# Emerging Technologies for Academic Libraries in the Digital Age

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# Emerging Technologies for Academic Libraries in the Digital Age

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To Mindi, Anji and Anyuan

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dedication and sacrifice, I would not have been able to pursue excellence in my academic teaching and scholarly achievements.

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# Preface

## Purpose of this book

This book has been written to promote academic strategic management and envision future library innovations, intelligence, and services in the digital age. It provides academic administrators, executives, consultants, faculty, instructors, IT specialists, librarians, library and information sciences (LIS) students, managers, trainers and other professionals with the latest information on trends currently developing among emerging technologies as applied to student-centered and service-oriented academic learning environments. This book explores various fields where innovative emerging technologies may have great implications for academic library information resources, services, teaching and other relevant internal operations based on diverse information technology architectures and managements.

Since the late 1990s, a great many studies have been made to describe various emerging technologies in the fields of artificial intelligence, bioscience, computer science, medical science, nanotechnology, network technology, space science, telecommunications and so on. However, few scholarly researches have ever been made to thoroughly explore emerging technologies and their implications for academic libraries and their distributed information infrastructures in the world.

To shed some light on currently developing trends in information technologies at academic library settings, this book overviews evolving emerging technologies applicable to academic library information resources, services, and teaching programs. The book is intended to draw a clear roadmap for all those professionals who have a strong interest in emerging technologies and their impacts on academic library information technology infrastructures and related applications, programs and services. This book focuses on which evolving emerging technologies could impact on ways of designing, developing, integrating and enhancing high-quality, seamless, dynamic, mobile and interactive web-based academic library information resources, services, and tutorials in the digital age.

## Features of this book

This book reviews innovative emerging technologies and their impacts on academic libraries and related academic library information resources, services, and tutorials in the digital age. From the perspective of an academic librarian with comprehensive experience of IT/academic library information services for over ten years, this book refers to the advances in cutting-edge and emerging technologies evolving in diverse academic library settings. The book includes, but is not limited to, the following primary features:

- The book focuses on the most recent emerging technologies which might impact on library administrations, resources, services, and teaching programs.
- The book draws a clear roadmap of how and where to monitor technologies which have begun to emerge in academic library settings.
- The book provides practical and realistic suggestions and solutions for how to utilize emerging technologies in dynamic and interactive academic learning environments.
- The book offers a wealth of real-world examples and case studies of diverse academic library scenarios.
- The book contains discussions about a variety of hot topics, including cutting-edge technologies, digital libraries, emerging technologies, library information technology architectures, social networking, Web 2.0, Library 2.0, and web search engines, etc.
- The book provides exercises in each chapter to promote skills in brainstorming, critical thinking, decision-making, and problem-solving.
- The book lists real-world examples in diverse academic library settings.
- The book raises questions in case studies for immediate consideration and further discussion.

## What's in this book?

The book consists of ten chapters organized into four parts. The chapters are independently modular so that readers can pick up or skip some chapters, based on their specific needs.

- **Part 1 Overview: emerging and cutting-edge technologies and academic libraries:**

- Chapter 1, entitled 'Emerging and cutting-edge technologies: concepts and features,' introduces some essential knowledge about emerging technologies and cutting-edge technologies.
- Chapter 2, entitled 'Understanding academic libraries in the changing world,' focuses on the new functions, new missions, and new services of academic libraries in the digital age.

■ **Part 2 Emerging technologies for academic libraries in the digital age:**

- Chapter 3, entitled 'Where will emerging technologies lead in academic libraries,' discusses approaches to following the trail of emerging technologies at academic library settings.
- Chapter 4, entitled 'Emerging technologies for academic libraries in the digital age,' is the core of this book. It covers the evolution of most of the primary emerging technologies applicable to diverse academic libraries in the digital age.

■ **Part 3 Impacts of emerging technologies:**

- Chapter 5, entitled 'Impacts on academic library administrators and executives,' focuses on how evolving emerging technologies could impact on and challenge academic leaderships and strategic views of academic library administrators and executives in the digital age.
- Chapter 6, entitled 'Impacts on management information systems in academic libraries,' overviews essential concepts about information systems and major impacts as well as the challenges of emerging technologies for management information systems at diverse academic library settings.
- Chapter 7, entitled 'Impacts on academic library information services,' outlines the major impacts of emerging technologies on academic library information resources and services. Also introduced are leading emerging technology projects for academic libraries around the world.
- Chapter 8, entitled 'Impacts on academic librarians,' explores the impacts of emerging technologies on academic librarians in the digital age.

■ **Part 4 Outlook for the future:**

- Chapter 9, entitled 'The eve of drastic changes,' overviews the new wave of innovative technology revolutions taking place over the Internet and the World Wide Web.
- Chapter 10, entitled 'Leveraging academic library information services in the digital age,' sheds some light on newly developing

trends in information technology in academic libraries and shows how to leverage academic library information services in the digital age.

## Who needs to read this book?

This book is written for academic administrators, executives, consultants, faculty, instructors, IT specialists, librarians, managers, trainers, LIS students, and other professionals who intend to keep a close watch on and follow current technology trends – especially in cutting-edge and emerging technologies – as applied to dynamic and interactive academic libraries in the digital age.

## Pedagogy suggestions

The educational purpose of this book is emphasized and each chapter is organized around dynamic teaching and learning activities. LIS faculty and instructors can select the whole book or some chapters of the book to emphasize their teaching on the currently developing trends in emerging technologies applicable to academic libraries. In each chapter, case studies, exercises, real-world examples and a summary are available to improve learning effectiveness.

For the purpose of exchanging and sharing different academic and scholarly opinions, however, I have not provided so-called standard answers for the exercises and case study questions in each chapter. I hope that this will promote the related knowledge and skills of critical thinking, decision-making, and problem-solving in LIS students. I believe that 'practice is the sole criterion of testing truth.' I do not intend to use my individual experience or opinions to interfere with diverse academic and scholarly teaching. History will be the final arbiter of the evolving emerging technologies and related practices applicable to academic library settings in the digital age. LIS faculty and instructors should be able to find the most appropriate answers or explanations, based on their own specific academic learning infrastructures.

## Primary benefits for LIS students

This book is also intended as a robust tool for LIS students who are aiming to promote their career development in the digital age. LIS students can use

this book as extensive reading material to update their views about academic library information resources, services, and teaching in the digital age. The book clearly suggests which hot skills LIS students must have before they build up their future academic librarianships in the fast-changing scenario of the real-world academic library environments.

## Primary benefits for educational agencies, libraries, museums, schools, and other organizations

This book has primary benefits for educational agencies, libraries, museums, schools and other organizations in use as a quick reference to enhance and integrate their specific information resources, services, and tutorials. For library administrators, executives, and managers, this book refers to critical and valuable information they need to envision future library functions, missions, and strategic developments in the digital age. In addition, this book can also be useful for academic faculty, instructors, librarians, and other professionals who intend to update their knowledge about currently developing trends in innovative cutting-edge technologies and evolving emerging technologies applicable to dynamic and interactive academic learning environments, especially for librarians who have a strong interest in information literacy instruction and web-based academic library services.

## Primary benefits for consultants and vendors of library information technology

This book also contains valuable information for consultants and vendors of library information technology. From this book written by an experienced academic librarian, consultants and vendors of library information technology can obtain first-hand feedback about the high demands and requirements of academic libraries. Utilizing examples mentioned in this book, consultants and vendors of library information technology should be able to design, develop, enhance, integrate, and update more advanced cross-platform applications, databases, programs, and services to boost their own competitive powers and market shares. Taking advantage of new surges of cutting-edge and emerging

technologies, consultants and vendors of library information technology will play more active roles in promoting innovation, intelligence, and service in academic library settings.

## A few final words …

I have made every effort to make sure that this book provides the latest information on evolving emerging technologies applicable to student-centered and service-oriented academic libraries. Please feel free to contact me if you happen to see, or if you have different opinions about, any new evolving emerging technologies applicable to the range of academic learning environments.

Finally, I sincerely hope that you will use this book as a quick reference when monitoring the currently developing trends in emerging technologies applicable to academic library settings. It will be a great encouragement for me if you find this book can give you more confidence and power to design and develop ubiquitous academic library resources, services, and tutorials in the coming years of the twenty-first century.

LiLi Li

# About the author

**LiLi Li** is an Assistant Professor/E-Information Services Librarian at the Georgia Southern University Library, which is located in Statesboro, Georgia, USA. He holds an MLS in Library and Information Sciences from the University of Southern Mississippi and an MS in Management Information Systems from Nova Southeastern University.

Before coming to the university, Professor Li worked as a computer programmer and software engineer for several American business firms. This real-world IT experience set down a solid IT foundation for his interest in dynamic and interactive academic learning environments. Professor Li has published on library information services and lectured at state, national, and international conferences.

At the Georgia Southern University Library, Professor Li has been utilizing HTML, XHTML, JavaScript, CSS, Photoshop, PHP, and MySQL to design and develop web-based academic library applications, ranging from distance learning and virtual references to web-based library instructions. He assists his colleagues and students to understand how and where innovative emerging technologies have been creating more dynamic ways of delivering and distributing academic library information resources, services, and instructions. He believes that writing a book on such a topic could attract more talented professionals and students to serve in academic libraries around the world.

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# Emerging and cutting-edge technologies: concepts and features

## Chapter outline

In this chapter you will learn:

- the definitions of emerging technologies and cutting-edge technologies;
- the association between emerging technologies and cutting-edge technologies;
- the trends in emerging technologies and cutting-edge technologies.

## Learning objectives

After you have completed this chapter, you are expected to be able to:

- define emerging technologies and cutting-edge technologies in diverse fields;
- distinguish between general emerging technologies and cutting-edge technologies;
- illustrate how emerging technologies are beginning to appear in dynamic academic learning environments.

# Introduction

Since the late 1990s, a wealth of new industries, new knowledge, new products, and new technologies have been constantly emerging from various fields in the modern information society. Influenced by the developing trends of economic globalization, the technology innovation life cycle has been significantly shortened. A new wave of global industrial restructurings and the worldwide expansion in enterprises, especially in information technology (IT) and related industrial fields, has greatly triggered a rapid growth of emerging and cutting-edge technologies in the digital age.

To meet the challenges of today's information exchange and sharing activities driven by the Internet and the World Wide Web (WWW), more and more academic administrators, executives, faculty, IT specialists, librarians, and other professionals worldwide are seeking new and innovative ways of enhancing and integrating academic information applications, databases, programs, resources, services, and systems in diverse student-centered and service-oriented academic learning environments. To foster and promote practical skills for critical thinking, decision-making, and problem-solving, they need to teach students how to dynamically and interactively access, locate, synthesize, store, and transform multi-format information in interactive academic learning scenarios.

However, many academic professionals still have difficulty in selecting the best innovative approaches and technical solutions when they try to improve and integrate their specific academic library information services. Many do not even know where to find or how to follow the developing trends in emerging and cutting-edge technologies. Many do not even understand how closely emerging and cutting-edge technologies are associated with each other. Many feel confused when multi-format data and information are dynamically accessed, converted, located, and processed via heterogeneous applications, channels, databases, networks, platforms, and systems.

It is therefore a matter of urgency for academic administrators, executives, faculty, teachers, IT specialists, librarians, managers, LIS students, and other professionals to understand emerging and cutting-edge technologies before they can make informed decisions and select the most innovative and practical approaches to designing, developing, improving, integrating, maintaining, and supporting their high-quality academic library resources, services, and instructions in the digital age.

## Defining emerging and cutting-edge technologies

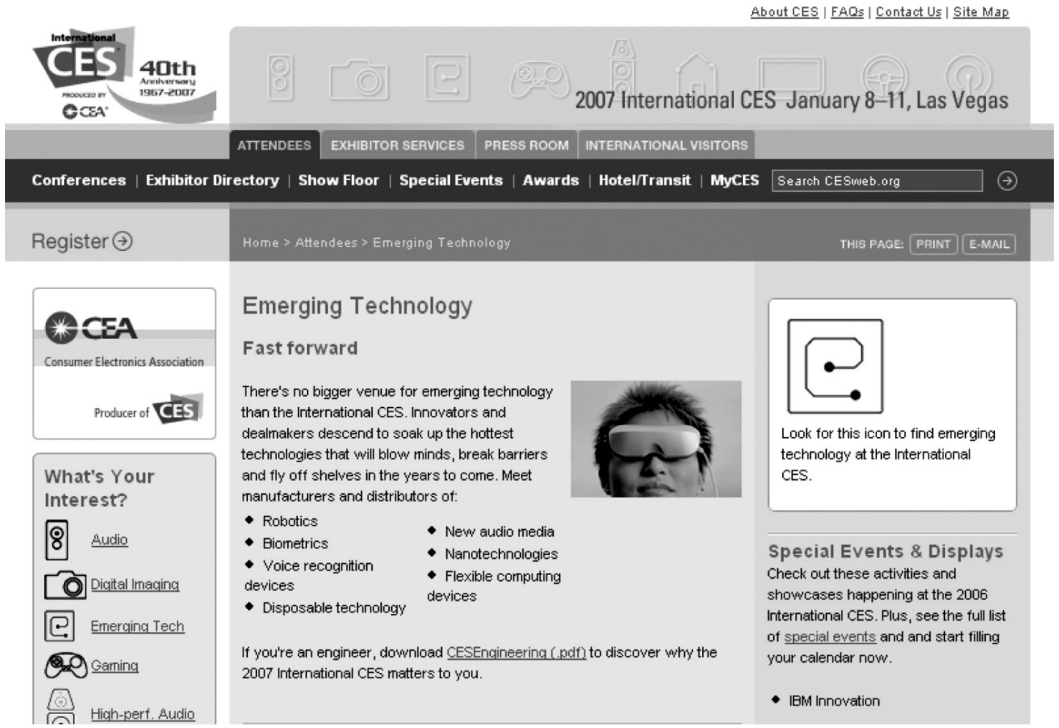
In today's information society, the Internet and the World Wide Web have become the most important platforms on which to access and locate information. If you need information, many people will recommend you to 'Google' it. If you search for information regarding 'emerging technologies' on the Web, for example, a list of 12,300,000 related search results will be generated by the Google web search engine within 0.04 seconds. If you try the same search on Yahoo.com, a list of 7,350,000 search results will be available within 0.26 seconds, and if you apply the same search on MSN.com, a list of 1,975,176 search results will be available. Moreover, I believe these lists of search results will become longer and longer as more and more emerging technologies are developed in the coming years of the twenty-first century.

To promote information literacy, the International Consumer Electronics Show (*http://www.cesweb.org/default_flash.asp*), an annual trade show held each January in Las Vegas, Nevada in the United Sates, provides information on the latest advances in emerging technologies in the fields of biometrics, disposal technologies, flexible computing devices, new audio media, nanotechnologies, robotics, voice recognition devices, etc. (see Figure 1.1). Interested readers can dig out more detailed information from other similar websites regarding emerging and cutting-edge technologies.

Relatively speaking, it is easy to search the Web for information using different web search engines. However, it is more difficult to answer questions such as the following:

- What are emerging technologies?
- What are cutting-edge technologies?
- How are emerging technologies and cutting-edge technologies associated with each other?
- How and where are emerging technologies emerging in academic library settings?
- What will emerging technologies mean to academic libraries and academic library delivery services in the digital age?
- Why should we care about emerging technologies which are applicable to service-oriented and user-centered academic library information recources and services?

**Figure 1.1** International Computer Electronics Show: emerging technologies




*Source*: *http://www.cesweb.org/attendees/markets/emergtech.asp.*

- Why do we need to monitor emerging technologies?
- How are we to manage and utilize the emerging technologies in the digital age?

In a world full of uncertainties, it is impossible to cover all the evolving emerging and cutting-edge technologies in a small book such as this. However, just because there is rapid growth in science and technology does not mean that we cannot understand and follow the trends in emerging and cutting-edge technologies as they develop. If you have a little bit of free time each day, this relatively small book can provide you with the essential knowledge and necessary information to keep track of emerging and cutting-edge technologies in the various fields of frontier and interdisciplinary science, especially advances in emerging technologies in academic learning environments. However, first of all we need to check the definitions of emerging and cutting-edge technologies. Then we can go on to explore other answers to the questions listed above.

## What are emerging technologies?

To put it simply, emerging technologies are new evolving innovative technologies with great market potential. Emerging technologies can help us to forecast the latest developing trends in the theory and practice of science and technology without large-scale commercial application or marketing. Successful emerging technologies have the potential to improve, integrate, and reorganize existing products and industries or to generate new advanced products and new industries. Unsuccessful emerging technologies will be discarded, since they do not have any practical commercial, scientific, or technical value.

Emerging technologies are evolving from a variety of fields in our modern information society, ranging from artificial intelligence (AI), biotechnologies, computer technologies, digital technologies, and genetics, to information technology, medicine, nanotechnology, networking technologies, telecommunications, web technologies, and so on. Although they have significant implications and potential, emerging technologies also contain too many technological uncertainties and present high financial risks.

## What are cutting-edge technologies?

Cutting-edge technologies, on the other hand, are new leading innovative technologies. Combined with large-scale commercial applications,

cutting-edge technologies represent the most advanced state-of-the-art technological developments in the competitive market. Cutting-edge technologies have the potential to boost social productivity with gigantic economic effects and epoch-making social changes.

Cutting-edge technologies are evolving from the same fields as emerging technologies. Compared with emerging technologies, however, cutting-edge technologies are more mature and have been honed to produce more direct economic effects within a short period. Though they still need additional improvement and upgrading, cutting-edge technologies can produce more profitable applications and products in competitive markets. Based on market feedback, the existing enhanced and updated cutting-edge technologies will become the technological basis for triggering new innovative emerging technologies in the future. This spiral-shaped developmental model of emerging and cutting-edge technologies will become the new driving force of a new wave of global technological revolution in the digital age.

## Who's who: emerging vs cutting-edge technologies

With the rapid advance of science and technology, more and more scientific and technological terms have begun to evolve in our daily work, language, and social life, especially since the second half of the twentieth century. In the academic world, emerging and cutting-edge technologies have become two of the most frequently used terms in academic and scholarly conferences, meetings, plans, programs, projects, publications, reports, speeches, theses, and so on.

Unfortunately, not all professionals are so 'savvy' about the exact meanings of emerging and cutting-edge technologies. Many do not even know the general differences between emerging and cutting-edge technologies despite using these hot phrases in their articles, conversations, lectures, papers, reports, and other works.

That is why this book is aimed at helping those who would like to know more about emerging and cutting-edge technologies. Based on the typical concepts we defined in the previous sections, Table 1.1 lists six key differences between emerging and cutting-edge technologies. These are described in greater detail below.

1. *Application*. Emerging technologies are only prototype technologies whereas cutting-edge technologies have practical application.

**Table 1.1** A comparison between cutting-edge and emerging technologies

| | Comparison | Cutting-edge technology | Emerging technology |
|---|---|---|---|
| 1. | Application | Practical | Prototype |
| 2. | Products | Commercial development | Experimental phase |
| 3. | Technical risk | High | Very, very high |
| 4. | Financial cost | High | Very, very high |
| 5. | Industrial impact | Enhancement | Potential and innovative |
| 6. | Outlook | Sure | Potential and unconfirmed |

Emerging technologies are new innovative technologies that focus on testing scientific theories or concepts whereas cutting-edge technologies are advanced leading technologies that have been applied to practices in the real world.

2. *Products*. Emerging technologies are pioneering technologies that are still at the trial stage whereas cutting-edge technologies are innovative technologies that have been given large-scale commercial development. Emerging technologies can only produce great economic effects and have social implications as step by step they are transformed into cutting-edge technologies.
3. *Technical risk*. Emerging technologies present more unpredictable technological risks than cutting-edge technologies. Unlike emerging technologies, cutting-edge technologies are more mature and stable, though cutting-edge technologies still need additional improvements via future upgrading and testing in the market.
4. *Financial costs*. Emerging technologies have more severe financial risks than cutting-edge technologies. The development of emerging technologies needs large amounts of funding support in terms of human resources, technical equipment, test devices, laboratory facilities, raw material supplies, and so on, especially during the long-term research and development phase.
5. *Industrial impact*. The impacts of emerging technologies lie in their potential for new applications, fields, products, and/or technologies whereas cutting-edge technologies are innovative leading technologies with more improvements. If an emerging technology cannot be transformed into a cutting-edge technology, the emerging technology will be eliminated by scientific and technological testing.

6. *Outlook*. The future of emerging technologies is uncertain while the future of cutting-edge technologies is more sure. If an emerging technology can be successfully transformed into a cutting-edge technology, the future for this emerging technology will be very bright. Otherwise, it will disappear from history and be replaced by another new emerging technology after further research and development.

Finally, it has to be pointed out that Table 1.1 only lists a number of essential technical features between emerging and cutting-edge technologies and represents my own personal understanding and interpretation gained through my own academic and IT career development. It is beyond the scope of this text to explore other related ethical, legal, psychological, and social implications which may be trigged by emerging and cutting-edge technologies.

## Tracks left by emerging and cutting-edge technologies

It is definitely a daunting job to uncover the various tracks left by emerging and cutting-edge technologies as they evolve from a variety of fields. If you find it difficult to search for relevant information, I am sure you are not the only one. Of course, it is beyond the scope of this book to retrace all the tracks of emerging and cutting-edge technologies, nor will general readers have time to study how they have been transformed. Instead, this book provides some shortcuts to following the tracks of emerging and cutting-edge technologies, as long as you have some experience, knowledge, and skill in the fields with which you are concerned.

Actually, it is not as difficult as you might expect if you pay a little attention to events around you. History is the best mirror. It can tell you when emerging technologies began to appear and how they evolved into cutting-edge technologies. Below are three real-world examples which show when particular emerging technologies began to appear and were transformed into cutting-edge technologies. I believe that this practical approach will help you discover the tracks left by those emerging and cutting-edge technologies in the fields related to your own careers or interests. In later chapters of this book, we will discuss other practical approaches to exploring which emerging and cutting-edge technologies are evolving in the dynamic and interactive academic learning environment, and especially in a variety of academic library settings.

# Real-world examples

## *Example 1.1 Digital camcorder technology*

In the digital age, to own a digital camcorder is the ultimate dream. In recent years, digital camcorders have been shooting up in popularity in the American market. Currently, most of the camcorders sold in the American market can be divided into the following six categories:

1. *High-definition camcorders*. Designed to represent the new generation of digital camcorders, more high-definition (HD) camcorder models are becoming available in the marketplace. HD camcorders, like high-definition television (HDTV) models, can record high-definition digital audio and video signals. For example, the Sony HDR-UX7 AVCHD DVD camcorder can deliver a resolution up to 1080 lines.
2. *Hard-drive camcorders*. Hard-drive camcorders use a hard drive to store high-quality digital video images instead of saving them on 8 cm DVD discs, MiniDV tapes (see below), or other storage media. Compared to non-hard-drive camcorders, hard-drive camcorders offer much larger storage capacities – up to 40 hours of recording time on a 60 GB hard drive. However, some users may experience difficulties transferring their digital videos from their hard-drive camcorders to their computers once the digital video disks are full.
3. *DVD camcorders*. The DVD was originally called the 'Digital Video Disk' and later the 'Digital Versatile Disk.' DVD camcorders capture digital pictures and save high-quality audio and video signals on mini DVD disks, which are playable on most home DVD players. The weaknesses of DVD camcorders include their limited recording time, high cost and the ease with which the mini disks are scratched.
4. *MiniDV camcorder*. DV is an abbreviation of 'Digital Video,' a digital video format introduced in 1995 to store video and audio signals on digital video tapes. In the American market, one MiniDV tape can hold up to 60 minutes of high-quality digital audio and video signals.
5. *Digital 8 camcorder*. This is a digital video recording and playback format defined by Sony. Digital 8 records digital signals on the same cartridges used by Hi 8 camcorders.
6. *Hi 8 camcorder*. This is an analogue video recording and playback format which records analogue signals on 8 mm videocassettes, available in 30, 60 and 120 minutes of recording time.

Currently, there are three high-definition formats – 720p, 1080i and 1080p – widely accepted by electronics vendors around the world. The 720p format delivers a resolution of 1280 × 720 pixels. The letter 'p' represents the progressive scan for sharper moving images. The 1080i format delivers a resolution of 1920 × 1080 pixels for images by means of an interlaced scan, the letter 'i' meaning that the delivered video image is 'interlaced.' Now, the newest high-definition format is 1080p, which delivers a resolution of 1920 × 1080 pixels for images by means of a progressive scan. At the time of writing, 1080p is the highest-quality high-definition video resolution available in the marketplace.

High-definition camcorders, which have been released by Sony and Panasonic, are adopting the new AVCHD (Advanced Video Codec High Definition) digital video camera recording format. This new format can deliver a resolution of 1080i and a resolution of 720p for certain digital video recorders. However, the resolutions of current high-definition camcorders in the marketplace have not reached the new full high-definition format at the time of writing. Because of the high speed with which digital products are replaced, it is a risk buying the latest top-level high-definition camcorders – which could lose at least 50 per cent of their value in the next 3–5 years.

From Table 1.2, we can clearly see the development in digital camcorder technologies. To put it simply, high-definition camcorders represent an emerging technology because they still need further improvements to reach the full high-definition format (1080p). Mini DVD and mini DV camcorders represent cutting-edge technologies, since

**Table 1.2** **A comparative table for video camcorder resolutions**

| | Format | Sensor image | Video resolution |
|---|---|---|---|
| 1. | High-definition camcorder | 1.0 ~ 4.0 megapixels | 1080 horizontal lines |
| 2. | Hard-drive camcorder | 680K pixels ~ 4.0 megapixels | 680 horizontal lines |
| 3. | Mini DVD camcorder | 680K pixels ~ 4.0 megapixels | 680 horizontal lines |
| 4. | Mini DV camcorder | 680K pixels ~ 1.0 megapixels | 680 horizontal lines |
| 5. | Digital 8 camcorder | 290K pixels | 500 horizontal lines |
| 6. | Hi 8 camcorder | 200K pixels | 400 horizontal lines |

they still form the bulk of video camcorders priced correctly in the marketplace. On the other hand, Digital 8 camcorders and high 8 camcorders are exiting the marketplace as time passes.

## *Example 1.2 Computer input technology*

Since IBM introduced the world's first personal computer (PC) on 12 August 1981, the computer keyboard has been used as a major input device for computers. With the rapid advance of wireless technology, more and more wireless keyboards and mice are available in the market. Another method called voice input, which is driven by speech recognition technology, is a new emerging technology that has been evolving since the late 1990s.

The traditional method for inputting data into a computer for processing is to use a wired computer keyboard and mouse. Wireless technology has made it possible for users to access information and input instructions via a wireless keyboard and/or a wireless mouse within a certain range. Speech recognition technology offers users an additional option to input instructions at a faster speed via a hands-free system (see Table 1.3).

However, speech recognition technology has not as yet been perfected. The existing technology has not reached a level of 100 per cent recognition when it transforms the human voice. Since it needs users to view errors on the screen before the system can correct them, it is impossible for blind people to use this technology. The technology also has some limitations for those with a speech impediment.

Based on the brief comparison in Table 1.3, we can see that the voice input method supported by speech recognition technology is still presently an emerging technology for computer input, since it still needs further improvement. Also, it has not been deployed widely yet. On the other hand, wireless computer input technology is cutting-edge. Although various wireless computer keyboards and mice are available and their prices are dropping, they have still not yet replaced regular

**Table 1.3** **A comparison of computer input technologies**

| | Item name | Input technology | Location | Price |
|---|---|---|---|---|
| 1. | Regular keyboard | Wired keyboard input | Static | Low |
| 2. | Wireless keyboard | Wireless input | Mobile | High |
| 3. | Voice input | Speech input | Static | Expensive |

wired computer keyboards and mice in the market. Wired computer input technology is still the dominant general computer input method because it is cheaper and easier to produce, maintain, and replace.

## *Example 1.3 Java technology*

Java technology, which was originally invented by Sun Microsystems in 1995, is today one of the leading computer programming languages in the design and development of Internet applications. While Java has now shown its innovative potential for modern computer programming languages and attractive e-commerce business opportunities, few companies wanted to take the high technical risks and business uncertainties associated with Java-based business applications when it had just been released in 1995–96. Instead, most businesses preferred to use languages such as C, C++, COBOL, PowerBuilder, Visual Basic, and Visual C++ to design and develop traditional client/server business applications at that time.

What a difference a few years make! Following the developing trend of the Internet and the WWW, Java has successfully become the most popular computer programming language offered to undergraduates in the academic institutes of higher learning worldwide. After a decade's practice in the real business world, Java, an innovative leading computer programming language, has been improved, integrated, and upgraded year after year. Today, Java technologies are running on three major business platforms:

1. *Java SE* – Java Standard Edition, which is the Java standard developing kit containing essential Java tools, Java runtime environment and Java APIs for Java developers to write, test, and run Java applets and Java applications.
2. *Java EE* – Java Enterprise Edition, which is a complete suite combining a variety of programming models and technologies to design and deploy enterprise-wide server-side applications.
3. *Java ME* – Java Micro Edition, which is the technology used to design and develop applications ranging from pagers, mobile phones, screenphones and DVD recorders to TV tuners and car navigation systems, etc.

This is why we say that although Java was an emerging technology in 1995, it has been evolving into a cutting-edge technology since then. In the future, new emerging computer programming languages could

replace Java technologies to further promote the growth of modern computer programming in the digital age.

In short, any product or technology must experience a transitional process from initial prototype to large-scale commercial production and technological application. As soon as it is widely recognized as an innovative approach representing an evolutionary and revolutionary breakthrough for large-scale commercial production, an emerging technology is transformed into a cutting-edge technology.

In short, emerging technologies are innovative and revolutionary technological breakthroughs while cutting-edge technologies are improvements and upgrades of existing emerging technologies. Cutting-edge technologies improve upon existing industries, products, and technologies while emerging technologies generate new technologies, products, and industries on the basis of what is already in existence. At the same time the emerging technologies promote the further development of future cutting-edge technologies, which in turn foreshadow the evolution of yet further emerging technologies.

The bottom line is that existing emerging technologies will be eliminated if they cannot be transformed into cutting-edge technologies during the evolutionary process of technological development. Meanwhile, the further development of cutting-edge technologies will boost the evolution of new evolving emerging technologies.

## Summary

- Emerging technologies are new evolving innovative technologies with great uncertainties and unpredictable futures. Successful emerging technologies could generate new industrial fields, new scientific and technological theories, new leading technologies, and new advanced products, etc. Emerging technologies are leading innovative technologies in prototype which have not been applied to large-scale commercial production.
- Cutting-edge technologies evolve from the basis of the scientific and technological theories and principles tested by emerging technologies. Cutting-edge technologies represent the leading innovative technologies applied to large-scale commercial production.
- Emerging technologies arise to promote future cutting-edge technologies. The breakthrough of cutting-edge technologies is the technological preparation for the appearance of new emerging technologies. The spiral of exchanges and transitions is a major driving force in the further

development of social productivity and the new wave of industrial revolution.

