

E-Commerce as a Capstone in Information Technology

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ABSTRACT

Universities interested in keeping pace with the rapidly changing field of Information Technology (IT) are often pulled in many directions. Because Information Technology is such a popular field of study and work, educators must manage rising enrollments in an era where the ubiquity of information technology demands an ever-increasing number of specializations. As a result, industry and students expect a wider range of courses and specializations in their upper division coursework. E-commerce, one of the most promising of these maturing Information Technology specializations, affords an excellent opportunity to draw together the fundamentals of the field into a capstone series of courses. E-commerce fulfills a present demand from industry, provides a wonderful project and group-based "studio-style" learning environment, and is quite popular with students. This paper discusses our e-commerce degree specialization as a capstone to undergraduate Information Technology coursework. We also discuss the motivation for, design and execution of, and results from our courses.

Keywords: E-commerce, information technology, capstone project, studio-style learning

1. MOTIVATION

E-commerce degrees and Computer Science/Information Technology specializations in e-commerce are becoming more and more popular with students, universities, and industry. Companies seek graduates with skills to develop and manage e-commerce solutions, and universities are responding with an increased offering of e-commerce-related courses and degree programs. This is no surprise given many forecasts that e-commerce will account for as much as \$1.4 trillion in revenue by 2003 (Menascé 2000).

As in many IT fields, student demand for e-commerce programs often exceeds capacity. In addition, the problem of offering an e-commerce program of study is exacerbated in that it is such an emerging discipline that requires new learning materials to be created and updated on an almost weekly basis. Many of the newly formed e-commerce programs across the United States report that there is a challenge to offer students the most up-to-date material while managing faculty resources (Dobbs 1999, Lord 2000).

Our motivation was to create an e-commerce specialization as a capstone to our newly formed IT degree program. Our approach is to combine the best practices of current e-commerce technologies and discuss these in

the context of proven and stable IT disciplines. These "cornerstone" disciplines include Human-Computer Interaction (HCI), Networking, Security, Programming, Information Systems Analysis and Design, Testing and Quality Assurance, and Database Design and Modeling.

The Information Technology Department of Clayton College and State University (CCSU) was founded in 1998 as part of the New College for Economic and Community Development. The College's charter includes

- Systematically empower students with employable skills in a 3-tiered Certificate/Associate/Bachelor degree program
- Utilize cutting-edge technology with an emphasis on theory and practicum
- Foster close ties with industry
- Offer current and in-demand specializations which offer experiential learning and prepare students for work in industry

Our three-tiered degree IT program is one of the first in the United States to allow students to acquire degrees as they progress through the curriculum. Students have the option of getting part- or full-time employment before completing their 4-year degree under our IT structure.

Thus our department is positioned to be flexible to new technologies and responsive to industry's need for graduates with cutting-edge skills.

The e-commerce specialization was formed in response to an advisory meeting with industrial leaders and the college faculty. The original intent was to offer a degree program jointly with the Department of Information Technology and the School of Business. This model follows the ACM/IEEE Curriculum 2001 suggestion that as more specializations become pervasive in IT/CS that joint degree programs are a viable solution. Our responsiveness to and partnering with industry also follows the ACM/IEEE guiding principles (Chang 1999).

The IT specialization was approved with the following mission:

Help students develop skills necessary to build E-Commerce infrastructures, understand the nature of secure E-Commerce transactions, and understand the legal implications of E-Commerce; IT graduates will be able to contribute to this growing segment of business and commerce.

The program was first offered to a group of 15 students in the Fall and Spring of 2000 after a year of development and planning. It is currently being offered to 18 students this semester, Fall 2001.

2. E-COMMERCE AND EDUCATION

It is quite apparent that e-commerce is a driving force in the "new economy." Business-to-Business (B2B) revenues are to exceed \$1 trillion by 2003, and on-line purchases are expected to reach \$380 million in the same timeframe. Thus students well versed in this burgeoning field will be able to capitalize on the many new job opportunities for years to come.

