E-Commerce Technologies and Information Systems Curricula

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Abstract

The World Wide Web (WWW), as the platfonn for E-Commerce, is the breeding ground for innovative applications. It is also providing the impetus for development of newer building blocks of infonnation systems (IS) platfonns. Today, novel applications such as push-type delivery of infonnation, television style channels, multimedia mail attachments, desktop video- conferencing, and other examples of electronic commerce exist on the web. None of these was in wide use even as late as 1996.

How are these technologies different from host-based and client/server technologies? What is the impact, if any, of these technologies on the skills set that IS majors need to have? This paper attempts an answer to the above questions by adopting an adult learning framework. Using the framework, we trace the impact of technology changes on skill requirements and the curricula. An appreciation of the fundamental differences that separate host-based, client/server and web-based platforms and E- Commerce applications can help in understanding this impact.

Keywords: World Wide Web, Information Systems, Client/Server, Skill, Curricula

I. INTRODUCTION

While the late 1980s saw a major platform shift from host- based systems to client/server systems (Orfali, Harkey and Edwards 1993), the late 90s are seeing a similar shift to E- Commerce applications running over the World Wide Web (WWW). The shift from host-based systems to client/server systems resulted in many advantages for the business user. For the first time, it allowed users to interact with transaction systems in the same manner as they did with word-processors and spreadsheets (Orfali, Harkey and Edwards 1993). Graphical user interfaces (GUI) provided an intuitive front-end to corporate data to business users who were not professional programmers (Chaudhury and Rao 1997). The late 90s are witnessing a similar transition into web-based platforms. This is evident from the increased demand for E-Commerce-related skills and proliferation of web related tools. Trade journals carry news about Universities introducing Web-master

certification programs (Computer World, page 33, Sept 7, 1998), and high, signing bonuses for Web-related skills (Computer Worlds, page 56, Sept 7, 1998). Cole-Gomolski (Computer World, page 22, Sept 14, 1998) notes that ..workers with the hottest skills- in areas such as enterprise resource planning, knowledge management, data mining and technologies related to the World Wide Web- are increasingly sought after." Vendors for client/server products have responded to this burgeoning need. Major vendors for client/server products such as Visual Basic (VB Programmer Journal, July 1998), PowerBuilder (PowerBuilder Advisor, April 1997) Oracle (Oracle Magazine, March 1998) and Windows (Business Week 1998) have committed themselves to making their tools and platforms Web-enabled and Web friendly.

Is web-based E-Commerce development an evolutionary extension of host-based systems and or .Client/Server *(CIS)* technologies? Or is there a fundamental and an abrupt change in platform characteristics that makes applications

possible in the web world that were not even conceivable in the *CIS* world? This paper will argue on behalf of the first option. The paper will describe the Web as a special kind of *CIS* platform, but with substantial differences in the building blocks that make up the web. If the web represents a major evolutionary transition, how does that influence the skills and knowledge of tools that information systems majors need to have in this new emerging world? The paper will trace how the skill set is changing as we migrate from the *CIS* world to the £-Commerce world.

Since, the focus of this article is on IS education for adults, and our objective is to determine a curriculum, we have chosen a popular theme from adult learning literature as a framework for our study. The literature on adult learning is concerned with how to teach adults and what to teach them in order that they become productive members of the economy Brookfield, 1986). The concept of andragogy (Brookfield, 1986) is dominant in this field. Andragogy is contrasted to pedagogy -the art and science of educating children and embodying teacher-focused education. In the pedagogic model, teachers assume responsibility for making decisions about what will be learned, how it will be learned, and when it will be learned. Teachers direct learning. Andragogy, initially defined as "the art and science of helping adults learn," (Knowles et. al., 1998) defines an alternative to pedagogy and refers to learner- focused education for people of all ages.

While the principles underlying the concept of andragogy can be interpreted in many ways, it brings into prominence three important factors that are relevant for this paper as shown in Figure I:

.IS World: There is a world of employment whose needs are evolving rapidly. In our case, this is the world of IS developers and practitioners. The nature of this world can be described in terms of IS applications and IS platforms-

.IS Skills: We have adult students who wish to be productive members of this world. The adult learners desire to learn skills and roles that would make them useful members of this society. The skills and roles that the adult learners need to learn have to be identified-

.IS Curricula: As IS educators we need to design a curricula that would serve the goals of our adult student body. The new curricula need to be determine

The framework helps us to relate three factors: changes in the IS world, resultant changes in IS skills and the changes in IS curricula. The next three sections are devoted to these factors. In section 2, we outline how the nature of E- Commerce applications that run on the web is qualitatively different from those that run on the host-based systems and the *CIS* architectures. Section 3 is devoted to the emergence of new IS applications and the evolution of the

IS platform. In section 4, we trace out the consequences of the changes in IS applications and IS platforms on the requirements for IS technical skills. In section 5, we discuss the changes that are required in a typical IS curricula to train people for the E-Commerce dominated world. Finally, we conclude in section 6.

2. EMERGENCE OF NEW APPLICATIONS

There are many ways to think about and classify IS applications. Alter (1992) classifies systems according to how they help to coordinate work and the degree of structure they impose on office processes. Zuboff (1988) classified systems according to their purpose. She divided the systems into those that automate and those that *informate* (a word she coined). The former encompasses transaction-processing systems. These systems automate an existing process by substituting computers for manual labor. Systems that informate, have their primary goal as informing business users about the business. This class includes all reporting and traditional management information systems. Morton (1991) extended this classification to a third class that included systems whose goal is to bring about organizational transformation. This class of applications includes inter-organizational systems such as Electronic-Data- Interchange (ED!) and collaborative systems such as Lotus Notes. More recently, Weill and Broadbent (1998) have classified IS applications into transactional, informational and strategic types. Their transactional systems correspond to Zuboffs automation systems, and informational systems correspond to her informate-type systems. Weill and Broadbent describe strategic systems as systems targeted towards "increased sales, competitive advantage, market positioning", etc.

