A Graduate Course on E-commerce Information Systems Engineering

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Abstract

Interest in developing and deploying e-commerce systems has grown greatly over the past few years, leading to a major shortage of qualified developers able to deliver such applications. This paper describes the development of a graduate course in e-commerce education that has been implemented as part of an Honours degree programme and a first year Masters offering for a traditional Information Systems programme. The aim of this course is to give graduate students a broad grounding and holistic set of skills to enable them to begin successful e-commerce systems development. This paper provides a background and context for this course, an overview and discussion of the course content, delivery methods and practical focus, and discusses experience in running and evolving the course over the past two years. We hope that our experiences and approaches will be useful for others who are planning similar courses focusing on e-commerce systems engineering.

1. Introduction

Many organisations are developing Information Systems to support e-commerce applications, typically using the World Wide Web to provide customer access to product and service purchase, and internet capabilities to support inter-organisational information exchange (Bambury, 1998; Bolin, 1998). There is thus a crucial need for Information Systems developers with skills in developing such applications. Such developers need a good understanding of both intra- and inter-organisational use of e-commerce systems, appropriate analysis and design techniques, and implementation, quality assurance and deployment technologies and methods.

This need for Information systems developers with a range of e-commerce system development skills has led us to design and run a graduate Information Systems course focusing on e-commerce systems development, as part of an Information Systems degree programme. This course can be taken either as an Honours year course (i.e. last year of 4-year professional degree) or as a first year Masters degree course. The course is aimed at equipping students, who have studied conventional IS analysis, design and implementation courses, with a range of skills and experience suitable for e-commerce systems development. The course takes a holistic approach to e-commerce IS systems engineering education: it covers current IS development processes, especially those suitable for highly distributed and evolutionary software development; e-commerce system IT policy, characteristics and deployment issues; requirements engineering; e-commerce system architectures and design techniques; user interface, database and middleware implementation technologies; and distributed IS quality assurance, including performance evaluation, usability engineering and organisational effectiveness measurement. The course uses a range of teaching strategies, including lectures, readings and web resources, student presentations, tutorial-based group activities and simulations, focused practical exercises, group development projects and individual research projects. This mix is intended to give students a balance of theory, practical development techniques, and practical system development experience focused on e-commerce systems engineering.

The following section provides a discussion of e-commerce system development issues that we believe are important in which to give students a good understanding. We then discuss the educational context in which our graduate-level course is run, give an overview of the course structure, content and teaching philosophy and approaches. The following sections respectively discuss the mix of theory, practical development technique and practical project-based experience the course provides students, the means by which this is achieved, and the assessment strategies we use. We conclude with a discussion of the effectiveness of the course and lessons learned from its delivery and evolution.

2. Background

There has been a tremendous growth in recent years in the use of "e-commerce", or "e-business", activity, and a corresponding growth in the need for Information Systems engineers with appropriate skills to realise such applications (Bolin, 1998; Dhamija et al, 1999; Jutla et al 1999b; Ge & Sun, 2000). Much of the interest in e-commerce systems has focused on their perceived ability to provide better customer service via the WWW and more timely exchange of information between organisations via the internet, along with cost savings, improved organisational effectiveness and quicker response to market

needs (Bambury, 1998; Bonn, 1996; Jutla et al 1998b; Timmers, 1999). Many organisations have developed e-commerce systems of one kind or another, some being electronic forms of traditional business activities (such as order processing and customer liaison and purchasing) (Jutla et al 1999a), while others are novel electronic business ventures (such as electronic product sales and virtual organisations) (Bambury, 1998; Fielding et al, 1998).

When developing e-commerce systems, a combination of management, technical and quality assurance issues must be addressed. Management and organisational issues include the use of appropriate project planning and cost/benefit analysis techniques, the choice of most appropriate development processes and tools being made, and user requirements being elicited and documented accurately (Schlueter & Shaw, 1997; Shafer et al, 1999). Many novel challenges in these areas are presented by e-commerce systems development, in addition to traditional Information Systems development issues. Novel challenges include how to go about cost/benefit analysis for systems that may have no existing counter-parts and/or are for untried application domains, highly distributed process and project management strategies (e.g. for "virtual" organisations), and the complexity of analysing requirements for a very diverse user base, some of whom may not be easy to identify, or may even change after a system has been deployed (Schlueter & Shaw, 1997).

Many challenging technical issues also present for e-commerce systems engineering, as these systems are complex, distributed applications with many and diverse users, use heterogeneous hardware, networking and user interface technologies, have important security, integrity and performance constraints, and are becoming "mission critical" parts of many organisations' IS Architectures (Diffie, 1998; Evans & Rogers, 1997; Jutla et al 1999a; Pour 1999). Developers need to appropriately specify and design such complex applications, including supporting not only functional specifications but also the myriad of complex non-functional constraints. They also need to develop often complex software architectures, good user interfaces (often for non-expert computer users), and implement systems using appropriate distributed system middleware, data management and user interface technologies. Integration with existing Information Systems is almost always required, and can be challenging to realise.