## Exercises

1. Identify the primary differences between emerging technologies and cutting-edge technologies.
2. Define five potential emerging technologies which could be applicable to academic libraries.
3. Why do we say emerging technologies are innovative approaches?
4. Give some examples of how emerging technologies are evolving in any areas of your choice.
5. In your opinion, which emerging technologies could greatly impact our human society and social life in the coming years of the twenty-first century?
6. Do you think that academic libraries could use emerging technologies? Why? Or, why not?
7. What kind of roles do you think that emerging technologies will play in dynamic academic learning environments?
8. Which emerging technologies do you think will be useful for improving and integrating academic learning environments?
9. What do you think of the idea that emerging technologies are of no use to academic libraries? Why?
10. Which emerging technology do you think will have a significant impact on human society in the twenty-first century? Why?

## Case studies

### *Case study 1.1 Apple iPhone*

On 9 January 2007, Apple, Inc. released its newest innovative product – the iPhone, a new pioneering product with the combined functions of a widescreen iPod, a revolutionary mobile phone and an Internet communication device. At the time of writing, Apple, Inc. is fighting a lawsuit with Cisco Systems, a networking giant, for claims to the trademark rights on the iPhone.

## Questions

1. Identify whether Apple's iPhone is a new innovative product with emerging technology features. Why?
2. Can you predict the next generation of mobile phones based on Apple's new iPhone?
3. What are the implications of the kind of developing technological trend represented by Apple's iPhone for academic learning environments?
4. Analyse which features the Apple iPhone contains and predict some of their potential implications for academic library information services in the future.

## *Case study 1.2 Stem cell technology*

Recently, British scientists have been in dispute with the British government over whether or not it is wise to ban human–animal embryo testing. In November 2006, two teams of scientists at Britain's University of Newcastle and Kings College, London applied for permission to create a 'half-man, half-cow' embryo test. Since this projected test would break the boundaries between humans and animals, the British scientists' plan immediately triggered a huge new ethical controversy worldwide.

## Questions

1. Why is the stem cell so important in today's cell technology?
2. Why are there so many ethical, legal, political, and social disputes about stem cell technologies?
3. Which technology does the stem cell technology represent, an emerging technology or a cutting-edge technology? Why?
4. How could the stem cell technology impact on us? Why?

## *Case study 1.3 Web 2.0*

In October 2005, Steve Johnson wrote an article for *Discovery* magazine. In this article, he discussed Web 2.0 as a new emerging technology 'to turn the Internet into a lush rain forest of information teeming with new life.'

- For your reference, his original online text is currently accessible at: *http://www.discover.com/issues/oct-05/departments/emerging-technology/*.
- For printed information, check Johnson (2005).

### Questions

Read Johnson's article and formulate your own opinion on the following questions:

1. Identify whether Web 2.0 is a new emerging technology.
2. Do you think that Web 2.0 represents the next generation of the Web?
3. In your opinion, how could Web 2.0 impact on academic learning environments in the digital age?
4. In which fields could Web 2.0 change academic library information services?

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2

# Understanding academic libraries in the changing world

### Chapter outline

In this chapter you will learn:

- about an academic library's new mission in the digital age;
- about new functions in academic libraries;
- about new services for the user of academic libraries in the digital age.

### Learning objectives

After you have completed this chapter, you are expected to be able to:

- understand academic libraries in the changing world;
- understand why new functions in academic libraries are so configured;
- understand in what ways academic libraries can expand their services.

## Introduction

In today's information society, heterogeneous data and information can be dynamically accessed, converted, disseminated, distributed, located, processed, and stored across diverse applications, channels, databases,

networks, platforms, and systems. Compared to what we saw ten or fifteen years ago, there have been a great many changes in today's academic libraries. In the golden age of the Internet, any number of web search engines can assist users to locate and access millions of pages of information within less than a second. High-speed information exchange and sharing is no longer confined to the library buildings.

With the rapid development of PC and network technologies, the old traditional printed library card catalogs have been replaced by computerized OPAC (Online Public Access Catalog) systems with a variety of web-based graphical user interface (GUI) functions since the mid-1990s. Through the Internet and WWW, online academic library catalogs have been accessible to on- and off-campus users for 24/7 operations without geographical limitations. In today's academic library infrastructure, also available are numerous e-databases, web search engines, and other web-based academic information resources, services, and instructions for academic library users to locate and access all kinds of information.

In facing up to the new information explosion, academic libraries will have to meet even more challenges and opportunities to serve students, faculty, staff, visiting scholars, and other public users, all with much higher expectations and many more demands triggered by the growth of emerging and cutting-edge technologies in academic learning environments. It is high time for academic administrators, executives, faculty, IT specialists, librarians, managers, scholars, and other professionals to review how academic libraries need to change and meet these new challenges and opportunities in the coming years of the twenty-first century.

## An academic library's new mission

Since I came on board at the Georgia Southern University in the summer of 2002, no one has ever questioned the university library's mission statement:

> The Zach S. Henderson Library is the central repository of recorded information serving Georgia Southern University and southeast Georgia. Library personnel strive to provide users with the necessary skills to become independent lifelong learners, to employ a patron-centered service ethic, and to ensure a comfortable and responsive study environment.

During one of the Library Committee meetings at the beginning of 2007, however, a professor from the College of Information Technology criticized our university library's mission statement as old fashioned and not reflecting what academic libraries are doing and will do in the digital age.

His main objection to our current mission statement was the description of the Zach S. Henderson Library as a repository: 'The Zach S. Henderson Library is the central repository of recorded information serving Georgia Southern University and southeast Georgia …' The professor pointed out that this mission statement left out the access we provided to information that is not housed within this 'repository,' such as the electronic resources and also the books and periodicals that are owned elsewhere but delivered through interlibrary loan (ILL) and the GIL Express. These allow students, faculty, instructors, and staff of the University System of Georgia (USG) to search a universal online catalog from 35 member libraries participating in the USG and request delivery of circulating library books to any designated user of the member libraries.

So what is a mission statement? What is the purpose of a mission statement? Why must a business or an organization have a mission statement? Some readers may be sufficiently curious to search for the answers, and if they type the search words 'mission statement and definition' into the Google web search engine, they will be astonished to see that the result list contains over 2,950,000 items! Readers may well remain confused about these terms after they have read a number of the explanations given in this search result list. It is impossible to find one standard definition for a mission statement.

In the forward to the book titled *Mission Statements: A Guide to the Corporate and Nonprofit Sectors*, John A. Pierce (1994) suggested that the purpose of a mission statement was 'to develop a new organization or to reformulate the direction of an ongoing organization. Strategic decision-makers determine the basic goals, characteristics, and philosophies that will shape the strategic posture of the organization.' Furthermore, he added, 'the organization's mission is a broadly defined but enduring statement of purpose that distinguishes if from other organizations of its type and identifies the scope of its operations in product and market terms.'

Based on Pierce's definition, we can see that an academic library mission statement aims to define its long-term strategic goals, service philosophy, and scope of functions in a specific academic learning environment. An academic library mission statement is the documentary

guidance which distinguishes the library's service commitment, philosophy, plans, roles, routine operations, and essential services, etc.

John W. Graham and Wendy G. Havlick (1994) recommended: 'A mission statement should include many or most of these elements: a statement of purpose for the organization, indication of line of business or specialty, geographic parameters, and mention of important groups in the organization's life, such as employees and shareholders.' Over ten years later their suggestions are still being used to guide us in building and fulfilling our long-term strategic missions and plans in academic library settings.

No matter how we modify the mission statement of the Zach S. Henderson Library of Georgia Southern University, it is a fact that academic libraries have to aim for a new mission in the digital age while focusing on access, delivery, and retrieval of information, since these are the historical tasks entrusted to the digital age. With the development of modern networking technologies, academic libraries have already expanded the scope of their services outside library buildings. Academic libraries no longer serve only as repositories for collecting, organizing, and preserving information and knowledge. In addition, the growth of the Internet and WWW has made it possible for academic library users to locate and access the information they need without any geographic or time limitations.

## New functions in academic libraries

Over the long course of history, social forces promoted the origin of the library for preserving records. As early as 3000 BC, records engraved in clay tablets were collected in Babylonian temples, while 'The first libraries as repositories of books were those of the Greek Temples and those established in conjunction with the Greek schools of philosophy (4th century BC)' (based on the New Encyclopedia Britannica, 1998). Across the globe, the Greek, Roman, and Chinese empires have a long history of libraries, while according to historical records, academic libraries such as that of Oxford University in the United Kingdom and Harvard University in the United States began to serve as repositories as far back as the seventeenth century.

Figure 2.1 shows us a picture of the Reading Room in the National and University Library in Ljubljana, Slovenia. From this picture, readers can see clearly how an academic library functions as a central depository for collecting, preserving, and storing achievements in the arts, education, history, language, music, science, technology, and so on. Conventionally,

**Figure 2.1** **The Reading Room in the National and University Library in Ljubljana**

The building, constructed in 1941, represents one of architect Jože Plečnik's most monumental works.

*Source*: *http://images.google.com/imgres?imgurl=http://www.uvi.gov.si/img/photo/slovenia/medium/029.jpg&imgrefurl=http://www.uvi.gov.si/eng/slovenia/photos/culture/029/index.print.html&h=500&w=500&sz=307&hl=en&start=1&tbnid=Gl_lnW9ukn4B0M:&tbnh=130&tbnw=130&prev=/images%3Fq%3DThe%2Breading%2Broom%2Bin%2Bthe%2BNational%2Band%2BUniversity%2BLibrary%2Bin%2BLjubljana%26gbv%3D2%26svnum%3D10%26hl%3Den%26sa%3DG*.

an academic library's basic functions include the classification, codification, generalization, and storage of various works under different subjects ranging from agriculture, art, construction, and engineering to history, language, literature, manufacturing, the military, philosophy, politics, science, technology, and so on.

The rapid development of modern information technologies has already laid down a solid foundation for a new innovative evolution in academic libraries in the digital age. Impacted by new advances in emerging and cutting-edge technologies, however, academic libraries have already transformed their specific functions in today's changing world:

- *Information center*. An academic library functions as a central gateway for library users to access, locate, transform, and utilize information resources in a variety of printed and electronic formats via diverse applications, databases, networks, platforms, and systems.
- *Learning center*. An academic library is committed to provide library users with dynamic equipment, facilities, resources, and services to support their learning activities, which range from assignments, presentations, and projects, to papers, reports, theses, and so on. An academic library should also take primary responsibility for promoting information literacy and practical learning skills in critical thinking, decision-making, and problem-solving.
- *Training center*. An academic library strives to provide the best supporting and training environments for faculty and instructors to engage students in interactive learning activities. With strong collaboration and support from the Center for Excellence in Teaching, an academic library should be able to provide the necessary instructional assistance and technical support for faculty and instructors to design, develop, enhance, integrate, and implement various teaching courses, programs, and workshops, including support for distance learning programs.
- *Publication center*. An academic library does its best to provide library users with computer hardware and software, audio/video equipment, and other supporting facilities and peripheral devices to create, design, develop, enhance, integrate, publish, and upgrade their various multimedia presentations, projects, reports, web designs, and so on.

## New academic library user services

Generally speaking, services for academic library users can be divided into two categories: public services and technical services. Public services in academic libraries refer to access, circulation, bibliographic instruction, distance learning, government documents, reference, special collections, and so on. Technical services in academic libraries focus on maintaining and developing library collections, such as acquisitions,

cataloging and classification, interlibrary loan and document delivery, serials and collection development, and so on, which are procedures and operations behind the scene.

Since the 1990s, the Internet and WWW have become the primary platform on which academic libraries build and deliver specific services for innovation, knowledge, and excellence in teaching. Also, there have been a lot of changes to the approach and scope of academic library services, which are no longer limited to the confines of the library buildings. Rapid advances in information technologies have made it possible for academic libraries to reach more users whether they are on or off campus.

Based on innovative cutting-edge technologies and evolving emerging technologies, five new service models are widely available for today's academic library users in the digital age:

- *Digital library*. A digital library is a virtual library providing access to part of or all its collections, such as plain texts, images, graphs, audio/video materials, and other library items that have been electronically converted, via the Internet and World Wide Web.
- *Information commons*. An information commons is an innovative and evolving collaborative academic library service model built on a variety of networked interactive academic learning platforms. The primary function of an academic library information commons is to integrate existing information resources, services, instructions, and other public service programs in the library into one consistent, dynamic, interactive, and scalable student-centered interactive academic learning environment.
- *Instant messaging (IM) reference service*. The instant messaging (IM) reference service is one of the real-time electronic consulting and reference services offered by academic libraries via specific software running on the Internet platform.
- *Weblog*. A weblog – sometimes also called a blog, web blog, or web log – is a new one-stop-shop web portal containing chronological web publications for personal or professional purposes. One of its common applications in library settings is to organize a library's related activities, news, notices, reports, and so on in a chronological order.
- *Wiki*. A wiki is innovative server software which permits any user or specified users only to create and edit web contents via a web browser. To enhance intranet communication and knowledge management, a library often uses a wiki as an information gateway to access, create, and edit a variety of information guides, resources, services, tutorials, and websites, etc.

# Real-world examples

## *Example 2.1 Digital library*

Currently, more and more academic libraries worldwide are planning to expand the scope of their services via the Internet and WWW. One innovative way of delivering and distributing academic library collections is to initialize and implement specific digital libraries. Like other academic libraries worldwide, the Bodleian Library, which is the main research library of Oxford University in the United Kingdom, has set up specific digital library services to better support their distinguished academic teaching and learning activities (see Figure 2.2).

Currently, the Digital Library Projects in the Bodleian Library include the following major collections:

- Bodleian Library Broadside Ballads;
- Bodleian Library/Toyota City Imaging Project;
- Browse images of manuscripts;
- CJK *allegro* Catalogues;
- Early Manuscripts at Oxford University;
- HEFCE-Funded Projects at the Bodleian Library;
- Internet Library of Early Journals;
- John Johnson Collection of Printed Ephemera;
- Oxford Examination Papers Online;
- Web Applications Hosted and Supported by the Bodleian Library.

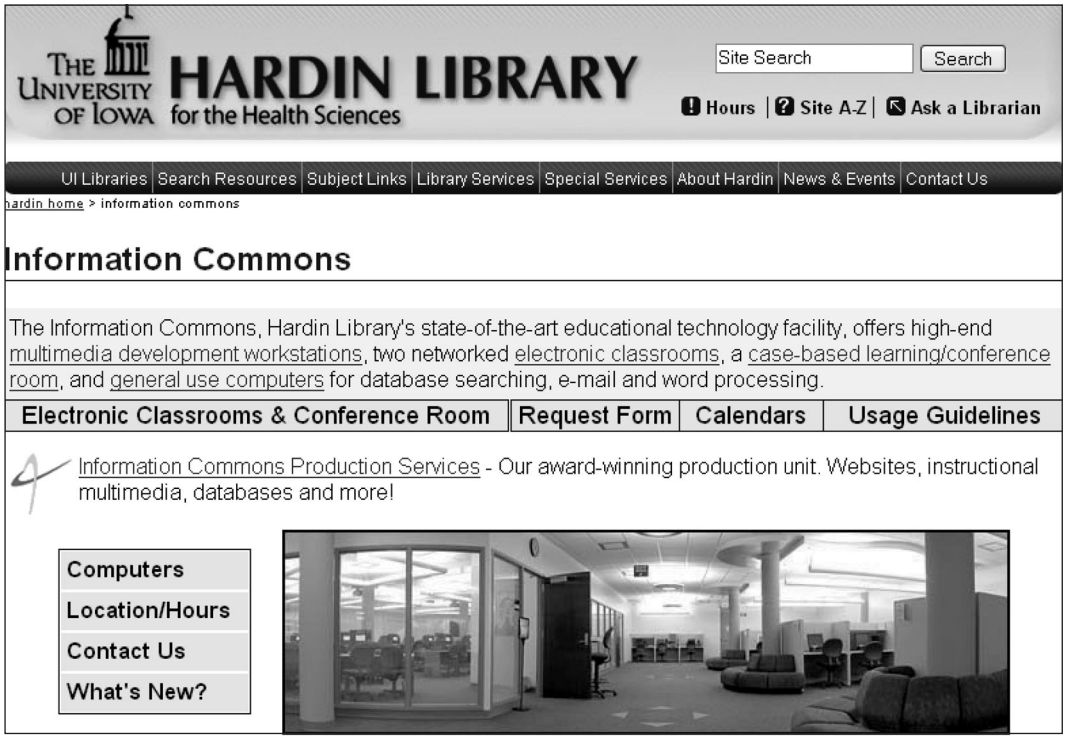
## *Example 2.2 Information commons*

An information commons, also called a learning commons, is an integrated one-stop information gateway for academic students, faculty, teachers, staff, and other public users of the library (see Figure 2.3). The Information Commons of the Australian National University Library (*http://sts-dev.anu.edu.au:8880/infocommons-web/pages/Home*), for example, has been a leading pioneer of enhancing and integrating academic library e-information services with cutting-edge and emerging technologies. Students, faculty, teachers, and staff of the university community have access to information resources, services, instructions, and other public programs via multiple network platforms.

**Figure 2.2** Home page of the Bodleian Library, Oxford University


*Source*: *http://www.ouls.ox.ac.uk/bodley.*

**Figure 2.3** Information commons of the Hardin Library, University of Iowa




*Source*: *http://www.lib.uiowa.edu/commons/*.

The major features of the information commons include:

- open access locations (typically associated with library buildings);
- around 1,000 computer terminals on campus;
- multi-operating systems: Windows, Macintosh, and Unix;
- an extensive collection of desktop software;
- a wireless network expanding the scope of the service;
- computer laboratories (which may be booked for classes);
- lecture theatres;
- a small number of training laboratories;
- multi-language support.

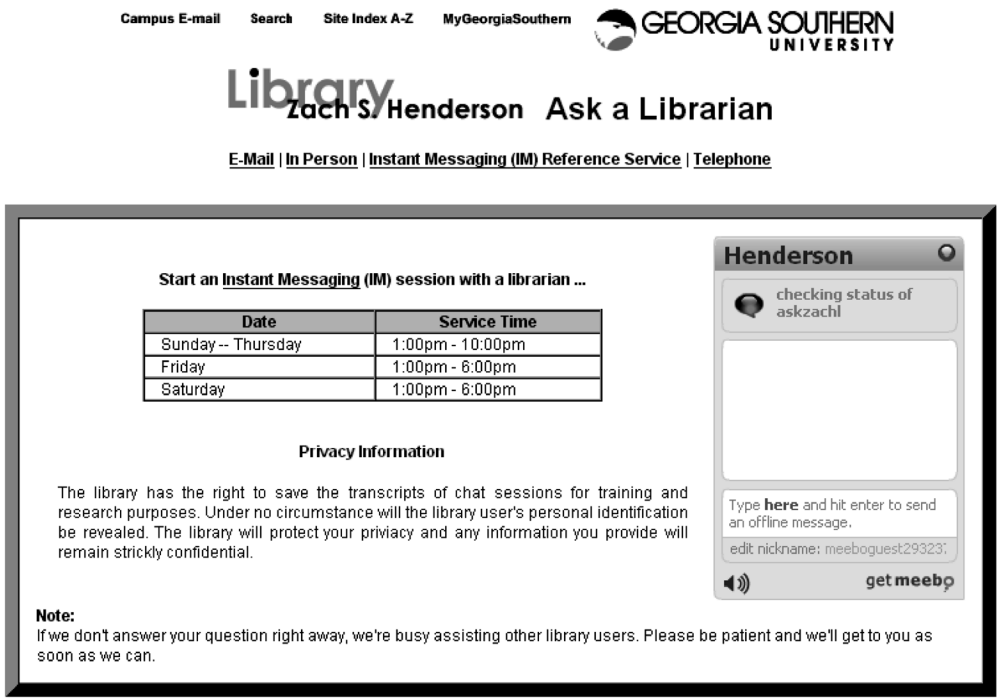
### *Example 2.3 Instant messaging (IM) reference service*

To enhance their live user information services, more and more academic libraries worldwide have started up a specific instant messaging (IM) reference service. In the summer of 2006, for example, the Zach S. Henderson Library of Georgia Southern University started its first IM reference service for its students, faculty, teachers, staff, and other public users (see Figure 2.4). Utilizing an embeddable IM window called Meebo-me Widget, library users can immediately start chatting with librarians without downloading and installing any software. The Zach S. Henderson Library of Georgia Southern University also supports other different IM software: AIM (America Online Instant Messaging), Google Talk, Meebo, MSN Messenger, and Yahoo Messenger.

## Summary

- It is imperative for academic library administrators, executives, faculty, instructors, managers, librarians, staff, and other professionals to review and reconfirm the mission statement of their specific library. In the digital age, academic libraries have already amended their new mission to provide a location for, access to, and delivery of information in support of academic teaching and learning needs. Academic libraries not only serve as depositories in which to collect, organize, and preserve information in the digital age. Impacted by the advances in emerging

**Figure 2.4** IM reference service offered by the Zach S. Henderson Library




*Source*: *http://library.georgiasouthern.edu/libref/imref.html*.

and cutting-edge technologies, academic libraries have changed from a single repository function to providing four motivational functions:

  - information center;
  - learning center;
  - academic training center;
  - academic publication center.

- Utilizing the Internet and WWW, academic libraries are delivering and distributing their specific information resources, services, and tutorials in dynamic formats. Looking around academic libraries worldwide, we see that digital libraries, information commons (learning commons), instant messaging (IM) reference services, weblogs, and wikis represent the new ultimate level of power for academic library information services in the digital age.

## Exercises

1. Identify three library services that could have the greatest implications for the growth of emerging and cutting-edge technologies in academic libraries.
2. Identify five new user services offered by today's academic libraries.
3. Select one academic library's mission statement and see what modifications or improvements are required to reflect its new function in the digital age.
4. Compare the mission statements from three different academic libraries and distinguish their specific points of focus.
5. Why is an academic library mission statement so important?
6. An IM reference service is one of the common user services offered by many academic libraries. What can you suggest to improve and upgrade such a service?
7. Select one academic library's website and make some practical suggestions as to how it could be enhanced and modified.
8. Review an academic library's wiki and make some practical suggestions for improving their web-based information resources, services, and web links.
9. In what ways would you suggest today's academic libraries could enhance and integrate their library user services?

10. What new services do you expect to see in future academic libraries? Why?

# Case studies

## *Case study 2.1 Library catalog*

Whenever you try to locate an item in a library, a catalog, which is the comprehensive holding list of a library collection, must be used. Many older people will still remember how they located a library book by searching through a printed library card catalog. As a result of advances in computer and network technology, however, most academic libraries are already using online library catalogs instead of the old printed card catalogs.

Answer the following questions based on your own personal experience of using modern academic libraries.

### Questions

1. Where would you find an online library catalog?
2. What are the major search methods available to you to find a journal by using an online library catalog?
3. Why are printed card catalogs no longer popular in libraries?
4. What other methods can you use to find a book if the local academic library catalog does not have it?

## *Case study 2.2 Information literacy*

According to the Association of College and Research Libraries' website, information literacy is defined as 'the set of skills needed to find, retrieve, analyze, and use information' (see: *http://www.ala.org/ala/acrl/acrlissues/acrlinfolit/infolitoverview/introtoinfolit/introinfolit.htm*). Many academic libraries around the world are striving to design and develop specific information literacy programs to assist academic users to effectively and efficiently access, analyze, locate, and utilize information. Many undergraduates and graduates are encouraged to take information literacy training in dynamic academic learning environments.

Answer the following questions after you have read the definition of information literacy above and checked the more detailed information available on the website.

### Questions

1. Have you ever taken any information literacy training? Why?
2. Can you suggest an example of information literacy?
3. How do you think information literacy skills will impact on your future career development?
4. Why will academic libraries need to promote information literacy in the digital age?

## *Case study 2.3 Web search engines and wikis*

In the Internet age, a variety of web search engines such as Google Web Search, MSN Web Search, Yahoo Web Search, and so on are available for users to search information at high speed. Since 2001, a new type of server program called a wiki has also appeared which enables users to freely access, edit, modify, and upload collaborative web contents without the need for a great deal of experience in and knowledge of markup languages. On 7 July 2006, Tom Stafford and Matt Webb wrote an article for the O'Reilley Network website to explain what a wiki is and how to use it successfully. The article may be accessed at: *http://www.oreillynet.com/pub/a/network/2006/07/07/what-is-a-wiki.html*. Answer the following questions, based on your own personal experience of using various web searching engines and wikis.

### Questions

1. What are the differences between a web search engine and a wiki?
2. Since we have a lot of web search engines and wikis available, do you think that academic libraries will become extinct in the future? Why? Or why not?
3. How do you think web search engines and wikis will impact on academic libraries in the digital age?
4. Specify which library information services have been affected by the advances in web search engines and wikis.

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# Where will emerging technologies lead in academic libraries?

## Chapter outline

In this chapter you will learn:

- about multiple information technology architectures in academic libraries;
- about emerging technologies evolving in academic library settings;
- about two golden keys to discovering the development of emerging technologies in academic libraries.

## Learning objectives

After you have completed this chapter, you are expected to be able to:

- understand information technology architectures in academic libraries;
- predict where technologies are emerging from academic libraries in the digital age;
- discover in which direction academic libraries could expand their services in the digital age.

## Introduction

With the rapid advances in cutting-edge and emerging technologies, it is recognized that the trends in information technology have had a great impact on ways of learning and teaching in academic library settings. Diverse data and information in multi-formats can now be dynamically accessed, distributed, exchanged, shared, stored, transformed, and transmitted across heterogeneous applications, channels, databases, networks, platforms, and systems. In facing up to the new information explosion driven by the Internet and WWW, many academic administrators, executives, IT specialists, librarians, managers, and staff are making the utmost efforts to meet the dynamic needs of users with their stringent operating budgets.

However, some academic library administrators, executives, librarians, managers, and staff may still be finding it difficult to monitor the developing trends in information technologies while projecting long- and short-term strategic goals and objectives for academic libraries in the digital age. When they need to modify or update their long- and short-term strategic goals, missions, and objectives, they are not so sure how and where to monitor cutting-edge and emerging technologies in service-oriented and user-centered academic library learning environments. This is why we need a practical roadmap to answer most of the puzzles. The following sections will provide a guide in the search for those answers.

## Where to follow emerging technologies in academic libraries?

Since the 1990s, numerous research articles and scholarly papers have been published to describe the developments in emerging technologies in many different fields. However, few of them can be used as a roadmap for academic library administrators, executives, IT specialists, librarians, managers, and staff to follow and monitor the developing trends in information technologies in the many types of service-oriented and user-centered academic library settings. Facing up to new advances in information technologies, academic libraries need to effectively and efficiently utilize innovative information technologies to enhance and integrate their specific information resources, services, and tutorials.

Since innovative information technologies usually contain a lot of financial and technical risks, those concerned are very cautious when reviewing the current developing trends in information technologies.

This chapter suggests a practical way to examine the development of emerging technologies in a variety of academic library settings. Day after day, year after year, many academic library staff members have been striving to deliver and distribute high-quality innovation, intelligence, and teaching in excellence. Many IT specialists and librarians have advanced knowledge and skills in the specific fields in which they serve in academic libraries. Unfortunately, few of them have ever become acquainted with the disparate information technologies or examined them in the macro-management services of specific academic library environments. That is why some have lost track of such technologies, especially the trends developing in cutting-edge and emerging technologies in the various service-oriented and user-centered academic library environments.

My suggestion is very practical. Once we have examined how data and information are accessed and delivered in a variety of academic learning environments, we should be able to follow and monitor exactly the trends developing in emerging technologies in a selection of academic library settings. Therefore I suggest that we should carefully examine the information technology architecture (ITA) in such settings, since they are the technical bases for the delivery and dissemination of academic information resources, services, and other related liaison programs as well as specific supports. As long as we have some basic experience, knowledge, and skills in relation to data communication, data transmission, and information retrieval, it will not be too difficult for us to find and monitor emerging technologies in academic libraries.

## Academic library information technology architectures

The information technology architecture (ITA) in an academic library is the technical foundation for designing, developing, enhancing, integrating, managing, and supporting academic library information services in the digital age. The ITA is a comprehensive structure combining management and technical modules to achieve the strategic objectives and business developments set out by an enterprise, government agency, institute of

higher education, etc. An ITA provides diverse functions for missions, objectives, regulations, standards, finance controls, human resources, user needs and requirements, system assessments and evaluations, and technical regulations as well as standards, etc.

Technically speaking, an ITA is an integrated framework for designing, developing, deploying, implementing, managing, and supporting the existing mission-critical business applications and operations of an organization. In the field of software engineering, the framework generally refers to a primary development structure. Different software languages have their own primary development frameworks. The components of an ITA range from the business rules, data, and the database management system (DBMS) to the graphical user interface (GUI), hardware, middleware, networks, the personnel, the server, the software, and so on.

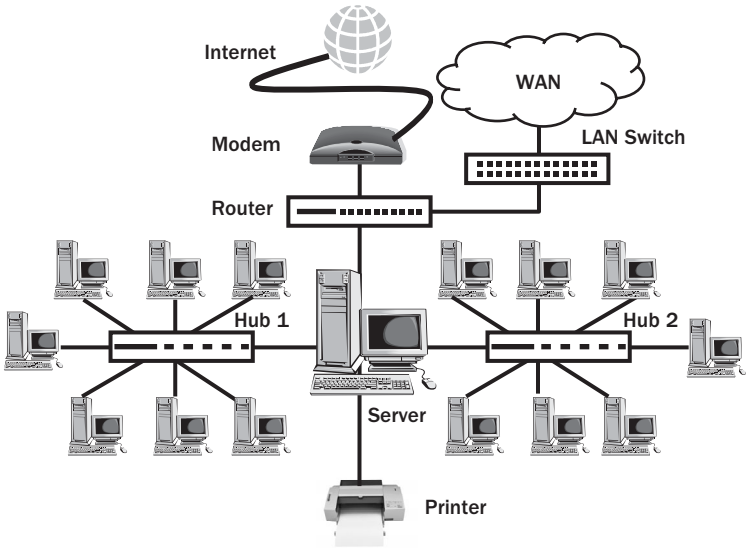
There are essentially three technology architectures available to initialize and implement academic library information resources, services, and teaching programs in a typical academic library setting:

- a LAN-based ITA;
- a wireless LAN-based ITA;
- a web-based ITA.