To understand the major difference between the above kinds of applications and E-Comrnerce based applications, let us visit some popular sites such as home.microsoft.com or www .amazon.com. The first aspect to note is that, in contrast to the focused applications mentioned above, these popular sites are built for universal visitors who may be students, researchers, business people or housewives. The sites are designed to focus attention on products and services that the company offers. The Microsoft site provides several web channels that a user can use to periodically download information. These web channels relate to different subjects such as sports, weather or general news. One can log into one of the web channels and have video clips or sound clips downloaded relating to a news item.

The Microsoft Web site (home.Microsoft.com) does not offer anything for sale and there is no transaction system either. The Amazon site is similar, but with a major difference. While one can browse through book reviews or

hear music clips, one can also place an order. One can go through an order entry system to order books or music CDs.

Unlike traditional IS applications, many E-Commerce applications are organized in terms of web documents. In general, the documents on web sites can be categorized as:

.Content-oriented documents. Such documents have a variety of contents such as text, sound and images. The author of the document determines the content and the document as such resides on the server. Such a document is said to have a static *structure,* because the document that exists on the server is the document that is sent over to the browser and displayed. Here there is no provision for any input from the user. An example of a content-oriented document is the home page on home.Microsoft.com. These kinds of documents are often known as shop-front applications. They act as a substitute for shop windows.

.Structure-oriented documents. Such a document does not exist in a pre-defined form. Instead, depending on the input from the user a query is executed on a database and the result of the query is then formatted as a HTML document and sent over to the browser. Such a document displays output from a database. These documents are said to have a dynamic structure because the actual content of the document is built based upon each request.

.Interactive documents. These documents allow the user to send information back to the Web server. This information could be in the form of hypertext links, e- mail, or parameters to a query to a database. The basic purpose of these documents is to provide interactivity.

Generally, in advanced Web sites, documents are simultaneously content-oriented, structure-oriented, and interactive. A good example of such a document is found on the Web site www.amazon.com. Often, the same document simultaneously has the following features:

.A textual part that describes a book, has pictures about the book cover, and additional textual description of the book and its author

.Structured data displayed in the form of price, and list of book's contents that are obtained from database tables that describe books

Input textboxes and option buttons to place an order or provide comments back to the server

The differences between applications that run over host- based systems or client/server system and those that run over the Web can be categorized into three:

.*target population:* For host-based or *cis* application the population is limited to business whereas it usually extends to the general population in the case of the Web. Web sites such as home.Microsoft.com or

www .Amazon.com are designed for a very varied clientele.

purpose of application: In the case of host-based or *cIs* systems, often, the objective of applications is to enhance specific and well-defined business processes or decision-making. In the case of Web based applications that is not necessarily the case. The home page of home.Microsoft.com. for example, is not designed to enhance any business process.

application content and style: In the case of host- based systems or *cIs,* the applications are primarily text-based with a rich interface for users to interact with the system. The content is also primarily text- oriented. In the case of the Web, the content is far richer, being graphic in nature as well as carrying multi-media elements such as animation, streaming video or sound. The opening page of www .amazon.com provides several such elements.
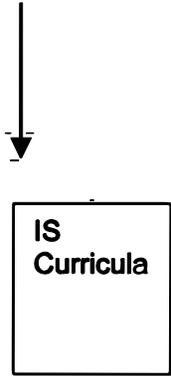
IS
Applications

IS Platform

IS Skills
and Roles

Figure 1: An **Adult Education Framework**

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Table I: Emergence of New Applications

Type

Transaction Processing Systems

Management Reporting Systems

Office Productivity Applications & **Decision Support Systems**

Collaborative and communication

Web broadcasting

Shop front

Entertainment and education

Business to business electronic commerce

Application Purpose

Automate business processes relating to order processing, accounting, inventory control

Automate periodic and standard report preparation function

To assist individual in their office tasks
To make decision better and Quicker

To assist in exchange of electronic mail and in collaborative activities

Parallel to the functions served by dail news a ers and television Functions as a substitute for catalog and brochures

Receive audio and video clips relating to online training and entertainment

Automating ordering and invoicing systems

Target Population Organizations

Organizations

Home users of computers Individual managers in a company

Small groups within an organization

The entire population at large

The entire population at large

The entire population at large

Multiple companies

Platform

. . . .

Host-based systems Client/Server WWW

Host-based systems Client/Server WWW

Host-based systems (Use of statistical tools such as SAS on the host) Client/Server (Use of spreadsheets, word processors)

Host-based systems (Use of e-mail) Client/Server (Use of Lotus Notes) WWW (Use of Web sites for community activities)

WWW

WWW

WWW

Host-based (Electronic Data Interchange) WWW

A **Metaphor What does the future hold in terms of Web applications? To appreciate the rapid evolution of these applications, let us use the metaphor of a developing human society. The precedent of the Web is the set of Internet based applications such as File-transfer-protocol (FTP), TELNET, Internet-relay-chat (IRC), Gopher, etc. These information tools can be categorized as tools appropriate for a *hunter-gatherer* society. Akin to a hunter-gatherer society, Internet users were expected to roam everywhere to collect information. They used tools such as FTP, Gopher, etc., to roam across different servers and sites as they foraged for information. Web based search engines are designed to help in this process of foraging. From the hunter-gatherer model, the Web evolved towards an *agricultural* model. An agricultural society is characterized by people settled in one locale where much of what they require is made available close to hand. Web based channels make it possible for the information to arrive at a user's desktop without the user going out to various Web sites. Finally, the Web is moving towards a *'society of traders'* model. In this world, the agent technology helps users find a good deal on airline tickets, used cars and music CDs as they bargain hunting over the Internet. Development of business to business electronic commerce and consumer-oriented business commerce is part of this trend. Table I, provides a synopsis of the points in this section. It is important to note that in the IS world**

emergence of new application types does not necessarily mean the eclipse of the old. This is so, because the newer applications have different objectives than the older ones. The older objectives stay valid and so do the applications that meet them.