The quality of e-commerce applications is important to assure, as with any IS project, but presents many new challenges. Testing of highly distributed e-commerce applications is difficult, especially given the range of hardware and networks parts of the system may be deployed on. Usability of the product is crucial, particularly if customers or other business users need to interact with it (Singh et al 1999). Ensuring an e-commerce system meets its usually complex non-functional constraints often takes considerable effort and expense, but is essential to ensuring the system will meet its stated goals. Finally, determining that an e-commerce system meets an organisation's needs, from staff needs to customer and related business needs, is in many ways still an open research topic. While some traditional organisational effectiveness metrics can be used, market research analysis and other techniques increasingly need to be brought to bear on the problem.
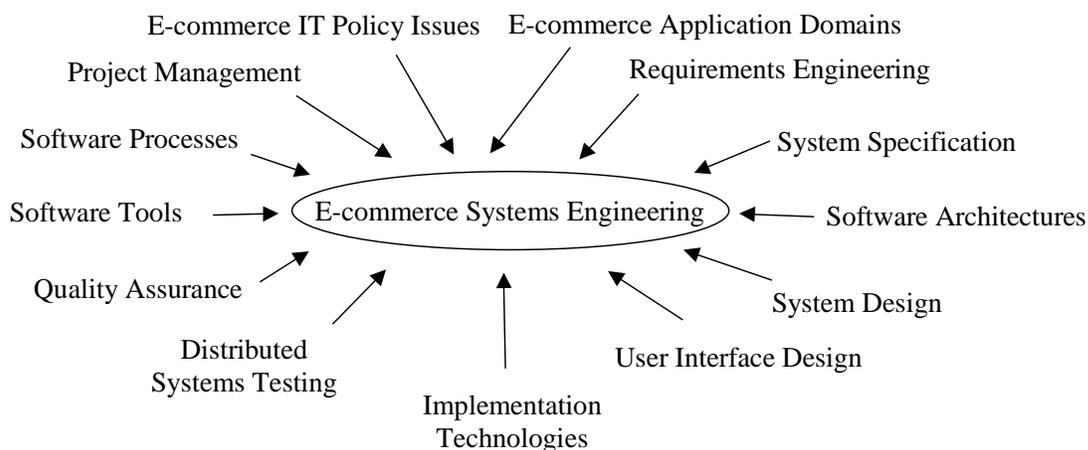

Figure 1. Some E-commerce systems engineering topics.

When considering a course, set of courses or even a whole programme on e-commerce systems development, one should carefully determine appropriate Information systems educational techniques are appropriately chosen to ensure the range of issues described above are adequately addressed. We have taught many IS development courses, using project-based learning as a central technique (<<Author>> 1996; <<Author>> 1997), i.e. students learning by doing individual and group projects. This would also seem appropriate for much of e-commerce systems engineering education, given the practical skill set intended for graduates focusing on this area (Dhamija et al 1999; Ge & Sun, 2000). In addition, as Information Technology used for e-commerce systems development changes so rapidly, it is crucial to ensure students are "educated for change" in this area, and become intellectually independent as a result of any course(s) they take (<<Author>> 1996; Ross & Ruhleder 1993). By this we mean students should be educated so that they are able to compare and contrast new development methods, techniques and tools as they become aware of them while practising in the industry. They need to be able to critically evaluate the many options at various levels they will have for developing e-commerce systems, in order to be able to make the best choices on the development projects with which they are involved. Given the rapid change in the Information Technology field, and in E-commerce systems engineering in particular, encouraging a desire among students to continue to learn and extend their skill set while in industry or taking a higher research degree is desirable.

