between the lecturer and students.

Although several textbooks have been published for the teaching and learning of general information systems publicly or inside the university, most of these publications are written for the students in computer science or management science (Capron and Johnson 2002). A specific textbook on information systems in construction has not been found. In some publications in construction management, a chapter is dedicated to the information systems (Harris and McCaffer 2001). Based on this circumstance, no textbook is prescribed or recommended in semester 1, 2003. The chapter 17 in modern construction management (Harris and McCaffer 2001), information resources and ICT systems, is made electronically accessible to the students under the support of the university library. Therefore, all students are able to read some additional materials after the lecture beside the lecture slides. In addition, reading materials, which are aligned to the current lecture themes and are available online or in the university library, are suggested during the lecture.

## **IMPLEMENTATION OF TEACHING AND LEARNING**

### **Lecture Material Preparation, Delivery, and Implementation**

The first lecture and tutorial are very important for connecting students to the course and unit. By chance, classes for this unit were scheduled on Mondays in semester 1 2003, and the first lecture of this unit was therefore the first lecture for students entering the university. The content in Lecture 1 is purposely designed to introduce the computer environment and existing information systems in Deakin University in addition to introducing the substance of the unit. During the first lecture, the teaching and learning modes were also explained to students.

All slides used in each lecture were distributed to students through the university Intranet. Slides in each lecture were organised in a similar way. The first slide described the lecture title and key points, the content slide summarised the lecture themes and objectives, while the main slides focused on the content. At the end, a slide titled 'thinking and further reading' posed questions to assist students to align their personal experiences with the lecture content. It also provided suggested reading material to extend lecture content. The final slide provided instructions about the day's tutorial activities.

The teaching approach was used as a demonstration of potential applications of information technologies. For example, the preparation and delivery of teaching material are supported by the Microsoft Office software tools, the network environment, the web techniques, and others. The slides in Microsoft PowerPoint with animations were easier for students to understand compared to having them available only in print. In addition, a collaborative teaching activity was carried out with the local government via a guest lecture to demonstrate the implementation of asset information systems for buildings in the second last week. This guest lecture expounds the main uses of information systems for asset management in recording the asset, depreciation, lifecycle cost, maintenance, and asset performance. The onsite lecture enlightened the students as to how information systems are used to manage the stock of some 750 council buildings. Based on the success of this collaboration, the guest lecturer indicated his willingness to contribute to this unit by repeating the lecture in future semesters.

### **Tutorial Design and Implementation**

The tutorials are mainly designed to improve the IT skills of students, and a current masters student in information technology course was appointed as the tutor with consideration of his IT skills and knowledge with the IT environment in Deakin. A total of eleven hours are provided for tutorials from week 1 to week 11. There are no tutorials either in the week taught by a guest lecturer or in the last week. The topics from week 1 to week 11 cover computer environment and information systems in Deakin (Week 1), data processing (Week 2), online search and data collection (Week 3), data analysis (Week 4), information presentation (Week 5), networking techniques (Week 6), web page design (Week 7), database design (Week 8), database management (Week 9), database application (Week 10), and electronic management environment (Week 11). As far as possible, the content was purposefully aligned with issues relating to the application potential in construction management. In each week, the one hour tutorial is carried out in the computer laboratory after the lecture, and both the lecturer

and tutor are available for contact. Before the tutorial, all students can download the tutorial instructions from the university Intranet. The instructions in Microsoft PowerPoint and/or Microsoft Word documents provide detailed information on the requirements and steps to complete during the tutorial so that the student can follow the instructions to achieve the tutorial purposes.

The students' computer capabilities and knowledge were very diverse. Some students demonstrated their high computer skills in the tutorials as they have held personal computers for as long as more than ten years. On the other hand, some students had not used computers too much before entering the university. The tutorials were purposefully orientated to the students with no previous computer training, while the students with more experienced computer backgrounds were provided with extra themes in some tutorials. Furthermore, the tutorials were considered as a platform for students to prepare themselves for future learning and assignments in the unit. As the students were trained with the basic computer operations during the tutorials, they therefore faced fewer difficulties in pursuing the whole unit.

### **Assessment Components and Procedure**

The assessment contained assignments and participation. The assignments provided for extensive practice in applying application techniques and demonstrating a broad understanding of concepts on information systems in construction management. The assignments were considered as an important part for the students to achieve the fundamental understanding and knowledge in both information systems and construction management. Each of three assignments was allocated 30 marks and classroom participation was allocated 10 marks.