It is interesting to note that many top-ranked universities have begun to offer e-commerce degrees or specializations at the undergraduate and graduate level in recent years (Dobbs 1999, Lord 2000, Menascé 2000). While the pace of the curriculum development might seem daunting in this emerging and ever-changing field, there is a set of core knowledge units that all e-commerce curricula should contain.

Menascé categorizes these into three distinct domains: business, customer-behavior (sociological), and IT. These models include the following topics (Ge 2000, Menascé 2000):

<p>Business Information Economy E-commerce Business Models Marketing Supply Chain Management</p>

<p>Customer-Behavior/Sociological Data Mining Statistical Data Analysis Human Factors Agents/Recommender Systems</p>
<p>Information Technology Security Database Management Networks Human-Computer Interaction (HCI) Hardware/Operating Systems Web Technologies</p>

While the e-commerce field is still in the formative stages and the various technologies used in e-commerce systems are in flux, it is possible to define core technologies and practices that define the field that will carry students into industry. Ge and Sun (Ge 2000) put it well in saying:

The process of developing an electronic commerce system is similar to that of the developing most information technology systems. It involves system analysis, requirements specification, design, implementation and testing. Therefore, the basic principles of system engineering and software engineering should apply.

3. INFORMATION TECHNOLOGY

Because of its applied nature, information technology encompasses many areas and spans multiple disciplines. While IT is certainly applicable in many fields, at its fundamental core IT consists of the following knowledge units:

- Systems analysis and design
- Programming
- Testing and quality assurance
- Software engineering
- Systems engineering
- Hardware
- Networks
- Human-computer interaction
- Database design and implementation

Information technology curricula must also go beyond the above listed skills. These programs should not neglect practicum (non-theory) skills and the "professional practice" skills of verbal and oral communication, writing, and the ability to work well on a team (Chang, 1999, Denning 2001, 10).

4. PREPARATORY COURSEWORK

The IT courses offered in our degree program relevant to the e-commerce specialization are shown in Figure 1. Courses range from introductory courses in IT, systems,

and programming, to advanced courses in database design and analysis, web technologies, human-computer interaction, and software engineering/testing and quality assurance. These pre-requisite courses lay the foundational knowledge upon which the e-commerce courses build. Degree levels pertinent to each course are also shown in Figure 1.

5. E-COMMERCE AS A SPECIALIZATION

The areas of interest in e-commerce (section 2) correlate nicely with the areas of interest in "more traditional" Information Technology (section 3). We find that a capstone specialization in e-commerce is well suited to draw together the major components of IT in the context of real world, open problems. Students apply what they've learned in previous courses as they learn how these fundamentals in IT apply to e-commerce systems.

E-commerce, whether dealing with consumer-driven, internet-based transactions, or more long-standing Electronic Data Interchange (EDI), is an important issue

in any modern Information Technology curriculum. Students with this specialization are well sought after in the job market.

In addition, almost all students in IT/CS have made purchases and interacted with e-commerce sites such as Amazon.com, Ebay.com, and other consumer-driven sites. We can capitalize on this by relating their experiences on the consumer-side to back-end, vendor-side technologies. This is the equivalent to "looking under the hood" to see how e-commerce transactions take place and what issues (security, non-repudiation, etc.) are relevant.

Allowing students to learn in group- and project-based settings is central to our teaching approach. This "active learning" method offers the highest rate of knowledge retention (Kuras 1999) but comes at the price of cost of development, complexity management, and the need to deal with an ever-changing field (Fincher 1998).

The major topics pertinent to e-commerce span domains in business, commerce, and IT/CS, and it is important that an e-commerce curriculum is balanced to include topics from all of these fields (Menascé 2000). Our approach is to allow students the flexibility to take elective courses in business, management, and finance as their interests direct them. We thus focus our offerings to four "core" e-commerce courses as described below.