Our graduate E-commerce Systems Engineering course is taught as part of the final year of an Honours degree programme, or as part of the first year of a Masters programme. The University of Waikato, where the course is taught, offers several specialised programmes as part of its Bachelor of Computing and Mathematical Sciences (BCMS) degree. The most popular is the Programme in Information Systems. The main IS courses taken by students in this degree programme are illustrated in Figure 2. Most are taught by the Department of Computer Science (CS), although several are taught by the Department of Management Information Systems (MIS). Part 4 is an Honours year, made up of a 2-paper whole year project and 4 additional semester-length courses. Part 4 courses can also be taken in the first year of a master of Computing and Mathematical Sciences (MCMS) degree.
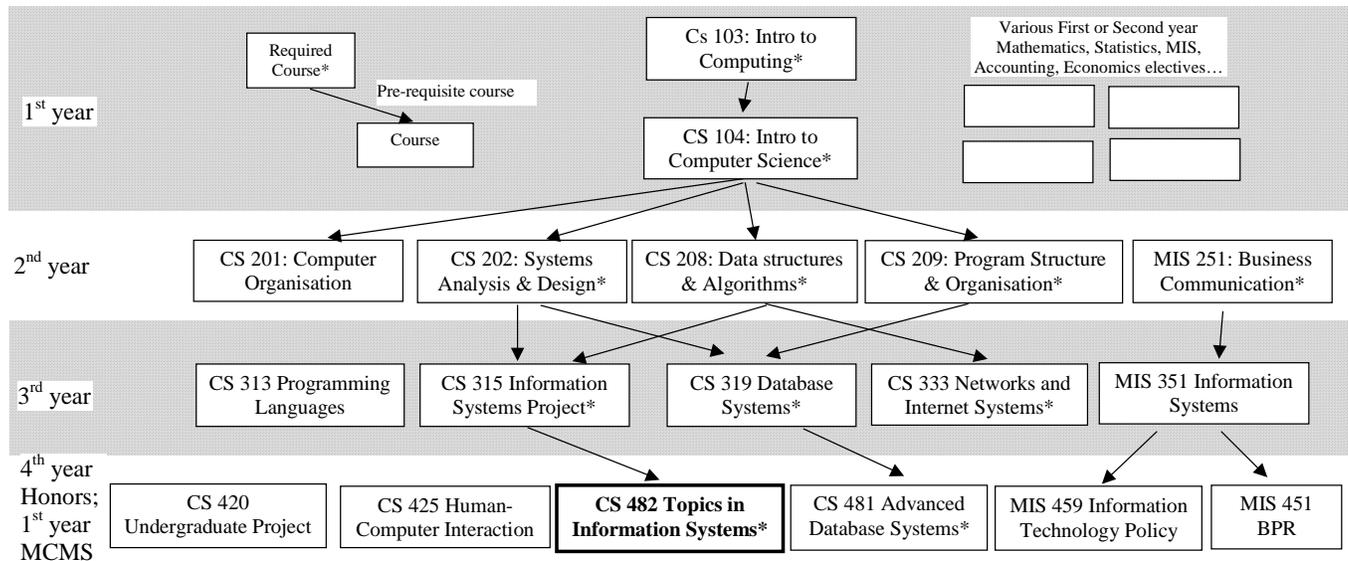
1st year	Required Course* → Pre-requisite course → Course	Cs 103: Intro to Computing* → CS 104: Intro to Computer Science*		Various First or Second year Mathematics, Statistics, MIS, Accounting, Economics electives…
2nd year	CS 201: Computer Organisation	CS 202: Systems Analysis & Design*	CS 208: Data structures & Algorithms*	CS 209: Program Structure & Organisation* MIS 251: Business Communication*
3rd year	CS 313 Programming Languages	CS 315 Information Systems Project*	CS 319 Database Systems*	CS 333 Networks and Internet Systems* MIS 351 Information Systems
4th year Honors; 1st year MCMS	CS 420 Undergraduate Project	CS 425 Human-Computer Interaction	**CS 482 Topics in Information Systems***	CS 481 Advanced Database Systems* MIS 459 Information Technology Policy MIS 451 BPR

Figure 2. Structure of the BCMS in Information Systems Programme.

The "Topics in Information Systems" course, the subject of this paper and taught by the author in 1999 (and an equivalent course at the University of Auckland in 2000), has traditionally focused on advanced data modelling methods. While this has its place in an IS Engineering degree, it was felt a change of emphasis to E-commerce Systems Engineering would better equip students for industry practice and give a larger range of research degree options. Most students taking Topics in Information Systems have done required Part 3 IS courses (e.g. IS Project, Databases, Network and Internet management), along with some MIS courses (e.g. Business Process Reengineering, Advanced Systems Analysis). The only specified pre-requisite is the IS Project course at Stage 3. This gives students experience in doing a substantial group IS development project in industry.

Most students taking Topics in Information Systems are BCMS IS programme majors, but the course also includes other BCMS majors and MCMS students, along with some MIS majors. Given these diverse backgrounds, we made the decision to give the course a strong practical IS Engineering focus, with E-Commerce systems development as the exemplar problem domain. E-commerce systems were chosen as the target kinds of IS systems to study, given the huge demand for skills in this area from industry and strong desire to learn about the engineering of these systems of students. Also, they are usually one of the more challenging kinds of systems to determine requirements of, design, implement, evaluate and deploy. The key aim was to give all students a useful, balanced mix of E-commerce engineering theory and conceptual material, practical techniques for engineering E-commerce systems, and experience at working on a realistic, moderately-sized E-commerce engineering project.

To this end, the course curriculum was intended to cover issues pertinent to managing IS Engineering projects, E-commerce systems applications and deployment issues, Requirements Engineering, Software Architectures and Design, User interface design and implementation, distributed systems implementation using middleware technologies, IS evaluation approaches, especially focusing on approaches relevant to E-commerce systems, and CASE tool support issues. This wide range of topics would build upon basic IS development skills students learned in the pre-requisite course, IS Project, as well as complement those from the Database, Internet management and various MIS courses. The delivery methods of the course would need to allow students from diverse backgrounds to not only gain a basic understanding of all of these key E-commerce engineering topics, but allow them to study in-depth a few selected E-commerce Engineering topics that best-suited their own areas of specialisation.

The delivery methods chosen were also intended to be quite "novel" i.e. break the traditional mould of lectures and assignments, and provide a more holistic learning environment. To this end, lectures were limited to one per week over the 12 week semester the course is run, and interactive tutorial activities and simulations, practical lab workshops, student presentations, group meetings and individual research projects were used. In addition, all course materials were published on the internet, all student projects (IS engineering and research projects) had their own web pages, and many Web-based example E-commerce systems and Web-based papers and other materials were referenced. A printed course manual was

provided to students containing project specifications, required and recommended readings, tutorial and practical exercise descriptions, project management materials and other supplementary information. Originally a web-only version of this was planned, but students preferred a conventional printed version which could be taken to lectures, tutorials and other meetings.