## *LAN-based information technology architecture*

A LAN (local area network) is a group of computers and their associated devices linked in some way, in most cases by a cable. Usually a LAN is limited to a local area such as an office or building. In today's information society, the most basic technical architecture for an academic library's information architecture is the high-speed LAN network. In most cases, the Fast Ethernet and the Gigabit Ethernet have become primary technical protocols for academic libraries to build their specific user information programs and services. To expand the network service range in an academic library, the broadband wireless LAN (WLAN) technology, which is currently defined in the IEEE 802.11 standard, is also used to transmit data and information over wireless media equipment. Another emerging wireless technology called Bluetooth is widely used to provide short-range wireless communications between desktop computers and peripherals, such as remote controls and wireless mice, in academic library settings. Figure 3.1 presents a basic hierarchical star network topology which provides high-speed data and

**Figure 3.1** LAN-based technology architecture for academic libraries

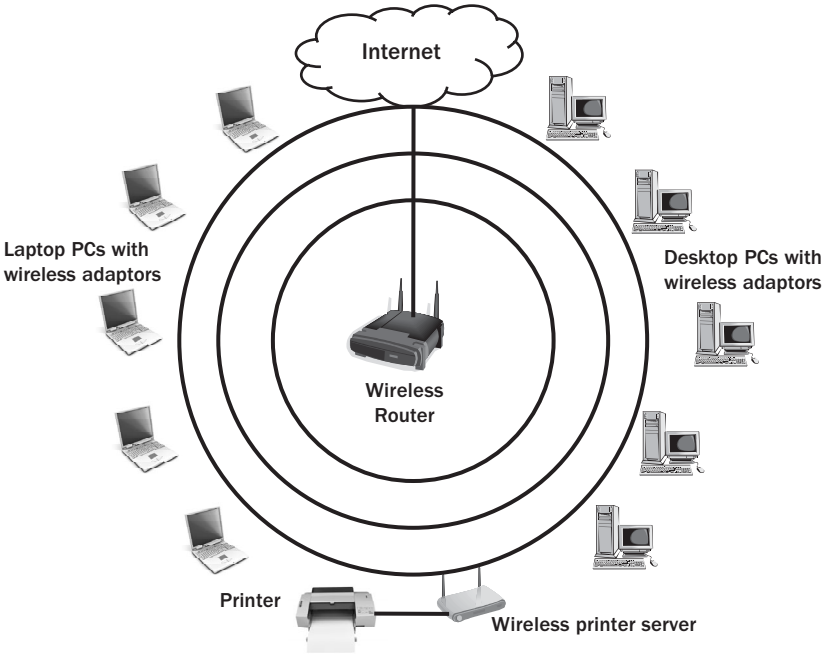



information exchange in a common academic library LAN networking environment.

## *Wireless LAN-based information technology architecture*

A wireless local area network (WLAN) is a mobile LAN communicating through high-frequency radio waves instead of regular wires (see Figure 3.2). On campus, the wireless LAN-based information technology architecture has not as yet become the dominant computer technology architecture for academic libraries. As a supplement to support the existing LAN-based information technology architecture, the WLAN technology is basically used to expand the existing service range and increase the number of entry points for academic library users to access the web-based academic information resources, services, and teaching. For quite some time to come, the wireless LAN-based information technology architecture will continue to lead future developing trends in new innovation, intelligence, teaching in excellence, and other liaison programs available from dynamic and interactive academic learning environments.

**Figure 3.2** Wireless LAN-based technology architecture for academic libraries



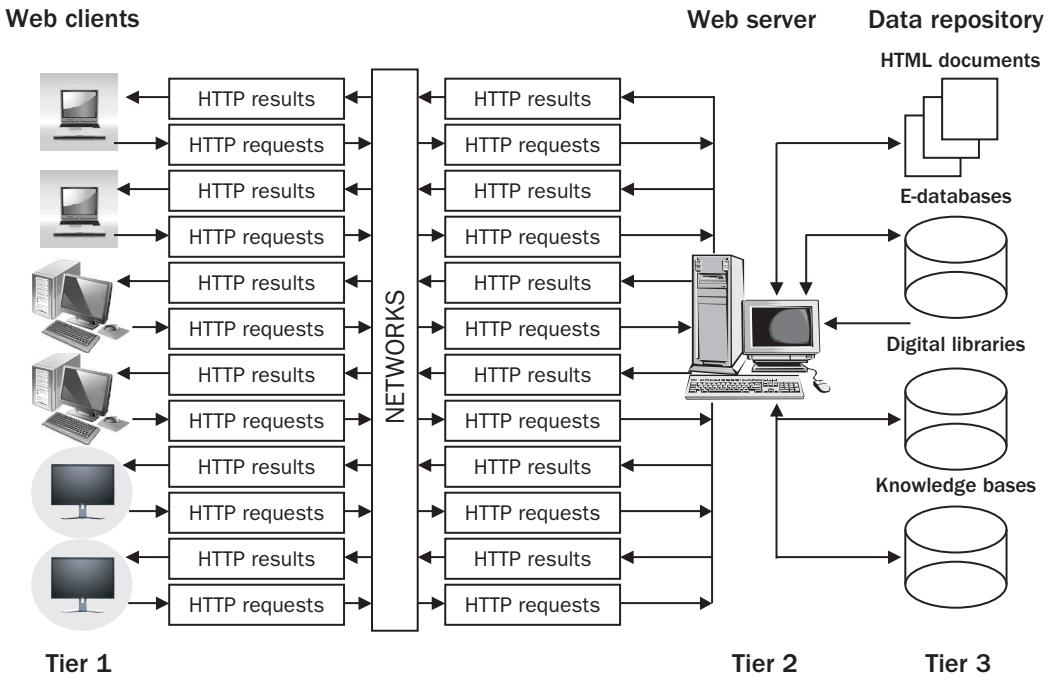

### *Web-based information technology architecture*

Since the 1990s, academic libraries around the world have been using the Internet and WWW as a primary platform to deliver and disseminate their specific information resources, services, and teaching programs (see Figure 3.3). On the basis of the evolving three-tier client/server web architecture, an academic library can provide academic students and instructors with access to specific web-based information resources, teaching supports, and other public services.

## Two golden keys to solving puzzles

Having reviewed the three primary information technology architectures in academic library settings, you should be able to understand the two golden keys which can solve all the puzzles surrounding the emerging technologies applicable to academic libraries. All you have to remember

**Figure 3.3** Web-based information technology architecture for academic libraries



is that an academic library is actually functioning as an information gateway in today's information society. On the one hand, you need to pay special attention to the information technology architectures which are used to deliver and disseminate academic library information resources, services, and teaching contents in the digital age. On the other hand, you should also closely study and watch how users access, locate, process, transform, and store the key information they need. This is the whole process of an academic library user's information retrieval cycle. From the specific information retrieval cycles users are engaged in, you should be able to understand which emerging technologies could have a great impact on an academic library user's activities in searching for information.

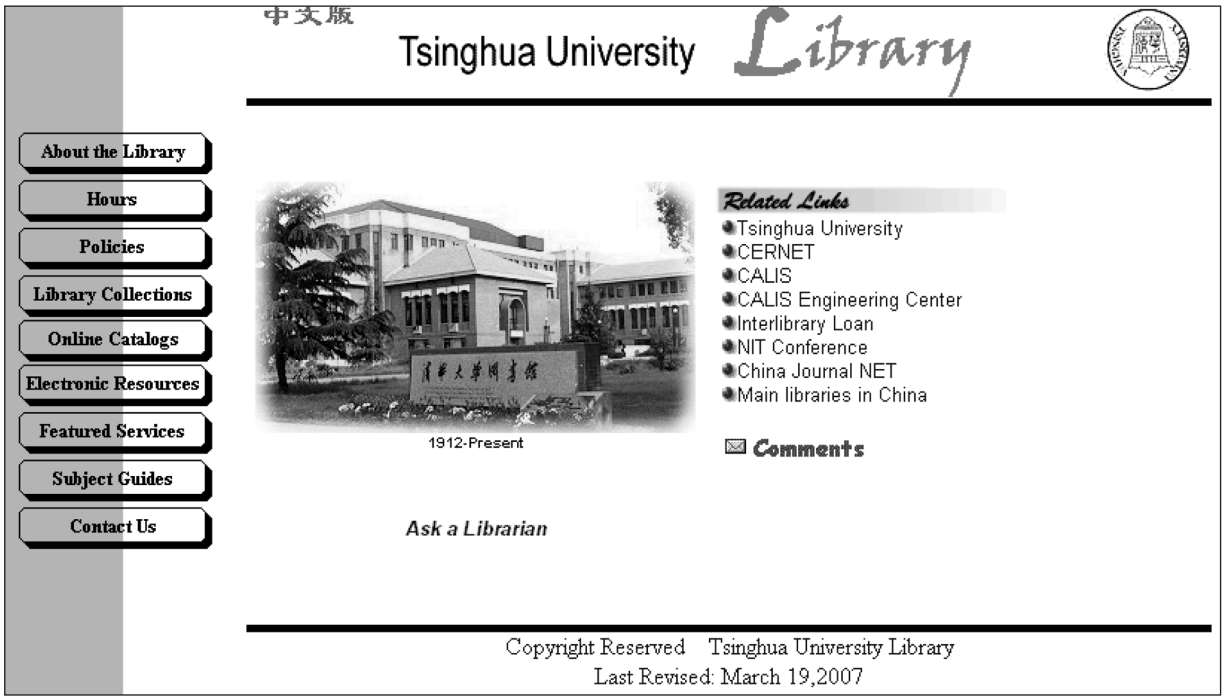
In the modern information society, academic libraries are always striving to provide academic library users with high-quality information services built on multiple information technology architectures. At the same time, the processes used by academic library users for information retrieval will promote the further enhancement and integration of future technology evolutions and revolutions. Therefore the information technology architecture should be your first golden key to uncovering the tracks of emerging technologies in academic libraries. A user's specific information retrieval cycle should be your second golden key to finding out how and where emerging technologies could arise in academic library settings. With these two golden keys, you will never have difficulty in following and monitoring the developing trends in information technologies in academic library settings. With these two keys, you will also be able to further examine where emerging technologies are arising in service-oriented and user-centered dynamic academic library learning environments.

# Real-world examples

## *Example 3.1 The Internet*

In today's information society, the Internet and WWW have become the basic platform for academic libraries to deliver and disseminate specific information resources, services, and teaching. Figure 3.4 is an example from the homepage of Tsinghua University Library (English Version) located in Beijing, China.

**Figure 3.4** English homepage of Tsinghua University Library, Beijing, China




*Source*: *http://www.lib.tsinghua.edu.cn/english/*.

### *Example 3.2 Remote access to library databases outside the library building*

With modern networking technology and the Internet, today's academic libraries have already extended their own specific information resources, services, and teaching activities outside the library buildings. The example shown in Figure 3.5 is from the University of California Berkeley Library in the United States, which utilizes a virtual private network (VPN) to provide faculty, instructors, students, and staff with access to the university library's databases and other information resources via the UC Berkeley network. To put it simply, the VPN provides users with secure remote access to restricted information resources via the Internet. Therefore UC Berkeley faculty, teachers, students, and staff can access all kinds of academic information resources, services, and teaching when they are off campus.

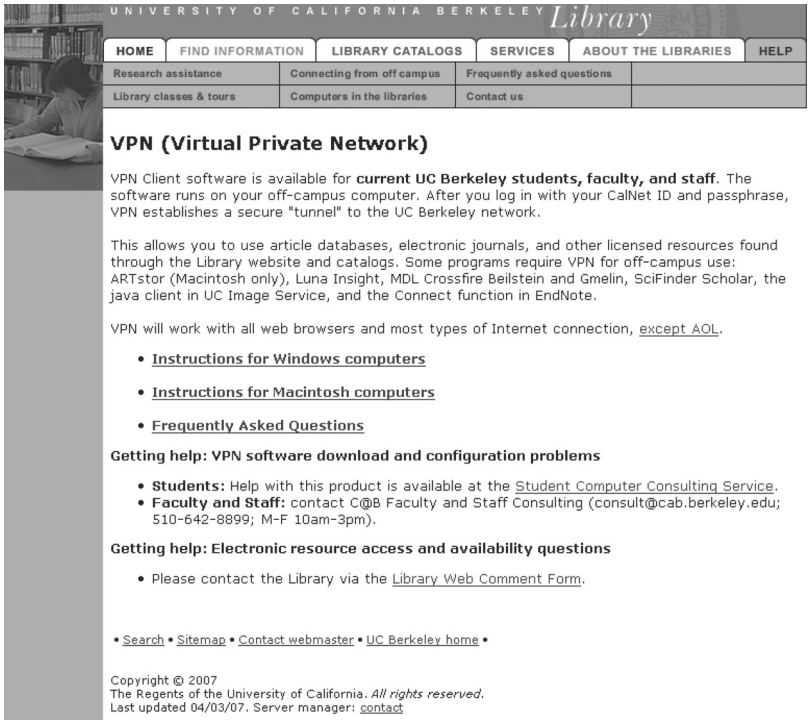
### *Example 3.3 Wireless access in academic libraries*

WLAN technologies are being widely applied to diverse academic library settings in the United States. Not only top research libraries but general mid-size university libraries too have started offering wireless network services for students and faculty. For example, Virginia Commonwealth University (VCU) Libraries are using a wireless local area network to expand the scope of their service (see Figure 3.6).

## Summary

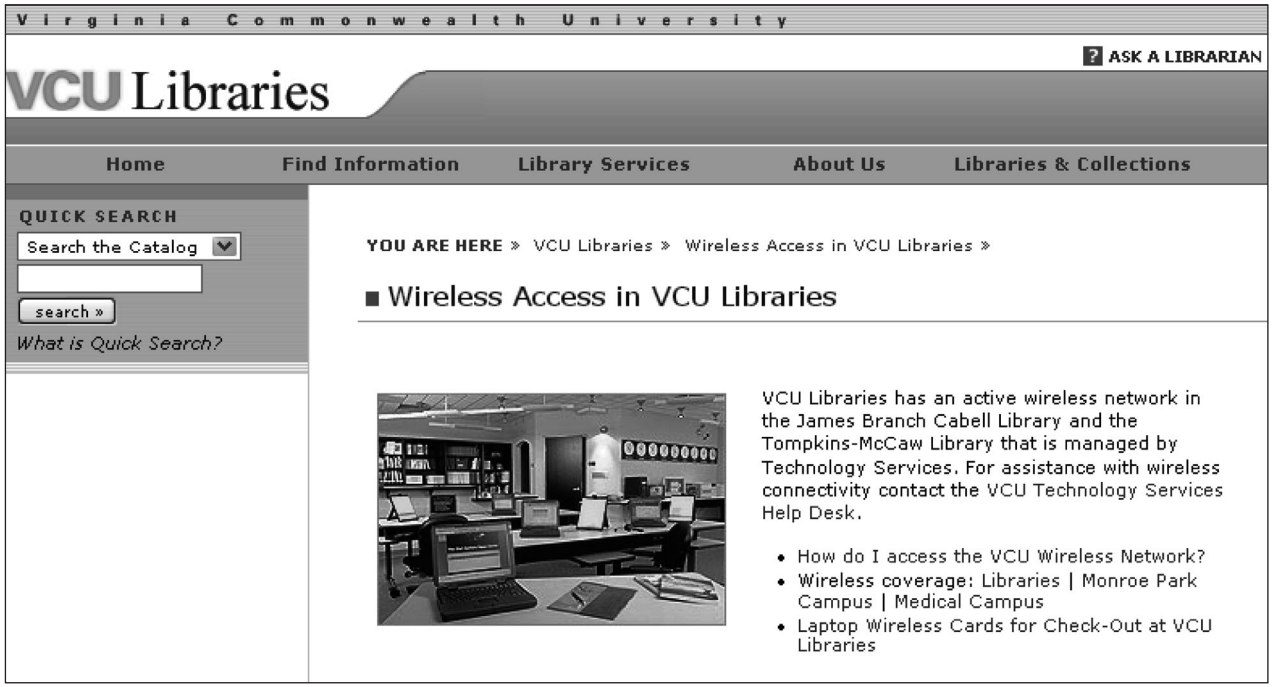
- Information architectures are technical bases for academic libraries to initialize, implement, maintain, and update their specific information resources, services, and instructions. Three information technology architectures: the local area network (LAN), the wireless local area network (WLAN), and the Internet, have laid down solid technical bases for today's academic libraries to deliver and disseminate information. The information technology architecture and the user's information retrieval cycle are two golden keys to solving all your puzzles about emerging technologies evolving in academic libraries.
- Since the late 1990s, academic libraries have been utilizing the Internet and WWW to deliver and disseminate information. Today, the Internet

**Figure 3.5** VPN at the University of California at Berkeley Library




*Source*: *http://www.lib.berkeley.edu/Help/vpn.html*.

**Figure 3.6** Wireless access in Virginia Commonwealth University Libraries




*Source*: *http://www.library.vcu.edu/wireless/*.

and WWW have become the primary platform for academic library users to access, locate, process, and utilize information across diverse applications, databases, networks, platforms, and systems.

## Exercises

1. How often do you use an academic library? Why?
2. What do you usually do in an academic library?
3. Specify five information technologies currently applicable to academic library settings.
4. Compare the pros and cons of three of the most popular instant messaging (IM) programs used in academic library information services.
5. Select one university library's website and see if you can make any suggestions to improve the web page design.
6. Go to an academic library and find out which web browsers are available for users to surf on the Internet.
7. Do you like using the wireless access in an academic library? Why? Or why not?
8. What do you usually do if you cannot find the information you need?
9. Do you think academic libraries will become extinct now that so many web resources and web search engines are available?
10. Which information technologies challenge your competency and skills in searching for information in the modern information society?

## Case studies

### *Case study 3.1 Kaleido Phone Library*

It was reported by Linda L. Briggs in 2005 that Digital Airways (*http://www.digitalairways.com/daw/default.jsp*), a European software company, started offering a new service called Kaleido Phone Library to assist manufacturers in the development of effective designs for MMIs (man–machine interfaces) for mobile phones, PDAs, and other devices. (For your reference, the web link of this article is at: *http://www.javareport.com/article.aspx?id=10742&page=*.)

### Questions

1. Which operating systems does Kaleido Phone Library support?
2. Which technical features does Kaleido Phone Library offer?
3. Why is it so important to develop the design of MMIs?
4. Where can you see future possible applications in academic library environments? Why?

## *Case study 3.2 Vendor turmoil in 2006*

A series of vendor mergers, including that between Endeavor Information Systems, Inc. and Ex Libris, Inc., astonished the global market for library automation systems. In March 2007, Information World Review, a blog located in the United Kingdom (*http://blog.iwr.co.uk/*), issued a report commenting on these vendor mergers and their potential implications from this web address: *http://blog.iwr.co.uk/2007/03/library_softwar.html*.

### Questions

1. What is a library automation system?
2. In your opinion, what does the merger between Ex Libris and Endeavor mean to those academic libraries which purchased their products?
3. What impact could this merger have on library information services? Why?
4. Based on these mergers, can you predict what trends may develop in integrated library systems (ILS) in the future?

## *Case study 3.3 Wireless network in academic libraries*

In March 2003, Wilfred Bill Drew wrote an article introducing the developing trend of wireless networking in academic libraries. His short article is a good entry point for anybody who wants to know why academic libraries are promoting wireless networks on campus. For reference, this article is listed in the reference section at the end of this chapter or you can use Google to search for other articles on wireless networking in academic libraries.

### Questions

1. What is a wireless network?
2. Which wireless network standard is currently used in academic libraries?
3. Compared to the traditional wired network, what advantages can the wireless network offer to students and faculty?
4. How can we use the wireless network safely in academic learning environments? Why?

## References and further information

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4

# Emerging technologies for academic libraries in the digital age

## Chapter outline

In this chapter you will learn:

- what information technology is;
- why information technology will leverage academic library information services;
- which emerging technologies will impact on academic libraries and their information services in the digital age.

The list of emerging technologies covered in this chapter includes:

- artificial intelligence;
- computer technology – hardware and software;
- digital technology;
- instructional technology;
- multimedia technology;
- nanotechnology;
- network technology;
- telecommunication technology;
- video technology;
- web and web technology.

### Learning objectives

After you have completed this chapter, you are expected to be able to:

- identify which emerging technologies will be appropriate for academic libraries in the digital age;
- follow the currently developing trends of emerging technologies in dynamic and interactive academic library learning environments;
- predict which new emerging technologies could impact on future information resources, services, and teaching in excellence delivered by academic libraries in the coming years of the twenty-first century.

## Introduction

In the modern information society, academic libraries are information gateways built on the platforms of information technology. Simply speaking, an information gateway is a central location to access, collect, classify, process, retrieve, store, and transform data and information across applications, channels, databases, networks, platforms, and systems. In dynamic and interactive academic learning environments, modern information technology includes artificial intelligence, computer technology, digital technology, multimedia technology, network technology, telecommunication technology, video technology, web technology, and so on. Based on the discussion in the previous chapter of the three primary information technology architectures available at academic library settings, it is obvious that emerging technologies for academic libraries in the digital age are evolving from these technology fields. This book is not intended to be an encyclopedia covering every emerging technology in the twenty-first century, but I believe that we should pay special attention to the following technology fields where innovative emerging technologies could have most implications for academic libraries, librarians, and library information services in the digital age.

## Artificial intelligence

Artificial intelligence (AI) refers to science and engineering that explores how to simulate various issues and functions in the field of human

intelligence. AI technology fields cover perception, recognition, reasoning, the learning process, natural language, machine translation, games, chess, and so on. With the upsurge of new technological innovations in the field of artificial intelligence, the emerging technologies discussed further below should be watched closely.

## Machine translation technology

Machine translation (MT) technology is the technology that converts and translates one natural language into another natural language by means of relevant computer technologies. In the digital age, MT has a wide range of potential applications for multi-language situations in individual communications, office operations, business translations, and government activities, etc. Since academic libraries have been making efforts to become ubiquitous libraries – that is universal libraries permanently accessible from anywhere and at any time – in the coming years of the twenty-first century, any new advances in MT will no doubt be combined with multi-language support offered at academic library settings to promote global information distribution and dissemination. Although there are no current machine translation technologies providing 100 percent accuracy for the intertranslation of natural languages, new advances in MT technology have provided a reference for further enhancements and modifications of human translation. At the time of writing, the most powerful free machine translation systems used in academic libraries include the following:

- *AltaVista Babel Fish Translation*. The AltaVista Babel Fish Translation (*http://babelfish.altavista.com/*) is powered by SYSTRAN, which is headquartered in Paris, France (*http://www.systransoft. com/*). SYSTRAN is one of the leading software companies providing multilingual language translation software products and solutions for individuals, small businesses, and large enterprises. Currently, AltaVista Babel Fish Translation offers intertranslation among 12 major foreign languages: Chinese, Dutch, English, French, German, Greek, Italian, Japanese, Korean, Portuguese, Russian, and Spanish.
- *Google Language Tools* (*http://www.google.com/language_tools*). Google Language Tools is a comprehensive language translation tool supporting intertranslation among 12 natural languages: Arabic, Chinese, Dutch, English, French, German, Italian, Japanese, Korean, Portuguese, Russian, and Spanish. In addition, Google Language Tools, designed by Google, Inc., can search web pages written in 35 natural languages located in 79 countries and regions. Also, Google

Language Tools provides the Google Web Interface written in 117 natural languages and Google Domains located in 137 countries and regions.

## Speech recognition technology

Speech recognition technology, also called voice recognition technology, is an advanced technology that transfers human speech signals into corresponding text through a process of interactive human–machine communications. During the past twenty years, speech recognition technology has made such progress that speech recognition error rates have been lowered to the 5–10 percent level. As one of the highly interdisciplinary scientific technologies, speech recognition technology has broad potential application across a wide range of fields. A number of industrial giants, including Google, Ford, IBM, Microsoft, and Yahoo, etc., are making efforts to apply speech recognition technology to a variety of fields.

- *Windows Vista*. Microsoft has already embedded speech recognition technology in its new operating system Windows Vista. Microsoft (2007) declared that Vista allows users to communicate with their operating systems for a series of activities, such as 'start and switch between applications, control the operating system, fill out forms on the web, and dictate documents and emails in commonly used programs.'
- *Sync*. At the well-known global International Consumer Electronics Show (*http://www.cesweb.org/default.asp*) held in Las Vegas on 7–10 January 2007, Ford and Microsoft displayed Microsoft's new software called Sync, which has been exclusively installed in Ford, Lincoln, and Mercury models sold in North America. Driven by speech recognition technology, Sync allows drivers to play digital music and dial a mobile phone by means of voice instructions. Of course, it is still only a dream for drivers to be able to drive a car by oral instructions alone.
- *Voice recognition software in academic libraries*. In dynamic academic library learning environments, the wired computer keyboard and mouse have long been used to input instructions and data. Although wireless technology has stretched the working distance between human and machine, the wired computer keyboard is still a primary tool for inputting. However, speech recognition technology has innovatively changed interactive human–machine communication. Academic library users can utilize voice recognition software to write

their papers and select audio/video files from digital libraries. Speech recognition technology will become a powerful tool in assisting some disabled academic library users to access and locate electronic collections in the academic library. Joseph R. Zumalt, Assistant Professor and Assistant ACES Librarian at the Isaac Func Family Library of the University of Illinois at Urbana-Champaign in the United States, recommended Dragon Naturally Speaking (*http://www.nuance.com/naturallyspeaking/*) as one of the top examples of voice recognition software in academic library settings. *Information Technology and Libraries*, a peer-viewed professional journal, published Zumalt's comparative study of speech recognition software in December 2005. As a quick reference for academic libraries in pursuit of voice recognition software, a list of the top such software is also available from the website of ConsumerResearch.com (*http://www.consumersearch.com/www/software/voice-recognition-software/*).

## Computer technology: hardware

Computer technologies focus on designing, engineering, and manufacturing computer hardware and software and related applications as well as developments in various fields. Since computer technologies are widely used to access, deliver, retrieve, store, synthesize, and transform data and information in today's information society, we will focus on the hardware and software applicable to dynamic academic library settings. Inside academic libraries, traditional box-style computer workstations are still essential components in the academic information infrastructure. With the development of computer and wireless network technology, the remarkable emerging technologies discussed below will greatly improve the efficiency of computer information systems in academic libraries.

### *Multi-core CPU technology*

The CPU (central processing unit) is a computer's heart and controls, manages, and processes the data input. Generally, a computer's CPU consists of three modules: the logical CPU module, the control module, and storage units. In response to the modern challenge for high-speed, low-power consumption, and multi-tasking computing environments, many chip makers are exerting great efforts to design and develop the next-generation multi-core chip, comprising a single processor containing two

or more processing units. In 2001, IBM introduced the first dual-core chip called Power4. In early 2004, Sun Microsystems and Hewlett-Packard shipped their dual-core processors. Subsequently, AMD (Advanced Micro Devices, Inc.) displayed its own dual-core chip and in April 2005 Intel also produced its own dual-core processor. All these chip makers are concentrating on how to enhance chip performance instead of just increasing CPU clock speed. Thus, for the computer industry and computer users, the growth of multi-core technology has opened the gateway to the age of the dual-core and multi-core CPU. The adoption of multi-core CPU technology is another epoch-making milestone for innovative technical designs in the semi-conductor industry. At present, the global computing industry is making progress in migrating from 32-bit to 64-bit computing. In June 2005, AMD declared that it had made the first 64-bit chip in the world to process both 32-bit and 64-bit computing with better performance, better compatibility, and better security.

## *Next-generation notebook computers: tablet PCs*

Since the late 1990s, new personal computers, such as notebooks, wearable PCs, and pocket PCs, have been emerging in the market. However, in academic library environments, conventional PC workstations will remain the primary computing devices for accessing library information systems, although tablet PCs, as the new generation of notebooks, will greatly enhance mobile information computing environments in libraries. Compared to normal notebook computers, tablet PCs have several strong advantages ranging from extended power life, rotating liquid crystal display (LCD) screens, enhanced human–computer interfaces, handwriting recognition, advanced note-taking programs, multiple language support, ink and pen technologies, and so on.

First of all, tablet PCs have enhanced human–computer interactions. Human–computer interaction refers to the exchange and transfer of information between computers and human beings. The LCD screens in tablet PCs can be rotated 180°, which is very convenient for tablet PC users wishing to display or present information. Secondly, tablet PC users can use a special pen, called a stylus, to point, draw, move, or resize objects on the LCD screen. Moreover, handwriting on the LCD screen can be converted to standard text by handwriting recognition technology. Thirdly, tablet PCs have an enhanced software user interface and other features. Microsoft's integrated ink technology will make it

possible for tablet PC users to use a stylus (an input device for writing or drawing lines on a computer screen) or a finger to highlight and cross out text and images while running Microsoft Word documents or PowerPoint slides. This specific feature is very useful for academic administrators, executives, faculty, instructors, librarians, and other professionals to correct, edit, highlight, and modify compositions, manuscripts, memos, papers, reports, slides, and other text items, etc.

## PDAs

A PDA (personal digital assistant) is a hand-held computing device for computing and information access, retrieval, and storage. A PDA can function as a cellular phone, e-mail program, fax machine, and personal organizer and permits web browsing, etc. Unlike a regular cellular phone, a PDA uses a pen-shaped input device called a stylus to handle the human–machine interactions instead of using a keyboard input. Some new PDA models can also utilize the keyboard, the touch screen, or speech recognition technology to process instruction inputs. However, the latest technological revolution in PDA devices is the Apple iPhone, which combines the diverse functions of the cellular phone, the widescreen iPod, and the digital camera in an enhanced graphical user interface (GUI) environment. Some human–machine interactions can be completed via Apple's invisible touch-screen technology. On 9 June 2008, Apple finally released its iPhone 3G handset, equipped with a 3G Internet connection, GPS navigation, 16 GB flash memory, and so on.

To boost the chances of success for the Apple iPhone across the global market, Apple has strengthened its collaboration with Google. On 1 May 2008, Google declared that Google News is now available to Apple iPhone users from 33 countries in 16 languages. In fact, more importantly, the Apple iPhone is the perfect combination of PDA and Google web search engine. Apple iPhone is no longer a conventional cell phone. Instead, Apple iPhone has become an innovative mobile computing device to access, locate, store, transform, and transmit multi-format information with multiple language support. After reviewing the Apple ads at *http://www.apple.com/iphone/*, readers will understand why Apple iPhone is leading a new developing trend in mobile computing and mobile telecommunication in the digital age.

The release of the Apple iPhone 3G demonstrates that wireless communication in the digital age has reached another new phase. Led by smartphones such as the Apple iPhone 3G, cell phones will become primary mobile devices to access, process, retrieve, synthesize, store,

transform, and transmit information in the digital age. Locating and accessing library information resources, services, tutorials, and other supporting programs on the Internet platform is now a reality for library users with cell phones such as the Apple iPhone 3G.

## Solid-state drive

As one of the latest achievements in computer hardware, a new type of data storage device called the solid-state drive (SSD) has been attracting more and more serious attention, especially after Samsung Electronics (*http://www.samsung.com*) displayed its 64GB SSD at the 2008 International Consumer Electronics Show (*http://www.cesweb.org/*). In appearance, an SSD looks no different to a conventional hard disk. However, an SSD uses a flash-memory-based storage medium instead of rotating magnetic media for data storage. Since it does not contain any rotating platters, the SSD has particular features such as an anti-high temperature, anti-seismic structure, high-speed data access and storage, low power consumption, and higher reliability. Thus the SSD is the most suitable solution for any specific situation requiring high reliability in a hostile environment, including aerospace, automotive, aviation, defense, earthquake monitoring, electricity, health care, intelligence, network monitoring, public security, video monitoring, and so on.

However, the biggest disadvantage of the SSD lies in data recovery. With traditional data storage media such as disks or magnetic tapes, parts of the data still might be saved if the storage media are damaged, but it is almost impossible to restore lost data once the flash chips of the SSD are damaged. Current data recovery approaches have not come up with a solution once the flash chips of a SSD are broken or its electrical circuits have degraded.