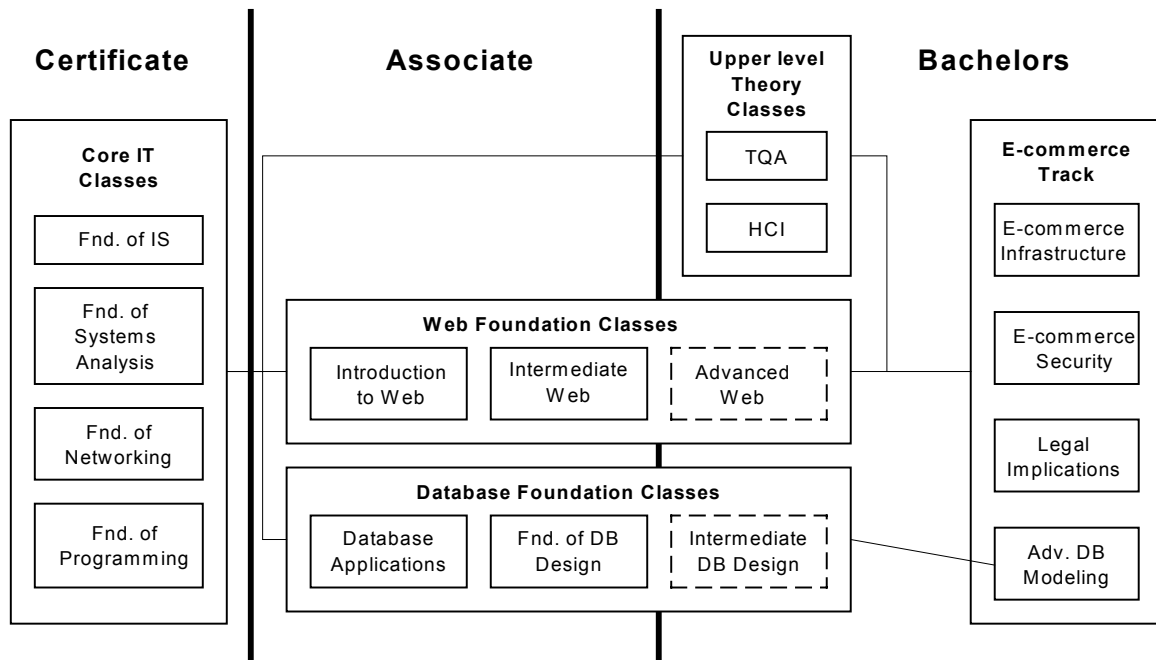


Figure 1 – E-commerce IT Specialization Related Courses

Infrastructure

The ability to build an e-commerce site is completely dependent upon a solid foundation in current technologies and design issues. The Infrastructure class lays the

foundation for understanding every other piece of the e-commerce capstone.

This course uses a team-based research, exploration, and hands-on approach to aid the student in understanding current e-commerce business models and associated

standards and methods. Based on the fact that many of the students have had basic classes in programming, human-computer interaction, networking, and web design, the class takes a more in-depth look at the issues that affect the design and implementation of each site that you produce and the best practices to carry out each solution.

The research and development piece of this course requires students to look at how current companies have chosen to implement e-commerce business models, and critique the success and failures of those approaches. As each student conducts their research, they must also produce their own fully functional e-commerce site using a concept that they develop. The students have a vested interest in learning and building a high quality site because at the end of the term they are required to participate in an "e-fair" where fellow students at the university will use the site to "mock" purchase items and judge the work.

The class also takes the students one step further by not only considering the current storefront implementations, but also network infrastructure and backend development as well. The entire visit to a web site is looked at to express the relationship between the client, server, and backend processing. Other topics include load balancing and server management, securing electronic transactions, and the complexities that arise in production of e-commerce web sites.

Security

The security class takes the students to the other side of e-commerce. In this course the students learn that a good storefront is only as good as the way that it is protected.

This course also takes a lab and research based approach to the topics. Current online examples are used to demonstrate loopholes and faults in technology. Other sites are used to demonstrate ideas such as user authentication, access control, cookies, SSL, and certificates.

Best practices to protect your online store and customers and the concepts of basic encryption are also discussed. PGP (Pretty Good Privacy) is used in the course to help demonstrate the concepts of current public and private key encryption methods, digital signatures, and key management. Current export laws for this encryption technology and how to implement safely with web sites is also discussed.

Other concepts in this class include network security and management from the standpoint of firewall security, managing security patches and updates, and protecting yourself and your site from unexpected downtime due to standard and distributed denial of service attacks.