4. Theory and Conceptual Material

Topics in Information Systems takes a holistic view of E-commerce systems engineering, building on traditional IS Engineering material from prior IS courses. The lecture content of the course aims at providing a context for more interactive tutorials, practical exercises and project work, and for providing necessary theoretical content delivery and explanation in conjunction with selected readings. This combination of lectures as context and explanation with readings as background theoretical content allows us to appropriately emphasise practical techniques and experience, in comparison to many traditional Graduate IS courses that focus strongly on theory and conceptual material.

To this end, each week of Topics in Information Systems has a "theme", and a one hour lecture each week centred on this theme is given by the course professor. One required reading related to the week's theme is set, and an additional "recommended" reading also provided in the course manual. Additionally, various library and web-based resources relating to the week's theme are given, although students are also expected to carry out their own research and locate relevant web-based or library-based material. Table 1 illustrates each week's theme in Topics in Information Systems in 1999 and 2000, along with recommended and required readings. Full details of the particular readings can be found off the course web-site: <<removed for refereeing to preserve author confidentiality>>

Week	Lecture	Required & Recommended Readings	Presentation Topic	Tutorial Activity	Practical Work (2000)	Deliverables
1	Course overview; Software Processes	The Personal Software Process, Humphrey 96, IEEE Software; No Silver Bullet, Brookes, Computer 1987	Where are the silver bullets?		Simple Java work scheduling tool	
2	E-commerce systems & project management	Taxonomy of E-commerce, Bambury First Monday, 1998; E-commerce systems framework, Schuler & Shaw, Internet Computing 1997	Virtual organisations	E-commerce project simulation	Client-server Scheduler applet using Sockets/RMI	
3	Requirements Engineering	Use Cases, Booch et al, UML User Guide; Goal-driven requirements engineering, Van Lamsweerde, IEEE TSE, 1998.	Formal vs informal requirements	Use cases & KAOS	MS Access forms to maintain scheduler database	Individual research project topic
4	OOA (UML)	Class diagrams, Fowler, UML Distilled; Ethnography in participatory design, Simonsen, CACM 98.	OOA vs. SA	OOA with UML for E-commerce example	Scheduler using Database information	
5	Software Architectures	Designing system architecture, Quatrani, UML & Rose, 1998; Comparing architectures, Shaw, IEEE Software 1995.	Client-server Architectures	E-commerce SA simulations	3-tier scheduler: client, application sever, database	
6	OOD (UML)	OO Design, Conger, The New Software Engineering, 1994; Design by contract, Meyer, COMPUTER 1992.	Y2K design problem	SA & OOD Evaluations	Group Project Work	1st half Workbook
7	User Interfaces	Choosing UI development tool, Valer, IEEE Software, 1997; Tailoring tools, Morch, Journal End User Computing, 1998.	Web-based IS Interfaces	Designing E-commerce UIs	Group Project Work	Requirements Draft
8	Distributed systems technologies	Java Applets and CORBA for e-commerce systems, Evans, Internet Computing, 1997; Workgroup Middleware, Kaiser, WETICE'98.	CORBA vs DCOM	ORB, RPC simulations	Group Project Work	
9	CASE Tools	Classification of CASE, Fuggetta, COMPUTER 1993; Why CASE not used, Iivari, CACM 1996.	Rose evaluation	Round-trip engineering	Group Project Work	Design Draft
10	MetaCASE Tools	MetaEDIT+, Kelley, CAiSE'96; MetaCASE in practice, Ebert, CAiSE*97.	Presentations	E-commerce systems tool design	Group Project Work	
11	IS Evaluation	Basic evaluation techniques, Preece, Human-Computer Interaction, 1994; Usability engineering lifecycle, COMPUTER 1992.	Presentations	IS Evaluation	Group Project Work	Prototype demo
12	Future of ISE	Innovation & Obstacles, Clark, COMPUTER 1998; Reactive Environments, CACM 1997.	Presentations		Group Project Work	Final Reports & workbook

Table 1. An outline of the course content (as used in 1999 and 2000).

Table 1 also shows the relationship of practical exercise, tutorial and project work deliverable milestones to the weekly themes. The selection of lecture and reading topics was done carefully to ensure students have appropriate topic background before embarking on practical and tutorial exercises and project work.

As can be seen in table 1, a wide range of E-commerce and IS engineering topics are covered in the scope of the course, and no one topic can be fully addressed in any great depth. This approach was deliberate, and allows students to gain basic understanding of important issues related to E-commerce systems engineering for each theme topic, but also allows them freedom to more fully explore selected issues on their own or in their project groups as is relevant to each individual and/or group (via the readings, web and library resources etc). It is possible for different professors to "tune" material to suit their particular interests or to adapt it to new directions emerging in the IS/E-commerce engineering areas. For example, the course could focus more on E-commerce IT policy, project management or requirements engineering, or on architecture and implementation, or on evaluation and tools as the professor feels is appropriate. As this course has a wide student intake from varied backgrounds, not just IS Engineering majors but also Computer Science and MIS majors, the broad topics help ensure all finish the course with a good understanding and experience of the main issues of E-commerce systems development, but also are able to focus on areas of their own interest or relevance. For example, we found MIS majors tend to focus on management and requirements issues, while most Computer Science majors tended to focus on design methods and implementation technologies.

