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ABSTRACT

The success of E-Commerce program depends heavily on rigorous technologies and market orientation. It is important to constantly watch and adopt new emerging technologies in E-Commerce education. This paper presents a case study of the adoption of a new technology, i.e. ASP.NET, for B.S./M.S. E-Commerce curricula at a large graduate school of a Midwest university. A phased strategy for new technology adoption is utilized to adopt the new technology. New technology adoption starts from faculty consensus on a new technology. The new technology is first introduced in advanced graduate electives. When it becomes more mature and instructors have gained sufficient experience, it is offered in a pilot course for undergraduate students. It is finally incorporated into B.S./M.S. E-Commerce curricula after the success of the pilot undergraduate course. The curriculum structure of the e-commerce programs allows us to implement this phased strategy of new technology adoption. The nature of the courses involved in the technology adoption and the key factors for the faculty to make decision on ASP.NET adoption are also addressed in the paper.

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1 INTRODUCTION

In September 1999, the School of Computer Science, Telecommunications, and Information Systems (CTI) at DePaul University launched a pioneering M.S. degree program in E-Commerce Technology. This new curriculum was built on a dual emphasis of E-Commerce strategies and applications of Internet-based technology (Chan and Knight 2000). The entire curriculum, including a wide range of new courses, was successfully implemented by June 2000. Subsequently, a B.S. degree program in E-Commerce Technology was developed and implemented in 2001.

E-Commerce Technology programs at DePaul University emphasize a tight integration of business strategies and technology solutions throughout the curricula. The curricula offer significant technical depth. The School of CTI is a technically oriented graduate school, embracing both technology and business applications of new technology. Its faculty is multi-disciplined, representing a wide spectrum of academic training and industry expertise. These programs are intended to prepare graduate students to lead e-business applications development in large corporations, consulting firms, or their own entrepreneurial endeavors. The curricula prepare students to develop a capacity for integrating business strategies, process, development tools, and technology in the dynamically changing environment of the IT industry.

One of the principles of IS curriculum is to focus on current and emerging concepts (Gorgone and Gray 1999). The success of both E-Commerce curricula depends heavily on rigorous technologies and market orientation. It is important for the curricula to constantly watch and adopt new emerging technologies. This paper presents the technology adoption strategies used for these curricula. A case study on adoption of ASP.NET is presented in the paper.

2 CURRICULUM STRUCTURE FOR TECHNOLOGY ADOPTION

The strategies for technology adoptions used at the School of CTI of DePaul University are illustrated in Figure 1. Since there is a wide variety of advanced electives in the M.S. program and students at this stage are technically prepared, new technologies are first introduced in advanced electives of M.S. program. When a new technology becomes more mature and instructors have gained sufficient experience, a group of E-Commerce faculty meets together and decides whether the new technology is suitable for the B.S. / M.S. curricula. When a consensus has been reached among faculty, the new technology is then introduced to B. S. senior electives and M.S. prerequisite courses. The new technology will gradually propagate to the more advanced courses. The new technology adoption process consists of three phases.