3. **EVOLUTION OF PLATFORMS**

An IS platfonn consists of various components: workstations that interface with users, communication networks, servers, applications and databases that run on these servers. An IS architecture defines the logical framework used to interconnect various components. Different architectures can be described as variations to a basic theme, that of a client/server system.

Host-basedPlatforml
In a client/server *(CIS)* architecture, the software functions include application, database, and interface logic and the interfaces. In the case of transactional *CIS* systems, the

1 In this paper, when we refer to host-based system we imply the old historical mainframe system that used dumb terminals as input/output devices and slow wide area network links. As our goal is to trace the historical development, we have adopted this restricted use of the term host-based.

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server only executes the database function and the client carries the other three. Contrast this with the host-based system where the client only provides a character-based display and the server executes the other three functions (Figure 2).

Client/Server Platform
In the client/server paradigm, there exist a **requester and** a **provider for** a **service. A host-based architecture is** a **limiting**
**form of** a **client/server where the client is** a **simple device**

Dumb Terminal

Text Display

that allows a user to log into a system and read and write. Except for display, **all** processing happens at the server end, the host mainframe. The network that connects the host to the terminal could be a LAN or a WAN. Since, only characters are exchanged between the terminal and the host, the data capacity requirement of the network is low. The host-based technologies (that include the data communication protocol) are most often proprietary in nature (e.g., mM's SNA).

Mainframe

Interface Logic Business Application Database

Request

Data
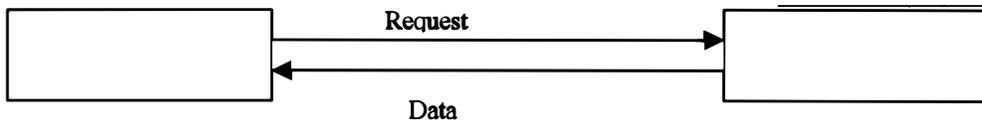
Figure 2: Architecture of a **Host-based System**

Because the clients carry such a heavy responsibility, the traditional *CIS* system is also called a fat client system. The counterpart is the thin client system, where the client carries the load of interface logic and the interfaces, and the server carries the application and also the database in the case of transactional systems. These examples are also known as single or l-tier client/server systems. An extension of a thin client system is where the server's

**Graphical Terminal: Client** Display
Interface logic

responsibilities are separated into two tiers. The first level server executes the application and the second-level server executes the database. This is known as a 2-tier client/server system (Figure 3). In a two-tier client/server system, the first layer of application can now be populated by business objects. Object-oriented development plays a major role in the development of 2-tier *CIS* systems.

Server Application

Server Database

Request
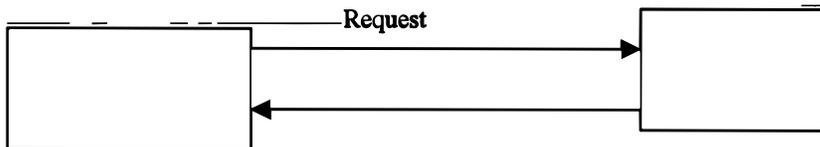
Figure 3: Architecture of 2-tier Client/Server System

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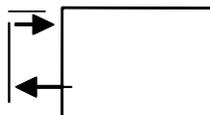
The transactional *CIS* system can be differentiated from the host-based system in terms of the following: The client in a *CIS* system runs on a much more powerful machine than a terminal, usually a personal computer. Second, the client carries a significant part of the total processing load, more in the case of a fat client and less in the case of a thin client. Third, the interfaces in *CIS* systems are graphic in nature and allow the use of mouse, menus, and graphical controls such as command buttons and text-boxes. Finally, in case of *CIS* architecture, depending on the application, the network capacity required may be heavy or low. Most *CIS* systems were initially implemented on high-speed local area networks. Larger *CIS* systems are implemented on wide area networks running over private or leased lines. While the technologies used in *CIS* are still proprietary, the standards are usually universally accepted standards such as SPX/IPX for Novell networks, COM for Microsoft based applications, SQL for relational databases, etc.

World Wide Web Platform The World Wide Web (WWW) is a part of the Internet system; a vast *distributed* system made up of millions of servers and where information is stored across many computers. A key to the power of the Web is the media that refers to kind of data or information that is sent over by the Web server to the browsers. It can be a plain text file, an audio file, an image, or a video clip. Hypermedia is away of linking these documents, where you have links and you can jump form one topic to another by using these links. As one chooses different links and moves around from one document to another, one may be jumping from one server on the Web to another without knowing it, while the WWW handles all the connections. Hypermedia is the basis of the WWW .

The WWW is also a client/server system. In such a system, the server is a repository of information and the clients are computers that request for this information. The Web is a

distributed client server system. Because the information is distributed over many Web servers, the WWW is sometimes described as an n-tier distributed client/server platform. These servers manage a collection of Web pages. In the case of WWW , the browsers on our personal computers act as clients and are served by the Web servers. Often, the Web server has to process a client's request before it can send over the information. For instance, for a query about a product, the Web server has to perform the following functions: The Web server has to send the query to a database; obtain the results from a database; format the results in a proper form for the browser to display, and send the results back to the client browser

Web servers, often dedicated machines that are repositories for Web pages, consist of:
.Hardware, which could be a personal computer, a workstation or a mainframe computer.
.An operating system such as Windows NT, Unix or some mainframe operating system such as VMS that runs on the hardware.
.The Web server software runs on top of the operating system. Some of the popular Web sever software are Microsoft's Internet Information Server, NCSA, CERN and MacHTTP.