5. Practical Techniques

In addition to one lecture per week and required/recommended readings, students participate in one one-hour tutorial per week, do five practical exercises during the course, and give one group "lecture" to the class as a group of 2-3. The aim of the tutorial is to "bring to life" the theme issue of each week in a joint problem-solving or group simulation exercise. Many of these focus on getting practice in groups with various IS engineering methods, while others focus on understanding problems, processes and technologies through interactive simulations. Table 2 shows the tutorials we have used to date. These, like lectures and readings, can be tuned to suit a particular professor's themes/expertise as necessary.

Student feedback has indicated these tutorials were one of the most liked and valuable parts of the course. The group problem-solving exercises greatly helped many students understand and apply key IS Engineering concepts for building E-commerce systems, and the small group approach enabled students to learn mainly through discussion and co-operation. The simulations were great fun for students and professor alike, as well as very illuminating. Some of the more popular tutorials included the groupware systems simulation, which had students create a document simultaneously on a piece of paper (a "shared workspace"), and necessitated developing conflict resolution and work allocation/co-ordination approaches as a group. The middleware tutorial involved passing "messages" over (sometimes faulty or slow) "networks" in paper cups, and included the need to locate remote services, marshal and de-marshal information and invoke remote services, as well as handle remote service and network failure. The CASE tutorial involved simulating CASE tool reverse engineering and code generation to and from a CASE tool "repository", and a meta-CASE tutorial involved designing a set of new tools for a particular kind of E-commerce systems development. Details of the activities can also be found off the course web site.

Tutorial	Activity	Description
1	E-commerce project simulation	Simulate an e-commerce system from both user and architectural viewpoints. Discuss issues to do with organising and running a project to develop a system.
2	Use cases & KAOS	Use UML Use cases and basic KAOS formal specifications to capture requirements about an example E-commerce system. Compare and contrast these approaches to codifying requirements.
3	OOA with UML	Develop in groups several UML diagrams to specify parts of an example E-commerce system. Compare and contrast different specifications developed.
4	SA simulations	Simulate several different E-commerce system architectures in groups. The architectures are quite different e.g. client-server vs decentralised vs web-based.
5	SA & OOD Evaluations	Given three example architectures for an E-commerce system specification, develop part of OOD model for system in groups. The architectures are from 4th activity and require quite different designs to realise.
6	Designing E-commerce user interfaces	Design a set of user interfaces for part of an example E-commerce system. Simulate example use of these interfaces, and in particular groupware interfaces.
7	ORB, RPC simulations	Simulate socket, database, RMI and CORBA-style distributed system implementations in groups. This involves passing "messages" between "systems" using the facilities such architectures provide.
8	Round-trip engineering	Simulate code generation and reverse engineering support as found in CASE tools. This involves generating "code" from a design, and after change to the "code", reverse engineering changes to the design.
9	Tool design	Design a CASE tool for a particular kind of E-commerce systems engineering domain. This involves identifying suitable tool features and discussing design and implementation issues for each.
10	IS Evaluation	Carry out a group evaluation of a given, real E-commerce system. A wide range of systems are investigated by different groups, including ATMs, telephone banking, on-line purchasing, on-line banking and virtual organisations.

Table 2. An outline of the tutorials activities.

The practical exercises are used to familiarise students with implementation language, database and middleware technologies used in the group development project to build a prototype E-commerce system. In 1999 and 2000 this involved using MS Access forms and reports, an SQL server database, Java applets and servlets, and Java JDBC, sockets and RMI. This could easily be changed to using different technologies, such as Active Server Pages and CGIs, different database systems and user interface builders, and different middleware technologies and development environments. Table 3 shows the practical exercises used in 1999 for students who were not very familiar with Java but had used Access and SQL Server, and in 2000 for students experienced with Java but not so familiar with MS Access and SQL Server.

Practical	1999 Practicals	2000 Practicals
1	Introductory tutorial to Java language facilities.	Build a simple Java project management work scheduler application.
2	Build simple project management work scheduler tool using Java. Introduces students to main Java facilities.	Extend to a two-tier distributed scheduler (client and server) using Java RMI or sockets.
3	Extend to a simple client-server version of scheduler. Gives practice with sockets in Java.	Build MS Access forms to maintain scheduler database. This gives students practice using a database and basic Access forms.
4	Build an Access database with schedule items & Java access to database. Gives experience with JDBC.	Extend scheduler to access and update Database information directly.
5	Extend to a three-tier scheduler with applet, application server and database. These techniques used in project for building E-commerce systems.	Extend to use applet, application server and database i.e. a three-tier, scheduler. Techniques used in project to build E-commerce systems.