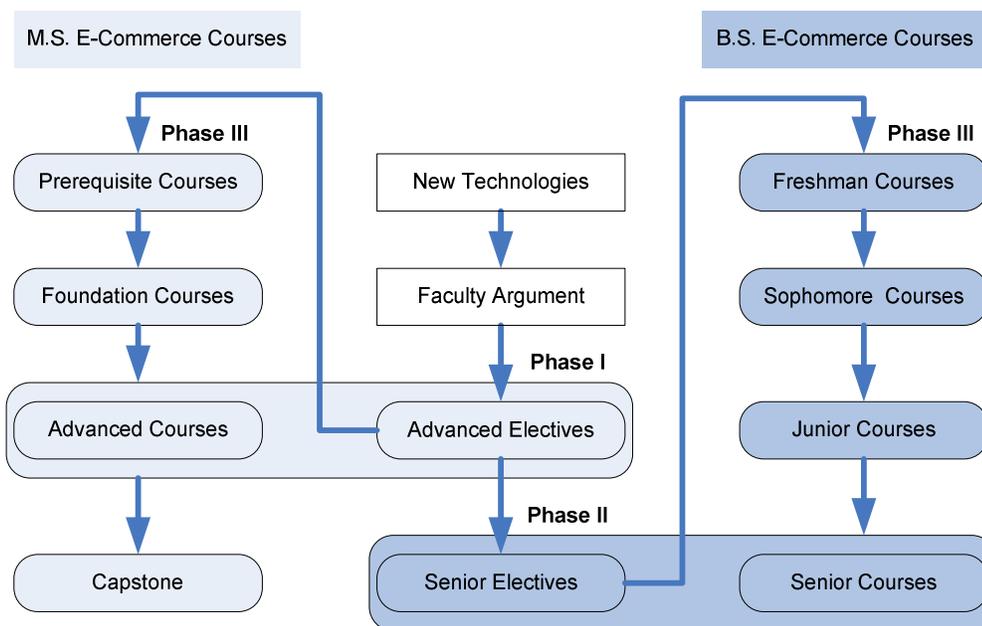


Figure 1. Curriculum Structure for Technology Adoption

2.1 Phase I: Training and Experimentation

In the M.S. curriculum, a variety of advanced electives are designed to give students exposure to a wide spectrum of new technologies and business strategies, such as advanced scripting technologies, web data mining technologies, mobile commerce, customer relationship management, Internet multimedia design, enterprise architecture design, and peer-to-peer technology. These courses are usually taught by senior faculty or adjunct faculty who are likely pioneers in the industry. Because instructors have the knowledge and experience and the class size is small (20 plus students in each class), these courses are the natural place where new technologies can be first introduced to classrooms. In this phase, instructors are allowed to try any new technologies that are deemed important. At the School of CTI, a group of network engineers provides technical services to the E-Commerce curricula. They maintain a web hosting service dedicated to E-Commerce classes and offer other technical solutions. Through these advanced electives, both instructors and the technical staff can experiment with new technologies and provide informative advices for potential technology adoption in the future.

2.2 Phase II: Pilot Courses

When instructors and the technical staff get more experienced with a new technology, it is then introduced to

undergraduate-level senior electives. Because undergraduate students are technically less prepared than graduate students, more instructional and technical barriers are expected. The senior electives allow instructors to try new technologies and instructional methods with a small group of undergraduate students. Potential textbooks are also explored in this phase.

2.3 Phase III: Full Implementation

When a new technology gets more mature, it is ready to be introduced in introductory or intermediate courses. These courses, such as Server-Side Web Application Development, provide technical preparations for more advanced courses. A group of E-Commerce faculty members meets regularly to decide contents and technologies used in various E-Commerce courses. In this phase, they will decide the major topics covered in the courses and possible textbooks, and consult the technical staff for technical supports to the new technology. Then the new technology will gradually be incorporated in the more advanced courses. By the time of graduation, our graduates will master the new technology that will very likely become a required skill in the job market.

In 2002, we decided to adopt ASP.NET as the new web application development technology to replace classical ASP, which is about to be obsolete in 2004. This phased strategy of technology adoption was successfully employed for the new technology adoption at the School of CTI. In the following section, we present the case study for the ASP.NET adoption in our B.S. / M.S. curricula.

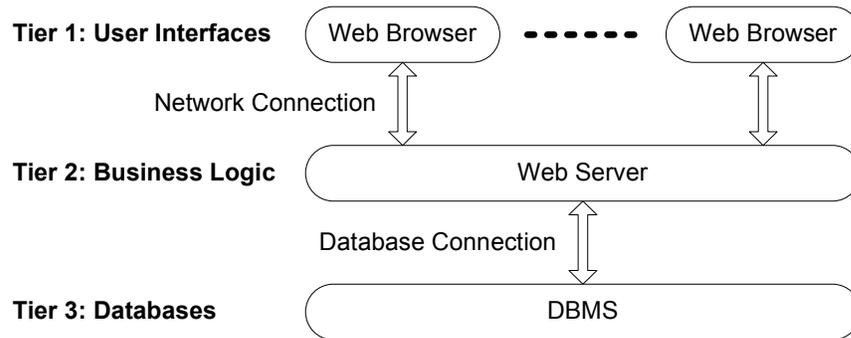


Figure 2. Web Application Model of E-Commerce Technology

3 A CASE STUDY: ASP.NET ADOPTION

The Web has become a widely accepted platform for delivering interactive applications for E-Commerce. Web application development is a preferred skill that practitioners expect graduates from E-Commerce programs to have (Mitchell and Strauss 2001). Various courses for web application development are offered in E-Commerce programs at the School of CTI to prepare students for meeting the demands of web application development. These courses provide a technical foundation for the applications of Internet technology to support consumer-oriented E-Commerce, enterprise e-business solutions, and emerging business-to-business trading models.