In addition, at current market prices, the SSD is still too expensive for regular computer users, although Dell has been installing the SSD in some of its high-end notebooks. However, some experts predict that the SSD will become more popular in the mainstream PC market of 2008. Nevertheless, there is still a long way for the SSD to go, since the data storage capacity of the traditional hard disk has reached 1TB.

## USB flash drive

The USB (universal serial bus) is an external serial bus standard supporting data transfer between a computer workstation and other peripherals, such as mice, digital cameras, flash drives, hard drives,

joysticks, keyboards, printers, scanners, speakers, and webcams, etc. The current USB 2.0 Standard supports data transfer up to 480 Mbps (short for **m**ega**b**its **p**er **s**econd). In today's academic library computing environments, academic library users need portable and high-capacity data storage solutions. The USB flash drive and the USB hard drive will become more and more popular, since they are the best solutions for satisfying dynamic computing tasks in the future.

- *The USB flash drive*, also called the universal smart drive, is a lightweight, removable, and rewritable data storage device. The data storage capacity of USB flash drives ranges from 16 MB to 32 MB, 64 MB, 128 MB, 256 MB, 1 GB, 2 GB, 4 GB, 8 GB, 16 GB, 32 GB, and even 64 GB (see below). In comparison with conventional floppy disks, zip disks, compact disk recordable (CD-R) disks, compact disk rewritable (CD-RW) disks, digital video disk recordable (DVD±R) disks, and digital video disk rewritable (DVD-RW) disks, the USB flash drive has many advantages such as the following:
  - *Compatibility*. The USB flash drive is compatible with different computer operating systems (Windows 98/2000/ME/XP/Vista, Mac 8.6 and higher, and Linux 2.4.x).
  - *Easy connection*. The USB flash drive does not need any software installed to operate it. Users just need to know how to plug and play.
  - *Easy use*. Compared to CD-R, CD-RW, DVD±R, or DVD-RW disks, users never need to format and burn their USB flash drives.
  - *Global access*. The USB flash drive does not need an external power supply. It can be used globally without electrical voltage limitations.
  - *Large memory capacity*. The USB flash drive has various memory storage capacities for academic students and faculty to download and store data in their daily study and work. A USB flash drive with 1 GB, 2 GB, 4 GB, or 8 GB capacity, for example, can store more data than one conventional CD-R or CD-RW disk. At the time of writing, the world's largest capacity USB flash drive, the Kanguru Flash Drive Max (*http://www.kanguru.com/flashdrive_max.html*) produced by Kanguru Solutions, Inc., has an enormous 64 GB storage capacity.
  - *Low cost*. The price of the USB flash drive is continuing to fall, which will be of benefit for users choosing large-capacity USB drives.
  - *Portable*. The USB flash drive is a very lightweight device and is very easy to carry.

  - *Rewritable*. Data saved in the USB flash drive can be easily copied and deleted.
- *The USB hard drive*, compared to the USB flash drive, is more powerful but more bulky. Available in capacities of 40 GB, 80 GB, 100 GB, 120 GB, 160 GB, 250 GB, 300 GB, 500 GB, 750 GB, and 1 TB, the USB hard drive can easily back up, store, and transfer large amounts of data without any capacity problems for library users. While the USB flash drive cannot compete with the USB hard drive in terms of capacity, the USB flash drive has a number of advantages which the USB hard drive cannot offer.

## Computer technology: software

Common computer software installed at academic libraries includes anti-virus software, computer programming software, database software, desktop publishing software, digital asset management software, groupware, multimedia software, speech recognition software, spreadsheet software, web publishing software, word processing software, etc. Since this book is not intended to be a computer software encyclopedia, we only focus on the most common computer software applicable to academic libraries. Naturally, we start with the next-generation computer operating systems as without them no computer software can be run.

### *Next-generation operating systems*

An operating system (OS) is a program to control and manage computer hardware and software. An OS is the soul of a computer system. It has been recognized that new 64-bit operating systems will better support computer software processing after chip makers release 64-bit CPUs. The dominant computer operating system in academic libraries at present is still Microsoft Windows. Only a very small percentage of academic library computer workstations are tuned to the Apple Mac OS. Normally, most academic library users use Windows to handle their daily activities, such as checking e-mails, surfing on the Internet, writing papers, and so on, although some prefer to use the Mac OS to handle their multimedia projects.

#### Windows Vista

On 30 January 2007, Microsoft formally unveiled its latest operating system Windows Vista (formerly having the code name 'Longhorn') to the

general public. Although Microsoft promised a lot of attractive features, such as an enhanced user interface, better system security, improved performance and reliability, Internet Explorer 7, and so on, a lot of computer experts are still not advising the general computer user to upgrade their operating system from Windows XP to Windows Vista. 'The Windows XP platform is remarkably stable, moderately secure and certainly able to host all the browser-based applications any business might desire,' commented Eric Lundquist, editorial director of the Internet magazine *eWeek,* in 2008. Academic libraries will have to face a critical decision over when to upgrade to the new operating system Windows Vista and how to deal with new security challenges.

On 9 May 2008, Microsoft released to the public its third and final 'Service Pack' (SP3) for XP, which immediately incurred a wave of complaints. 'According to the rush of disgruntled XP users, the SP3 download is causing all manner of problems with their computers including sudden system crashes, freezes, and reboot looping, which have subsequently forced many affected users to perform a full System Restore in order to get their computers up and running again,' reported Stevie Smith (2008). At the same time, John E. Dunn at the website of TechWorld.com warned that Windows Vista, like Windows 2000, still does not possess a basic level of protection.

## Windows 7

At the website of *InformationWeek* it was reported by Paul McDougall on 7 April 2008 that Microsoft might release Windows 7, the next-generation of the Windows operating system, by 2010 (*http://www.informationweek.com/news/windows/operatingsystems/showArticle.jhtml?articleID=207100040*). In addition, McDougall mentioned: 'To experience all of Vista's features, PC users need a computer with at least a 1 GHz processor, 1 GB of memory, and a 40 GB hard drive. By contrast, Windows XP Professional requires only a 300 MHz processor, 128 Mbytes of RAM, and a 1.5 GB disk.' On 27 May 2008 Microsoft Chairman Bill Gates and Microsoft CEO Steve Ballmer previewed Windows 7 at the sixth 'D: All Things Digital' conference held in California. Interested readers can watch the first official Windows 7 video which is available from YouTube.com (*http://www.youtube.com/watch?v=GqDQ0wUcSPQ*). It is clear from this video that Microsoft's Surface Computing Technology, together with other related advances in digital technologies, multimedia technologies, network technologies, web technologies, etc., will become one of the primary technological features of the future Windows 7.

More information about Windows 7 may be found in a short article titled 'Seven things you need to know about Windows 7: What will it do? When will it launch? Here's the lowdown,' which appeared on Techradar.com on 21 August 2008 (*http://www.techradar.com/news/software/operating-systems/seven-things-you-need-to-know-about-windows-7-454790*).

## Windows 8: Midori

On 4 September 2008 it was reported by Ed Scannell and Mary Jo Foley on Redmondmag.com (*http://redmondmag.com/reports/article.asp?EditorialsID=779*) that Microsoft is developing a non-Windows-based operating system named 'Midori.' Although there is little detailed information available at present, it nonetheless shows that Microsoft has clearly realized that the future of sharing and exchanging information in the digital age has already been switched from Windows to the Internet platform. The prosperity of the Internet and WWW has made inevitable competition between Microsoft and Google, a new and growing web giant with leading web technologies, for control of the web markets. Sooner or later, it will be a time for the Windows operating system to exit after over twenty years of service for the entire computing industry. With its successful control since the 1980s of the personal computer (PC) market via the various Windows operating systems, Microsoft has a dream that Midori, its new operating system running on the Internet platform, will become one of its new secret weapons in the fight to regain control of global information exchange and sharing in the coming years of the twenty-first century.

## Mac OS X

In the first half of 2005, Apple released the Mac OS X Tiger with over 200 so-called new features, among which two major features give Mac users a different experience of using this new operating system. The first is Spotlight, which is designed to search for any files, images, e-mails, and other contacts within the computer system very quickly. The second feature is Dashboard, which is an integrated user interface to track information about calendar, flights, personal contacts, stocks, the weather, etc. On 26 October 2007, Apple released its latest Mac OS X Leopard, Mac OS X version 10.5, for Mac computers. Like Windows Vista, the Mac OS X Leopard will accelerate the migration of computer

software from 32-bit to full 64-bit processing. Claiming to have over 300 enhancements, Apple's Mac OS X Leopard is expected to snatch more market share from Microsoft's Windows Vista.

### Linux operating system

Linux is a Unix-type operating system. Compared to other operating systems such as Windows or Mac OS X, Linux does not have a consistent visual interface. To promote the Linux desktop deployment, the Linux Tango Project was initialized in October 2005 to design key functions across multiple desktop environments. It is still unclear how Linux will penetrate academic library computing environments in the future, although it has become more popular for business enterprise information systems.

## *Office software*

Inside academic libraries, the most common office software is Microsoft Office Suite software, in addition to Corel WordPerfect Office software. Although Microsoft Office Suite software dominates academic learning environments, Microsoft has had to face more and more strong challenges from other vendors.

### Microsoft Office Suite 2007

On 30 January 2007, Microsoft formally released its Microsoft Office 2007 to the general public, offering an enhanced GUI with more user-friendly tools. Among the list of enhanced and integrated features, Microsoft Office 2007 allows users to export and save their files in the PDF (Portable Document Format) and the XPS (XML Paper Specification) formats. The XPS format is an electronic document format designed and developed by Microsoft. As a powerful tool up against the Adobe PDF format, Microsoft's Office 2007 Suite, including Word, Excel, PowerPoint, Access, Publisher, Visio, OneNote, and InfoPath applications, will provide XPS portable document format support. The XPS format also allows users to attach digital signatures and digital rights with their documents. Also, a new search tool called OneNote 2007 will assist users to search all contents they have created and saved, including audio files, clippings, texts, images, and videos, etc., on the hard drive. Unfortunately, Microsoft Office 2007 does not include any web page development tools. Users have to purchase these separately at additional cost.

## EI-Office 2007

In October 2002, a little-known Chinese computer company called Evermore Software (*http://www.evermoresw.com/weben/index.jsp*) released its first version of Evermore Integrated Office (EI-Office) to challenge Microsoft Office. The latest version of EI-Office is EI-Office 2007.

The biggest advantage of EI-Office 2007 is that it provides one integrated application environment for users to perform word processing, spreadsheet applications, and presentation applications, instead of a collection of different software. For example, the current Microsoft Office 2007 Suite does not provide users with one integrated user interface to handle multiple complicated tasks which include word processing, spreadsheet applications, database applications, presentation applications, desktop publishing, and web publication. Microsoft Office users have to use different software to complete their tasks, which could cause some file-transfer or file-sharing problems among the different user interfaces.

In addition, EI-Office 2007 supports multiple operating systems such as Windows and Linux, and can convert Word documents into multiple formats including Adobe PDF without additional software. Also, EI-Office 2007 provides multiple-language support including Chinese (Simplified and Traditional), English, French, and Japanese. Evermore Software is now developing EI-Office support for Mac OS X and Solaris.

## StarOffice 8

Sun Microsystems released the newest version of their office software suite StarOffice 8 (*http://www.sun.com/software/star/staroffice/index.jsp*) on 27 September 2005. Unlike Microsoft Office 2003, StarOffice 8 integrates and enhances more powerful features for users to perform word processing tasks, spreadsheet applications, presentations, drawings, and database operations. StarOffice 8 supports multiple operating systems such as Windows, Linux, Mac OS, and Solaris. StarOffice 8 can help users convert Word documents into multiple formats such as HTML and Adobe PDF. In addition, StarOffice 8 has a more powerful function for users to import database files from MySQL and Oracle. According to the 43 StarOffice 8 user reviews available at the website of Sun Microsystems, most users agree that StarOffice 8 offers strong features and high performance. However, some of the 43 users complained that StarOffice 8 is let down by a slow startup and data loss when moving between Word and spreadsheet documentation. It is to be hoped that Sun Microsystems will solve these issues in its latest patches and updates.

## OpenOffice.org 2

OpenOffice.org 2 is the innovative open-source office software suite developed by OpenOffice.org (*http://www.openoffice.org/index.html*), which is supported by Sun Microsystems (*http://www.sun.com/*). OpenOffice.org 2 supports multiple operating systems: Microsoft Windows, Solaris, and Linux, and also provides support for 45 foreign languages in addition to English. The latest OpenOffice Suite version is OpenOffice.org 2.4.1. It contains software covering word processing called WRITER, a spreadsheet called CALC, multimedia presentation software called IMPRESS, database software called BASE, 3D graphic software called DRAW, and a specific Math tool to create various mathematical signs and equations.

## Corel's WordPerfect X4

Formerly produced by Novell, Corel's WordPerfect Software Package (*http://www.corel.com/servlet/Satellite/us/en/Product/1207676528492*) is only used by a very small percentage of academic libraries. The latest version of Corel's WordPerfect is WordPerfect Office X4, of which there are three different versions: the Standard Edition, the Professional Edition, and the Home & Student Edition. Compatible with Microsoft Office products, Corel WordPerfect Office X4 offers more enhanced features such as creating and editing PDF documents without additional software. For example, Corel WordPerfect Office X4 – Standard Edition contains the word processing software WordPerfect X4, the spreadsheet software QuattroPro X4, the presentation software Presentations X4, WordPerfect Mail, the data analysis software Visual Intelligence Set, the web-connected digital notebook WordPerfect Lightening, and additional software tools. Based on his review of Corel WordPerfect Office X4 – Standard Edition published on the website of PC World, Matthew MacDonald questioned the overstated compatibility of Corel WordPerfect Office X4, including imperfect PDF document conversions, awkward QuattroPro charts, and so on. In addition, the fatal weakness of Corel's WordPerfect Office X4 is that it can only run under Microsoft's operating systems Windows XP and Windows Vista, which limits the deployment of WordPerfect for users running other operating systems.

## IBM Lotus SmartSuite

IBM Lotus SmartSuite 9.8 is the latest offering from IBM (*http://www-01.ibm.com/software/lotus/products/smartsuite/*). It includes Lotus 1-2-3

Word Pro Freelance Graphics, Lotus Approach, Lotus Organizer, Lotus FastSite, and Lotus SmartCenter. Like Corel's WordPerfect Office 12, IBM Lotus SmartSuite 9.8 can only run under Microsoft's Windows operating systems. While IBM Lotus SmartSuite still holds some market share among enterprise users, in general it is rare to see IBM Lotus SmartSuite software in academic libraries.

## *Database management systems*

A database management system (DBMS) is a computer software program to handle data definition and manipulation and provide data control. Databases are widely used in academic libraries as primary repositories for large collections of specific records, files, and other information. Technically speaking, databases can be divided into four categories – flat file, network, relational, and object-oriented – depending on the mechanism used to organize, store, update, and access the data structures. In academic libraries, four leading relational databases are widely used.

### MySQL

MySQL is among the world's most successful open-source database software applicable to academic learning environments. For small- and medium-sized academic libraries, MySQL is recognized as one of the key components of LAMP (Linux, Apache, MySQL, PHP/Perl/Python) evolving in the fast-growing enterprise computing markets. MySQL offers two different packages for customers with different needs: MySQL Community Server and MySQL Enterprise. MySQL 6.0 Community Edition – Alpha Development (*http://dev.mysql.com/downloads/mysql/6.0.html*) is the latest release from MySQL to provide enhanced and new business features, including stored procedures, triggers, cursors, views, information schema, and distributed transactions, to support enterprise operations. Also, MySQL 6.0 Community Edition – Alpha Development added one 'SELECT … FOR UPDATE' function and fixed a list of bugs. In addition, MySQL offers MySQL Enterprise to support enterprises and institutes of higher education in the handling of their highly reliable, scalable, and secure business applications.

MySQL Enterprise is composed of three modules: MySQL Enterprise Server, MySQL Enterprise Monitor, and MySQL Production Support (*http://www.mysql.com/products/enterprise/?rz=gdl*). Combined with

so-called 'Web 2.0 technologies,' the latest release MySQL Enterprise 2.0 is designed to support data-driven web-based enterprise applications, architectures, and other related frameworks (*http://www.mysql.com/industry/enterprise2/*). On 26 February 2008, Sun Microsystems declared that it had completed the acquisition of MySQL for US$1 billion, which also raised concerns over whether Sun Microsystems, the new owner of MySQL, will continue to keep the original open-source technical features MySQL used to provide freely open to their customers.

## PostgreSQL

PostgreSQL, like MySQL, is another example of open-source database software well known around the world. PostgreSQL 8.3 (*http://www.postgresql.org/*), released by the PostgreSQL Global Development Group, is the latest powerful open-source relational database management system. It supports all major operating systems such as Linux, Windows, and Unix. Utilizing SQL92 and SQL99, PostgreSQL 8.3 is also designed to support the storage of binary data including audio, images, and videos. However, Alan Williamson, chief technology officer at Blog-City, a professional self-publishing company in the UK (*http://www.blog-city.com/*), thinks that 'the open source database PostgreSQL was also an option, but the Java database connectivity driver support was not sufficient at the time, and community support for the operating system was not as great as that for MySQL.' For more detailed information, readers should refer to Arif Mohamed's complete interview with Alan Williamson, published by *Computer Weekly* on 19 February 2008.

## Oracle

Oracle is recognized as the world's top relational database management system (RDBMS) with a high reputation for performance, reliability, scalability, and security for mission-critical enterprise applications running under computing environments. Oracle 11g (*http://www.oracle.com/technology/products/database/oracle11g/index.html*) is the latest release designed for high-end enterprise applications running under multi-core/multi-CPU server environments. To tackle the growing challenges from other competitors, Oracle has strengthened its cooperation with its allies. At the Oracle OpenWorld Conference held in San Francisco on 11–15 November 2007, Cisco offered its new protocol called Reliable Datagram Sockets (RDS) to boost Oracle 11g's performance. Lewis Cunningham, an experienced Oracle ACE and

a Senior Solutions Architect at EnterpriseDB Corporation, has compiled a comprehensive list of Oracle 11g New Features at *http://www.dba-oracle.com/oracle11g/oracle_11g_new_features.htm*. After completing its acquisitions of web application test tools Empirix and middleware BEA Systems, Oracle is proving to the world that it is continuing to expand its power in today's IT markets.

### Microsoft SQL Server

Microsoft SQL Server is another world-class advanced relational database management system. To meet growing challenges and dynamic needs for information storage, Microsoft finally released its latest relational database management system (DBMS) SQL Server 2008 (*http://www.microsoft.com/sqlserver/2008/en/us/default.aspx*) at the end of February 2008. SQL Server 2008 provides enterprise users with a wealth of services such as data query, data analysis, data reporting, data integration, data synchronization, data search, and data storage, etc. SQL Server 2008 mainly enhances and integrates primary functions in three key areas: enterprise data management, developer productivity, and business intelligence. Aiming at Oracle 11g, Microsoft offers a free download of SQL Server 2008 Community Technology Preview (CTP). To organize and manage productive, scalable, and secure corporate data flow, SQL Server 2008 is a very good option for mission-critical business applications running in Microsoft Windows operating systems.

## *Collaborative software*

### Microsoft Groove 2007

Groove Network's Groove Virtual Office was one of the most successful examples of software facilitating team collaboration and communication through a corporate intranet and web browser. This software made it possible for team members to simultaneously share, modify, and manage Word documents, proposals, projects, records, and other information created by Microsoft Office. After the acquisition of Groove Network in 2005 for an undisclosed sum, Microsoft integrated Groove Network's Groove Virtual Office into its own Microsoft Office System (*http://office.microsoft.com/en-us/groove/default.aspx*). The successful integration of Groove Virtual

Office into Microsoft provides enterprise customers with access to complete collaborative intranet, extranet, and web projects running on multiple computing platforms.

## Open-source software

Open-source software provides free access to the source code, free software customization, and free software distribution. Apache, Eclipse, JBoss, Linux, Mozilla, MySQL, PostgreSQL, Tomcat, and OpenOffice .org 2 are the most well known and successful among the thousands of examples of open-source software. In academic library environments, Apache, Mozilla, MySQL, PostgreSQL, and Tomcat are the five leading open-source software products used in web-based academic library information technology architectures.

In the future, any new open-source software in the fields of database management systems, digital copyright protection, digital file management, e-mail, image creation, instant messaging, integrated library systems, office software, operating systems, visual sharing, web content management, web servers, and so on will be widely integrated into web-based academic library information architectures. For example, more and more academic libraries around the world have shown their strong interest in LAMP (Linux, Apache, MySQL, and PHP), which are essential components for building up open-source web-based information technology architectures in academic library settings.

Interested readers can find a great many open-source software products available on the Internet. The OpenSourceWindows.org (*http://www.opensourcewindows.org/*) displays a list of the best and most well-known open-source software for Windows, while OpenSourceMac.org offers a list of free open-source software for Mac OS X (*http://www.opensourcemac.org/*). Java-Source.net provides a list of open-source software in Java (*http://java-source.net/*). The World Wide Web Consortium (W3C) also provides a list of recommended open-source software (*http://www.w3.org/Status*). The United Nations Education, Scientific and Cultural Organization (UNESCO) (*http://www.unesco.org/cgi-bin/webworld/portal_freesoftware/cgi/page.cgi?d=1*) has created a web portal to boost the 'free software and open-source technology movement.' Surprisingly, open-source software is also widely used to design and develop integrated library systems (ILS). The most successful open-source integrated library systems (ILS) applications include the following.

### Koha

Koha (*http://www.koha.org*) claims to be the world's first fully-featured enterprise-class open-source integrated library system (ILS), and was initially designed and developed by Horowhenua Library Trust and Katipo Communications in New Zealand. The complete Koha modules include acquisition, branch relationships, cataloging, circulation, OPAC (Online Pubic Access Catalog), pattern management, reserves, serials, and so on. At the time of writing Koha version 2.2 is the latest offering.

### OpenBiblio

OpenBiblio (*http://obiblio.sourceforge.net/*) is a free and open-source integrated library system for managing school library collections. Designed and developed by PHP (Hypertext Preprocessor), the application covers functionalities which include OPAC, cataloging, circulation, and related library staff management, etc.

### PhpMyLibrary

PhpMyLibrary (*http://www.phpmylibrary.org/*) is an integrated library system built by PHP and MySQL. Its automated application modules include cataloging, circulation, and WebPac. The system also has import-export functions. The whole application strictly follows the USMARC (United States Machine-Readable Cataloging) standard, a technical format standard for bibliographical records in the library, to register library materials. Currently, PhpMyLibrary is available for small libraries worldwide that only check in and out between 10,000 and 100,000 library items.

## *Web publishing*

Generally speaking, web publishing is the process of designing, developing, initializing, and implementing a website through a web server. For a long time, Microsoft FrontPage and Adobe (formerly Macromedia) Dreamweaver have been the most popular web publishing software available in academic libraries. With strong features of WYSIWYG (what you see is what you get), these two examples of web publishing software are available for academic library users to design and develop their web pages and websites. Both Adobe and Microsoft have offered new products for web publishing.

### Adobe Dreamweaver CS3

This is the latest innovative web development tool for the design, development, and maintenance of web applications and websites. Dreamweaver CS3 (*http://www.adobe.com/products/dreamweaver/*) provides web developers with more powerful features to handle web page frames, CSS (cascading style sheets) layouts, browser capability checks, and web menus, etc. in a new enhanced API (application programming interface). Together with Adobe Flash CS3 Professional, Adobe Fireworks CS3, Adobe Contribute CS3, Adobe Photoshop CS3, Extended, Adobe Illustrator CS3, and Adobe Acrobat 8 Professional, Adobe Dreamweaver CS3 is embedded into Adobe Creative Suite 3 Design Premium, a new integrated software suite used to design, develop, enhance, and maintain interactive and mobile websites and web applications focusing on high quality and enterprise productivity.

### Microsoft Expression Web Designer

FrontPage 2003 is the final version of FrontPage available on the commercial market. As a strong competitor, FrontPage is well known for its user-friendly API, fast learning curve, and lower price favored by a lot of entry-level web-page designers. On 14 September 2006, Microsoft finally unveiled Expression Web Designer (*http://www.microsoft.com/Expression/*), which totally replaced FrontPage 2003. Microsoft Expression Web Designer is not old wine in a new bottle but offers an enhanced and integrated API with better control of XHTML (Extensible Hypertext Markup Language), CSS, and XML (Extensible Markup Language) for web designers and web developers.

## Digital technology

Simply speaking, digital technology is an innovative electronic technology to convert data from analog form (electronic signals) to digital binary form (numeric number '1' or '0') and disseminate, process, record, store, and transmit such data through computers, networks, and other electronic devices as well as peripherals. In the digital age, digital technology should not sound strange to the general public. If we consider the electronic products around us, we can easily see that a lot of digital products, such as digital cameras, digital music players, digital TVs, digital video recorders, and so on, are evolving in the marketplace. With the rapid

development of digital technologies, more and more innovative digital products and technologies are applicable to dynamic and interactive academic learning environments. Because of the limited scope of this book, we focus on just three digital technology fields where innovative emerging technologies are showing important implications for academic information resources, services, and teaching.

## Digital television

Digital television (DTV) is a new-generation television system which utilizes digital encoding technology to process collections, recordings, broadcasts, and transmissions of television programs. Compared to the traditional television, DTV provides the general public with massive numbers of television channels, high-definition pictures, high-fidelity stereo sounds, and independent on-demand services. According to the transmission medium, DTV can be categorized as digital cable television, digital satellite television, or digital mobile television. On 20 October 2005, the US Senate Commerce, Science, and Transportation Committee approved the setting of the deadline Tuesday, 17 February 2009 for switching to DTV in the US. At the time of writing, plasma, LCD (liquid crystal display), and MDTV (micro-display TV) with DLP (digital light processing) represent the highest level of DTV broadcasting technologies. However, digital TV only changes the signal format of TV broadcasting, and does not radically change the way TV contents are transmitted.

For academic libraries, the greatest benefit of DTV technology is its potential for the creation of powerful digital multimedia workstations. As long as a large-screen HDTV (high-definition television) set is wired to a PC workstation via a TV tuner card, multimedia software, and other audio/video equipment, academic library users will have access to a very powerful multimedia workstation on which to design and develop their digital multimedia presentations and projects. In addition, once it is connected with a high-speed Internet access, a DTV set will function as a top information gateway.

## Digital library

Built on the platform of the WWW, a digital library (DL) is an electronic information delivery system for disseminating digital library contents via computer technology, digital technology, multimedia technology, web technology, wireless technology, and video technology.

A digital library is different from a library digitization. A library digitization refers to the process of utilizing digital technology to electronically collect, compress, copy, scan, and transform digital information resources, including audio files, images, graphics, pictures, texts, and videos, etc. The digital library is thus an electronic information platform for accessing, locating, managing, and storing distributed digitized library information resources. In academic library settings, a digital content management (DCM) system is often used to ensure the successful initiation and implantation of digital library projects. The DCM system, also called a digital asset management (DAM) system, is a system to access, catalog, locate, and store digital products, such as images, music, and videos, etc. For academic libraries in the United States, CONTENTdm (*http://www.contentdm.com/*) is a common option for digital content management (DCM) in academic library settings. Also relevant here is digital rights management (DRM) technology, which has been designed and developed to allow digital copyright owners, such as distributors and publishers, to control and limit the usage of protected digital products, including movies, music, and software. The website of DRMWatch.com (*http://www.drmwatch.com/*) functions as one of the leading information resources for digital rights management (DRM) technology. To satisfy the demands for high-speed information exchange and sharing, the digital library and library digitization will lead to new innovative academic library information resources, services, and tutorials in the digital age. The Google Library, which has been attracting global attention, is leading the way in reshaping the global electronic library. The Google Library Project and other well-known global digital library projects will be further discussed in Chapter 7.

## *IPTV*

IPTV (Internet Protocol TV) is a new innovative emerging technology which utilizes the broadband cable network to transmit and receive television programs via the Internet platform. Combining digital technology, multimedia technology, and telecommunications technology, IPTV provides consumers with the capability to view TV programs either via a computer workstation or via a set-top-box converter wired up to an ordinary family television set. Functioning as a brand new information platform, IPTV provides consumers with a variety of online multimedia services, including watching digital TV programs, enjoying

IP video phones, playing DVD/VCD disks, surfing the Internet, exchanging e-mails, and engaging in other online business, educational, and entertainment activities. TVover.net (*http://www.tvover.net*), 'a leading weblog for news and information about IPTV, Internet TV, online video and related topics,' reported: 'The total number of IPTV households will grow dramatically over the next five years, rising from just under 6 million homes worldwide in 2006 to more than 80 million in 2011.' In comparison with digital TV, IPTV provides academic libraries with more media channels through which to offer their information resources, services, tutorials, and other programs via the Internet platform. From a long-term perspective, the rapid growth of IPTV will definitely impact on the future form and scope of academic library information services in the digital age.

## Instructional technology

In their well-known book entitled *Instructional Technology: The Definition and Domains of the Field*, authors Barbara. B. Seels and Rita C. Richey (1994) provided the following definition: 'Instructional Technology is the theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning.' Since then, their classic research result has been used as a basis to assess and evaluate diverse paraphrases and definitions of instructional technology. Rapid advances in computer technologies, digital technologies, multimedia technologies, network technologies, video technologies, and web technologies, etc. have greatly expanded the applications of modern instructional technologies in service-oriented and student-centered academic learning environments. In the digital age, computer-aided instruction keeps growing and changing around the world.

Traditionally, the core value of instructional technology is computer-aided instruction. In the digital age, instructional technology integrates artificial intelligence (AI), computer technology, digital technology, multimedia technology, networking technology, web technology, and video technology together to create various interactive teaching and learning environments. In academic libraries, instructional technology is widely used to promote and facilitate bibliographic instructions, distance learning programs, and virtual reference services over the Internet platform. The most well known examples of instructional technology are discussed below.

## Blackboard Technology

Blackboard (*http://www.blackboard.com*) is one of the leading providers of e-learning courseware applications and services. The so-called Blackboard Technology utilizes network technologies and web technologies to design and develop an online interactive teaching and learning environment on the platform of the WWW. Simulating the human learning process and behavior, the Blackboard Technology integrates the different activities of instruction and learning in an innovative enhanced networked GUI, which supports curriculum design, interactive learning design, online assessment, web content management, and so on.

On 12 October 2005, Blackboard announced that it had purchased its rival WebCT. For many years, these two companies had been two major pioneers in providing online learning management systems globally. Blackboard's products include the Blackboard Academic Suite and the Blackboard Commerce Suite. WebCT's products include WebCT Campus Edition and WebCT Vista. Blackboard's software has been accepted by more than 1,200 American school districts while WebCT software has been used by thousands of institutions in over 80 countries. After the merger, the combined company's over 3,700 academic clients will become the focus for promoting interactive and innovative e-learning projects all round the world. Also, the combined company's two leading online learning software products – Blackboard Learning System and Blackboard WebCT – are being used widely in wireless computing, videoconferencing, online interactive instruction, and instructor–student online communication.