Table 3. Practical exercises.

Student presentations (or "lectures") are intended to give students practice at researching, preparing and delivering oral presentations of technical material, as well as further group work experience. It also served to motivate students to learn in more depth issues relating to the particular week's theme issue of their presentation. Each presentation related loosely to each week's theme issue, with students able to have considerable flexibility in the focus of their presentation and material they used. Most presentations were very professionally prepared and delivered, with most student groups using software demonstrations, PowerPoint presentations and other multi-media facilities like video. Many used a considerable amount of material off the WWW. Table 4 shows a summary of student presentation topics for 1999.

Week	Presentation Topic	Material Presented by Students
2	Virtual Organisations	Group overviewed the issue of virtual organisations and their requirements for E-commerce systems support. Also briefly discussed issue of virtual software organisations.
3	Formal vs informal requirements specification	Group compared and contrasted UML Use case requirements modelling and KAOS formal requirements modelling.
4	OOA vs Structured Analysis	Group compared and contrasted UML class diagrams and collaboration diagrams with SSAD Dataflow diagrams and ER diagrams.
5	Client-server Software Architectures	Group overviewed current trends in client-server computing, and briefly discussed issues relating to technologies and architecture design.
6	Y2K Problem	Group overviewed y2k problem as a "design" problem.
7	Web-based E-commerce system user interfaces	Group discussed various design and implementation issues for web-based Information Systems, particularly E-commerce system user interfaces.
8	CORBA vs DCOM	Group compared and contrasted CORBA and DCOM distributed object technologies for building E-commerce systems.
9	Current CASE Tool Technology	Group surveyed commonly used CASE tool facilities and their suitability for supporting E-commerce systems engineering.

Table 4. Student presentations.

6. Project Work

Two projects are carried out by students in Topics in Information Systems: one a group E-commerce systems engineering project, and the other an individual research project. The group development project is intended to give students both group work experience and to allow them to use the practical development techniques covered in lectures, tutorials and practicals on a moderately-sized realistic problem. The specification for the group project was deliberately open-ended: basically just develop an E-commerce system for some organisation. Students had to ensure the system corresponding loosely to the architecture illustrated in Figure 3. The student's system needs to provide: various interfaces for staff of the organisation (to maintain product/service details, generate reports, service customer on-line requests etc.); an on-line interface for customers over the WWW to search for and purchase products, check on order status, update information (if required) etc.; and an

interface to a "bank" credit card processing server. The bank server protocol was provided by the course professor and students had to incorporate electronic payment facilities in their own organisation's server that used this.
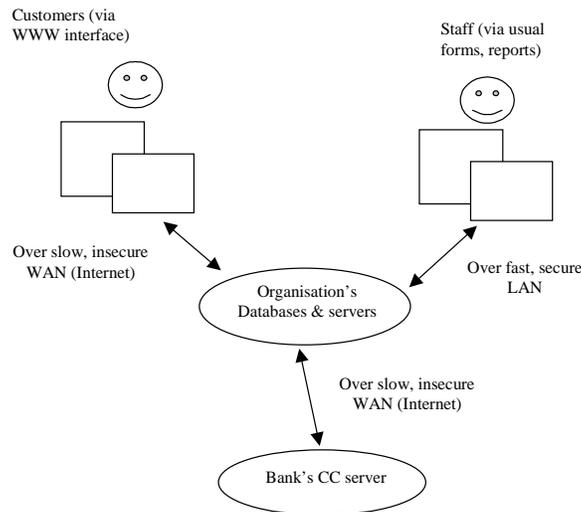

Figure 3. E-commerce systems architecture for the group development project.

The scope of the final project report was to describe the requirements of the particular E-commerce system the group has developed, a comprehensive specification, software architecture and design using the Unified Modelling Language, a prototype developed using MS Access™, SQL Server™, Java and HTML, and the results of an evaluation of the prototype (basic test plans, usability analysis and organisational effectiveness analysis). A wide range of projects were developed by students, as illustrated in Table 5.

Group	Project	Description
1	On-line book store	Basically a similar concept to Amazon.com™. The student provided a rich set of navigation mechanisms as well as purchasing functions.
2	On-line clothing store	Similar to the book store, but the student used HTML and Java applet images to provide a very rich set of multi-media information, in addition to search-and-buy functionality.
3	Virtual software store	Provided a software sales site, using a brokering metaphor i.e. site allows customers to buy from various vendors via one web site.
4	Furniture store	Used a concept of on-line sales to augment traditional sales. Customers could buy on-line but also browse store in person, or browse store items on-line and buy in-person. Nice mix of traditional and E-commerce retail concepts.
5	Cookery site	Used a concept of "shareware" recipes and cooking materials, which was very interesting. Also has a very rich range of HTML/Images to augment searching, publishing and discussion functionality.
6	Virtual art gallery	A rather novel system where artists publicise their works in a co-operative manner and customers purchase works. Nice combination of HTML and Applet interfaces.

Table 5. Some examples of group E-commerce system development projects.