The fundamental architecture for web application is a client server model. Web application model typically consists of three tiers. Tier 1 is the user interfaces rendered in a web browser, which is running at a client computer. Tier 2 is the business logic implemented in a web server. Tier 3 is the databases for data storage and retrieval controlled by a database management system. Figure 2 illustrates the conceptual model. This model meets the major requirements of courses for web applications in E-Commerce curriculum.

When the School of CTI launched its M.S. program in E-Commerce Technology (ECT) in September 1999, courses on Server-Side Web Application Development were offered in the curriculum (Knight, Chan, Epp, and Kellen 1999). These courses provide students with the tier 2 technology in the tiered model of E-Commerce technology as shown in Figure 2. Active Server Page (ASP) was chosen for these courses. ASP is a Microsoft web application development technology, which can be used to develop web applications modeled in Figure 2. However, with the release of .NET framework in early 2002, Microsoft stopped the development of ASP technology. Therefore the technology is inevitably going to be out of market. The courses on Server-Side Web Application Development must adopt a new technology.

Server-side web application technologies are presently taught through three ECT courses. However, the new technology adoption not only affects these three ECT courses on Server-Side Web Application Development, but also other ECT courses in ECT programs. This section outlines the nature of these courses, factors determining the technology adoption, and the migration process.

3.1 Courses on Server-side Web E-Commerce Application Development

Server-Side Web Application Development is taught in three courses in B.S./M.S. ECT programs. The three ECT courses are designed for IS (Information Systems) and ECT majors:

- An undergraduate introductory course on server-side web application development, which also serves as a prerequisite course for graduate IS and ECT programs;
- A graduate elective course on advanced scripting technologies, and
- An undergraduate elective course on advanced scripting technologies.

When the School of CTI launched the M.S. ECT program in 1999, Microsoft platform—Microsoft Access, Active Server Pages, and Internet Information Services (IIS) were chosen as the preferred database, server side scripting tool, and server platform for the introductory course on Server-Side Web Application Development (Knight et al 1999). After that, ECT courses that involve web application development are based on these technologies.

Technical support is an important technical foundation for ECT courses. A web hosting service (Yan and Zoko 2004) provides a web application development environment for these courses. Students enrolled are provided with web accounts. A student utilizes the web account to test and debug his/her web applications. The

web hosting service supports the entire web application development cycle. By 2004, our web hosting service is able to support up to 1,000 student web accounts simultaneously. Students can upload their web pages and run their codes in their web accounts. Simple text editors are recommended for students to write their web programming assignments, and FTP through Microsoft Internet Explorer is the preferred tool for uploading web pages onto student accounts.

The web hosting service is primarily implemented and managed by technical staff at the School of CTI (Yan and Zoko 2004). Management tools are deployed to restrict resource requests from a student web account because students' programs are often full of bugs and prone to request exorbitant computer resources. Monitoring resource requests from a student account is a key for the success of web hosting service. Student programs that request excessive resources are killed automatically. Course web servers restart every three hours to ensure the proper status of each server. As of June 2004, the course web hosting services are very successful. Few students complained about the stability and responsiveness of the course web servers.

With the release of Microsoft .NET platform in early 2002, Microsoft has stopped the development of ASP technology. Obviously, ASP technology is going to be phased out and another server-side technology should be considered to be its replacement.

3.2 Faculty Argument: Key Factors for ASP.NET Adoption

As ASP technology is about to become obsolete, a debate on what server-side technology should be taught started in 2002 among faculty members in the E-Commerce Technology program. This is the first step of new technology adoption as shown in Figure 1.

The faculty debate centered on JSP/Servlet versus ASP.NET. JSP/Servlet is a part of Java 2 Platform, Enterprise Edition (J2EE). J2EE is an industry standard and the result of a large industry initiative led by Sun Microsystems. ASP.NET is a component of .NET framework, which is a product of Microsoft. Both technologies can be used to develop the web application modeled in Figure 2. Therefore they both are potential candidate technologies for the courses of web application development.