In order to display the Web pages a user needs to have a WWW client program called a browser. Common browser programs are Netscape Navigator, MOSAIC, Microsoft's Internet Explorer, and many others. The browsers run over a variety of platforms such as Windows, Unix, MacOS, etc. In the WWW , any server running on any platform can interact with any browser running over any client machine. This makes the content of the WWW system universally available all over the Internet. (See Figure 4)

Client

Web browser

Web Server
Server Scripts & **Application**
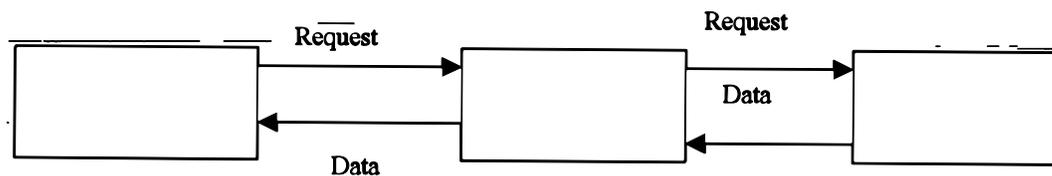
Database Server Database

Figure 4: The Web Platform

While the Web is a form of a client/server system, there are many fundamental differences between a *CIS* platform and the Web. First, unlike the *CIS* architecture the power of Web architecture results from a multitude of servers acting in concert. The WWW is a system of distributed servers. Second, as we move from one Web server to another the process is totally transparent. This is made possible through the use of Hypertext Transfer Protocol (HTTP) that is memory-less. One does not need to set up and close a session in order to jump from one Web server to another

(refer to Appendix A for details on protocols used on the Web). Third, communication takes place over the wide area networks. Fourth, since the content of the communication may consist of audio or video, the interface devices have to be more than graphic. They should have the necessary hardware and software to allow audio clips, video clips and streaming audio and video transmissions to run. Table 2, shows the differences between the host-based system, the traditional client/server and the Web platforms.

Table 2. **Evolution of Platforms**

Type of Platform	Interface devices	Nature of databases	Nature of communication platform	Architecture
Host-based system	Primarily character-oriented	Relational and hierarchical record-oriented databases	Slow speed wide area networks	1-tier
Client / server	Graphical user interfaces	Relational record-oriented databases	High-speed local area network and private wide area networks	1 and 2-tier
World Wide Web	Multi-media (sound, video and graphics) interfaces	Relational record oriented databases plus document based, and multi-media objects databases	Wide area networks running over telephone lines	n-tier distributed server platform

4. IMPACT OF NEW APPLICATIONS AND PLATFORMS ON IS SKILL-SETS

In this section, we concentrate on the evolution of IS skill- sets. We focus only on technical skills and outline the impact of two change factors, new IS applications and IS platforms on IS skills. We discuss IS skills as a composite of three elements. We call the first, domain knowledge, the second, core IS skills and the third, tool literacy. Knowledge about a particular domain is particularly important, for example, if an IS person is developing an accounting application, he must have a good understanding of accounting processes and standards. Similarly, somebody developing an order entry system should have a deep familiarity with that business process. Second, an IS person needs to possess basic technical skills related to programming, systems analysis and database design. Finally, the IS person must be familiar with the tools that he is expected to work with. IS skills required are often associated with different IS roles. The notion of roles is useful in tracing as to how these skill sets are evolving over time

How has the requirement for domain knowledge, core IS skills and tool literacy changed with the advent of the Web? There are two ways to study this. First, we can trace the impact of changes in factors such as IS applications and IS platforms on IS skills. Second, we can study the new IS roles that are el:nerging for WWW world. In this section, we do both.

There are several new IS roles that are emerging in the world of Web. Some of these are Web designer, Web architect, producer (artists, illustrator, animation expert), Web master, etc. Morris and Paul (1998) have studied the issue of new IS titles intensively. They have categorized these new titles into several roles (page 87). These are Web master, analyst, quality assurance, producer (content developer such as graphic artists), Web designers, programmers and database designers. Some of the roles are also prevalent in the world of client/server or the host- based system and these are programmer, database designers, analyst and quality assurance. Newer roles include Web producers, Web designers and Web masters.

Web Designers, Producers and Masters: Domain Knowledge, Core Skills and Tool Literacy:
Unlike the client/server and the host-based world, the data that appears on the interface is not limited to texts. It may include images, sound, animation, etc. Producers are content developers who work in these media. They usually specialize in one specific media such as sound, video, graphic art, etc. They bring along their skills in those media to develop contents on the Web. The domain knowledge of Web producers includes knowledge of subjects such as advertisement and mass communication. Their core skills include proficiency in the different art media. The Web designers are the ones who design and enforce aesthetic standards on the Web. What the designers design, the producers develop. Like the producers, the domain knowledge of Web producers includes subjects such as advertisement and communication. Similarly, their core skills include proficiency in the different art media. Both

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the content developers and designers need to be familiar with tools such as Macromedia Director, Adobe Photoshop and Microsoft's Image Composer .

The roles of Web designer and the producer are critical in Web applications such as Web broadcasting, shop-front applications, ~ntertainrnent, etc. Their roles are limited in applications that focus on transactions or business to business electronic commerce. Much of technology progress on the Web is related to the rich media types. Audio or video clips or streaming audio and video, and virtual reality are impacting the core skills and tool literacy that designer and the producer are supposed to bring on to the job.