After the successful acquisition of WebCT, Blackboard has continued to focus on product design enhancements, integrating its products into three categories: Blackboard Academic Suite, Blackboard Commerce Suite, and Blackboard Connect (*http://www.blackboard.com/products/Academic_Suite/index*). Blackboard Academic Suite is the most comprehensive e-learning software package in its product line, which contains:

- the Blackboard Learning System – Enterprise License;
- the Blackboard Learning System – Vista Enterprise License;
- the Blackboard Learning System – CE Enterprise License;
- the Blackboard Content System;
- the Blackboard Community System;
- the Blackboard Outcomes System;

- the Blackboard Portfolio System; and
- the Blackboard School Central.

To improve teaching and learning effectiveness through ongoing assessments and evaluations, Blackboard has now released Academic Suite Release 8.0 to boost online teaching and learning on the Internet platform. Focusing on access, communication, and instruction, Blackboard Academic Suite 8.0 provides an enhanced e-learning platform for faculty and students engaged in the service-oriented and student-centered twenty-first-century learning campus.

## The interactive electronic whiteboard

The interactive electronic whiteboard is a new of type interactive electronic instructional tool that integrates a computer, a blackboard, and a projector via touch-screen computer technology. The interactive electronic whiteboard can function not only as one stand-alone whiteboard, but also as an integrated and interactive touch-sensitive presentation screen. The interactive electronic whiteboard can e-mail, print, save, and scan drawings, images, graphs, notes, pictures, tables, texts, and other marks on its whiteboard. Connected with the computer network and the Internet, the whiteboard can be used in different teaching and learning situations, such as group presentations, interactive instructions, and teleconferences. As a quick reference for academic libraries, the website of the Electronic Whiteboards Warehouse (*http://www.electronicwhiteboards warehouse.com/*) offers a comprehensive collection of the leading interactive electronic whiteboards in the marketplace.

## Course management systems

Course management systems (CMS), also called learning managing systems (LMS), are widely used in a variety of online environments. From among the various CMS software, Moodle (*http://.moodle.org*), free open-source software designed to promote e-learning, has emerged to challenge Blackboard's dominating position in e-learning courseware applications and services. Claiming to have 'over 200,000 registered users speaking over 75 languages in 175 countries,' Moodle is attracting more and more users through praise and reputation, since 'it can scale from a single-teacher site to a 50,000-student university.' At the time of writing, the latest version to be released is Moodle 1.9.

# Multimedia technology

In the fields of computers and telecommunications, the most essential media are summarized as audio, image, text, and video, which are used for the dissemination, storage, and transmission of data and information. In the digital age, multimedia technology is an emerging technology which simultaneously collects, presents, records, stores, transforms, and utilizes more than one type of information media, including animations, audios, graphics, images, texts, videos, and so on. Multimedia technology refers to both the multimedia hardware and the software, including the chips, 3D graphics software, computer workstations, DVD players, earphones, networks, speakers, and so on. Based on the process of designing, developing, initializing, implementing, and maintaining multimedia applications, the future evolution of network bandwidth, software functionality, and web architecture will influence future advances in multimedia products and technologies. Academic administrators, executives, faculty, teachers, IT specialists, librarians, and other professionals believe that the innovative advances in emerging technologies discussed below will have a great impact on interactive multimedia experiences in dynamic academic learning environments.

## *SMIL*

SMIL (Synchronized Multimedia Integration Language) is a new markup language used by web developers to define and synchronize the sequential order of audios, animations, graphics, images, texts, and videos displayed on the Internet. Developed from the basic structure of XML (Extensible Markup Language), SMIL uses tags to define multimedia contents. SMIL is the technological basis for defining and synchronizing streaming media.

By studying the paper entitled 'Implementing an educational digital video library using MPEG-4, SMIL, and Web Technologies' by Marcelo Milrad, Philipp Rossmanith, and Mario Schulz (2005), readers will be able to see how SMIL can be used to design and develop an academic video library in Sweden. In December 2006, the W3C issued the new SMIL 3.0 draft version to define and synchronize multimedia presentations over the Internet.

## *Streaming media*

Streaming media, also called streaming video, refers to the display and transmission of a sequence of specially compressed digital media

content – such as animations, audios, graphics, photographs, texts, videos, and so on – to the end-user over the Internet. In the past, end-users needed to completely download and save the entire audio or video file on their local computers before playing or viewing these files. Unlike playing conventional audio or video files, a streaming media file does not need to be completely downloaded and saved before playing or end-users can start displaying them on a local computer. After part of a streaming media file has been downloaded and stored in the computer's cache, end-users can start viewing the file while the downloading and saving process is still continuing. The streaming media technology can save end-users' waiting time and a computer's storage space. Obviously, the streaming media data flow contains the three features continuity, real-time, and sequence.

In academic libraries in the United States, the primary software to play streaming media includes Microsoft's Windows Media Player, RealNetwork's RealOne Player, and Apple's QuickTime. With rapid advances in the field of hot streaming media technology, more and more streaming video production software, freeware, and shareware have made it possible for academic faculty, teachers, IT specialists, and librarians to design and develop specific web-based subject-oriented or service-oriented library tutorials. Adobe (formerly Macromedia) Captivate (*http://www.adobe.com/products/captivate/*) and TechSmith Camtasia (*http://www.techsmith.com/camtasia.asp*) are usually the two top tools selected during the process of designing and developing streaming media audio and/or video programs in academic libraries.

Based on their review of these two leading computer screen capture programs, John D. Clark and Qinghua Kou, two health system analyst programmers from the Eskind Biomedical Library of Vanderbilt University Medical Center in the United States, think that 'Camtasia's procedure of creating a presentation through an individual movie works best for developers who are familiar with video applications,' while 'editing content through slides in Captivate 2 is generally less tedious than the movie format used in Camtasia.' Therefore they recommend that 'developers wishing to produce content for the iPod will be limited to Camtasia, while those mainly interested in producing simulations will want to select Captivate 2.' In other words, the choice between these two different computer screen capture software products depends on which media formats and which presentation contents academic librarians decide to convert over the Internet platform. John D. Clark and Qinghua Kou suggest that academic libraries should select Camtasia to produce

lengthy presentations in 'a wide range of media formats.' Otherwise, Captivate is the best for its easy editing process and 'options for creating printouts.' At the time of writing this book, however, the latest versions of Adobe Captivate 3 (*http://www.adobe.com/products/captivate/*) and TechSmith Camtasia Studio 5.1 (*http://www.techsmith.com/camtasia.asp*) are also available. Academic library administrators, executives, IT specialists, and librarians can select the best computer screen capture software they need to convert their specific media formats and presentation contents.

### *VRML*

VRML (Virtual Reality Modeling Language) is an international standard defined by the International Organization for Standardization (ISO) for the display of 3D graphics on the WWW. The application of the next generation of the Internet (IPv6) and ultra-wideband networks will present brand new multimedia experiences. Using VRML, computer-simulated 3D virtual reality will become more realistic. In the near future, VRML will be widely used to define 3D web graphics, as long as a VRML browser or a VRML plug-in is embedded in the web browser. Examples of VRML files can be viewed at the Library of 3-D Molecular Structures (http*://www.nyu.edu/pages/mathmol/library/library.html*) of the MathMol Project developed by New York University and the ACF Scientific Visualization Center in the US (*http://www.nyu.edu/pages/mathmol/more.html*).

## Nanotechnology

Nanotechnology refers to the science and technology that designs, develops, and produces devices, structures, and systems at the atomic, molecular, or macromolecular level (approximately 1–100 nanometres). Generally speaking, nanotechnology products are manufactured by the assembly of atoms in ultra-micro environments. The arrangement of atoms determines the nature of the product. Nanotechnology has a close relationship with precision engineering. Among numerous nanotechnology products, the innovative advance discussed below should have revolutionary implications for the future development of the global news media, printing, and publishing industries, including libraries and museums, and so on.

## Electronic paper

Electronic paper, also called 'e-paper' or 'digital paper,' is a kind of ultra-thin, ultra-light electronic display. Electronic paper has the same features as traditional paper: thin, lightweight, flexible, mobile, and readable. Also, electronic paper has other super-digital features for information exchange and sharing in today's information society: large capacity storage; easy retrieval; easy copy, scan, and transmission functionality; embedded navigation; hyperlinks; relevant security protection; and so on.

Based on the rapid advances in electronic paper technology, electronic paper products can be divided into two categories in the marketplace: LCD and electrophoresis technology. Led by Fujitsu (*http://www.fujitsu.com/*) and Xerox (*http://www.xerox.com/*), LCD-based electronic paper is being developed that utilizes special liquid crystal materials and display modes instead of polarizing films or color filters to reduce the thickness of the monitoring device. In contrast, electrophoresis technology presents images by means of voltage changes applied to black-and-white microcapsules. E-Ink (*http://www.eink.com*), which was founded in 1997 in Cambridge, MA in the United States, represents the leading global manufacturer for non-LCD-based electronic paper display (EPD) supported by electrophoresis technology.

Since a Chinese named Cai Lun invented it in 105 AD, paper has been used as an essential medium for the exchange and sharing of information. Throughout history, paper has made incalculable contributions to the continuous development of human civilization. However, once the graphic contents are printed on the paper, nothing can be changed, which is the biggest shortcoming for the craft of printing with ink on paper and for duplication. In the modern information society, this fatal weakness of paper means it cannot meet the demand for information exchange and updating at high speed.

To promote information dissemination in the digital age, therefore, it has been a hard task to design and develop the next generation of paper – electronic paper. However, prompted by new innovative advances in nanotechnology, electronic paper has now entered the practical stage. Numerous manufacturers have started selling diverse e-paper reading terminals for digitized books, magazines, newspapers, and so on. The current e-paper reading terminals have remarkable features such as high-resolution, a wide viewing angle, and low power consumption, and are shatterproof. In the near future, electronic paper will have a bright outlook in many fields, including e-books,

e-newspapers, e-dictionaries, LCD displays for notebooks and tablets, PC accessories, etc. Electronic paper could mark a new starting point in the process of library digitization and the paperless information era.

## Network technology

A network consists of a group of computers linked by cables or other media. The purpose of a network is to exchange and share data and information. Network technology is a combination of computer and telecommunication technologies. Network technology is the backbone of data communication and information dissemination in dynamic and interactive academic learning environments. Since the beginning of the twenty-first century, wireless network technology has been shown to have a most promising future in academic library networking environments. Currently, the Institute of Electrical and Electronics Engineers (IEEE) Standard 802.11x dominates wireless networking in American academic environments. The current standard IEEE 802.11b (Wi-Fi) supports up to 11 Mbps in the 2.4 GHz band while IEEE 802.11g (Wi-Fi) supports up to 54 Mbps in the 2.4 GHz band. Similar to IEEE 802.11, the high performance radio local area network standard (HiperLAN), promoted by the European Telecommunications Standards Institution (ETSI), is the wireless local area network (WLAN) communication standard popular in European countries. HiperLAN/1 supports up to 20 Mbps in the 5GHz band while HiperLAN/2 supports up to 54 Mbps in the 5GHz band. In his book entitled *Wireless Networking Technology: From Principles to Successful Implementation*, Steve Rackley, Senior Business Consult at RDF Group, an IT services company in the UK, also made a comprehensive review of diverse wireless networking technologies for high data transmission bandwidth.

However, current wireless network technologies are suffering from three bottlenecks: speed, range, and price. At the present time, the wireless broadband network is still a supplement to or expansion of current existing cabled computer networks in academic library information technology architectures. In academic library settings, the real breakthrough in the wireless broadband network technologies may come from new advances in the innovative technologies discussed below.

## Bluetooth

The Bluetooth technology, an industrial standard for wireless personal area networks (PANs), is the wireless technology specified to connect devices such as desktops, digital cameras, keyboards, laptops, mobile phones, mice, notebooks, PCs, PDAs (personal digital assistants), printers, remote controls, and scanners, etc. within a short range. For example, academic librarians enjoy wireless computer mice, which are supported by the Bluetooth technology, to handle computer inputs or printouts.

## WiMAX

WiMAX (Worldwide Interoperability for Microwave Access), officially known as IEEE 802.16x, is specified as an alternative to cable and DSL (Digital Subscriber Line). WiMAX is a real long-range (up to 30 miles) and high-throughput (approximately 75 Mbps in the 10–66 GHz band) broadband wireless metropolitan access network (MAN). When WiMAX capabilities are embedded in PDAs and notebooks, academic library users will have real mobility with the ability to access high-speed networks or high-speed Internet via Ethernet when docked, via IEEE 802.11 within wi-fi hotspots or via IEEE 802.16 within cities or suburbs. In April 2007, Olga Zlydareva and Claudio Sacchi from the Department of Information and Communication Technology (DIT) at the University of Trento in Italy published a paper exploring the framework of WiMAX and the Universal Mobile Telecommunication System (UMTS) applicable to multiple existing 2G wireless communication standards in academic information technology architectures. With the growth of WiMAX (IEEE 802.16x), the capability of academic faculty and students to access, locate, and transmit large data files on the faster Internet platform will become a reality.

## Wireless USB

After years of development, a new fast wireless connecting technology called the wireless USB (WUSB) is expected soon to connect PCs and their peripherals, including fax machines, printers, scanners, and so on. WUSB devices possess the greatest short-range convenience and mobility. Comparable to the regular USB 2.0, the WUSB can transmit at speeds of

480 Mbps within a range of 3 meters and at speeds of 110 Mbps within a range of 10 meters. Since the power consumption of a WUSB is much lower than that of Bluetooth, all major computer vendors worldwide have planned to promote this new technology in the coming year. For example, NEC Electronics declared on 17 April 2007 that the company would be the first vendor in the industry poised to deliver certified WUSB chips. On its website on 4 January 2008, the Lewis Walpole Library, one of the academic library units of Yale University Library system in Connecticut, USA, released the information that 'Wireless USB adapters are available on a limited basis for laptops not equipped for wireless' (*http://www.library .yale.edu/walpole/ html/research/reader_guidelines.html*).

## Ultraband Network

In networking environments, the bandwidth refers to the frequency range for the transmission of data in a cable network. The bandwidth capacity of a network determines the power of the network transmission. The broader the bandwidth, the greater the amount of data that can be transmitted at a particular moment in time. The Ultraband Network is a broadband network that can provide sufficient bandwidth (scalable bandwidth from 5 to 1,000 Mbps or even higher) service. To solve network bottlenecks, the Ultraband Network is the best technological solution for transmitting digital multimedia files, including high-definition DVD-quality streaming videos, at high speed. For example, Crystal Communications, one of the leading suppliers of broadband access and equipment located in Los Angeles, California, USA, states it will provide 'Ultraband Internet Access (10 Mbps – 1000 Mbps Ethernet), and point-to-point Virtual LANs (100 Mbps – 1000 Mbps) between office locations' (*http://www.crystalcommunications.com/index.html*).

## UWB

UWB (Ultra-Wideband) refers to the most advanced short-range (up to 10 meters or 30 feet or so) wireless broadband PAN technology with a bandwidth over 500 MHz. In contrast to traditional wireless communication using radio waves, the UWB network can use short pulses to transmit a bandwidth of at least 500 MHz for linked cellular phones, computers, digital cameras, modems, set-top boxes, televisions, and other devices. Although Intel and Motorola are still arguing over the UWB standard, UWB technology with high bandwidth presents a prosperous

outlook for high-rate, short-range wireless network communications, especially for multimedia data and high-definition digital video communications. For more detailed information, readers should access the Intel web page at *http://www.intel.com/technology/comms/uwb/* to review current developing trends in UWB and Intel's UWB vision.

## Telecommunication technology

Modern telecommunication technology refers to technologies for voice and video communication as well as data transmission, including audio, animations, graphics, images, numbers, texts, videos, and so forth, via cables, radios, satellites, telephones, telegraphs, etc. With new advances in the Internet and WWW, telecommunication technology is laying down a solid foundation for further advances in the information highway in the digital age. To meet high-volume demands to access, locate, synthesize, and transform large amounts of information in dynamic and interactive academic learning environments, academic libraries around the world are striving to utilize intelligent telecommunication technologies and applications. We review below those evolving emerging technologies which could have great implications for academic telecommunications and academic library information services in the digital age.

### *3G telecommunication*

3G telecommunication refers to the third-generation wireless telecommunication for wide-area wireless cellular telephone networks. The first-generation wireless telecommunication introduced in 1995 could only process analog voice communications. The second-generation wireless telecommunication in 1996–97 added additional functions, such as checking e-mails and scanning web pages, in addition to normal digital voice communications. Compared to the previous two generations, 3G telecommunication can better process streaming media contents, including audios, graphics, images, texts, and videos, at much higher speed. 3G telecommunication is a powerful wireless communication technology for information services in the digital age, especially for e-commerce business activities, video conferences, and web information scanning, etc. The International Telecommunication Union (ITU) has already identified three major mainstream 3G communications wireless interface standards.

## W-CDMA (Broadband Code – Division Multiple Access)

This evolved from early studies in Japan and Europe to promote the 3G telecommunication standards. As one of the wideband wireless communication standards, W-CDMA transmits and supports scalable data transmission speed rates: 384 Kbs in the fast-moving status or up to 2 Mbps in the low-speed or indoor environment. W-CDMA is primarily supported by vendors in Europe, Japan, and the United States.

## CDMA2000

Also known as IMT-CDMA Multi-Carrier, this was originally developed by Qualcomm (*http://www.qualcomm.com/*) located in the United States. CDMA2000 is widely supported by Japan, South Korea, and other countries and regions in North America. The CDMA2000 standards include multiple radio interfaces: CDMA2000-1X, CDMA2000 EV-DO, CDMA2000 EV-DV, and CDMA2000-3X. CDMA2000-1X belongs to the field of 2G telecommunications, which only support data transmission at speeds of 307 Kbps (downlink) and 153 Kbps (uplink). CDMA2000 EV-DO and CDMA2000 EV-DV belong to 2.5G telecommunication. CDMA2000 1xEV-DO increases the average data transmission rate to between 300 Kbps and 600 Kbps, while CDMA2000 1xEV-DV integrates the data transmission rate at speeds of 4.8 Mbps. CDMA2000 3x belongs to 3G telecommunication. CDMA2000 3x uses three 1.25 MHz CDMA channels to reach higher data transmission rates. CDMA2000 is incompatible with W-CDMA and TD-SCDMA.

## TD-SCDMA (Time Division – Synchronous Code Division Multiple Access)

This is primarily supported by the People's Republic of China (PRC). In the competition for the international 3G telecommunication standards with W-CDMA and CDMA2000, China's TD-SCDMA has become one of the global 3G telecommunication standards recognized by the International Telecommunication Union (ITU). TD-SCDMA marks China's status as one of the most important wireless communication leaders in the twenty-first century. On 5 November 2006, it was reported by Xinhua News Agency, the official press agency of the government of the PRC, that 'China would offer 3G service in 2008 when the Olympic Games will be held.'

## *Instant Messaging*

Instant Messaging (IM) is an IP-based technology which can be used not only for real-time short text messages but also for online talk, video sharing, and web page access, etc. on the Internet platform. AOL Instant Messenger, Google Talk, Meebo, MSN Messenger, and Yahoo Messenger are the leading free IM applications running in American academic libraries. Yahoo and Microsoft have already successfully integrated their separate IM services. Now Yahoo Messenger users are able to communicate directly with MSN Messenger users on the Internet platform.

Another well-known advanced IM reference service management software is OCLC-QuestionPoint (*http://www.oclc.org/questionpoint/*), which provides academic librarians with stronger fee-based technical features, such as application sharing, co-browsing, escorting, page pushing, reporting, and so on, to handle 24/7 live chat references.

However, there are several limitations blocking further advances in IM services in academic libraries. First of all, not all IM users can communicate interactively across different IM applications. For example, Yahoo Messenger users cannot communicate with AOL's Instant Messaging (AIM) users. Secondly, it is not convenient for academic librarians to log into multiple IM accounts at the same time to support their specific IM users via AIM, Google Talk, Meebo, MSN, and Yahoo. Consequently a lot of academic libraries in the United States have started to use the multiple login platform provided by Meebo.com (*http://www.meebo.com*) to support their multiple IM system users. Thirdly, academic libraries still lack effective mechanisms to collect statistical data regarding their specific IM reference services. They need to know not only the number of IM users but also the classification of user questions within a specific time range. Although it does provide a GUI to log into multiple IM, Meebo.com (*http://wwwl.meebo.com/*) does not possess any functions for collecting IM reference statistics. Moreover, Meebo does not offer the same advanced features as QuestionPoint. Most academic libraries in the United States, for example, still have to manually open IM log files one by one to analyze and collect the data they need if they use Meebo or other open-source software to initialize and implant their specific IM services. It is a time-consuming process, especially for academic librarians working in a large academic library system.

## RFID

RFID (radio frequency identification), commonly known as electronic tagging, is a non-contact automatic wireless identification technology to track target objects at a distance (from a couple of inches to up to 20 or 30 feet away). The frequency of the RFID technology ranges from 50 KHz to 5.8 GHz. Through radio frequency signals, RFID automatically identifies targets and acquires data without manual intervention. The RFID identification process can work in various harsh environments. With features such as quick access and convenient operations, RFID technology can identify high-speed moving objects and multiple tags at the same time. A basic RFID system consists of the following components:

- *Labels* (tags) are composed of coupling components and microchips attached to identified objects. Based on different RFID systems, labels (tags) have different shapes and sizes. Currently, there are three different types of RFID labels (tags) available: passive, semi-passive, and active, which represent the different ways that the labels (tags) are powered.
- *Readers* are devices used to acquire (and sometimes are also able to write to) label (tag) information. Readers can be designed to be hand-held or fixed.
- *Antennae* are used to transmit radio frequency signals among tags and readers.
- A *server* is the middleware which handles information flows between labels (tags) and the existing computer database.
- A *database* is the primary repository which manages, processes, and stores target information.

As a new global advancement in wireless automatic identification technology, RFID has been developing rapidly in various industrial fields, such as access control, animal tracking, automobile anti-theft, clothing, defense, food security, identity recognition, logistics, manufacturing, medical care, parking control, retail business, traffic control, and so on. Compared to traditional barcode technology, RFID technology has many advantages, such as quick access, data encryption, long-range reading distance, great data storage capacity, and free information changes, plus it is waterproof, magnetically shielded, and resistant to high temperature, etc.

Although the theory behind RFID technology was initially formed in 1948, large-scale exploration for theoretical and commercial

applications of RFID did not begin until the 1990s. Since the mid-1990s, RFID technology has been rapidly advancing and is thriving in the age of the global economy. Many of the world's leading corporations, including Gillette, Philip Morris, Procter & Gamble, Wal-Mart, etc., have been promoting the application and further development of RFID technology. However, there are still many hindrances and obstacles that prevent academic libraries worldwide from applying RFID technology to academic library settings. Before they decide how and when to initialize and implement RFID solutions, academic library administrators, executives, IT specialists, librarians, and staff need to consider many key issues, such as those discussed below.

## Cost

Compared with conventional barcode technology, the high cost of developing and deploying RFID technology still makes many academic library administrators and executives cautious in switching to this rapidly developing state-of-the-art technology in academic library settings. For a medium or large academic library (system) with a collection of more than two million library items, there is no way of initializing and implementing a RFID system without huge start-up funds. Based on the average cost of RFID tags (7–15 US cents) as estimated by the website of RFIDJournal.com (*http://www.rfidjournal.com/faq/20/85*), an academic library with a collection of 2,000,000 library items needs at least US$140–300,000 for RFID tags, plus additional costs for RFID readers and servers, etc.

## Frequency

The RFID technology transmits radio signals via several frequency bands: low frequency (0–300 KHz), high frequency (3–30 MHz), ultra high frequency (433–960 MHz), and microwave frequency (2.45–1,000 GHz). Generally speaking, the low-frequency RFID systems offer a shorter scan range and lower costs. The current developing trend of commercial RFID technology is switching to the ultra high frequency (433–960 MHz), since it provides a longer scanning range and high network throughputs. However, the ultra high frequency RFID systems cannot penetrate fluids and metal so well. Academic library administrators, executives, IT specialists, librarians, and staff will need to select different RFID frequency bands based on specific user needs assessments, IT architectures, library working environments, operating budgets, training programs, and so on.

## Health concerns

How will the strong electromagnetic energy used in RFID technology potentially impact on the long-term health of library users and library staff? Unfortunately, there are no medical records worldwide to prove whether or not it is absolutely safe for long-term study and work in such a strong electromagnetic field, especially after chronic exposure to the strong ultra high or microwave frequencies emitted by RFID readers.

## Job security

RFID technology has proved that it can greatly improve the efficiency of library staff working in the circulation department, since RFID readers can scan library items at a distance, and to scan a target object, library staff do not need to open a book cover or touch a video case on the bookshelf. Although there are no reports of library staff layoffs after the implementation of RFID solutions in various libraries, the wide application of RFID technology would reduce the number of library staff and cut personnel expenditure from library operating budgets.

## Legislation and standards

In the face of new global advances in RFID technology, primarily promoted by tracking through the global supply chains, many countries around the world, including the United States, have not initialized related legislation and standards to oversee the implications of the further development of RFID technology in the modern information society. In the United States, there are no federal or state government codes, policies, rules, or specifications available for companies to follow when they collect, distribute, secure, store, and destroy RFID data they have scanned. In accordance with a report on the website of the RFID Law Blog:

> Several states, including California and Florida, are pursuing ePedigree requirements that may include RFID. There are also more than 20 states considering legislation to regulate RFID in some capacity. The role of the federal government versus that of the states is important for those in the RFID space to understand and determine how best to address their public policy interests. (*http://rfidlawblog.mckennalong.com/archives/cat-state-legislation.html*)

### Privacy

Current RFID technologies cannot prevent unauthorized access to library tag data, which includes author, title, patron information, check-in/check-out records, shelf location, etc. Therefore a patron's name and contact information could be revealed without consent. What is more important is that a patron's reading history and library records could be investigated for the sake of counter-intelligence surveillance and national security. The solution for this issue therefore is that library RFID labels (tags) should not contain any patron information.

## *VoIP*

VoIP (Voice over Internet Protocol) is an Internet-enabled technology to transfer digitalized voice signals over the broadband network. Since the communication is by means of the Internet, the cost of a phone call is only 10 percent or less of that of a regular phone call connected with a regular phone line. With the popularity of high-speed Internet broadband and lower costs for user connection, more and more people will select VoIP technology to experience more powerful Internet phone services in the digital age. Through a high-speed broadband connection at a low cost, VoIP technology enables you to use your computer to instigate a conversation PC to PC or to use a regular phone hooked up with a telephone adaptor to call anyone else around the world. At the receiving end, your digitalized voice is converted by VoIP either via a regular phone or via a computer hooked up with an earphone. Utilizing the Global IP Sound (GIPS) codec, VoIP has greatly improved voice quality over the Internet. Embedded within the Instant Messaging service and e-mail software, VoIP can empower academic libraries to promote and expand their distance learning services, virtual reference services, and other global collaboration services. A list of free open-source VoIP software is available at the website of voip-info.org (*http://www.voip-info.org/wiki-Open+Source+VOIP+Software*) for academic librarians who would like to explore free VoIP technology applicable to academic library settings.

# Video technology

Based on the definition set by Wepopedia.com, video technology refers to the recording, processing, and displaying of motion pictures and texts

via computer monitors, television sets, video recorders, and other display devices. In the digital age, video technology has become a very important part of multimedia technology. Combined with new advances in computer technology, digital technology, multimedia technology, telecommunication technology, and web technology, etc., video technology has enabled brand new experiences in accessing, locating, converting, transmitting, recording, storing, and displaying information and data in the digital age. The most encouraging breakthroughs in video technology are discussed below.

## Digital video technology

Digital video technology is technology which first uses the digital form (logic number '1' or '0') to encode, record, store, and transmit video signals and then to decode, reconstruct, and display the video signals on terminals. Digital video technology is a comprehensive system which combines digital encoding formats, digital signal processing, optical disk storage formats, digital tape formats, video compression technology, video connection formats, video display formats, video resolution standards, and so on. With new rapid advances in cutting-edge and emerging technologies, the range of applications for digital video technology has already expanded from traditional radios, recorders, telephones, and televisions to airplanes, automobiles, cameras, cellular phones, computers, networks, televisions, web applications, and so on. In the digital age, the further development of digital video technology depends on digital signal processors, digital video development tools, software for managing, recording, and compressing digital videos, and other relevant system technologies. The complexity of embedding digital video applications arises from more than just encoding, compressing, decoding, and optimizing audio and video signals. In the face of diverse technological formats and standards, engineers and technicians need a new comprehensive digital video development platform to run the low-cost video subsystems available and reduce video design complexity.

## DaVinci technology

DaVinci technology, an innovative emerging technology designed and developed by Texas Instruments, Inc. (*http://www.ti.com/*) in the United States, could solve all the technical problems in further enhancing and integrating digital video productions. On 8 September 2005, Texas

Instruments declared that it had successfully launched a new digital video software development kit (SDK) based on the Linux platform for digital video applications. Initially, DaVinci technology ran well on the Linux operating system. To leverage the power of digital signal processing and the development of digital video products, Texas Instruments declared on 13 February 2006 that it had released a new software development kit (SDK) supported by Microsoft's Windows Embedded CE operating system. On 15 May 2007, Opera Software and Texas Instruments also declared the availability of the Opera Web Browser to support DaVinci technology.

DaVinci Technology consists of the following four major components:

- DaVinci Software – which leverages and optimizes digital signal processing (DSP).
- DaVinci Development Tools/Kits – which are a set of complete system-level development systems.
- DaVinci Processors – which are DSP-based (digital signal processing) SoCs (system-on-chip) processors.
- DaVinci Support – which includes system integrators for hardware and software vendors using DaVinci technology.

To view this amazing video technology, interested readers can watch a short YouTube web movie titled 'Texas Instruments DaVinci™ Technology Spirit of Invention' (*http://www.youtube.com/watch?v=ODwtB6NLPIQ*) and thereby see how this innovative emerging technology will transform the impossible into the possible in the near future.

## Web and web technologies

The greatest scientific and technological achievements in the twentieth century should include the Internet and the World Wide Web, which thoroughly changed the way we communicate, entertain, live, read, study, teach, and work in the modern society. The Internet is the global network connecting world computers via the TCP/IP (Transmission Control Protocol/Internet Protocol), while the WWW is the method of accessing and disseminating hypertext documents via web browsers and web servers running over the Internet platform. In today's information society, it would be impossible for academic libraries to expand their information resources, services, and tutorials outside library buildings if

the Internet and WWW platform were lost. Consequently we will pay special attention to the following new emerging technologies which may drive a new wave of innovation for the Internet and WWW.

## Internet 2

First of all, some misunderstandings about Internet 2 need to be clarified. Internet 2 (*http://www.internet2.edu*) cannot represent the next generation of the Internet, because it does not create any standards or protocols. Internet 2 is merely a consortium that has attracted more than 200 American universities to design and deploy advanced networking applications to promote the next generation of the Internet in higher education environments. For academic administrators, executives, faculty, librarians, and other professionals, it is a mistake to assume that Internet 2 is one of the emerging technologies which could lead the future evolution of the Web in academic library settings.