In 2002, the School of CTI switched its major programming language for instruction from C++ to Java. JSP/Servlet was considered as an alternative to ASP. Furthermore, because an advanced graduate ECT course covers JSP/Servlet in the context of the development of an e-marketplace system, there was a strong interest in adopting JSP/Servlet. On the other hand, Gartner Research (Driver 2001) predicts that .NET framework will reach a critical mass by 2004, and .NET framework will be the default development framework for more than 95

percent of Microsoft-based solutions by the end of 2005. Given the existing huge population of Microsoft-based systems, .NET framework becomes an important technology for application development in the industry. However, the debate on J2EE vs. .NET cannot be ended in the near future. As Williams (2003) points out in "The Web Services Debate: J2EE vs. .NET", it is pointless to argue currently that one tool is superior to the other. Instead, other factors should be taken into consideration for the choice of a technology.

As web hosting service is crucial for the success of ECT courses that involve web application development, faculty members consulted technical staff regarding technical support for course web servers. Since we have accumulated experience on the management of the web hosting service, which is implemented based on Microsoft systems. Therefore adoption of ASP.NET has the minimum effect on the existing systems of web hosting service. It will be more seamless in the view of technical support for ASP.NET. Finally, after taking technical supports into consideration, the faculty reached consensus to adopt ASP.NET.

3.3 Migration Process

As illustrated in Figure 1, we took a phased deployment strategy for ASP.NET migration. The migration started in September 2002 and completed in November 2003. The migration process consists of three phases.

Phase I Training and Experimentation: This phase took two academic terms from September 2002 to March 2003. The advanced graduate course was switched into ASP.NET first. ASP.NET was incorporated into half of lecture hours in the graduate course, and another half was remained with ASP. Typical topics covered by the advanced graduate courses during this phase were:

The first half of the course:

- Components and Web Application Architecture
- Building ASP COM Components
- COM+ Applications
- ASP and Transacted Web Applications

The second half of the course:

- Introducing ASP.NET
- Visual Basic .NET
- ASP.NET Web Server Controls
- ASP.NET User Controls
- ASP.NET Web Services
- ASP.NET Error Handling

The first half of the advanced graduate course still covered the advanced ASP topics. However, introductory topics of ASP.NET were taught in the second half of the course. Meanwhile, ASP.NET was introduced in a 3-hour lecture in the undergraduate course, and the other contents of the undergraduate course were still introductory topics of ASP.

Graduate students who take the advanced course have learned fundamental knowledge of web application technologies from previous courses. They already have experience with server-side web application technology, and are ready to get into emerging new technology. Because Microsoft just released .NET framework at the beginning of 2002, web application development based on ASP.NET technology may not be in the skill-set expected in the market at that time when students graduated from the school. Therefore, faculty was able to experiment with a variety of instructional methods to teach this new technology. During this phase, faculty became familiar with .NET framework and accumulated teaching experience with the new technology in the advanced graduate course. The mixed topics of ASP and ASP.NET as listed above prepared students, instructors, and technical staff for the migration from ASP to ASP.NET. The lessons learned from this phase could benefit faculty to further structure other related courses, such as the pilot course in phase II. Moreover, graduate students had been trained for ASP.NET technology. They became the potential teaching assistants (graders) and lab assistants for undergraduate courses. Various textbooks were examined and tested in the advanced graduate course.

Web application development courses are supported through a web hosting service at the School of CTI. Because the class size of the advanced graduate course is relatively small (typically about 20 students), it is easier for technical staff to configure the web server and to provide technical supports for a small population of graduate students. A separate web server was set up to support web application developments with ASP.NET. In the meantime, other web servers were still providing support for students to develop web applications with ASP. The web hosting service for ASP.NET was experimented and tested during this phase, and got prepared to support more demands from undergraduate students.

Phase II Pilot Courses: The introduction of ASP.NET in the advanced graduate course received positive feedbacks from students, instructors, and the technical staff. It encouraged us to launch a new undergraduate advanced course on server-side scripting using ASP.NET in the spring term of 2003. This course is a senior elective course, and has a small enrollment, typically about 20 students. Therefore, web hosting service for ASP.NET can be further tested and tweaked to support undergraduate students. The pilot course demonstrated that the web hosting service is ready to support undergraduate students.

Undergraduate students should learn fundamental knowledge. Therefore, the basics of ASP.NET need to be identified and be taught through a pilot course. At the end of this phase, faculty committee reached consensus on topics that are essentials of ASP.NET and should be taught in the introductory course:

- Programming language: VB.NET.
- Client-Server interaction: HTML server controls, web server controls, and validation server controls.
- Dynamic web page presentation: web server controls
- Server state management: Application and Session state
- Database Access: ADO.NET
- Security: Form-based security.