The position of a Webmaster is similar to that of a project manager of a development team. A Webmaster needs to be familiar with different Web technologies such as CGI, Java, Javascript, etc (refer to Appendix A). She should have the ability to manage cross-functional teams and coordinate technical staff with content providers (Computer World, October 5, 1998, page75)

Programmers, Database designers, Analysts and Quality Assurance: Domain Knowledge, Core Skills and Tool Literacy
The traditional roles of programmers, database designers and analysts are changing too. This follows from the change in the type of applications that run on the Web and the altered nature of the platform. The purpose of the Web applications is rarely purely business and the platform is very different from that of the host-based system or the client/server. All data interchange between the client and the back-end database is mediated by the Web server (refer to Appendix A). This makes the platform a kind of n-tier distributed client/server system.

There are three classes of programs that run on the Web: on the client side browser, on the Web server and on the database server. The data that arrives at the client end, that is the browser is usually in the form of an HTML document. Knowledge of HTML or the meta-language XML (Extensible markup Language) is necessary to develop documents or channels for the Web. The programmer is expected to familiar with the means of integrating multiple media elements in his documents. Currently, the programs that run on the Web server employ scripting languages such as VBscript or Perl. The requirement of a database designer is least affected by the advent of the Web.

The domain knowledge that programmers, analysts and quality assurance people need to bring to their job depends very much on the nature of the application. If the applications are transaction oriented then the domain knowledge they need is similar to the world of host-based systems and client/server. If the applications are oriented towards collaborative activities or community building exercises, their domain knowledge need to include

understanding of group processes, nature of communities and a broad knowledge of sociology and anthropology.

With the rapid proliferation of tools for Web development, the requirement for tool literacy for programmers, analysts and quality assurance people are now very different. Totally new tool environments are being created, for instance, Microsoft's Visual InterDev and a product called SilverStream.

Table 3 summarizes the evolution of skill sets. The first column refers to the two change factors and the IS skill areas. The other three columns describe this impact in the worlds of host-based processing, *CIS* and the World Wide Web.

5. PROPOSED IS CURRICULA

In this section, we study the linkage between IS skills and IS curricula (refer to Figure I). Recent literature (McCubbrey, 1999) has described an electronic commerce curriculum. This paper takes a different viewpoint. A brief outline of the changes that are required in a typical undergraduate IS curriculum to account for the concerns that have been articulated in sections 3 and 4. We believe that while many of the fundamentals covered in most IS curriculum will continue to be relevant, much needs to be changed in order to meet the different needs of the Web dominated world.

The proposed curriculum consists of six courses. It is assumed that preceding these six courses is an introductory course that teaches basic computer skills such as how to use a word-processor, use a spreadsheet, and surf the Web. The number of courses is constrained by the requirements of AACSB. AACSB requires that half of the undergraduate curriculum be in the general education area, outside the business school. Further more, it requires at least another twelve courses be in the business school core. With all the other requirements, it is unlikely that more than six courses will be allowed for an IS major in a business school.

The courses are so set out so that undergraduates from both business school or the liberal arts and fine arts can undertake this course sequence. While the business school background will provide requisite domain knowledge to students planning to develop business applications on the Web, the liberal arts and the fine arts will provide the domain knowledge for developing applications for collaborative uses, advertisement, marketing, entertainment and news. The purpose of these six courses is to introduce the students to the core IS skills and the tools that are currently being used in the industry .It should be noted that that the revised contents proposed here would only expose students to the fundamentals required in the Web dominated world. Classroom coverage is insufficient to develop any form of industrial strength expertise. With the exposure provided here, it is hoped that their learning cycle will be expedited.

Journal of Infonnation Systems Education

Table 3: Evolution of Skill-sets

Change Factors

Skill Area Changes in Application types

Programming Skill

Changes in Application types

Systems Design Skills

Changes in Application types

Database Skills

Changes in Platform

Network Management Skills

Impact on roles, core-skiUs, domain knowledge and tool literacy

Host-based ~Application Development (programmers and quality assurance)

Client/Server ~Application Development (programmers
i and quality assurance)

! Web-based

RQk;..Application Development (programmers, quality assurance, Web producers and Web designers)

Core-Skills and Domain Knowledl!e: Understand business processes and decision-making and build applications to support them Toolliteracv:
Development is limited to a single vendor's proprietary environment. Familiarity with COBOL language and CICS environment

Core-skills and Domain Knowledge: In addition to mainframe, learn about GUI interfaces and event-driven programming
Toolliteracv: Development is limited to a few vendor's proprietary environment Alternative development environment include Microsoft'
environment such as Visual Basic, Microsoft's Transaction Server and SQL server Visual Basic or PowerBuilder with Oracle

Core-skills and Domain Knowledl!e: In addition to client/server, learn about development of Web-based interactive systems, development of
television- style channels.
Familiarity with HTML and XML and scripting languages such as Java Script and VB Script Toolliteracv:
It is mostly an open environment where many vendors compete to provide tools to similar specification
Development within Microsoft's Visual InterDev environment or using Java based environment such as SilverStream
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R2k;.-Systems Analysis **and** Design

Core-skills: Traditional waterfall method

~Systems Analysis and Design

Core-skills In addition to mainframe, learn about rapid application development, joint ~~D~ion developme~!.~

~Systems Analysis and Design

Core-skills In addition of client/server, learn to use new metaphors such as that of theatre (Laurel 1993) and building architecture (Mitchell 1996)
to design ~tes and Web aQplication

~Data Designers

Core-skills and Domain Knowledge: Hierarchical and relational databases for records relating to business objects and events Toolliteracv: Databases such as DB2

~Data Designers

Core-ski\\s and Domain Knowledge Design and implement relational databases for records relating to business objects and events Toolliteracv: Databases such as Oracle and Microsoft SQL ~erver