## The next generation of the Internet: IPv6

When today's web users surf on the Internet, they use their unique Internet Protocol (IP) addresses, which are defined by Internet Protocol Version 4 (IPv4), to access web information. Originally, IPv4 was expected to support the current Internet at least until 2025. The biggest weakness of IPv4 is that in theory it can only support about 4,294,967,296 (about 4.29 billion) 32-bit unique IP addresses, that is less than one unique IP address for each person on the planet. According to the current speed at which the Internet is developing, IPv4 will not have sufficient IP addresses available to provide any new IP addresses by 2025. Also, IPv4 cannot efficiently support the mobile IP connection.

To solve the IP address exhaustion problem, IPv6, the new standard for the next generation of the Internet, has been established to support 128-bit next-generation IP addresses. It is reported by the IPv6 Forum (*http://www.ipv6forum.com*) that 35 task forces are testing and deploying IPv6 across the globe. Compared to Ipv4, IPv6 has more advantages including more IP addresses available, high-speed interconnection, efficient mobile IP support, enhanced cyber security, built-in quality services, multicasting and any-casting capabilities, and so on.

However, it would be wrong to assume the IPv6 is still some way off. In December 2004, China declared it had successfully launched the world's first IPv6-based next-generation Internet connecting 25

universities in 20 cities across the PRC. During the sessions of the Global IPv6 Summit on 12–13 April 2007, the Global IPv6 Forum (*http://www.ipv6forum.com/*), the international organization for advocating the next generation of the Internet, awarded the prize for 'Vanguard of the Global IPv6' to Professor Jianping Wu at China's famous QingHua University for his outstanding achievements in research and development of the next generation of the Internet (IPv6).

## China's new Internet: IPv9

On 25 June 2004, it was reported from the 'New Internet and Decimal Network Technology Proseminar' held in China's ZheJiang University that the Decimal Network Standard System Workgroup (DNSS Workgroup) had been set up for the research and development of the new IPv9 specification. The People's Daily Online (*http://english.peopledaily.com.cn*), one of the official websites controlled by the Chinese government, formally declared to the world on 24 July 2005 that 'China's Internet technology IPv9, being compatible with IPv4 and IPv6, has been formally adapted and popularized into the civil and commercial sector.' Since then, the PRC has applied for a patent for IPv9 and the PCT international patent (PCT/CN99/00166). With the copyright registration number (09-2000-A-003), China's IPv9 has also obtained copyright from more than 100 other countries.

Introduced by its founder Professor Xie Jianping, China's IPv9 is built upon a 10-decimal computing method. China's IPv9 has its own independent address protocol, nameplate protocol, transitional protocol, and digital domain name regulations and standards. Compatible with existing IPv4 and IPv6, China's IPv9 utilizes 10-digit phone numbers (Arabic numbers 0–9), instead of conventional English letters, to handle web navigations. According to James Seng, an Internet expert in Singapore:

> [China's IPv9] is basically a modified DNS server. The modified DNS will 'intercept' domain names which contain all numbers, and then forwards it to their own 'root servers' to be resolved. As it is based on DNS, it can resolve to an IPv4 or IPv6 address, and thus they can claim 'compatibility with IPv4 and IPv6.'

Based on its innovative decimal technology, China's IPv9 is particularly suitable for various web applications in the fields of banking, defense,

e-commerce, government agencies, insurance, public security, and telecommunication, etc., since they are related to a nation's critical economic activity and require a high degree of confidentiality and security. In terms of boosting its high-speed sustainable economic development and protecting its national assets in the virtual world, therefore, China's IPv9 is of importance for at least the following significant reasons.

- *China's IPv9 will break up the US monopoly of the Internet*. It is well known that America is retaining control of the current Internet. According to the records from root-servers.org (*http://www.root-servers.org/*), there are 13 Internet DNS (domain name system) root servers running in the world, all of which are located in America. Primarily, America sets up the rules of the Internet protocol and decides how to distribute IP addresses, which are the keys to navigation among websites worldwide. Hampered by the current Internet Protocol rules of IPv4 and IPv6, China has no way of setting up its own Internet DNS (domain name system) root servers.
- *China's IPv9 is intended to seize the high ground of information technology in the coming years of the twenty-first century*. The successful initialization and deployment of the debated IPv9 will assist China to gain the right to participate in the future development of Internet technology. Based on the decimal network technology, China will become only the second country after the United States to own and control root servers and the allocation of IP addresses.
- *China's IPv9 will boost China's ability to deal with unexpected international incidents via its independent Internet protocol*. For the sake of national defense and security as well as economic development, China needs to ensure that its 'virtual territory' will not be occupied just in case a large-scale international conflict was to occur in the future. With the promotion of IPv9, China will change its role from 'an Internet game player' to 'an Internet policy-maker and practitioner.' Obviously, China's IPv9 users will be able to navigate international websites (IPv4 and IPv6), while international IPv4 and IPv6 users cannot view China's IPv9 websites.
- *Based on the decimal network technology, China will be able to allocate more IP addresses for its own Internet users*. Limited by the IPv4 standard, it was reported that China had only been assigned some 29 million IP addresses by the end of 2004. Even though IPv6 can provide many more IP addresses than IPv4, China still has no idea how many IP

addresses will be allocated to Chinese Internet users. China needs more IP addresses, especially since it is determined to promote RFID, 3G and 4G telecommunication systems in the future. With the innovative IPv9, China will be able to own more Internet domain name resources.

All in all, there is still a long way for China's IPv9 to go before it could become a successful network standard recognized by most of the countries around the world. Since the global networking industry is still perplexed about China's IPv9, it is important to clarify some misunderstandings.

- *China's IPv9 does not represent the next generation of the Internet*. The technical standards of China's IPv9 have not been recognized by the Internet Engineering Task Force (*http://www.ietf.org/*), which is 'a large open international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet.' The Internet Corporation for Assigned Names and Numbers (ICANN) (*http://www.icann.org/*), which is 'responsible for the global coordination of the Internet's system of unique identifiers,' has not accepted China's IPv9 either. In other words, China's IPv9 is only an alternative global network standard and is recommended only by China. China's IPv9 could be developed and deployed as an alternative to the global network.
- *IP addresses*. Limited by the technical features of 10-decimal telephone numbers (2 decimal numbers for the country code + 8 decimal numbers for the local phone number), there is no way for China's IPv9 to replace the next generation of the Internet IPv6. China's IPv9 cannot compete with the next generation of the Internet IPv6 and provide more unique IP addresses for every conceivable reason. Though China's IPv9 can provide eight times more IP addresses than IPv4, IPv6 can support 128-bit IP addresses, i.e. $2^{128}$ (about $3.4 \times 10^{38}$) unique IP addresses for global Internet users.
- *Cultural, historical, and social conflicts*. Due to different cultural, historical, and social backgrounds, it is impossible for English-speaking countries to give up their Internet domain names spelled in English, to say nothing of giving up world-renowned English IP addresses, such as 'Amazon.com,' 'AOL.com,' 'BBC.co.uk,' 'Ebay.com,' 'Google.com,' 'MSN.com,' 'MySpace.com,' 'Yahoo.com,' 'YouTube.com,' etc., for 10-decimal telephone numbers. Compared to China's IPv9's flat 10-decimal telephone numbers, moreover, IP addresses spelled in meaningful English are much more easily memorized by Internet users.

## *Semantic Web*

Semantic Web refers to a highly intelligent web technology which fills the knowledge gap between a machine-readable language and a human natural language. 'Semantic Web provides a common framework that allows data to be shared and reused across application, enterprise, and community boundaries,' as defined by the W3C led by the Internet founder Tim Berners-Lee. As one of the greatest inventions of the twentieth century, the WWW has dramatically changed our ways of exchanging and sharing data, information, and knowledge electronically. Current web technologies have made it possible for us to access, collect, integrate, retrieve, and store multi-format information, such as audios, graphs, images, texts, videos, etc., via the Internet and WWW. With the continuing expansion of the WWW, no one knows exactly how many web pages are available every day in the world. The web keeps evolving. A textual web page can be changed, deleted, modified, and updated at any time within its life cycle. A website can be merged or shut down for any reason, too. As a result, current web search engines often provide us with incomplete and irrelevant information, especially when we intend to search information collected and grouped under different subjects.

One of the limitations of current web search engines is that they often depend on a keyword or keywords to search information among web pages. Unfortunately, existing web searching technologies still cannot fully uncover the hidden meanings and internal connections between words with polysemous meanings and implications in natural languages. That is why we often see millions of web pages displayed when we use an existing web search engine to search information – this is the common situation called an 'information explosion' which is actually caused by information overload. As pointed out by Jaroslav Pokorný, a professor of computer science at Charles University in Prague in the Czech Republic:

> The first Web information services were based on traditional information retrieval algorithms, which were originally developed for smaller, more coherent collections than the Web. Due to the Web's continued growth, today's Web searches require new techniques – exploiting or extending linkages among Web pages, for example. (Pokorný, 2004)

Therefore, Semantic Web is designed to explore the hidden and implied relationships among data and information processed and synthesized via databases and web searching technologies. According to the 'Semantic

Web Activity Statement' from the W3C, the core of Semantic Web is the Resource Description Framework (RDF), which is an XML-based markup language for defining metadata about web information. The ultimate objective for Semantic Web is to make web information more accessible and reusable across diverse applications and databases running on the Internet and WWW. Semantic Web holds the promise for the future development of web technologies and web search engines.

## *Web services technology*

Web services technology refers to the mechanism of integrating diverse data and software with other software applications in order to build distributed and service-oriented web-based applications running over the Internet platform. According to the definition set by the W3C, web services are an Internet-oriented and standards-based web API (application program interface) using XML-based messages to assist application-to-application communications over the Internet. Web services technology functions like a gateway for controlling and accessing local information systems.

The primary web technologies used in academic library information technology architectures are basically composed of HTTP, HTML, CGI, CSS, JavaScript, ColdFusion, Java, .Net, Perl, PHP, databases, web browsers, and web servers. The biggest challenge for web-based academic library information technology architectures is how to enhance, integrate, synthesize, transform, exchange, share, and distribute diverse academic library applications and heterogeneous data seamlessly and dynamically. From among the different approaches, application-level integration, though it is more time-consuming, more expensive, and more complicated, has been proved to be more effective than data-level integration, because academic library users need to retrieve a large amount of information from heterogeneous information resources. Traditionally, different middleware were used to handle communications among heterogeneous applications across the network. Because of problems such as cross-organizational interactions, cross-operating systems, and cross-application interfaces, it is a fact that conventional middleware platforms cannot solve application integration so well. However, the situation is different when the Web provides the standard HTTP (Hypertext Transport Protocol) and XML (Extensible Markup Language), which set up the foundation for web services technology to integrate heterogeneous applications over the Internet.

Web services technology includes the key components HTTP, XML, SOAP (Simple Object Access Protocol), WSDL (Web Services Description Language), and UDDI (Universal Discovery Description Integration). HTTP is the protocol to execute the web services. XML is used to build XML messages so that web services can support heterogeneous communication. SOAP is the protocol to handle interactions among web services. WSDL defines the mechanism to access the web services available. UDDI specifies a registry for web services. Compared to traditional legacy systems, web services technology offers a new business model to handle an enterprise's heterogeneous applications over the Internet. Due to various obstacles such as budget, data, performance, platform, security, staffing, and web architecture, it is still a big challenge for academic library executives and librarians to initialize and implement web services technology in academic library information technology architectures.

# Real-world examples

## *Example 4.1 Internet Protocol version 6 (IPv6)*

On 8 December 2003, Caron Carlson warned that it was very possible that the United States would be left behind while Asian countries, particularly led by China, were showing strong interest in initializing and implementing the next-generation Internet – Internet Protocol version 6 (IPv6). Unfortunately, American governments, enterprises, universities, and the US Department of Defense did not pay close attention to her lone voice. On 24 December 2004, one year after Caron Carlson had issued her warning, the China Education and Research Network Information Center (CERNIC) declared that it had successfully launched China's first IPv6-based network called China Education and Research Network 2 (CERNET2). CERNIC also reported that 25 universities across 20 Chinese cities were connected at speeds up to 10 Gbps (gigabits per second). The successful operation of the world's first large-scale pure IPv6-based backbone network means that the Chinese have laid down the first cornerstone for the global application of the next generation of the Internet. Further detailed information in English about the China Education and Research Network 2 (CERNET2) is available at the following web address: *http://www.edu.cn/cernet_1377/index.shtml*.

### *Example 4.2 Digital content management solution: open-source software*

Because of the budget crunch, it is impossible for many academic libraries in America to purchase expensive digital content management software to integrate and manage their rapidly growing digital collections. The real-world story which happened at Western Illinois University Libraries in the United States may help you to select the appropriate technology solution to solve your particular problem. If you are interested in reading their story, check the following resources:

- Printed resource: Dunlap, I.H. (2005) 'Open source digital image management,' *Computers in Libraries*, 25 (4): 6–48.
- Online resource: Dunlap, I.H. (2005) 'Open source digital image management,' *Computers in Libraries*. Retrieved 13 May 2007 from: *http://www.infotoday.com/cilmag/apr05/dunlap.shtml*.

### *Example 4.3 Web 2.0*

With the growth of Web 2.0, more and more academic libraries are trying to apply related Web 2.0 applications in academic library settings. Feedmyapp.com, a website claiming to be a Web 2.0 directory, provides a comprehensive list of Web 2.0 and Web OS applications at *http://www.feedmyapp.com/web_20_web-os_applications_sites*. Also, an online education database called OEDB.org has compiled a list of the top 25 Web 2.0 search engines at *http://oedb.org/library/features/top-25-web20-search-engines*. Academic administrators, executives, IT specialists, librarians, and other professionals should take the time to see how these Web 2.0 applications could be adapted to their specific academic library information technology infrastructures. Although there is still a lot of debate about the definition of Web 2.0 and Web 2.0 technologies, it is absolutely necessary to monitor how Web 2.0 is changing scholarly communications and user-centered services in evolving academic learning environments in the digital age.

## Summary

- Emerging technologies for academic libraries in the digital age are primarily represented by rapid advances in fields such as the Internet,

artificial intelligence, computer technologies, digital technologies, human intelligence, instructional technologies, network technologies, multimedia technologies, open source software, web technologies, and so on. Any new innovative technology breakthroughs in emerging technologies will definitely provide academic libraries with new dynamic ways of delivering and disseminating information resources, services, and teaching in academic library settings.

- The next generation of the Internet (IPv6) will become the future primary platform for academic libraries to deliver and disseminate specific high-speed information resources, services, and teaching in a more secure mobile computing environment. Whether or not China's IPv9 could be accepted as one of the alternatives for IPv6 in the world is still in question. Modern computer technology, including hardware and software, will continue to play a major role in access to and conversion, retrieval, and storage of information in dynamic academic library settings. New computer operating systems and the multi-core CPU will greatly improve the efficiency and speed of accessing and locating information. Combined with computer technologies, human intelligence, multimedia technologies, and telecommunication technologies, information technologies will make it possible for academic library users to learn and work more effectively and efficiently in new computing environments. Utilizing new advances in computer technologies, digital technologies, network technologies, and multimedia technologies, etc., instructional technologies will be dramatically enhanced and integrated to improve learning effectiveness. In the coming years of the twenty-first century, however, the Internet and WWW will be the most important platform in academic learning environments. With XML, XHTML, and other web technologies, academic teachers and students will be able to access and locate information in dynamic formats across diverse applications, databases, networks, platforms, and systems, etc.

## Exercises

1. Since so many cutting-edge and emerging technologies are being used in academic libraries, why are some students, especially undergraduates, still complaining that it is hard for them to access and locate information?
2. In addition to the computer hardware introduced in this chapter, specify additional hardware which might improve computing environments in academic libraries.

3. In addition to the computer software discussed in this chapter, list additional innovative software used in academic libraries.
4. Which open-source software will impact on the design and development of digital library projects? Why?
5. Since the Instant Messaging (IM) service is available, why do we still have to use the traditional e-mail service?
6. What additional instructional technologies do you think might improve learning outcomes in academic libraries?
7. Specify additional emerging technologies which might impact on academic libraries in the digital age.
8. How will Web 2.0 impact on academic libraries and their services? Why?
9. Do you think that HTML will become extinct once XML becomes more and more important in today's information society? Why? Or why not?
10. Which new innovative web technologies will improve communications between academic library users and academic library services? Why?

# Case studies

## *Case study 4.1 Internet disaster in Asia*

On the evening of 26 December 2006 when the general public in the western world were making a toast in celebration of Christmas a strong earthquake and its aftershocks took place in the sea 15 kilometers off southern Taiwan, China and broke six out of seven submarine cables. It was reported that this powerful earthquake was equal to the explosion of six atomic bombs. As a result, 90 percent of the international telecommunications, including e-mail, fax, the Internet, and international long-distance telephones, between North and Southeast Asia to North America were disrupted. Normal residential life and international business activities were severely affected. It took more than two weeks before these broken submarine cables were completely fixed. This earthquake showed us how the global Internet remains weak in the face of natural disasters.

### Questions

1. Which submarine cables connect Asia and North America?
2. What are the major methods of Internet connection for the global Internet?

3. Since earthquakes threaten the safety of global Internet connections, why do we still have to depend on submarine cables for international communications?
4. Between cables and satellites, which Internet connection mode is better? Why?
5. In addition to earthquakes, what else threatens the safety of the global Internet?
6. What suggestions can you make to reduce the vulnerability of the global Internet?

## *Case study 4.2 Touch Wall*

In dynamic academic learning environments, it is always a critical challenge for academic libraries on stringent operating budgets to satisfy the growing demands of faculty and students. To improve teaching and learning effectiveness, academic faculty and students also expect to see more innovative emerging technologies applicable to dynamic and interactive teaching and learning activities. Microsoft Chairman Bill Gates displayed a new multi-touch computer and interface called Touch Wall at Microsoft's annual CEO Summit on 15 May 2008. For more detailed information, readers should access the report from the website of TechCrunch at *http://www.techcrunch.com/2008/05/14/microsoft-touch wall-can-inexpensively-turn-any-flat-surface-into-a-multi-touch-display/*. Then, after viewing the web movie available at YouTube.com, answer the following questions.

### Questions

1. What is Touch Wall?
2. What are the differences between Microsoft Touch Wall and Microsoft Surface?
3. Why are we excited by Microsoft Touch Wall and Microsoft Surface in today's dynamic and interactive academic learning environments?
4. Compared to the interactive electronic whiteboard, how will Microsoft Touch Wall and Microsoft Surface be used to improve learning effectiveness?
5. Which of Microsoft Touch Wall and Microsoft Surface do you consider will have a much brighter outlook in academic libraries? Why?

## *Case study 4.3 Weblogs*

With the rapid development of the Internet, a new way of exchanging and sharing information on the Web – the weblog, often simply called the blog – has become more and more popular in the virtual world of the WWW. As a new social cultural phenomenon, academic libraries will have to pay more serious attention to the weblog. For example, it is reported by *Information Today* that the library school professor Sarah Johnson at Eastern Illinois University's Booth Library and the librarian Rachel Singer Gordon at Franklin Park Public Library District in Illinois, USA created the web log 'Beyond the Job' (*http://librarycareers.blogspot.com/*) focusing on library career development. Visit their weblog and answer the following questions.

### Questions

1. What is the definition of a weblog?
2. Is the weblog an emerging technology? Why?
3. What changes can a weblog bring to academic libraries?
4. What are the differences between a website and a weblog?
5. How can you create a weblog for an academic library?

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5

# Impacts on academic library administrators and executives

## Chapter outline

In this chapter you will learn:

- how emerging technologies will impact on academic library administrators and executives;
- about a selection of leading emerging technology projects in the academic world;
- how academic library administrators and executives will be challenged in the digital age;
- how fancy buzzwords can confuse academic library administrators and executives.

## Learning objectives

After you have completed this chapter, you are expected to be able to:

- identify in which fields emerging technologies are impacting on academic library administrators and executives;
- understand some leading emerging technology projects in the academic world;
- understand how evolving emerging technologies are challenging the competency, knowledge, and skills of academic library administrators and executives;
- identify some fancy buzzwords in dynamic and interactive academic learning environments.

## Introduction

Over twenty years ago, a storm of change swept over graduate schools of library and information sciences in America. Michael E.D. Koenig and Charles Hildreth, two professors from Long Island University in the United States, reviewed this movement for change in their research paper entitled 'The end of the standalone "library school,"' which was published by the *Library Journal* in 2002:

> Beginning in 1982, when the Graduate School of Library and Information Science at Rutgers University was incorporated into the School of Communication, Information and Library Science, more and more 'independent,' standalone LIS programs have been incorporated into larger academic units. By the end of 2001, 17 of the 56 American Library Association (ALA)-accredited LIS programs – nearly a third – had experienced a similar fate.

In their research paper, Koenig and Hildreth (2002) listed several major academic programs, such as communications/media, computer science, education, and management/administration, into which graduate schools of library and information sciences in America were merged between 1982 and 2002. Koenig and Hildreth (2002) provided an analysis: 'Whether the change is self-directed (as with the I Schools) or largely unwilling (as with mergers and incorporations), the ALA-accredited master's degree is becoming one of several degrees offered by a larger academic unit no longer devoted to one degree or one constituency.' No matter whether Koenig and Hildreth's conclusion was correct or not, I believe that the mergers involving graduate schools of library and information sciences in America which took place between 1982 and 2001 reflected the recognition of the trend towards the interdisciplinary nature of graduate schools of library and information sciences in the developing information age.

Since the late 1990s, however, the success of the Internet and WWW has significantly promoted the delivery and dissemination of data and information in diverse formats across heterogeneous applications, channels, databases, networks, platforms, and systems. In today's networked world, there is a vast array of information available right at the fingertips of faculty, teachers, students, and other information seekers. The Internet and WWW as well as the various web search engines have entirely changed the usual ways of locating and accessing information in our society. Will the Internet and WWW change academic libraries, too? Will future academic libraries be replaced by a number of

web search engines? Some faculty, teachers, scholars, and other professionals are wondering if it is still necessary to fully fund academic libraries in the Internet age.

In her article entitled 'If the academic library ceased to exist, would we have to invent it?' (2007), Lynn Scott Cochrane, Director of Denison University Library located in Granville, Ohio, United States, predicted seven scenarios of what could happen were an academic library to stop its operations in an institute of higher education. No matter whether Cochrane's predictions are true or not, it is a fact that top-level academic library administrators and executives are under pressure to defend their essential operating budgets for quality services committed to meeting the high demands of faculty and students in dynamic and interactive academic learning environments. No matter what changes happen to academic libraries in the future, it is obvious that rapid advances in information technologies, especially innovative cutting-edge and emerging technologies, have thoroughly impacted on the functions and roles of academic libraries in today's intellectual landscape.

In this chapter, therefore, we will explore the impact of emerging technologies upon academic library administrators and executives. To meet the new waves of emerging technologies applicable to dynamic and interactive academic learning environments, library administrators and executives are under pressure to guide librarians and staff as to how they should fulfill their mission in the ever-changing and technology-driven academic library settings. As primary leaders in academic libraries, their academic leadership and strategic decision-making will impact on the future prosperity of academic libraries in the coming years of the twenty-first century.

## Impacts on academic library administrators and executives

In the modern information society, information refers to data which has been processed. For academic library administrators and executives, the academic library management process refers to the analysis and utilization of the information and/or its feedback to make critical decisions. However, the real value of information depends on whether or not it is recognized and how it is utilized by different library administrators and executives in a variety of academic library settings.

In dynamic and interactive academic learning environments, newly emerging technologies not only provide academic libraries with new and

innovative approaches to delivering and disseminating information, but also challenge the leadership and strategic views of administrators and executives in a variety of academic library settings. Their professional capability, experience, knowledge, and skills of monitoring and utilizing information technologies is much needed to guide the necessary critical decisions and strategic views regarding the application of cutting-edge and emerging technologies in diverse academic library settings. Their administrative decisions and strategic views will decide the future direction of development for an academic library (system) in a fast-changing world. Their strength of will and their ability to put that will into practice will test the effectiveness and efficiency of their leadership and their strategic views for enhancing and integrating student-centered and service-oriented academic library information resources, services, and tutorials in the digital age.

Academic library administrators and executives therefore bear more responsibilities for the strategic development and routine operations of an academic library (system) in dynamic and interactive learning environments. In this section, we will explore how newly emerging technologies could have an influence on those library administrators and executives. First of all, we will examine where newly evolving emerging technologies could impact on academic library administrators and executives. Secondly, we will review some ongoing emerging technology projects in the academic world so as to assist library administrators and executives in their pursuit of current trends in emerging technologies. Thirdly, we will explore how academic administrators and executives will face up to the challenges of new and innovative emerging technologies applicable to diverse academic library settings. From the point of view of an experienced academic information services librarian, I believe that new and evolving emerging technologies will challenge top-level academic library administrators and executives in the following primary ways.

## *Mission statement*

The mission statement defines an academic library's unique existence in terms of its essential nature, roles, services, and values in today's dynamic and interactive academic learning environments. Following on from our previous discussion in Chapter 2 of the library mission statement, an academic library's mission statement serves as a benchmark against which to measure the library's existing and projected information resources, services, teaching, and other relevant programs. Impacted by emerging technologies, an academic library's administrators

and executives will have to review and update their specific library mission statements in order to provide student-centered and service-oriented information resources, services, and instruction in the digital age. If an academic library's administrators and executives cannot redefine the library's position in today's dynamic and interactive academic learning environments, it will not be unusual to hear more and more concerns about whether or not an academic library could survive in the digital age. Also, an academic library's mission statement is not intended simply as decoration. Otherwise, the statement will be reduced to a mere slogan if a library's administrators and executives do not know how to effectively and efficiently enhance and integrate their existing innovation, intelligence, and teaching in excellence across diverse applications, channels, networks, platforms, and systems.

## Library functions and roles

New waves of emerging technologies have meant that academic library administrators and executives have had to redefine how academic libraries could fit into the modern information society. Faced with the new information explosion, an academic library no longer simply serves as a central repository for collecting, organizing, and storing information. Utilizing new advances in evolving emerging technologies, an academic library's administrators and executives are able to envision what specific applications, programs, resources, and services their library (system) can offer to faculty and students in dynamic and interactive academic learning environments. New innovative emerging technologies will expand and shape an academic library's new scope of services in the modern information society. Successful emerging technologies applicable to academic library settings will cultivate and promote not only new library functions but also the role of enhancing and integrating the fragmented and scattered information resources and services in the process of building ubiquitous academic libraries in the digital age.

## Library financial management and control

To ensure high-quality student-centered and service-oriented instructions, programs, and services, academic library administrators and executives are expected to improve their financial management and control. Their financial decisions and solutions need to be aligned with the business operations and financial needs generated in diverse academic library

settings. It is always a big challenge for academic library administrators and executives with stringent operating budgets to meet the library user's high expectations, especially when innovative cutting-edge technologies and evolving emerging technologies are impacting on the entire process of accessing, locating, transforming, and storing information across heterogeneous applications, databases, networks, and systems.

## Budgetary control

Budgetary control is part of the essential financial management used by academic library administrators and executives to effectively and efficiently control their operating expenditures. The bottom line of budgetary control is to ensure that the development of the library collection meets the high demands and expectations of teaching, learning, research, and scholarly development in a specific academic learning environment. Other operating expenditures, such as those for equipment, student workers, supplies, and traveling, can be dynamically adjusted. The policies and procedures relevant to budgetary control in an academic library will directly affect the quality of information resources, services, and instructions delivered by an academic library (system). Unfortunately, not every academic library has formal policies and regulations set up to regularly review budgetary control activities each fiscal year. Few academic library administrators and executives prefer decentralized management approaches to handle budgetary control procedures. As a consequence the personal experience, knowledge, and skills of library administrators and executives will become the key factors impacting on the effectiveness and efficiency of budgetary controls across the range of academic library settings.

## Funding support

Stable funding support is the foundation for the success of an academic library in the digital age. It is easy for an academic library (system) to initialize and implement specific information resources, services, and teaching. However, it is more challenging to integrate, manage, support, and upgrade them across the various applications, databases, equipment, facilities, platforms, programs, resources, and systems, especially while keeping them running within a stringent operating budget. There is no free lunch anywhere in the world. Due to the high costs of initiation and implementation of cutting-edge and emerging technologies, academic library administrators and executives have to seek innovative approaches

to considering, attracting, and promoting additional donations, fees, funds, grants, investments, partnerships, programs, etc. for an academic library's funding support.

### Resources allocation

In the modern information society, new waves of emerging technologies could provide academic libraries with new and innovative ways to access, locate, retrieve, and store information. The success of the Internet and WWW, for example, promoted the wide use of e-databases in diverse academic libraries. To meet the various demands for high-quality information resources and services to support the activities of teaching, learning, and research, academic library administrators and executives need to effectively and efficiently allocate academic information resources and services within the limits of their stringent operating funds. Faced with rising costs year after year, academic library administrators and executives have to clear overlapping e-databases while allocating and maintaining core high-quality printed and electronic information resources in academic library collections.

## *Human resources management*

Generally speaking, human resources management refers to the administrative activities, procedures, and regulation involved in the control, development, selection, retention, and utilization of human resources in a business or organization. In a large academic library setting a professional specialist will have been set up in charge of human resources management. In medium and small academic libraries, the library administrators and executives usually coordinate and collaborate with a college or university's human resources department for their human resources management. There is space in this book to focus only on the roles of academic library administrators and executives when they need to create new positions for librarians in today's technology-driven academic library infrastructures.

### Defining new job titles and duties

Newly evolving emerging technologies applicable to dynamic and interactive academic learning environments will require pioneering new approaches to and scope for delivering and disseminating information in

academic library settings. Academic library administrators and executives will also need to define new job titles and duties for their projected programs and services. The 'emerging technology librarian' has become a new title in the academic library arena. At the time of writing, for example, the American Association of Law Libraries is looking for an emerging technology librarian to 'serve as a link between the library and the law school faculty in integrating emerging technologies within the library and the classroom.' Also, the University of North Carolina at Chapel Hill in the United States is searching for 'a creative, outgoing, and collaborative Reference Librarian for Emerging Technologies' to join their Electronic Services Section in the Davis Library.

## Cross staff training

Library administrators and executives will need to set up specific cross training programs for librarians and staff working in diverse academic library settings. For instance, new collaborative information service models, such as information commons and/or learning commons, need librarians to take on board greater knowledge of IT and improve their skills for their daily operations and services. Otherwise, they will not be able to provide timely technical support when library users have problems in accessing and locating information across various applications, databases, networks, and systems.

## New criteria for job performance and evaluations

It is strongly recommended that academic library administrators and executives should set up new criteria for job performance and evaluation in the modern information society. Newly evolving emerging technologies in academic learning environments will always mean an expansion in the scope of services from academic libraries to faculty, students, and other community users. Academic library administrators and executives need to use new benchmarks and criteria to evaluate the creativity and enthusiasm of librarians and staff when they deliver high-quality academic information resources, services, and instructions in ever-changing technology-driven academic library settings.