Every assignment had three questions focusing on theories, applications and skills of information systems respectively, and each question was worth 10 marks. Although the structure of questions in each assignment was similar, the requirements became progressively more difficult from Assignment 1 to Assignment 3. In the information system theory question of each assignment, 10 sub-questions were designed to require the students to describe their own understanding of fundamental terms such as information and system, information system technologies such as ftp and telnet, or information system applications such as the benefits of a server/client system. The second question in each assignment focused on the information systems implementation in construction management including the data collection and analyses of an international construction project, the latest information technology development and potential applications in construction enterprise management, and the electronic data transfers and electronic commerce in construction industry respectively. The third question in each assignment aimed to develop the students' information system skills in the construction management fields. In the three assignments, students were asked to analyse the data of international construction companies in spread sheets, to design the poster and web pages of a construction management conference, and to summarise and present information resources and systems in construction management respectively.

Regarding assignments marks, all students were invited to come to the lecturer's office to discuss in detail the marks awarded, the comments on each question by the lecturer, and the reasons for reducing some marks in each question. Communicating in such a manner is time consuming and students may find out their marks a few days later. This is based on several considerations. First, some first year students did not operate the online assignment submission well. They sometimes mis-attached or omitted files that contained the necessary answers to some questions. Second, the currently used online teaching and learning environment developed and maintained by the lecturer was not as effective as a commercial software package. For example, using the email assignment submission, the previously submitted files could not be automatically replaced. This increased the possibility for the lecturer to mark the answers that were not the correct files prepared by the students. Third, this activity provided an excellent opportunity for the students to participate in the teaching and learning activity positively and actively. In order to revise and mark the assignments, it is important for the lecturer to understand what the students think about the assignments and how they dealt with them.

The confirmation of assignment submissions by students is also initially achieved by email. The lecturer purposely opens the time before the due time of assignment submission for email confirmation. Most students can receive an email from the lecturer within a couple of minutes after their submissions. In addition, at the lecture following the due date of assignment submission, all students were reminded to check their emails and contact the lecturer if necessary. The final marks for each assignment were also confirmed by an individual email. The majority of students were quite satisfied with such an online assignment procedure.

## **FURTHER DEVELOPMENT NEEDS**

### **Feedbacks from Students**

Comments and suggestions from students were considered as invaluable contributions to the existing teaching and future sustainable development of this unit. The lecturer purposefully established a flexible teaching and

learning environment so that the students were provided with various opportunities to express their views in both lectures and tutorials, and during other contact hours. For the most part, the various communication channels ensured that students participated in all teaching and learning activities positively and actively. For example, early in the semester, a few students requested to be excused from this unit as they had used computers for many years, and some of them had attended training courses before enrolling at the university. After communicating with the lecturer and understanding more clearly the teaching content of the unit, no students submitted an application for exemption from any aspect of the unit.

All students were encouraged to actively participate in the unit throughout the semester. At the beginning of semester, the lecturer tried to leave time for the students to discuss a given issue in groups before completing each lecture. However, the results were not effective due to the lack of time. Then, at each lecture, the students were given a question to think about after the lecture, and very few students contacted the lecturer or tutor regarding the question each week. In addition, in an assignment question, the students were required to take the role of a lecturer to teach a given book chapter. Through this question, the students could not only learn the knowledge involved in that chapter and the information presentation, but also have some understanding of learning from the viewpoint of teaching.

In order to collect as much feedback as possible from students about various aspects of the unit, two trials have been carried out in Semester 1 2003. It is realised that the assessment marks concern the students deeply. The first trial is based on the notifications of marks of an assignment. All students were invited by the lecturer to discuss individually their assignments, and the lecturer comments on their assignments. As mentioned above, various feedback was successfully collected although much additional time and effort was required. Furthermore, after the last lecture, a unit summary was carried out among students in order to take into consideration the students' opinions for future unit development. Because the number of students enrolled in this unit was relatively small, it may not make sense to summarise the statistical data for the purpose of publication. Instead of multiple choices that are widely used in questionnaires, open questions were designed so that students could be flexible when commenting on any issues. The summary texts are appended as Appendix 2. The unit summary was collected and analysed anonymously, and the lecturer only received a summary report detailing the students' concerns.

In the future, with the development of online teaching and learning environment, the discussion board and network communications will provide more opportunities to encourage the students to participate in the teaching and learning activities positively and actively, and therefore to provide more feedback instantly. As a unit offered to the first year university students, the opportunities to collect on-campus students' feedback will continue to exist although the percentage of online teaching and learning action may increase drastically in the following years.

### **Modifications for offering the Unit next year**

Based on feedback from students and the teaching experience in Semester 1 2003, the following modifications would be necessary in the future teaching of this unit.

Textbooks are still considered as the primary reading material by many first year university students. They expect to have a fixed textbook to be used for the whole semester. To some students, an authorised publication is essential to understand the scope of a unit and study its content, which necessitates the preparation of a detailed study guide or textbook for this unit in the near future.