~Data Designers

Core-skills and Domain Knowledge In addition to client/server, learn about document databases, and databases containing multi-media objects Toolliteracv: Databases such as Oracle and Microsoft SQL server

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~: Network Manager Core-skills and toolliteracv: Familiarity is limited to a few vendor's proprietary environments and protocol suites

~: Network Manager
Core-skills and toolliteracv:
Familiarity with an open environment where many vendors compete to provide gear to a single suite of Internet Q!Q!ocols

The curriculum reflects the nature of the Web platform (Figure 5- Appendix). We have a course for client-side (browser) development, a course for development of programs on the Web server and a course for development of database (on the database server). The protocols used on the Web (Figure 6 -Appendix) are to be discussed in the course

on technologies for e-commerce. The changing nature of the applications is reflected in the content and tools proposed for the client-side and Web server development course. The proposed curriculum is structured as follows:

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2. 3. 4. 5. 6.

Programming in procedural and object-oriented languages
Client-side applications development Server-side applications development Database design
Systems Analysis and Design
Technologies for E-Commerce

The detailed content for the above courses are indicated in Table 4. The first column lists the change factor, IS skills. Various skill elements are listed there. The other two

columns describe the impact of this change factor on IS curriculum in the world of client/server and the Web.

An important bench-mark in IS curriculum design is that of ACM/DPMA. Figure 7 provides a relationship between the proposed curriculum structure and the IS curriculum as proposed by ACM/DPMA. However, the latter curriculum is based on a ten course structure. It is unlikely that business schools or students from department of fine arts or liberal arts will afford the extra time required to complete the ACM/DPMA course sequence.

Table 4: Evolution of IS Curricula

No.

2

3

4

5.

6

Change Factor: IS Skill areas

Procedural and object-oriented programming

Client-side applications development

Server-side applications development

Database design

Systems Analysis and Design

New Protocols and Technologies for E- Commerce

Impact on IS Curricula 0_-

Client/Server **World**

c is used to expose students to procedural programming and C++ is used for object-oriented p~grammin~

Visual Basic or PowerBuilder

World Wide Web

Java or Visual J++ to expose students to procedural and object-oriented programming. Develop applets that run in a browser environment and develop stand- alone Java aQJ?1k~tions

Extensible Markup Language (XML) and HTML. Use ofVB Script or JavaScript for client-side scripting.
Development of multi-media contents such as graphics, and animation that will be displayed in a browser
Learn use of media tools such as Adobe Photoshop, Macromedia Director, etc

Advanced Visual Basic or PowerBuilder to develop middle tier business objects

Relational database theory, entity- relationship diagrams, using Oracle's or Microsoft-SQL ~erver's SQL

Use traditional waterfall approach and rapid application development methodologies

Focus on communication protocols, the OSI model, characteristics of Network Operating System, nature of local area networks, wide area networks and the Internet, design of simple Ethernet LANs
--
CGI/Perl for server side programs on Unix systems or VB/ASP for Windows NT systems. These programs usually connect to a database and read/write to it. Learn to develop within Microsoft's Visual InterDev environment
.-
Relational database theory, entity-relationship diagrams, using Oracle's or Microsoft-SQL server's SQL

Continue with client/server approaches

Similar to the Client/Server program with additional emphasis on WWW protocols such as HTTP, PPP , TCP/IP, new version ofIP, IP for multicast operations, security, encryption, streaming technologies
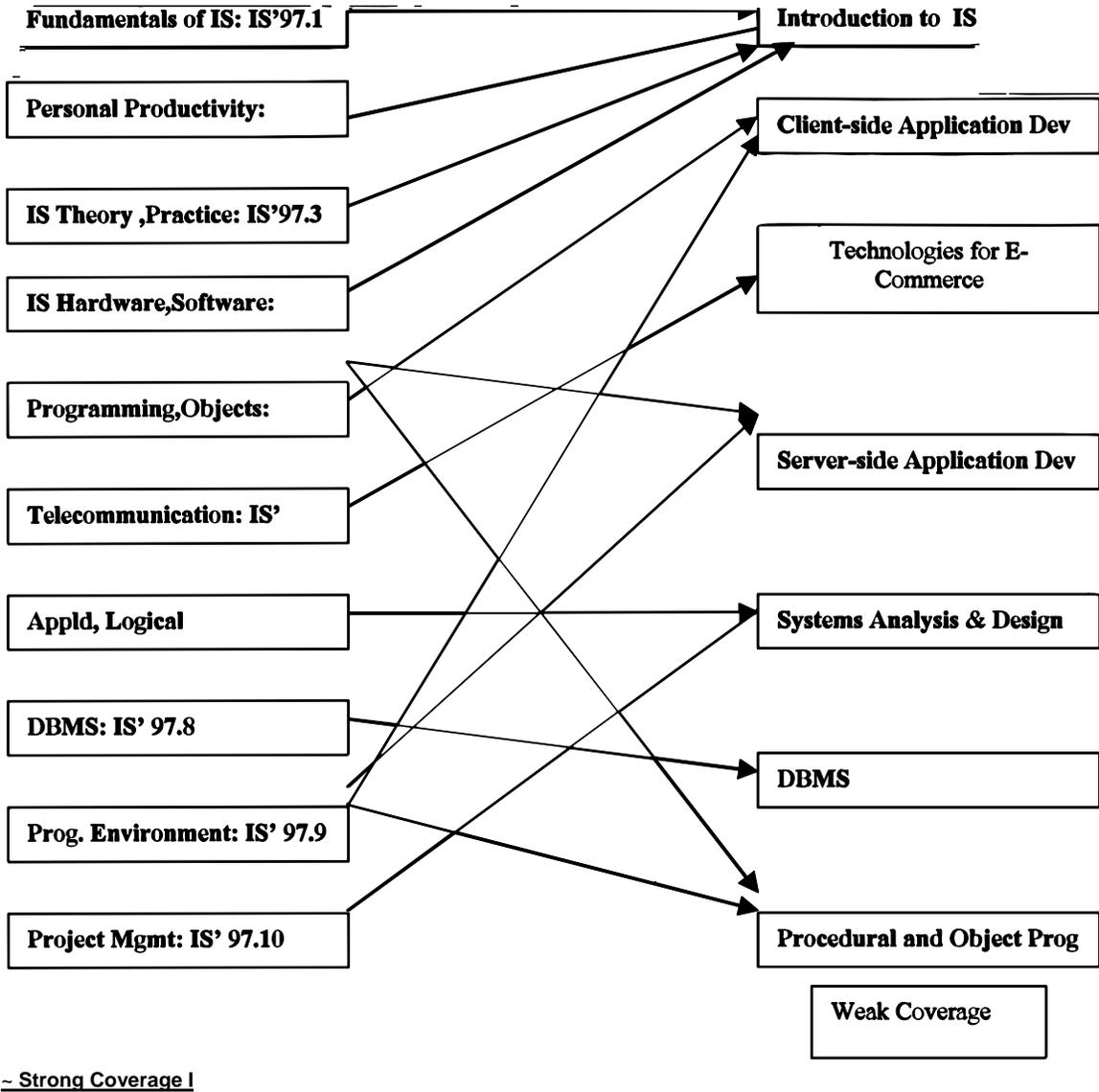
Fundamentals of IS: IS'97.1