## Promotions and rewards

It is recommended that academic library administrators and executives should set up relevant policies and regulations to reward and provide

incentives to academic librarians and staff who have made outstanding contributions to improve and promote student-centered and service-oriented library programs and services. Otherwise, academic librarians and staff will eventually lose their energy, creativity, and passion, to say nothing of taking risks when initializing and implementing emerging technology projects. As long as academic librarians and staff can grasp and utilize cutting-edge and emerging technologies, an academic library will be able to maintain its pioneering position in the delivery and dissemination of multi-format information across heterogeneous applications, databases, networks, platforms, and systems.

## *Aligning academic library services with a library's mission*

Impacted by new waves of evolving emerging technologies, an academic library (system) functions as a central gateway to access, locate, and store information across heterogeneous applications, databases, networks, platforms, and systems in dynamic and interactive academic learning environments. Although most academic libraries have separate managers in charge of daily activities and the routine operation of the library's programs and services, top-level academic library administrators and executives still have to bear their primary responsibility to align their library services with the library's mission statement. No matter how heavy their administrative workloads are, academic library administrators and executives should examine and monitor daily operations in information resources, services, and teaching activities.

If they possess more professional experience of, knowledge of, and skills in an academic library's information technology architecture and current trends in emerging technologies, academic library administrators and executives will be in a position to guide and monitor department heads in how to enhance and integrate the various academic information resources, services, teaching, and other liaison programs, instead of only reviewing the reports and statistics submitted by those heads. An academic library's administrators and executives should be able to use their library's mission statement as a benchmark against which to measure their successes and weaknesses. They will then understand what information services they need to improve for the digital age, otherwise the library's strategic development will lose its direction. Even though there may be a mission statement displayed at a library's website, who will be able to guide the librarians and IT specialists in the design,

development, improvement, and integration of a library's information resources, services, and other programs, if the library's administrators and executives are not sure about the current developing trends in cutting-edge and emerging technologies in the digital age?

## Emerging technology projects in the academic world

As important components of dynamic and interactive academic learning environments, academic libraries are striving to provide high-quality service-oriented and user-centered information resources, services, and instructions in the digital age. Constricted by stringent operating budgets and the limited technical forces available, unfortunately most small and medium-size academic libraries worldwide often have difficulty in initializing and implementing innovative emerging technology projects independently. Therefore the most effective and efficient approach for such libraries is to actively take part in the emerging technology projects launched by the various consortiums and institutes of higher education. Also, leading research libraries may coordinate and collaborate with leading IT companies and vendors to initialize and implement advanced emerging technology projects across different fields. To promote awareness of the current trends in emerging technologies applicable to dynamic and interactive academic learning environments, briefly reviewed below are several leading emerging technology projects in the real academic world. These examples will provide academic library administrators and executives with some practical tips on how and where innovative emerging technology projects could arise in academic library settings.

### *Harvard University: emerging technologies (United States)*

Website: *http://www.uis.harvard.edu/emerging_technologies/*

As have many other leading research universities in the United States, the University Information System (UIS) of Harvard University has set up Emerging Technology Groups to focus on emerging technologies of potential benefit to the Harvard Community. As defined by its mission, UIS's Emerging Technologies Group explores 'the concepts, standards, operations and applications' of emerging technologies and their potential

to 'improve practice, collaboration, communication and to enhance the content and delivery of education [is] assessed.' Currently the Emerging Technologies Group of Harvard UIS is testing leading pilot projects ranging from IP multicast, Internet Protocol version 6 (IPv6), Project ICE (integrated communications with exchange), video streaming, voice over IP (VOIP), and wireless LANs, etc.

## *MIT: electronic paper project (United States)*

Website: *http://www.media.mit.edu/micromedia/elecpaper.html*

Paper has been used as an essential medium to pass on, record, and share information for thousands of years. As a consequence of the information explosion, global paper consumption has increased as much as tenfold over the past ten years. As introduced in Chapter 4, electronic paper, also called 'digital paper,' is an ultra-thin, ultra-light electronic display. From the end of the twentieth century, leading Japanese and American companies such as 3M, Canon, Epson, Fujitsu, Hitachi, IBM, Kodak, Motorola, Panasonic, Sony, Toshiba, Xerox, and other well-known international companies have been concentrating on the research and development of electronic paper. In March 2005, Japan's Chiba University, which leads in the research and development of materials science, horticulture, and urban planning, declared that it had successfully developed electronic paper of a thickness of only 0.1 mm. On 13 July 2005, Fujitsu displayed the world's first flexible color electronic paper with image memory functions. The participation of Massachusetts Institute of Technology (MIT) in the United States means that leading academic institutes of higher education are also involved with the promotion of the practical application of electronic paper. In the near future, electronic paper will significantly expand the scope of information services offered by academic libraries in the digital age.

## *Ohio University: Vital Lab (United States)*

Website: *http://vital.cs.ohiou.edu/index.php/Main_Page*

The Virtual Immersive Technologies and Arts for Learning (VITAL) Laboratory at Ohio University in the United States is a multidisciplinary research and development unit focusing on creating 'appealing immersive virtual environments and synthetic worlds to enhance teaching, learning, and training activities.' Their research projects

include the design and development of the Ohio University Second Life Campus – a virtual 3-D learning environment to promote a whole set of life learning, outreach services, teaching tools, learning aids, and other related learning activities and services. This ongoing project is a perfect example of leading academic universities such as Ohio University focusing on the combination of emerging technologies and teaching practices in dynamic and interactive academic learning environments.

### *University of Birmingham: pervasive computing (UK)*

Website: *http://www.eee.bham.ac.uk/pcg/*

Pervasive computing, also called ubiquitous computing, is a new and innovative computing model which is involved with artificial intelligence, embedded systems, digital video/image technology, digital voice technology, distributed computing, human–computer interaction, information integration, mobile computing, network awareness, and so on. With the aim of 'exploring the impact of a wired world on human performance,' the University of Birmingham's Pervasive Computing Group (UK) is focusing its research on projects as varied as context computing, the lab of tomorrow, wearable computing systems, wearable imaging, and so on. In short, pervasive computing marks the beginning of our exploration of the future of the computing age. The research undertaken by universities such as that at Birmingham in the UK will assuredly influence the future of computing hardware and software applicable to diverse teaching and learning settings in the digital age.

## Challenges for academic library administrators and executives

With the rapid development of computer and networking technologies, management information systems (MIS) in academic libraries have been shifting in scope from the local to the wide area via the Internet and WWW. Academic library administrators and executives need to examine and monitor their library information resources, services, and teaching, and urge department heads to align them with the goals and missions of the library system. As a result of the new waves of emerging technologies, academic library administrators and executives will have to face up to the challenges discussed below.

## Assessments and evaluations

Assessments and evaluations are common approaches for library administrators and executives to measure many administrative, instructional, and service attributes, such as learning effectiveness, quality of services, user needs, and so on, in library settings. Generally speaking, assessment focuses on the cognitive appraisal processes of data gathering and data analysis, while evaluation supports administrative decision-making based on collected assessment information and data analysis reports. With many innovative emerging technologies applicable to dynamic and interactive academic learning environments, academic library administrators and executives are being challenged to decide whether or not it is necessary to assess and evaluate those emerging technologies which could impact on their specific information resources, services, and other departmental liaison programs. If they do not explore what is driving innovative changes in library settings, their specific academic information resources, services, and programs will fall behind the scientific and technological developments in the twenty-first century. The academic information infrastructure, funding support, and user requirements should be the three primary concerns for library administrators and executives when they assess and evaluate the evolving technologies applicable to academic library settings.

## Benchmarks, procedures, and standards for utilizing emerging technologies

Faced with the impacts of emerging technologies, academic library administrators and executives are being challenged to effectively and efficiently utilize those technologies applicable to academic libraries. Unfortunately, there are no 'one size fits all' benchmarks, procedures, or standards available for selecting and utilizing emerging technologies in academic library settings. Different libraries are delivering different information resources, services, and instructions to faculty and students via different information technology architectures. Academic library administrators and executives need to define and update their policies and regulations for utilizing information technologies in their specific library environments. On the basis of their existing policies and regulations for applying information technologies, academic library administrators and executives should be able to design and develop their own practical benchmarks, procedures, and standards for utilizing evolving emerging technologies applicable to their academic library settings. Academic library

administrators and executives must have a thorough understanding of their own specific information technology architectures, operating budgets, and user needs in dynamic and interactive academic learning environments. Otherwise, they will not be able to provide the right direction to their staff in the provision of student-centered and service-oriented academic library services in the digital age.

## *Financial and technical risks for utilizing emerging technologies*

Whenever they make long- and short-term strategic development plans, one of the biggest headaches for academic library administrators and executives is how to manage the financial and technical risks surrounding emerging technologies. Due to the great uncertainties surrounding emerging technologies and their high cost, academic library administrators and executives are usually very cautious about supporting emerging technologies which may be applicable to dynamic and interactive academic learning environments. With stringent operating budgets, administrators and executives from small- and medium-size academic libraries cannot afford any financial and technical risks when they seek innovative emerging technology solutions to enhance and integrate their particular information resources, services, and other programs. Comparatively speaking, the leading research academic libraries usually possess significant advantages in terms of sufficient financial support, wide information resources, and highly qualified technical expertise to explore evolving technologies applicable to academic library settings. By coordinating and collaborating with pioneering IT companies, therefore, leading academic research libraries have the leverage to initialize and implement national and global emerging technology projects. For small and medium-size academic libraries, this is also one practical way to participate in the university-wide and/or consortium-wide projects to provide faculty and students with high-quality library innovation, intelligence, and excellence in teaching as they expected.

## *Importance of monitoring and utilizing evolving emerging technologies*

Since emerging technologies are so uncertain and risky, why should academic library administrators and executives bother to monitor which technologies are emerging in the modern intellectual landscape? This

question was asked of Dr Bede Mitchell, Dean of Georgia Southern University Library, during a short interview about emerging technologies. He responded with two questions of his own:

- Must we use these evolving technologies simply because we feel the need to be current?
- Or should we utilize emerging technologies only when they become cost-effective and prove themselves useful in meeting staff or patron needs?

China's late leader Deng Xiao Ping had a very famous quotation: 'As long as the cat can seize mice, it is a good cat regardless of whether or not its skin color is black or white.' As long as they can satisfy dynamic user needs within budget limitations, these technologies are good technologies regardless of whether or not they are cutting-edge or evolving emerging technologies. However, evolving emerging technologies are the driving forces for future innovative changes in the digital age. Successful emerging technologies will outline the potential scope of future academic library services in the coming years of the twenty-first century. That is why academic library administrators, executives, IT specialists, librarians, and other professionals must keep a close watch on innovative emerging technologies applicable to academic library settings, and that is where the importance of monitoring and utilizing emerging technologies lies. Of course, we must be extremely cautious when we monitor and utilize any emerging technology. We need to manage their financial and technical risks within the parameters we can control. I believe that, limited by stringent operating budgets, most administrators and executives from small and medium-size academic libraries will follow Mitchell's practical approach of selecting evolving emerging technologies based only on their cost-effectiveness and the specific user needs in particular information technology architectures.

## *Recognizing buzzwords to follow emerging technology trends*

In the digital age, emerging technologies are challenging the abilities of academic library administrators and executives to recognize the buzzwords which energe from trends in information technologies. As defined by Answers.com, a buzzword is 'a word or phrase connected with a specialized field or group that usually sounds important or technical and is used primarily to impress laypersons.' Bewildered by too

much technological jargon driven by the information explosion, some academic library administrators and executives often find it difficult to follow the current trends in emerging technologies and assume that it might be a short cut to focus instead on the new technology buzzwords surrounding dynamic and interactive academic learning environments. Unfortunately, do new technology buzzwords really represent current technology trends? Are those fancy and hot technology buzzwords we often hear concepts or technologies? If they are concepts, how can we transform them into reality? If they are technologies, how can we utilize them to enhance and integrate our existing academic information resources, services, and programs in our particular information technology infrastructures? If academic library administrators and executives cannot recognize the different meanings of buzzwords, the improvements and integration in an academic library's innovation, intelligence, and excellence in teaching could stray from the library's mission statement.

## *Rethinking Web 2.0 and Library 2.0*

Web 2.0 was the hottest tech buzzword in 2006. On the crest of the Web 2.0 wave, some library professionals are ready to embrace the next technological advancements. However, professionals are advised to be cautious when trying to promote Web 2.0 and so-called Web 2.0 technologies. It is beyond the scope of this book to cover in depth Web 2.0 and its impacts on academic libraries as well as their services. However, it is important to exchange and share some opinions about Web 2.0 and Web 2.0 technologies before planning how to build service-oriented and user-centered academic library information resources, services, and programs in the digital age.

### What is Web 2.0?

At least so far as the definition of Web 2.0 is concerned, there's still a huge amount of disagreement among academic experts, IT specialists, and other professionals. Tim O'Reilly (2005) described Web 2.0 as follows:

> Web 2.0 is the network as platform, spanning all connected devices; Web 2.0 applications are those that make the most of the intrinsic advantages of that platform: delivering software as

> a continually-updated service that gets better the more people use it, consuming and remixing data from multiple sources, including individual users, while providing their own data and services in a form that allows remixing by others, creating network effects through an 'architecture of participation,' and going beyond the page metaphor of Web 1.0 to deliver rich user experiences.

Obviously Tim O'Reilly thought that Web 2.0 was a mishmash of websites and web services that promote collaboration and participation between web information and resources. We are not arguing here whether or not his definition of Web 2.0 is accurate. In the author's opinion, O'Reilly's compact definition of Web 2.0 should throw cold water not only on those Web 2.0 advocates who are just fishing for fame and compliments but also on those who are promoting Web 2.0 bubbles, seeking funding support for so-called Web 2.0 websites. Any attempts to use the concept of Web 2.0 to promote new Web 2.0 applications will be in vain.

## Is Web 2.0 a concept or an emerging technology?

According to the definition in the Wikipedia, Web 2.0 refers to a perceived second-generation of 'web-based communities and hosted services, such as social networking sites, wikis, and folksonomies.' Wikipedia considers Web 2.0 is only a concept, a service, or a principle, instead of an application, software, or web tool. The importance of Web 2.0 lies in online collaboration and web sharing of information and resources. Therefore, Web 2.0 is not a technology, or even an emerging technology. From the first moment he put forth this concept, O'Reilly has been emphasizing Web 2.0 as a social network, not a new innovative technological revolution.

## Is Web 2.0 the next generation of the Internet?

No. The reason is the same as we gave for Internet 2. Like Internet 2, Web 2.0 does not represent the next generation of the Internet since it has never defined any Internet Standards or Protocols for the next generation of the Internet. Only the W3C (*http://www.w3.org/*), the forum for the promotion of information on and related application of communication via the Internet platform, defines and develops the guidelines, specifications, standards, and technologies which govern the Internet and WWW.

## Does Web 2.0 represent current trends in information technology?

I don't think so, not yet. Web 2.0 represents the transition from static to interactive web service. The change of web service model will definitely promote current developing trends in information technology. According to the concept of Web 2.0 as defined by Tim O'Reilly in 2005, Web 2.0 itself is only a concept of a web service model, not an applied technology. In the digital age, information technologies are advancing in so many different fields, and the Web is only one of the primary platforms for information technologies to initialize and implement their applications. While I agree that Web 2.0 can be recognized as a buzzword, not every buzzword represents a developing trend in information technology.

## What are Web 2.0 technologies?

Many information technology experts are still arguing about how to define Web 2.0 technologies, since the major components of Web 2.0 technologies, such as AJAX (Asynchronous JavaScript and XML), blogs, CSS, HTML, RSS (Rich Site Summary), and wikis, etc., were existing web technologies a long time before the concept of Web 2.0 became popular in 2004. It does not make sense to grab hold of a number of existing web technologies and name them Web 2.0 technologies.

Academic library administrators and executives need to be careful when they use fancy and hot buzzwords like 'Web 2.0 technologies' to discuss enhancing and integrating current academic library information resources, services, and related liaison programs. No matter how information technology experts define it, the concept of Web 2.0 cannot display any roles without the support of many existing web technologies. It is therefore merely a fancy slogan to build future academic library information services on the foundations of so-called 'Web 2.0 technologies.'

## How do we utilize Web 2.0?

In 2007 Heather Havenstein wrote an article to introduce how the US Department of Defense's lead intelligence agency is utilizing Web 2.0, covering wikis, blogs, and RSS, etc., to improve information exchange and sharing. Based on this real-world example, I strongly believe that academic library administrators and executives could creatively utilize Web 2.0 to enhance and integrate their specific academic library information resources, services, and teaching activities in the digital age.

Personally, I think that the meaning of social networking conveyed by Web 2.0 should have concrete implications for academic library functions and services. However, library administrators and executives should consider how to improve an academic library's functions and roles via the concept of Web 2.0, instead of via so-called 'Web 2.0 technologies'. For all academic library administrators, executives, IT specialists, librarians, staff, and other professionals, it is not important how Web 2.0 is defined. What is more important and practical for them is how to utilize the new Web 2.0 service model and place all the library information resources, services, and other related programs at the fingertips of library users via social networking services and websites.

### What is Library 2.0?

With the explosion of interest in Web 2.0, some academic, public, and school librarians and other professionals are trying to transplant the concept of Web 2.0 into the field of the library. The concept of Library 2.0 was formally put forward in the ninth annual conference on the Internet Librarian 2005 (*http://www.infotoday.com/il2005/*), an annual conference 'for information professionals who are using, developing, and embracing Internet, Intranet, and Web-based strategies.' Imitated from the meme map of Web 2.0, a meme map of Library 2.0 has also been created to define the service model of Library 2.0. Based on the meme map of Library 2.0, some librarians are defining Librarian 2.0, too. Some librarians are even discussing how to utilize 'Web 2.0 technologies' to build Library 2.0.

This is highly amusing! How can an academic library's web-based information resources, services, and tutorials be built up by non-existent 'Web 2.0 technologies'? Also, I don't believe the definition of Library 2.0 is equal to the formula 'Web 2.0 + Library 2.0.' Don't expect to enhance, integrate, and upgrade existing library services to Library 2.0 just via a wiki and/or a blog – such a definition of the concept of Library 2.0 is too ambiguous.

## Real-world examples

### *Example 5.1 The Blogging Libraries wiki*

Amanda Etches-Johnson, the User Experience Librarian at McMaster University Library, Canada, has created a wiki to gather together a list of library blogs from academic libraries, public libraries, school

libraries, special libraries, library associations, and library directors. Although the list of library blogs does not contain every blog around the world, we still can view the opinions and views of some library administrators in the blogs in her list. For interested readers, the related information is available at: *http://www.blogwithoutalibrary.net/links/index.php?title=Welcome_to_the_Blogging_Libraries_Wiki*.

### *Example 5.2 National Center for Education Statistics*

Website: *http://nces.ed.gov/*

As the primary federal agency for collecting and analyzing educational data, the US Department of Education's National Center for Education Statistics (NCES) provides academic and public administrators, executives, faculty, teachers, librarians, and other professionals with free access to annual reports, data, fast facts, search tools, surveys, and other related information, including data from school, college, and library searches. If interested, library administrators and executives can use the website's search tools to compare and search academic libraries, public libraries, school libraries, state libraries, and other statistics programs.

### *Example 5.3 Visions: the academic library in 2012*

In May 2003, James W. Marcum, University Librarian at Fairleigh Dickinson University in the United States, predicted what could happen at a number of academic libraries in 2012. No matter whether or his predictions turn out to be accurate in 2012, they shed some light on one administrator's personal opinions on changes in library functions and roles as well as other new features in the world of the future. For your reference, Marcum's paper is accessible from: *http://www.dlib.org/dlib/may03/marcum/05marcum.html*.

## Summary

- Briefly, emerging technologies are impacting on academic library administrators and executives primarily in the following ways:
  - mission statement;

  - functions and roles;
  - financial management and control;
  - human resources management; and
  - aligning services with mission.
- Emerging projects introduced in the academic world provide academic library administrators and executives with a chance to glimpse some of the ongoing emerging technology projects applicable to the future of academic libraries. With the new waves of emerging technologies, academic library administrators and executives are being challenged to display their determination and competency to realize enhanced and integrated service-oriented and user-centered academic library services in the swiftly changing world. To catch up with the new developing trends in information technology, academic library administrators and executives should review and update their existing policies, regulations, and standards with regard to utilizing emerging technologies relevant to academic library settings. Academic library administrators and executives will lose their pioneering leadership and strategic vision if they fail to realize the importance of monitoring and utilizing emerging technologies. It is imperative for academic library administrators and executives to learn how to analyze and identify any new technology buzzwords before they assume they represent new trends in information technology.
- The Web has become a platform since the first day it was created and will not change its unique features, whether or not there is a Web 2.0. It will only sound impressive to build up academic library resources, services, and other programs via what are effectively non-existent Web 2.0 technologies. Likewise, it will be impossible to build up a ubiquitous library via the ambiguous Library 2.0 service model in the coming years of the twenty-first century.

## Exercises

1. Use your imagination to predict what could happen if academic libraries vanish in the future.
2. How do you think academic libraries could flourish in the digital age?
3. In your opinion, why could emerging technologies impact on academic library administrators and executives?

4. Can you suggest how academic library administrators and executives can follow current trends in cutting-edge and emerging technologies?
5. What other additional emerging technology projects could impact on future academic library information resources, services, and teaching?
6. Why must academic librarians monitor and utilize evolving emerging technologies?
7. What could happen if an academic library's administrators and executives were not sure how to follow up current new waves of emerging technologies?
8. What advice would you give if an academic library was preparing to utilize emerging technologies relevant to academic library settings?
9. In your opinion could Web 2.0 and Library 2.0 enable an academic library to build new library services in the digital age? Why? Or why not?
10. Realistically, what would taking advantage of Web 2.0 and Library 2.0 mean for academic libraries around the world?

# Case studies

## *Case study 5.1 Book ATM*

It is reported that Espresso Book Machine (EBM), an automatic book-making machine, has been produced by On Demand Books (*http://www.ondemandbooks.com*). Emily Maltby (2007) states: 'The machine can print, align, mill, glue, and bind two books simultaneously in less than seven minutes, including full-color laminated covers. It prints in any language and will even accommodate right-to-left texts by putting the spine on the right.' The New York Public Library is the world's first library to install an Espresso Book Machine for public services. For more detailed information, access the related news report from the website of the New York Public Library: *http://www.nypl.org/research/sibl/services/espressobook.html*.

### Questions

1. What do you think of the EBM?
2. Based on the information you have searched, do you think the EBM needs to be improved?

3. Is the EBM a product of cutting-edge technology? Why? Or why not?
4. Is the EBM a product of emerging technology? Why? Or why not?
5. What will be the impact of the EBM on libraries around the world in the future?

## *Case study 5.2 Future of the Internet*

The Pew Research Center (*http://pewresearch.org/*) is a well-known non-partisan 'fact tank' located in Washington, DC, United States. The 'Pew Internet & American Life Project' is one of its seven research projects exploring 'the impact of the internet on families, communities, work and home, daily life, education, health care, and civic and political life.' On 24 September 2006, the Pew Research Center released its latest research report, 'The Future of the Internet II,' which lists seven possibilities for the future development of the Internet. For more detailed information about the report entitled 'The Future of the Internet II,' interested readers should go to the following web address: *http://www.pewinternet.org/PPF/ r/188/report_display.asp*.

### Questions

1. What did you learn from Pew Research's report?
2. Which prediction do you think could impact on the future development of libraries around the world? Why?
3. Based on these seven predictions reviewed by Pew Research, can you predict what the future of libraries will be in 2020?
4. In your opinion, why cannot Pew Research predict the future of the Internet after 2020?

## *Case study 5.3 Library with Starbucks Coffee*

More and more libraries in the United States, like Georgia Southern University Library and the library of the University of West Florida, are introducing Starbucks Coffee into their library buildings. For many years, many academic libraries have forbidden food and drink inside their buildings. However, their attitudes have changed during recent years.

### Questions

1. Why have academic libraries changed their attitudes to allow food and drink inside library buildings?
2. What do you think of Starbucks Coffee inside the library?
3. What benefits can academic libraries get after they introduce Starbucks Coffee into their library buildings?
4. Will academic librarians and staff become 'food police'? Why? Or why not?
5. What else do you suggest an academic library could do better to enhance its social networking services?

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6

# Impacts on management information systems in academic libraries

## Chapter outline

In this chapter you will learn:

- some fundamental concepts about data, information, and information systems in academic libraries;
- the basic components of a management information system (MIS);
- what an MIS is supposed to do in academic libraries;
- how emerging technologies have impacted on MIS in academic libraries.

## Learning objectives

After you have completed this chapter, you are expected to be able to:

- understand the fundamental concepts of information and information systems;
- learn the general architecture of an MIS and its role in diverse business situations;
- utilize the MIS application in academic library settings;
- identify the impacts of emerging technologies on MIS in academic libraries.

## Introduction

In the digital age, new waves of cutting-edge and emerging technologies have allowed many innovative approaches to the delivery and dissemination of information across heterogeneous applications, channels, databases, networks, platforms, and systems. As one of the central information gateways on and off campus, academic libraries are doing their utmost to provide faculty, instructors, students, staff, and other community visitors with service-oriented and user-centered information resources, services, instructions, and other liaison programs. In this chapter, we will first review some fundamental concepts about information and information systems. Then we will discuss some of the primary functions and missions of information systems in academic libraries, including essential technical features. Finally, we will explore the impact of evolving emerging technologies on management information systems (MIS) in diverse academic library settings.

## Fundamental concepts for information and information systems

In the modern information society, the delivery and dissemination of information are primarily completed by information systems. What is information? Information is processed data. What are data? Data are original and raw facts or records about observed examinations, phenomena, operations, tests, transactions, etc. What is a system? James A. O'Brien explained in 2002 that 'A system can be most simply defined as a group of interrelated or interacting elements forming a unified whole.' What is an information system? In accordance with the definition set by Kenneth C. Laudon and Jane P. Laudon in 2004, 'An information system can be defined technically as a set of interrelated components that collect (or retrieve), process, store, and distribute information to support decision making and control in an organization.' In other words, an information system is a system that collects, classifies, disseminates, processes, retrieves, and stores information to support administrators' decisions on how to control, develop, and operate a business or an organization.

In today's computing environments, the information system we often talk about refers to a specific information system combined with

computer and networking technologies. For example, a typical information system comprises the following six key components:

- *Computer hardware* – which refers to the essential components building up an information system, including CPUs, keyboards, motherboards, microphones, mice, screens, scanners, printers, etc.
- *Computer software* – which can be subdivided into three different categories ranging from (1) system software (such as the operating system software or database management software); (2) application software (such as digital content management software or word processing software); and (3) middleware (such as a web server). The major function of middleware is to link system and application software.
- *Data* – which is the core component in an information system. Without the data, an information system will lose its existing functions. In an information system, data resources and data formats, such as images, graphs, pictures, texts, voices, etc., will have vital implications for further information processing.
- *Repositories* – which refer to diverse locations where data is stored, such as the cache memory, compact disks (CDs), databases, floppy disks, flash drives, random access memory (RAM), storage cards, etc. One of the key functions of repositories is to mark the information sources.
- *Network telecommunications* – which refer to various methods of information transmission, such as computer network communications, digital television communications, instant messaging communications, telegraph communications, and wireless cellular phone communications, etc.
- *Users* – which refer to people who design, develop, maintain, process, and utilize an information system. An information system must be a user-centered system to satisfy dynamic user expectations and requirements. An information system without users has no reason to exist.

In the real world of competitive business, the experiences of successful enterprises such as Apple, Amazon, eBay, GE, Google, IBM, Microsoft, and Toyota have proven that information systems and technologies have become indispensable components of successful business administration and management. From the 1970s, MIS have evolved into a discipline which studies how information systems support the routine and strategic administration, control, decision-making, plans, and operation of a successful business. As defined by Laudon and Laudon (2004),

'Management Information Systems (MIS) serve the management level of the organization, providing managers with reports, and, in some cases, with online access to the organization's current performance and historical records.'

In typical business management situations, the architecture of an MIS is usually composed of the following five interrelated components:

- *information source* – which refers to the origination of information across applications, channels, networks, platforms, and systems;
- *information repository* – which refers to the place where the information is stored;
- *information process* – which refers to the collection, classification, processing, transformation, and storage of information;
- *information user* – which refers to end-users who need to access, analyze, process, transform, store, and utilize the information. Information user also includes IT staff that design, develop, maintain, and support an information system;
- *information management* – which refers to the administration, control, operation, and storage of information to support the management's decisions.

With the high speed of scientific and technological development, MIS have been evolving into an integrated cross-discipline involving computer programming, databases, broadband networks, wireless communications, the WWW, etc., plus management, linear programming, operations research, statistics, and other disciplines. Driven by new waves of cutting-edge and emerging technologies, what is covered by MIS will be further expanded in the future. More and more new disciplines and related cross-disciplines will come to be associated with MIS.

## MIS in academic libraries

An academic library (system) is only one of the administrative, instructional, and service modules of an institute of higher education. Usually, an academic library's information technology (IT) department coordinates and collaborates with other associated university-level IT departments in the application of information technologies in academic libraries. In addition to the general technological features of common business information systems, information systems in academic libraries

are designed and deployed to support specific academic instruction, learning, research, and other related academic developments. In comparison with many other common business information systems, information systems in academic libraries contain their own typical technology features, which are generated from the same computer hardware as used by general business information systems:

- *Multiple operating systems*. To better support the diverse demands of end-users, the software for the information systems in academic libraries usually run on multiple operating systems: Mac and Windows. In the future, Linux might be another operating system to support end-user computer software in dynamic and interactive academic learning environments.
- *Diverse computer software*. Information systems in academic libraries provide library users with a wide collection of computer software, including common office software, desktop publishing software, multimedia software, open-source software, programming software, web publishing software, etc. running on the Mac, Windows, or Internet platforms. In addition to software for end-users, information systems in academic libraries also contain computer software to support library operations and services via additional information systems, such as: (1) integrated library management systems (ILMS), which are used to manage routine academic library operations; (2) interlibrary loan and document delivery services (ILL/DDS), which are used for teaching material support and scholarly information sharing among academic libraries; and (3) digital content management software, which is used to manage digital assets in academic libraries, etc.
- *Multiple data formats*. An academic library collection usually contains audios, books, digital assets, microfilms, microfiches, periodicals, videos, etc., which are the primary data collected and classified by ILMS in academic libraries. In addition, a large number of e-databases with abstracts, full-texts, and indexes are also recognized as primary data for information systems in academic libraries. All these items are collected, classified, hyperlinked, transformed, and stored as audios, graphs, images, pictures, PDF documents, texts, videos, etc. by information systems in academic libraries.
- *Multiple repositories*. In many academic library settings, data repositories are located in both local area scope and wide-area scope across applications, databases, networks, and platforms, including consortium-based, outsourced, and system-based data repositories. For

the sake of safety, an academic library (system) may utilize outsourced web hosting services to keep their key data and statistics in a computing environment much more secure against computer viruses or data loss.

- *Multiple network telecommunications*. In many academic library settings, information systems must provide multiple network telecommunication supports, ranging from local area networks (LANs), satellite, and television to wireless local area networks (WLANs) and the Internet in order to satisfy high demands for multi-tasking computing in active and interactive learning environments.
- *Dynamic users* Most information system users in academic libraries are administrators, executives, faculty, students, staff, and other local community visitors, including exchange students, short-term trainers, and visiting scholars, etc., each with different information needs.