The groups were required to keep a log of meetings, tasks assigned to and deliverable work done by each member, and timesheets. Some process improvement information, such as defects detected and corrected at each stage of development, were also kept. We allowed groups to self-select into 2-4 people, and many students had worked with their other group members in previous courses. Milestones for the project included draft Requirements, specification and design and prototype, in addition to a final project report at the end of the course. The scope and quality of the developed E-commerce system prototypes was quite astounding. Even groups containing mainly MIS majors who has significantly less software development experience than IS and CS majors in the course produced excellent, working systems. Most of the systems outlined in Table 5 were of close to commercial quality in terms of scope, functionality, usability and the potential for extension.

The individual research project was aimed at students gaining an in-depth understanding of an area of IS engineering related to E-commerce systems development. There were no intermediate deliverables as with the group project, except for an initial one page proposal early in the course. The project specification was to write a 6 to 8 page paper (in IEEE Press format), on a selected IS engineering topic. In addition, students needed to write a set of web pages describing their project and providing additional information about their paper topic, including useful web resources, and give a short (15 minute) conference-style presentation of their paper to the class near the end of the course. Table 6 shows some of the topics covered by student papers in their individual research project.

Individual	Project	Description
1	Visual Basic for E-commerce systems engineering	Compared using Visual Basic and active server pages to using HTML, CIGs, DHTML and Java applets/servlets for building E-commerce applications.
2	CORBA for E-commerce systems infrastructure	Compared using a CORBA-based middleware infrastructure to using sockets, database connections (via SQL) and Java RMI for E-commerce systems.
3	Rapid Applications Development	Compared the RAD development process and tools to more traditional Information Systems development methods, especially for E-commerce systems development.
4	Enterprise Resource Planning Systems and E-commerce	Overviewed ERP system facilities and architectures, and discussed implementing E-commerce systems via such packaged software solutions.
5	XML for E-commerce systems development	Gave an overview of the eXtensible Markup Language and discussed its possible role in E-commerce systems development, especially for Business-to-Business E-commerce applications.
6	Electronic money systems	Overviewed the concept of electronic money, compared and contrasted different approaches to supporting electronic money in E-commerce applications, and important related security and integrity issues.

Table 6. Some examples of research projects.

Quite different approaches were taken by students to this project. Some did a considerable amount of software development work and basically reported on their experience with a particular technology and tools they used. For example, one student re-implemented the group project prototype them had worked on using OMG CORBA instead of Java sockets, and compared the two in their paper. Other students did a more conceptual piece of work. For example, one student surveyed ERP and other packaged software systems and their relevance to E-commerce systems development and deployment. Another investigated Rapid Applications Development processes and useful tool support.

7. Assessment

The assessment in Topics in Information Systems is made up of four parts, as illustrated in Table 7. The group development project and individual research project are weighted equally, as is the final examination for the course. Students were required to keep a workbook throughout the course, which includes their practical work and tutorial results, along with critiques of readings, lectures and other group presentations. It also contains material used for their own presentations and research project and any other material they feel is relevant to their work on the course.

Assessment Item	Weighting
Group E-commerce systems development project (all group members receive roughly the same mark)	25%
Individual research project, comprised of: • paper – 15% • web site – 5% • paper presentation to class – 5%	25%
Final examination	25%
Workbook, comprised of: • Group class presentation – 5% • Tutorial and practical exercise results – 15% • Readings, lectures, presentation critiques – 5%	25%
Total coursework mark:	100%

Table 7. The assessment weightings for Topics in Information Systems.

The group project is assessed as an equal mark for all group members, based on the final report and prototype software. A small variation in this mark per group member is allowed for based on anonymous peer assessments handed to the lecturer at the end of the course reporting on each group member's assessment of their own and other group members' performances on the project. This makes group assessment straightforward and reasonably fair (<<Author>> 1997). The individual project paper is "refereed" by the course professor, according to usual IS conference refereeing criteria, and mark for this project comprises the paper "result" plus web site and class paper presentation assessment results. We found students quite enjoy the concept of writing a "paper" and "submitting" it for "refereeing", and having their in-class presentation treated like a conference paper presentation.

The examination is a two hour essay on a selected E-commerce systems engineering topic, chosen by students from a small selection. In 1999 the topic options are shown in Table 8. Students have to choose one question on which to write an essay. Their essay should demonstrate they have a good understanding of the chosen topics, can use appropriate references to course readings or other materials to back up their statements, and should produce a coherent argument for their point of view. The essay examination is open book, and thus students have available all their notes as well as the course manual with copies of the

students to formulate a coherent argument relating to their selected topic question, drawing on course resources as appropriate.

	Exam Question
1	"E-commerce system requirements are more difficult to analyse than for conventional Information Systems applications". Critique this statement. Your answer should cover E-commerce systems development processes, E-commerce system application domains and deployment issues, and Requirements Engineering issues.
2	"Object-oriented analysis and design are better for large, distributed systems development than structured techniques." Critique this statement. Your answer should cover OOA, Software Architecture and OOD issues to do with Information Systems development
3	Compare and contrast web-based Information Systems user interface development to conventional Information Systems user interface development. Your answer should refer to OOD, user interface, middleware and Information Systems evaluation issues to do with such user interface development.
4	"It is very difficult to use metrics to improve one's software process." Critique this statement. Your answer should address general software process issues, CASE tool capabilities and MetaCASE issues.