It is also important for faculty to examine textbooks in the pilot course. When faculty reached consensus on the topics of ASP.NET, a textbook was chosen to match the topics. Finally, we were ready to enter phase III for full implementation of the new technology adoption.

Phase III Full Implementation: In the fall term of 2003, all courses on Server-Side Web Development were migrated to ASP.NET. These courses have an enrollment of about 150 students in total. These courses on web application development provide technical foundation for E-Commerce applications. The introductory course covers the essential topics of ASP.NET, which faculty reached consensus on during Phase II. And the advanced courses moved on to advanced topics of ASP.NET, such as:

- Advanced Data Access: Advanced ADO.NET
- ASP.NET Classes and Tiered Web Applications
- Advanced Control Programming and Custom Controls
- Advanced Web Server Controls, such as DataList and DataGrid Server Controls
- ASP.NET Web Services
- ASP.NET Mobile Controls
- ASP.NET Error Handling

After students take these courses that have adopted ASP.NET, they will bring the technical skills learned into more advanced E-Commerce courses, such as E-Commerce Application Models, E-Commerce Website Engineering, Intranets and Portals, Internet Supply Chain Management, and etc. The adoption of ASP.NET will finally spread among courses in ECT curricula. Eventually, the adoption of ASP.NET affects 11 courses in ECT curricula and has an enrollment of about 350

students in total. Phase I and Phase II of the migration process had adequately prepared the full implementation. Faculty consensuses had been reached at the end of each phase. Therefore, we achieved the migration to ASP.NET very smoothly and successfully.

Overall the migration to ASP.NET is successful. Students are showing enthusiasm on new ASP.NET courses. We even have attracted students from other programs to take the ASP.NET courses.

4 CHALLENGES AND SOLUTIONS

Faculty coordination is an important factor for a successful adoption of new technologies, especially when the new technology is a fundamental technology, which affects a lot of courses. Two strategies were used to address this challenge: a course-mentoring process and a program committee for E-Commerce curricula. One faculty member acts as the mentor for each important introductory course. The mentor is responsible for preparing guidelines and sample syllabus for the course. He/she regularly communicates with all instructors who are teaching the same course via email or meetings and makes sure that essential topics are covered in all sections of a course. The program committee for E-Commerce curricula mainly consists of faculty who are teaching E-Commerce courses. The committee holds regular meetings to align technical coverage across different courses.

During the adoption of ASP.NET, we applied the phased strategy of technology adoption. Faculty met regularly at each phase during the technology migration process and reached consensus at the end of each phase. The strategy helps the coordination among faculty and made the technology migration smooth and successful.

Technical support to E-Commerce courses is an essential factor for a new technology adoption. Therefore, we believe that technical services that support E-Commerce courses need to be taken into consideration when we make decision on a new technology adoption. E-Commerce courses at the School of CTI are supported by a web hosting service. The service provides each individual student a client server environment to support the development cycle of web application development (Yan and Zoko 2004). The primary service provider is technical staff, and students are the customers and users of the services. Instructors together with technical staff provide students support services. Overall, the web hosting service makes it easy for students to learn and develop web application without concerning integrated networks, computer systems and application components required to support web applications.

Since the web hosting service is the technology foundation of E-Commerce courses, new technology adoption should fit into the model of web hosting service. Moreover, changes on the implementation and management of the web hosting service need to be accomplished during phase I, i.e. Training and Experimentation phase,

of the adoption. Since phase I involves only graduate students, the technical services can be experimented with and tested in this phase and get prepared to support more demanding undergraduate students. Technical services need to be further tested and tweaked while supporting a small population of undergraduate students in a pilot undergraduate course during phase II. Finally, the technical services are ready for a large population of inexperienced undergraduate students.

5 CONCLUSIONS

The curriculum structure of E-Commerce Technology programs at the School of CTI allows us to deploy a phased strategy for new technology adoption. The adoption of ASP.NET, which becomes the new technology foundation of E-Commerce programs, demonstrates that the phased strategy can help E-Commerce programs adopt a new technology, and make E-Commerce curricula focus on current and emerging concepts of technologies and E-Commerce strategies.

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