Examples in construction management are considered as the best tool to enlighten students understanding of existing information systems. Due to the lack of professional knowledge of the first year students, examples under no prerequisite requirements in any specific subject are preferred by the students. More case study examples are to be added in teaching and learning activities including lectures, tutorials, assignments, and discussions.

Innovative teaching management systems will benefit both teaching and learning sides as well as communication among students and lecturers. Further development of online education approaches will use the advantages of well-developed online teaching management software packages such as the Deakin Studies Online using WebCT Vista. It has been planned that this unit will be taken into consideration as a pilot unit for online studies in the construction management course in 2004.

The participation of students needs to be enhanced in various aspects. A studio-based student project exhibition will be explored in the future. Although paperless teaching and learning is one originally established target of this unit, pinning up or presenting students' projects may be valuable to make their efforts more respected. Therefore, the students would like to participate in all activities of this unit more positively.

## DISCUSSION AND CONCLUSIONS

Information systems have been developing as an indispensable management tool in all construction related project, enterprise and industry managements. It is essential for construction management students to learn the basic knowledge in understanding the existing information systems in construction from this unit and the necessary capabilities in studying more by themselves. This paper has presented the unit development and online teaching of information systems for the first year construction management students in Deakin University in the first semester of 2003.

A spiral model was used to structure the teaching content deepening the knowledge on information system from the basic concepts on data and information to the system design and management. Information was considered as the driver for developing the unit from the basics of information, through information technologies and management, to information systems. The fundamental application and implementation lecture modes from the lower to upper stages enabled students to understand both the principles and methodologies of information systems and their operations in the construction field.

In semester 1 2003, online teaching and learning was implemented under a self-developed courseware management platform. This platform facilitated the basic online teaching and learning requirements, and necessitated much extra time and effort in maintaining the proper functions. A professionally developed teaching management software package is essential for the wide application of online teaching and learning, particularly for a unit in which the number of enrolled students is large and frequent communications among students and lectures is expected.

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## APPENDIX 1: TEACHING AND LEARNING PLANNING

WEEK NO	LECTURE TOPICS AND DESCRIPTIONS
1	<b>Introduction: Information Systems in Construction and Deakin</b> Introduction to the unit Information Systems in Construction, Computer laboratory, ID usages, Information technology service division, Deakin University library, Deakin software (Deakin mail, Explorer, etc.)
2	<b>Fundamental I: Basics of Information and Systems</b> Data and Information, Data lifecycle, Data media, Systems, etc.
3	<b>Application I: Data Collection</b> Data collection and sources, Survey sampling, Survey techniques, Pre-processing of survey data, etc.
4	<b>Implementation I: Data Analysis</b> Conceptual, statistical and graphical analyses of collected data, Software applications and development, etc.
5	<b>Fundamental II: Basics of Information Technologies</b> Computer hardware and software, Overview of information technologies (IT), Information presentation techniques, etc.
6	<b>Application II: Electronic Communication</b> Communication, Computer networks, Communication systems, etc.
7	<b>Implementation II: The Internet and Web</b> Concepts and services of the Internet, Web page construction technologies, Development of personal page, etc.
8	<b>Fundamental III: Information Management</b> Database overview, Database principles, Database development, etc.
9	<b>Application III: Database Application</b> Database architecture, Data modelling technologies, Database technology overview, etc.
10	<b>Implementation III: Knowledge Management</b> Knowledgebase development, Expert systems, Artificial intelligences
11	<b>Fundamental IV: Information Systems</b> Information systems development, Information system perspectives, Information system supporting management, etc.
12	<b>Application IV: Electronic Commerce</b> Basics of electronic commerce systems, and information systems management, etc.
13	<b>Implementation IV: Asset Information Systems for Buildings</b> Real applications of database management system, geographical information systems, and Internet in Geelong

## **APPENDIX 2: UNIT SUMMARY (SEMESTER 1, 2003)**

### **Unit Overview**

How often did you use computers before you enrolled in this unit and what did you mainly use them for?

What did you expect to learn from this unit and to what extent were your expectations met?

What were the most important things you learned about information systems from this unit?

### **Unit Instructions and Implementations**

What changes, if any, should be made to the unit topics? (You are welcome to comment on all lectures from Week 1 to Week 13, or any specific lectures.)

What changes, if any, should be made to other parts of the unit instruction, particularly the assessment section?

What changes, if any, should be made to the tutorial activities from Week 1 to Week 11?

What changes, if any, should be made to the content and structure of assignments?

What changes, if any, should be made to the e-learning aspects, including the online information delivery from the lecturer, and the online assignment submission by students, and the email interactions?

### **Unit Development**

What kinds of IT/IS knowledge would you expect to learn if a subsequent unit were to be offered?

Do you have any further suggestions or comments?

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