Introduction to IS

Personal Productivity:

Client-side Application Dev

IS Theory ,Practice: IS'97.3

IS Hardware,Software:

Technologies for E-Commerce

Programming,Objects:

Server-side Application Dev

Telecommunication: IS'

Appld, Logical

Systems Analysis & Design

DBMS: IS' 97.8

DBMS

Prog. Environment: IS' 97.9

Project Mgmt: IS' 97.10

Procedural and Object Prog

Weak Coverage

~ Strong Coverage I

Figure 7: Comparison with '97 ACM/DPMA Curriculum

6. CONCLUSION

In the late 90s, we are witnessing a major shift from host- based systems and client/server into World Wide Web (WWW) systems. There is overwhelming anecdotal evidence available pointing to such a shift. It is also evident from increased demand for Web-related skills and proliferation of Web related tools.

The focus of this paper has been on the question: Is WWW development an evolutionary extension of host-based systems and or Client/Server *(CIS)* technologies? Or does it imply a fundamental and an abrupt change in platform characteristics that makes applications possible in the Web world that were not even conceivable in the *CIS* world? This paper argued on behalf of the first option. If the Web represent a major evolution, how does that impact on the skills and knowledge of tools that information systems professionals need to have in this new emerging world? The framework from adult learning allowed us to link three factors, nature of IS world, IS skills and IS curricula. The nature of IS world was studied in terms of IS applications and IS platforms and was limited to technical IS skills.

The paper demonstrated how the natures of applications that run on the Web are qualitatively different from those that run on the host and the *CIS* architectures. They differ with respect to factors such as: the target population, application purpose, and the application content. In the host-based systems and *CIS* world, the target population was exclusively limited to the business world. In contrast, the Web applications are targeted as much to a domestic consumer as to a businessperson. In the client/server and the host-based world, the objective was supporting business processes and helping decision-making and the content was overwhelmingly text-based. In the Web world, the purposes of the applications are immensely varied. They range from entertainment, to education, to community building exercises. The content varies from text, to graphic images to streaming video.

We focused on the evolution of IT platforms in terms of its components and architecture. Later, we traced out the consequences of the changes in IS applications and platforms on the requirements for IS skills, while concentrating on elements such as core skills (programming or database design), domain knowledge (understanding of business processes) and tool literacy (as in familiarity with the Oracle environment). Finally, we described the changes that are required in a typical IS curricula to train people for the Web dominated world.

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Appendix A World Wide Web Protocols: Figure 5 shows the different protocol layers involved in a WWW service. The important protocols are:
.Hyper Text Transfer Protocol (HTTP). It specifies the interactions between browsers and servers in terms of the type of requests that browsers can submit and the types of responses that the server make
.Hypertext Markup Language (HTML). It is used to format documents interchanged between the Web servers and the Web browsers
.Transmission Control protocol (TCP). It opens and closes connection, breaks data into packets and ensures end-to-end delivery.
.Internet Protocol (IP). It gives a unique address to each machine and specifies how the packets find their way through the network from one computer to another.
.Data link protocols. It is concerned with point to point transmission of electrical signals. This is a whole family of protocols. It includes protocols such as Point-to-Point protocols (P-to-P) that allow our PCs at home to connect to the computers at the Internet Service Providers (ISPs) and exchange TCP/IP packets.