Law

Understanding that E-commerce is more than just a technological trend, but currently one of the fastest

growing ways doing business, is essential to truly understanding it. In looking at e-commerce, the student must understand not only the technical implications but the legal implications as well. What are the parts of a valid contract; what a copyright, trademark, or patent are and what they protect; what a privacy statement really protects; and can you fully protect yourself and your interest on the web?

Ideas of design and security are left completely out of this discussion-based course. The class uses a round table and open lecture format to discuss current e-commerce law and the issues surrounding it.

Basic topics include: concepts of intellectual property laws and how they are interpreted on the Internet, jurisdiction, online contracts, taxation, privacy, user rights and limitations, personal attacks, Internet and computer crime, and, of course, global issues. Case studies and current developments are used as the primary tools for demonstrating these concepts.

The students are taught to be cautious and protect themselves and their organizations' interests, which they serve. The web itself has extremely high potential in creating companies and newer technology, but "new and improved," in today's world, seems to come with a darker side. With an increase in information, you also see an increase in piracy, theft, and manipulation, and a decrease in privacy and personal security. Understanding how to protect your business' assets (technically and legally) has to be considered in this industry.

Database

Just behind the forefront of any data driven e-commerce site is the ruggedly designed and fully functional database. In order to create and fully understand the evolution and the amount of flexibility that a web database must permit, the students are placed through a course in advanced database modeling.

Based on industry standards and current products that are used in commerce and other development environments, products such as Oracle, SQL server, and other relation database management systems are used in this lab-based class. The students are required to develop normalized, large scale databases based on criteria provided by the instructor.

The content of this course leans mainly towards relational database theory. Relational algebra is taught and used in order to take the student back to the basics of database design, table layout, and advanced queries. The main decision in using relational algebra is to teach the students to produce streamlined and refined information. Efficiency is stressed constantly. After acquiring relational algebra skills, the students move on to strict SQL. Every lab and assignment in the class must be coded by hand and be as efficient as possible in order to receive credit.

Current, cutting-edge products are used in class, and other concepts of advanced database processing are discussed; these include backend architectures, error logging, and data distribution.

The Business Side of E-commerce

The reader will well note that there has been little discussion of the business implications of e-commerce thus far in the paper. This is due to the fact that the faculty in our department acknowledges that we cannot cover the business and management material as well as faculty in the School of Business.

As a result, we have decided to “outsource” the business topics pertinent to e-commerce (and IT in general). The *Principles of Management* course is required of the IT degree and the e-commerce specialization within our program; thus all students graduating within the e-commerce specialization will have some management and business background. Students are also required to take a *Business Process Reengineering* course. We acknowledge that the business side of our curriculum is somewhat lacking (only requiring two courses), but the focus of our program is more technical in nature. As stated earlier in the paper, the e-commerce degree track was initially a joint venture with the School of Business, but their involvement has been smaller than initially anticipated due to teaching load and accreditation issues. Students do have the ability to select elective courses within our degree program; consequently it is possible for a student who is more interested in the business side of e-commerce to elect to take more management, business, and marketing courses than required.

6. ANALYSIS

The e-commerce courses intentionally utilized projects that were open and whose problem definition and solutions were inseparable. This approach forces students to iteratively refine their solutions until reasonable requirements are satisfied (Docherty 2001). Issues of system design and interface aesthetics were approached from the consumer, systems engineer, and management perspective. This proved quite fruitful in seeding discussions of maintenance and systems engineering topics.

The grades in the e-commerce courses demonstrate that students performed at varying levels. We attribute success in these courses to factors such as time on task, prior learning success and retention in pre-requisite courses, and the ability to work well on a team. The mean pass rate for the classes is 87%, thus the majority of students passed the classes.

Many students reported that they learned more in the e-commerce courses that they had in previous courses. While this is flattering, we hypothesize that students were able to solidify concepts that they had already learned from other courses in the experiential setting of these e-commerce courses. Once students were able to see the topics converge into entire systems, we surmise

that the relevance of each subtopic became evident and coalesced in their minds.