Table 8. Examples of essay exam questions.

The workbook evaluation completes the course assessment of Topics in Information Systems. This mark is a combination of evaluations of group class presentation, tutorial and practical exercise write-ups, and various course material critiques. Encouraging students to critique the course lectures and web-site, as well as other group presentations and readings, has proved popular, giving students a chance to formally give structured feedback on the course.

8. Discussion

Topics in Information Systems has succeeded in delivering a balanced mix of theoretical and conceptual material, practical IS development methods and techniques, and project experience in developing E-commerce systems, for a diverse range of students. Giving each week of the course a theme ensures students gain a basic understanding of a range of important E-commerce engineering issues, as well as helping to structure course pace and focus. The individual research project, readings and lectures, and group development project all allow scope for in-depth study of selected E-commerce engineering topics, that students focus to their own individual needs. We were pleased that a balance of MIS, IS Engineering and Computer Science material was covered during the course, all tailored to focus on E-commerce systems engineering. This made the course attractive to a wide range of students, and this range of student backgrounds proved to beneficial to all involved, providing a rich, co-operative learning environment throughout the course.

E-commerce systems provided to be a very popular focus area for students, with a number of very high quality prototype systems developed and excellent project reports written. E-commerce systems are also an excellent example of a challenging IS development problem. They have a diverse user base and consequently eliciting their requirements is difficult, they usually have relatively complex software architectures, being complex distributed systems, their design and implementation is usually quite complex, a variety of evaluation techniques are necessary, and a diverse range of tools exist to aid their development.

Particularly successful parts of Topics in Information Systems proved to be the tutorials, group project work and student presentations. Tutorials which emphasise group problem-solving with new techniques, or interactive group simulations, were a lot of fun as well as being very educational. Working in groups was found to be very useful by students, despite many already having considerable group work experience from previous courses. The student presentations were of excellent quality and very professionally developed and delivered. Many employers have expressed concern to us in the past about graduates' poor written and oral presentation skills, and we were pleased to be able to give students guidance and practice in these important areas. The workbooks of most students proved to be of a high quality, although many found it difficult to compare and contrast methods and technologies, and to critique readings and presentations. Sadly, many students reported it was the first time they had been asked to do "critical comparison and analysis" tasks in their degrees!

The individual research project received good feedback from students in terms of the freedom to chose their own topic and emphasis, and its use of the concept of papers and paper presentations. Unfortunately, apart from a few outstanding examples, most of these projects were poor quality. Many papers were extremely poorly structured (despite the required and recommended readings giving students many examples of "good" papers!), many involved quite cursory "research" work, the use of references was almost non-existent, and the web pages developed by students usually just an electronic form of their paper. This was disappointing, and in future we plan to give students more guidance and coaching in writing technical papers.

The essay examination was not well received by students, many claiming they had never had to write an essay before during their time at University (which seemed, to the course professor, an excellent reason why they should have at least one experience of this!). The essay topics were quite broad, and all asked students to compare and contrast various conceptual and practical E-commerce development issues. Students were advised to treat the essay as a "report" an industry IS manager may ask them to write to help them understand and compare various IS engineering issues. Despite a cool student reception to the essay concept, the essays on the whole were very good, several being of exceptional quality.

Formal and informal student evaluations of Topics in Information Systems have been excellent. The general consensus has been that the course in its form described in this paper provides an excellent combination of breadth and depth, with students able to individually gain additional expertise in self-selected areas of E-commerce systems engineering. Particularly popular aspects of the course included the tutorials, group and individual projects and the themes used for each week. The focus on E-commerce systems engineering was very popular. Several students thought the prototype systems they developed were of near-commercial quality, an opinion shared by the course professor. Many students used their project reports as additional material when applying for industry jobs. Feedback from employers requesting references for students from the course professor have been extremely positive about the course material and student expertise in E-commerce systems engineering.

9. Summary

Our graduate-level course Topics in Information Systems has been modified to focus on E-commerce Systems Engineering theory and concepts, practical techniques and practical experience. A range of E-commerce engineering topics are covered in the course, with delivery via lectures, student presentations, readings, web resources, tutorials and practical exercises. In addition, two projects, one a prototype E-commerce system development and the other an individual research project, give students experience in using the concepts and techniques presented in the course. This has been a very successful course in terms of the quality of student projects, particularly the development projects, the interest of students as expressed in the tutorials, presentations and workbook write-ups, and in terms of both student and industry feedback. The model for an advanced E-commerce Systems engineering course as presented in this paper has worked very well in the context it has been used: augmenting fairly traditional four-year Information Systems Engineering honours programme and Masters degree. Particular features are its holistic approach to covering E-commerce systems engineering topics, its use of readings, student presentations and tutorials, and its emphasis on student-directed learning. We believe the model for this course would also work well even if more E-commerce related courses were taken by students prior to this course. Obviously a change in content and emphasis would be necessary depending on these prior courses, for example to enable this course to focus more on management or technical or evaluation topics as appropriate.

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