Hyper Text Transfer Protocol (HTTP): The passing of information between the Web server and the browser is arranged through TCP/IP and HTTP. The TCP/IP protocol creates and maintains the connection, and HTTP composes the request and the response. The exchange of information between the server and the browser takes place in four steps (Figure 6):
.A connection is established between the Web server and the browser, which is handled by TCP/IP
.The browser sends a request to the Web server in the form of an HTTP message
.The Web server processes the request and responds to the client in the form of an HTTP message
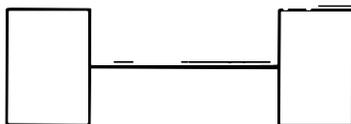.The connection between the browser and the server is terminated

HTTP, FTP, TELNET

Transmission Control Protocol

Internet Protocol

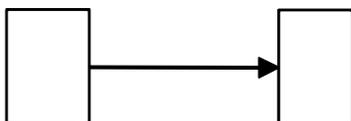Data link protocols such as P-to-P

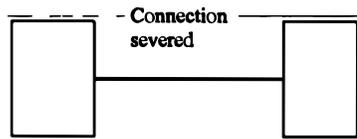Web Browser: Client Web Server

TCP/IP establishes cnnnectinn

Get Request

Get
response

Connection
severed
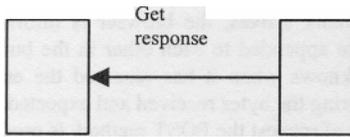
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Figure 5: **Protocols of World Wide Web**

Figure 6: Interaction between
Web browser and Web

The browser makes the request through a GET command. With such a request, a browser informs the server about its characteristics.
For instance, a browser will inform the server about its: .Operating system
.File types it can accept, and the language used (such as English)
.CPU, the size ofits screen, and the color .Willingness to use the same connection to make
several requests rather than making a separate connection for each request
.The address of the host and the Web pages requested. This address is known as Uniform Resource Locator (URL)
A typical GET request looks as follows: Get! HTTP ! 1.0
Accept: Image!gif, image!JPEG Accept- Language: en UA-pixels: 1024*768 UA-color: color8
UA-OS: Windows 95 UA-CPU: x86
User-Agent: Mozilla!2.0 (compatible: MSIE: 3.00) Host: www.abcinc.com!somedirectory!index.h tm
Connection: Keep-Alive

A server will respond to a GET request with a header, which is then followed by the file requested. The header will inform the browser about:
.The name and version ofWeb server software .Willingness to reuse the connection
.The date and time and the date the returned pages were last modified
.The file type being returned and the length in bytes of the returned pages.

```
A typical response header by the server looks like: HTTP /1.0
Server: Microsoft-IIS/3.0 Connection: keep-alive
Date: Mon, 01 June 199822:12:09 GMT Content-Type: text/html
Last-Modified: Sun, 31 May 1998 22:12:12 GMT
Content-Length: 3345
```

The data follows immediately after the header. Usually, the data will arrive in multiple chunks. Each time a new chunk arrives, the browser is informed. The chunks are appended to each other in the buffer. The browser knows when it has received the entire data by comparing the bytes received and expected.
A second type of request the POST method, is used by browsers having Web pages with forms. With the POST method, the browser informs the server about the text boxes' names and their entries. This information goes in a separate file.

Cookies: The **HTTP** protocol is *stateless.* A connection is said to be stateless when the connection retains no memory during or after the connection is closed. This constitutes a major problem for interactive applications. The information provided by a user on one page cannot be related to information provided by the same user on other pages or during another transaction. Cookies are one way out of this problem.

Cookies are data exchanged between a server and the browser, and which resides on the browser PC. The infonnation provided by the user to the server is written on browser PC and is made available whenever the browser makes a connection to the server. Cookies are Web server specific. Whenever a browser makes a connection to a server, it checks if there is any relevant cookie file. If there is, the information in the cookie file is passed on to the server. This infonnation helps the server to identify a particular user, and maintain continuity between sessions old and new.

Query String: HTTP allows not only files to be fetched from the Web server, it also allows programs to be executed on the server. URL's have optional fields for this purpose. In such cases, the URL specifies the name and address of the program on the server that the user wants to execute. Often these programs require parameters values to be passed on. This is called a query string and is a sub-field of a URL. An example of a query string is shown below:
http://mis.mgmt.umb.edu/programs/gra de.exe?ssn="307964887"&course="mis41 4"
The above URL asks for the execution of a program called grade.exe and passes on two parameter names and values. These parameters relate to social security number of a student and the course number. The name, value pairs are separated by ampersand (&)

MIME Type Messages: The GET response in HTTP headers specifies the type of data being sent by the server. For instance for standard text-based HTML files, the HTTP header from the server will include the line:
Content-Type: text/html The content-type indicates the type of data that will follow. The different types of data include images, video clips, sound clips, etc. *Multipurpose Internet Mail Extension* (MIME) is a standard that defines the different data types that can be exchanged over the Internet using mail or the Web. The browsers use the MIME type information to launch the appropriate viewer. For instance, if it were a sound clip an appropriate program would convert the binary data into sound. Some of the common MIME types are Quick Time Movie, Rich Text Format, Screen Saver, etc.

Hyper Text Markup Language (HTML): The Web servers act as repository of documents. The documents have a variety of text fonts and sizes, graphics, and links to other documents. Each document on the Web server is represented by Hypertext Markup Language (HTML). HTML allows the author of a document to specify in general terms the contents and the looks of the document. HTML is called a markup language because it marks different parts of the document specifying in general terms how it should look when displayed in a browser. The browsers run the HTML interpreters. These interpreters use the HTML markup comments to display the document as desired.

Common Gateway Interface (CGI): The task of a Web server is simple when it receives request for static content-oriented documents. It reads the GET request, finds out the URL of the document, fetches the document and sends over a copy as a part of a HTTP response. However, when a server receives a request for structure-oriented dynamic documents, it needs to do several additional steps. Request for such documents contain in their GET a URL pointing to a program. These additional steps include:
.The server has to execute the program referred to in the URL and pass to the program the parameter values received with the URL
.The program usually executes a query on the database, which responds back with a data set. The server has to capture this output from the database
.The server needs to format this data output in a HTML format and compose the HTML document that will be sent back to the browser
The technology that achieves the above is called Common Gateway Interface (CGI). The CGI standard specifies how a Web server interacts with an application program and develops as a response a structure-oriented dynamic document. The application that does this is known as CGI application. CGI provides a very general guideline. It does not enforce anyone language for developing CGI applications. Common languages used are Java, Perl, and C.

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