Students also report that they were able to quickly apply what they had learned in their current part-time or recently acquired full-time positions. One student reported that he was offered a job in the e-commerce field, and before he was able to accept, the company had raised the offered salary twice¹; certainly this supports the idea that there is a definite need for students trained in e-commerce and Web-related skills.

7. FUTURE WORK

While our experience over the past year has proven the e-commerce specialization a success, there are many opportunities for improvement.

We plan on restructuring our introductory Web courses (pre-requisites to the e-commerce specialization) to increase emphasis on advanced Web programming technologies such as ASP, Java Servlets, VBScript, JavaScript, and XML. The motivation here is that these courses have become slightly dated and require a fresh look at some of these more modern technologies. Because these courses feed into the e-commerce specialization (see figure 1), we will be able to use e-commerce class time to go into more depth with these technologies.

The project-based nature of the courses lends itself well to the courses' experiential learning style, but it is questionable if this model scales to larger classes. Enrollment is expected to double this Fall, and this will obviously necessitate changes in the course structure. We intend to keep the projects and group work as part of the class, but student-led in-class demos will have to be managed in this larger setting. One solution is to have all students present in class once, and handle some presentations outside of class time to allow all to present without taking up too much class contact time.

The didactic nature of the "Legal Implications" course works well in the current course size of 15-20 students, but when enrollment increases, will some students get "lost in the crowd?" We must be sure to actively engage all students in case study discussions and be sure that all students have an opportunity to be heard.

8. CONCLUSIONS

E-commerce is a viable capstone project course for Information Technology curricula; it makes use of the fundamental knowledge units of IT and provides an authentic project- and team-based environment wherein students apply knowledge gained in previous courses. Anecdotal evidence suggests that graduates from this program are successful in finding good jobs. While we

¹ It turns out that this student was not able to complete the e-commerce specialization for medical reasons, so this company was knowingly offering a job to a student without a degree and who hadn't even completed the courses!

will always continue to iteratively improve our courses each semester, the fact that we base our e-commerce curriculum on solid IT skills helps reduce the flux of the material. Keeping current in this rapidly changing field is a daunting task and much initial development is required, but the payoff in successful students who have learned to see the "forest" and the "trees" of IT is well worth the effort. Demand for this popular field of IT is expected to remain high, making e-commerce a worthwhile and economically viable degree specialization into which faculty, students, and industry should invest.

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10. REFERENCES

- Chang et al. "Curriculum 2001: Bringing the Future to the Classroom." *IEEE Computer*. Vol. 32, No. 9. September 1999. 85-88.
- Denning, Peter J. "Who Are We?" *Communications of the ACM*. Vol. 44, No. 2. February 2001. 15-19.
- Dobbs, Kevin. "New Rage on Campus: E-Commerce Degrees." *Training*. December 1999. 62-64.
- Docherty et al. "An Innovative Design and Studio-based CS Degree." Proceedings of SIGCSE '01 (Charlotte, NC) ACM, New York. February 2001. 233-237.
- Fincher, Sally and Marian Petre. "Beyond Anecdote Toward Real Transfer: Using Other Institutions' Experience of Project Work." Proceedings of ITiCSE '98 (Dublin, Ireland) ACM, New York. July 1998. 86-89.
- Ge, Yuzhen and Jiangeng Sun. "E-commerce and Computer Science Education." Proceedings of SIGCSE '00 (Austin, TX) ACM, New York. March 2000. 250-255.
- Kuras et al. "Changing IS Curriculum and Methods of Instruction." Proceedings of ITiCSE '99 (Cracow, Poland) ACM, New York. June 1999. 36-39.
- Lord, Mary. "Suddenly, E-Commerce is the hot new specialty." *U.S. News and World Report*. April 10, 2000. 62-64.
- Menascé, Daniel A. "A reference model for designing an e-commerce curriculum." *IEEE concurrency*. Vol. 8, No. 1. 2000. 82-85.
- Roberts, Eric. "Computing Education and the Information Technology Workforce." *Inroads: SIGCSE Bulletin*. Vol. 32, No. 2. June 2000. 83-89.