MIS in academic libraries focus on the application and management of information technologies, which include computer hardware, databases, multimedia, networks, software, telecommunications, the Internet, etc., in a variety of academic library settings. The mission of MIS in academic libraries is to utilize information technologies and systems to enhance and integrate an academic library's administrative, control, and decision-making operations, and its plans to achieve specific strategic goals and service-oriented objectives. Through their routine operations in a variety of academic library settings, MIS are expected to display the following functions:

- controlling, managing, and maintaining information systems to support the library administration's management decisions and strategic developments;
- enhancing, integrating, and leveraging multiple information systems to promote excellence in teaching, learning, research, and scholarly developments;
- providing a user-centered technical support for the facilitation of key information resources, services, and teaching activities in dynamic and interactive learning environments;
- setting benchmarks and standards in utilizing cutting-edge and emerging technologies in academic library settings;
- reviewing and scanning current developing trends in information technologies applicable to dynamic and interactive academic libraries;
- planning and measuring the enhancement and integration of information systems for academic library users.

# Impacts on MIS in academic libraries

In the modern information society, the application of information technologies will provide academic libraries with more innovative technological approaches to delivering and disseminating information over a much wider range. New evolving emerging technologies will become the driving forces in the promotion of information technologies in dynamic and interactive academic learning environments. Typical impacts of emerging technologies on MIS in academic libraries are discussed in the following sections.

## *Academic information technology architecture*

New evolving emerging technologies will have the innovative potential to enhance and integrate existing academic information technology architecture. For example, the next generation of the Internet (IPv6), 3G wireless telecommunication, web services technology, and WiMAX (Worldwide Interoperability for Microwave Access), etc. will change future n-tier client/server architecture to access, disseminate, process, retrieve, synthesize, transform, and store information across applications, channels, databases, networks, platforms, and systems in diverse academic libraries. In the coming years of the twenty-first century, broadband and wireless communication will dominate the developing trends of information technology architectures in dynamic and interactive academic learning environments.

## *Functions of MIS*

New evolving emerging technologies will have the potential to change and expand the functions of MIS in academic libraries. Any new innovative emerging technologies applicable to a range of academic library settings will have direct implications on information formats, end-users, IT architectures, repositories, and relevant information resources and services, as well as instructions for various subjects. In the face of the various driving forces of change and innovation, MIS in academic libraries need to set specific objectives for supporting excellence in teaching, learning, research, and scholarly development. In the Internet age, MIS in academic libraries need to focus on web content and knowledge management via the enhancement and integration of the innovative cutting-edge and evolving emerging technologies applicable in dynamic and interactive academic learning environments.

## Computer programming

New evolving emerging technologies will impact computer programming in many academic libraries. With the rapid growth of the Internet and WWW, more and more academic libraries have realized that the design and development of customized web-based library applications and systems have become one of their most urgent programming tasks. To facilitate information access and delivery, their greatest concern is how to enhance and integrate heterogeneous information resources, services, and instructions into one universal information interface. New innovative emerging technologies, such as the next-generation computer programming languages, the next-generation database management systems (DBMS), document object models (DOMs), open-source software, and web services technologies, etc., will definitely impact future computer programming processes, software programming tools, software life cycles, and software project management, etc. in the various information technology infrastructures. High demands for mobility and wireless access in today's information world will lead the way for future computer programming in the coming years of the twenty-first century.

## Data communication and database management

New evolving emerging technologies will have great potential for data communication and database management in the various academic library settings. Dynamic data formats are technological features for database management in libraries. Successful heterogeneous data communications across applications, channels, databases, networks, platforms, and systems are essential for dynamic and scalable information delivery and dissemination in academic libraries. During the process of building a digital library, for example, effective communication between the GUI and data repositories is key for the successful implementation of a digital library application. The application of new evolving object-relational database management systems (RDBMS) and web services technologies will impact on the design, development, initialization, and implementation of new digital library applications and database management in the digital age.

## End-user computing environments

New evolving emerging technologies will impact on end-user computing environments in dynamic and interactive academic library settings. New

computer software and hardware, such as the new 64-bit multi-core CPUs, large-capacity hard drives, integrated office software, and the next generation of operating systems will make it possible for personal computers to have more powerful functions in multi-tasking computing environments. Once these new personal computers are combined with digital multimedia technology, digital video technologies, and instructional technology, such as large LCD (liquid crystal display) and plasma television screens, hi-fi surround systems, and high-speed Internet connections, academic library users will be able to access, present, process, retrieve, synthesize, and transform information in a multi-dimensional information world.

## Networks and telecommunications

New evolving emerging technologies will promote the role of networks and telecommunications in dynamic and interactive academic learning environments. In the modern information society, a specified network bandwidth will impact on content, format, and quality of information delivered across the various applications, channels, databases, networks, platforms, and systems. For example, the next generation of the Internet (IPv6), the Ultraband Network, WiMAX, and 3G wireless telecommunication, etc. will significantly enhance the speed and efficiency of information access in the digital age.

## Network security and control

New evolving emerging technologies will raise new concerns and requirements for network security and user privacy controls in academic library settings. As the Internet and WWW continue to grow as the primary platform for the delivery and dissemination of information, for example, MIS in academic libraries need to strengthen the network security control of information services and resources, such as application system controls, data transmission controls, backup and recovery controls, management information systems controls, user access controls, and so on. MIS in academic libraries should provide academic library users with secure networking environments in which to access and locate key information without losing their privacy, especially when academic libraries intend to promote any social networking applications such as wikis.

## Quality control and improvement

New evolving emerging technologies will challenge the capability of academic libraries to effectively and efficiently enhance, integrate, support, and update existing information resources, services, and instructions. MIS in academic libraries bear primary responsibility for providing the library administration with advice and information regarding current developing trends in IT and their technological impacts on library IT infrastructures. Without a strong MIS, academic libraries will lose their quality control over and improvements in their information resources, services, instructions, and other related liaison programs in the ever-changing academic library settings. Student-centered and service-oriented academic information resources, services, and teaching activities will then become mere words without meaning.

## Staff education and training

New evolving emerging technologies will impact the education and training of library staff. It is always a big challenge for academic library administrators, executives, librarians, and staff to closely follow current developing trends in emerging technologies applicable to dynamic and interactive academic learning environments. Without highly skilled academic librarians and staff, it is impossible for academic libraries to deliver high-quality and user-centered information resources, services, and teaching programs in the digital age. In today's information society, it is impossible to deliver and disseminate information without IT. Successful evolving emerging technologies are expanding the scope for IT applications in academic library settings.

## Web content control and knowledge management

New evolving emerging technologies, such as the next generation of the Internet (IPv6), the Ultraband Network, and web services technology, etc., will further promote the delivery and dissemination of information via the Internet and WWW. With the rapid growth of large numbers of web-based information contents, it is vital for MIS in academic libraries to select appropriate web content management systems to tighten control of their web content and knowledge management. In the digital age, it will always be a challenge for MIS in academic libraries to design and

develop an enhanced GUI for non-technical librarians and staff to maintain and update web-based information resources, services, and instructions in academic library settings.

# Real-world examples

## *Example 6.1 Automated storage and retrieval system*

In the modern information society, access to and storage of information have become two of the primary concerns for academic libraries around the world. In the face of the rapid growth of library collections, more and more academic libraries around the world, including Georgia Southern University in the United States, have deployed an automated storage and retrieval system (ASRS) to solve the contradiction between the rapidly growing library collections and the limited library storage space. Interested readers may visit the website of Sonoma State University Library, located in California, to find out more about this innovative method of accessing and storing academic library collections at: *http://library.sonoma.edu/about/ars.html*.

## *Example 6.2 Picasa*

In the digital age, digital cameras have become popular tools for consumers to capture events, people, incidents, etc. However, it is a common challenge for academic library users to find free and functional software to manage digital picture collections. Now this issue has been solved – Google has released its improved photo management software called Picasa (the newest version at this moment is Picasa Version 2.7). This is part of the free Google software suite and allows the user to access, edit, retrieve, share, and view photographs. It is downloadable from the following web address: *http://picasa.google.com*.

## *Example 6.3 Social networking websites*

Since News Corp finalized its purchase of MySpace.com for $580 million in July 2005, the prosperity of social networking websites has been greatly stimulated around the world. According to the definition set by Wikepedia:

> A social network is a social structure made of nodes (which are generally individuals or organizations) that are tied by one or more specific types of relations, such as values, visions, idea, financial exchange, friends, kinship, dislike, conflict, trade, web links, sexual relations, disease transmission (epidemiology), or airline routes.

It was reported by Joan Oleck in July 2007 that 55 American public libraries started using MySpace.com to attract pre-teens and teenagers via advertisements with animations, banners, sound effects, and web links. Since the American Library Association has already created an account with MySpace (*http://www.myspace.com/atyourlibrary*), will other American academic libraries follow their lead?

## Summary

- In the modern information society, accurate data, qualified information (i.e. data which have been carefully collected, evaluated, and processed according to various business goals, procedures, rules and standards), and well-designed systems are three key fundamentals for successful information processing and information management. Data comprise the raw records collected and categorized according to certain requirements, while information is processed data filtered on the basis of certain standards.
- In today's computer environment, an information system consists of six key components: computer hardware, computer software, data, repositories, network telecommunications, and users. The primary functions of a management information system (MIS) are to support the administration's decision-making and routine operations by focusing on activities ranging from information sources, information repositories, information processing, information users, and information management. The MIS in an academic library aims to support the needs of academic executives with respect to overall administrative activities, budgetary controls, resource allocations, routine operations, strategic developments, and so on.
- New evolving emerging technologies will challenge management information systems in academic libraries from a variety of aspects, such as IT architectures and enhancements, the integration of information services, end-user computing environments, web content control and knowledge management, security and user privacy control, and so on.

## Exercises

1. What is information?
2. What is data?
3. What is an information system?
4. What is a management information system (MIS)?
5. Why are data and information so important for information systems?
6. Why is an MIS so important for an academic library administration?
7. How do emerging technologies impact on MIS in academic libraries?
8. What is the greatest challenge for MIS in academic libraries?
9. Why must an academic library monitor evolving emerging technologies in the digital age?
10. What will be the driving forces which shape future information systems in academic learning environments? Why?

## Case studies

### *Case study 6.1 Emerging technology trends in e-learning*

In the modern information society, evolving emerging technologies have shed light on future potential applications in dynamic and interactive academic learning environments. Ellen D. Wagner wrote a paper to explore the emerging technology trends in e-learning. Read her article at the web address *http://www.linezine.com/2.1/features/ewette.htm* and answer the related questions below.

#### Questions

1. What are the emerging technology trends in e-learning?
2. What did the author suggest to improve e-learning outcomes? Why?
3. What is the infrastructure for e-learning?
4. In your opinion, how will evolving emerging technologies continue to impact on e-learning? Why?

## *Case study 6.2 University of Virginia Library: management information services*

With the rapid development of information technologies, successful management information services have become essential for academic administrators, executives, librarians, and staff to reach their specific goals and missions in support of learning, teaching, research, and other scholarly developments. Answer the following questions after you review the Management Information Services at the University of Virginia Library in the USA at: *http://www.lib.virginia.edu/mis/about/services.html*.

### Questions

1. What do you think of the mission statement of Management Information Services at the University of Virginia Library?
2. In your opinion, what else could management information services cover in an academic library?
3. What do you suggest for Management Information Services at the University of Virginia Library?
4. Review their statistics for the financial year 2006–7. What do you think could be done to improve their statistical reports for the library administration?

## *Case study 6.3 Virtual Office*

In the Internet age, a new online office called the Virtual Office has become popular in today's competitive business world. Evolving cutting-edge and emerging technologies have made it possible for administrators, bankers, engineers, entrepreneurs, executives, faculty, instructors, investors, managers, salesmen, technicians, traders, and other professionals to access data and information via the Internet and a web browser. Check any related information about the Virtual Office via Google before you answer the following questions.

### Questions

1. What is a Virtual Office?
2. What benefits can a Virtual Office provide for today's information seekers?

3. How are an academic library's web-based services different from a Virtual Office?
4. How can an academic library follow the concept of the Virtual Office and enhance its current information services?

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7

# Impacts on academic library information services

### Chapter outline

In this chapter you will learn:

- what are academic library information services;
- what are the impacts of emerging technologies on academic library information services;
- what are the leading emerging technology projects for academic libraries in the digital age.

### Learning objectives

After you have completed this chapter, you are expected to be able to:

- understand the driving force of new innovative enhancements for academic library information services in the digital age;
- identify new developing trends in enhancing and integrating information services for academic libraries in the digital age;
- follow the current developing trends in library digitization in the modern information society.

## Introduction

Needless to say, the rapid growth of cutting-edge and emerging technologies has provided academic libraries with many innovative ways of delivering and disseminating information across heterogeneous

applications, channels, databases, networks, platforms, and systems. However, many academic administrators, executives, faculty, instructors, IT specialists, librarians, LIS students, staff, and other professionals are still not so sure how and where innovative emerging technologies have impacted on library information services at academic library settings. I believe that our discussions in this chapter will provide them with key information they need.

In this chapter, we will briefly review current academic library information services first. Then we will explore the impacts of emerging technologies on academic library information services in the digital age. Finally, we will examine ongoing emerging technologies relevant to academic libraries in the real world. Combined with cutting-edge technologies, emerging technologies will be one of the leading driving forces for further enhancing and integrating library information resources, services, and instructions in the coming years of the twenty-first century.

## Current academic library information services

Utilizing modern computer and networking technologies, current academic library information services primarily assist users to access, process, retrieve, synthesize, store, and transform multi-format information effectively and efficiently via a range of applications, channels, databases, networks, platforms, and systems. Impacted by rapid advances in IT applicable to a variety of academic libraries, library information services have also been evolving into two new categories: conventional library information services and electronic library information services. Our discussions in this chapter will focus on the electronic library information services built on the platform of the Internet and WWW.

In the digital age, the most common on-site library information services still start from the personal oral or written communications between librarians and library users. *Conventional* library information services thus have the following two major characteristics:

- *Face-to-face* – traditional library information services are usually processed by face-to-face personal communication, including eye contact, facial expression, oral communication, and written communication.

- *On-site* – conventional library information services include, but are not limited to, on-site bibliographic instruction, campus outreach coordination and collaboration, classroom instruction, library tours, ready references, technical support for users, and other related programs and services.

Based on the Internet and WWW platform, *electronic* library information services range from bibliographic instructions, computerized library catalogs, digital libraries, distance learning services, e-databases, government documents, instant messaging services, interlibrary loan and document services, ready references, virtual classrooms, virtual references, and so on. Electronic library information services thus have the following primary characteristics:

- *Web-based* – current electronic library information services are built up on the Internet and WWW platform.
- *On-site/off-site* – current electronic library information services cover on-site and off-site user services.
- *24/7* – current electronic library information resources and services are accessible without any geographic or time limitations.

In the meantime academic libraries worldwide are faced with many new challenges triggered by the explosion in cutting-edge and emerging technologies. Many academic library administrators, executives, IT specialists, librarians, and other professionals are looking for effective and efficient solutions to enhance and integrate existing information resources, services, and instructions in library settings. They must strive to meet the high demands and expectations of academic faculty and students despite stringent operating budgets and shortages of skilled staff. They must find practical solutions to improving learning effectiveness for information literacy programs and services. They must follow developing trends in innovative cutting-edge and evolving emerging technologies, so that they can set up high-efficiency and low-cost infrastructures in service-oriented and user-centered academic learning environments. They must obtain timely feedback and statistics to measure their progress or lack of it. However, their mission is near impossible if they do not understand how and where to monitor the impacts of cutting-edge and emerging technologies on library information resources, services, instructions, and other liaison programs in today's dynamic and interactive e-learning environments.

## Impacts on academic library information services

In the digital age, the rapid advances in emerging technologies have provided academic libraries with many potential ways of enhancing and integrating their information resources, services, and programs. Very commonly academic libraries use online integrated library information management systems (LIMS) to manage their collections and relevant routine operations. Over the platform of the Internet and WWW, diverse electronic information resources, ranging from e-books and e-databases to instant messaging (IM) services, virtual classrooms, and virtual references, etc., have become primary information resources for library users. Based on those previous reviews, we have reason to believe that new advances in innovative emerging technologies will continue to impact on future academic library information services in the following remarkable ways.

### *Transformation between space and time*

One of the most obvious impacts of emerging technologies on library information services is the transformation between space and time. Over the next generation of the Internet and the World Wide Web, it will be possible for academic libraries to deliver and disseminate information at high speed. Academic library users will have no limits to accessing, locating, storing, and utilizing web-based library information resources, services, and instructions no matter where they are and at any time they want via new innovative media.

### *Distributed library information resources*

Impacted by the rapid development of emerging technologies, the provision of dynamic and seamless distributed library information services in the distributed information technology environment has become one of the greatest challenges for academic libraries around the world. In the modern information society, data and information can be accessed, disseminated, exchanged, located, processed, stored, and transformed across heterogeneous applications, channels, databases, networks, platforms, and systems. Academic library users can locate and access the information they require at any location in diverse networked computing environments.

## Information diversification

Information diversification is one of the technical features of information delivery and dissemination in the current information society. Information diversification in the digital age covers two technological features: (1) information formats; and (2) information media. The new advances in cutting-edge and emerging technologies, on the one hand, have made it possible for information to be collected, compressed, converted, delivered, processed, stored, and transmitted in multiple formats ranging from audios and graphs to images, texts, and videos, etc. On the other hand, library users can use dynamic devices, such as desktops, cellular phones, digital cameras, laptops, PDAs (personal digital assistants), tablets, recorders, and televisions, etc., to locate, access, synthesize, transform, and utilize the information delivered and disseminated in a variety of academic libraries. To promote global information exchange and sharing, academic library users are at the same time also looking for great multi-language support for scholarly communications across consortiums, platforms, and systems.

## Library digitization

Library digitization is the process of utilizing computers, databases, multimedia equipment, networks, video equipment, and web technologies, etc. to electronically collect, classify, copy, compress, scan, store, and transform conventional library information resources. New advances in cutting-edge and emerging technologies have laid down a solid technological basis for library digitization. Library digitization is different from a digital library. Library digitization focuses on the process of making diverse library information resources electronically available, while a digital library is a platform for accessing, collecting, managing, searching, and storing distributed digitized information resources over the Internet and WWW. Thus library digitization is the essential process for the initialization and implementation of a digital library.

To speed up information exchange and sharing in the process of social information transformation, library digitization has been recognized as a worldwide challenge to promote the further development of global digital libraries. Library digitization represents one of the major developing IT trends in academic libraries worldwide, and will eventually trigger a profound transformation in the status and functions of future academic libraries in the coming years of the twenty-first century.

## Bandwidth, network speed, and wireless

In today's information society, bandwidth and network speed have become two of the primary technological bottlenecks blocking the high-speed delivery and dissemination of information. Bandwidth refers to the data transmission rate in a given time (usually one second). The wider the bandwidth, the more data will be transmitted in a given time. Network speed impacts on the speed of data transmission. As we migrate towards the innovative broadband network technology and the next generation of the Internet (IPv6), the previous data transmission speed will be greatly improved. Also, wireless networking technologies such as WiMAX (Worldwide Interoperability for Microwave Access) will not only expand the range across which users may access and locate diverse information in the mobile environment, but also expand the service scope for academic libraries around the world.

## Privacy and information security

In the modern information society, privacy and information security have become more and more important in dynamic and interactive settings for academic learning. While promoting information exchange and sharing in the digital age, new advances in cutting-edge and emerging technologies have also increased the dangers of computer virus infections and loss of privacy, such as identify theft, Trojan horses, worms, and so on. As a central information gateway, an academic library must take primary responsibility for protecting user privacy and related library data. To provide users with a secure computing environment, academic libraries should set up related policies and regulations on how to locate, access, store, transform, and utilize information in the different scenarios in which academic library information services operate.

## Streaming media and video

The next generation of the Internet (IPv6) and innovative broadband technologies will lead a new wave of multimedia applications in academic libraries around the world. That Google has recently purchased YouTube.com for $1.6 billion proves that streaming media and video will become one of the primary information media running over the Internet and WWW. New advances in streaming multimedia and video technologies will also assist academic libraries worldwide to enhance and integrate their specific information resources, services, and instructions via new media.

### *Web-based information services*

In the digital age, the Internet and WWW will keep functioning as the primary platform for academic libraries worldwide to build up their specific web-based information resources, services, and other tutorial programs. Combined with the next generation of the Internet (IPv6), and innovative broadband networks, streaming media, video technologies, etc., it will be possible for academic libraries to promote information exchange and sharing in more dynamic and interactive ways in the digital age. Academic library administrators, executives, IT specialists, librarians, and other professionals should study hard how to effectively and efficiently leverage their specific web-based information resources, services, and tutorials to satisfy the information needs of academic faculty and students within their stringent operating budgets.

## Leading emerging technology projects for academic libraries

To satisfy the high demands for digitized information in the digital age, various digital library projects are taking center stage in academic libraries worldwide. Among all kinds of digital library projects, I believe that the following four ongoing projects will represent the most advanced cutting-edge and emerging technologies for digital libraries in the world. The success or failure of these projects will not only reorganize the new framework for the global digital library, but also have long-term deep impacts on copyrights and copyright holders, ranging from authors and editors to distributors, film-makers, musicians, printers, and publishers, etc. In the centuries-long course of historical development, libraries have been positioned at the end of the knowledge production chain, since libraries came into being as centralized repositories for information and knowledge about human civilization and social development. New and rapid developments in cutting-edge and emerging technologies have given academic libraries a chance to participate in the initiation and implementation of new evolutions and revolutions in the global digital library.

### *Google Print Library Project*

On 14 December 2004 Google declared that it had started working with several American university libraries plus New York Public Library to build the world's first large-scale searchable online digital library

collection over the Internet. This news was greatly welcomed by libraries, librarians, and library users worldwide. However, because of copyright disputes, Google has had to suspend its Print Project temporarily, after complaints from the Association of American Publishers and the Association of American University Presses as well as other copyright holders. Furthermore, the agreements signed between Google and several American universities did not contain any provisions for protecting the privacy of people who search the Google Print Library. On 3 November 2005, Google launched Google Book Search (*http://books.google.com/*). Although it contains only card catalog-like information on books in the public domain, such as books on US Civil War history, US government documents, the works of Henry James, and other materials, the launch of Google Book Search marks Google's first successful step towards the final Google Print Library Project.

Although the copyright dispute is not over, it is a fact that Google Book Search is expanding its influence to more and more new partners in European countries. For example, Google declared in May 2007 that 'two new European library partners' – the University Library of Lausanne located in Switzerland and the University of Ghent located in Belgium – were participating in the Google Book Search Project, too.

## The British Library and Microsoft

In competition with Google, Microsoft and the British Library (*http://www.bl.uk/*) also announced on 4 November 2005 that Microsoft would digitalize about 100,000 out-of-copyright books from the British Library's 150 million items. British Library users could search the digitalized collection under the new MSN Book Search Service, the beta version of which became available in 2006. In May 2008, however, Microsoft unexpectedly declared that it was stopping the Live Search Books and Live Search Academic projects as their business models were too vague.

## Amazon Pages and Amazon Upgrade

On the same day that Google announced its Google Print Library Project, Amazon, Inc. also declared that it would promote two digital book projects in 2006. Amazon Page will allow Amazon customers to pay per page or chapter of a book for online viewing, while Amazon Upgrade will provide customers with full online access to the printed books they purchased. For example, the cost for online viewing of a $20

printed book could be as little as $1.99. Random House, the world's largest trade publisher, has agreed to Amazon's proposed projects, saying that it would support online viewing on a pay-per-page basis. If these projects were to be successfully completed, Amazon Pages and Amazon Upgrade could threaten Google's Print Library Project.

### *The European Digital Library*

To compete with the Google Print Library Project, 19 European libraries signed up during the two-day European Culture Meeting in May 2005 to support the European Digital Library Project (*http://www.edlproject.eu/*), which was initially proposed by the French National Library in early 2005. Also, France and Germany agreed in April 2005 to design and develop the European web search engine known as 'Quaero' to challenge Google's global ambition 'to organize the world's information.' (In Latin, Quaero means 'to seek.') In the future, the European Library, which currently has online access to 11 million records in ten different languages from the collections of nine European national libraries, may become the backbone of this ambitious European Digital Library Project.

Because of complicated copyright issues, the road to the long-expected European Digital Library will not be straight. However, the European Digital Library Project should be one of the greatest and most ambitious digital library projects once over 6 million books, documents, and other cultural works become accessible online over the next five years.

## Real-world examples

### *Example 7.1 Microsoft's Windows Movie Maker 2.1*

It is critical for academic libraries to have capable video creation and editing software during the course of designing and developing web-based library tutorials. Microsoft's Windows Movie Maker 2.1 is therefore recommended to academic libraries with stringent operating budgets. Initially, Microsoft's Windows Movie Maker was introduced in 2000 with Microsoft's operating system Windows ME. Due to its modest features and negative user feedback, Windows Movie Maker did not attract serious attention. In 2005, Microsoft released the enhanced Windows Movie Maker 2.0 with great improvements. It is a free, lightweight

video creation and editing software for academic librarians to grasp without the need for a steep learning curve. It can also be used to burn a DVD. The latest version is Microsoft's Windows Movie Maker 2.1, which is available with Windows XP (SP2). For more detailed information, access the following Microsoft web page: *http://www.microsoft.com/windowsxp/downloads/updates/moviemaker2.mspx*.

### *Example 7.2 Digital library initiatives*

The United States is the birthplace of the Internet. The new advances in digital library initiatives and projects in this country will attract a lot of global attention, too. Among the current improvements to digital libraries, it is very important to find a central information gateway for all kinds of issues concerning library initiatives and implementations. I believe that the National Synchronization for the Digital Library Initiative (*http://dli.grainger.uiuc.edu/national.htm*), which is being supported by the University of Illinois at Urbana-Champaign in the United States, will provide much key information via multiple language support.

### *Example 7.3 iGoogle*

Google has released iGoogle (*http://www.google.com/ig?hl=en*), a new web search interface that allows users to add the date and time, calendar, news, and other personalized web search pages. iGoogle is free, and users can enjoy surfing the net in their own personalized web search interface. However, the price you pay is letting Google know all of your web activities, so that Google can analyze and monitor your individual preferences and information needs.

## Summary

- All in all, the rapid growth of cutting-edge and emerging technologies has provided academic libraries with innovative ways of delivering and disseminating information across heterogeneous applications, channels, databases, networks, platforms, and systems.
- The impacts which emerging technologies have on academic library information services include:
  - transformation between space and time;
  - distributed library information resources;

  - information diversification;
  - library digitization;
  - bandwidth, network speed, and wireless;
  - privacy and information security;
  - streaming multimedia and video technologies; and
  - web-based information services.
- Also, the growth in library digitization and digital library projects worldwide is building a new framework for the global digital library in the twenty-first century.

## Exercises

1. In what respects do you think an academic library can enhance and integrate its user information services?
2. If you were in charge of information services in an academic library, on which areas would you focus first? Why?
3. In your opinion, how can an academic library enhance and integrate its specific library information services?
4. What are the key technical factors impacting on the further development of information resources, services, and tutorials in academic libraries?
5. What technology will solve the contradiction between growing information needs and the limited storage capacity in an academic library?
6. In your opinion, which digital content management (DCM) software is the best for an academic library of your choice? Why?
7. Why is library digitization so important for the successful launch and implementation of a digital library?
8. Why is Google Book Search attracting more and more European library partners?
9. In what ways do you think Google Book Search and other leading digital libraries will impact on the future development of the global digital library?
10. What new information services could be offered at academic libraries in the next 15–20 years?

# Case studies

## *Case study 7.1 3D web browser*

It is reported that SpaceTime, a software company located in New York, on 8 June 2007 released a web browser which allows users to view web contents in a 3D environment. Go to the SpaceTime website (*http://www.spacetime.com*) and download the free 3D web browser. It is guaranteed that you will have a brand new 3D experience of surfing on the net!

### Questions

1. Describe your own experience of using this 3D web browser.
2. What technical features do you like when you use this 3D web browser?
3. What negative impressions do you have when you use this 3D web browser?
4. What else do you worry about using this 3D web browser?
5. Which aspects of SpaceTime do you think need to be enhanced?

## *Case study 7.2 Electronic paper*

### Sony LIBRIé and Sony Reader

Sony declared on 24 March 2004 that the world's first electronic paper display (EPD) had been developed successfully by Philips (*http://www.philips.com*), Sony (*http://www.sony.com*) and E-Ink (*http://www.eink.com*). In 2006 Sony displayed the second generation of the E-Book Reader. Visit the web page at *http://www.learningcenter.sony.us/assets/itpd/reader/reader_features.html* and answer the following questions.

### Questions

1. In your opinion, which type of electronic paper has the brighter outlook? (If you're not sure, review the related contents regarding EPD in Chapter 4.)
2. Which fields can electronic paper be applied to?
3. What advantages does Sony Reader have?

4. What weaknesses does Sony Reader have?
5. Why cannot academic libraries use EPD like Sony Reader now?

## *Case study 7.3 Web search engines*

The web search engine is an information search and retrieval system that recognizes and retrieves information over the Internet and WWW. To test your experience with and knowledge about web search engines, answer the following questions.

### Questions

1. Which web search engine do you often use? Why?
2. In addition to the one you always use, what other web search engines do you know?
3. Based on your own experience, which web search engine should be listed in first place? Why?
4. In your opinion, which four web search engines have most users around the world?

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8

# Impacts on academic librarians

## Chapter outline

In this chapter you will learn:

- how academic librarians are defined and what they do in the digital age;
- whether or not web search engines will replace academic libraries and librarians in the paperless age;
- what the major impacts of cutting-edge and emerging technologies are on academic librarians in the digital age;
- what challenges and opportunities academic librarians will have to meet.

## Learning objectives

After you have completed this chapter, you are expected to be able to:

- understand why academic libraries in the digital age will not become extinct;
- understand the implications of cutting-edge and emerging technologies for academic librarians in the digital age;
- be able to assess and evaluate the competency, knowledge, and skills academic librarians will require in the digital age;
- identify new functions and missions for academic information services librarians in dynamic and interactive academic learning environments.

## Introduction

In the digital age, the rapid developments in cutting-edge and emerging technologies have remarkably changed the ways in which information and relevant services are delivered and disseminated. Since there are plenty of e-databases and web search engines available, will we still need academic libraries and librarians? In their article entitled 'In the age of Google, will libraries become extinct?' Roy M. Mersky and Rhonda Hankins wrote in 2004:

> Technology has already radically changed the way librarians define themselves and the way they think about their jobs and the institutions where they work. Like many other former 'library schools,' for example, the Graduate School of Library and Information Science at the University of Texas has changed its name to the 'School of Information.' Many of its students pursue a master's of information science degree in hopes of becoming 'information specialists,' rather than librarians. The difference is not merely semantic. The new terminology reflects substantive changes in the way information is accessed, the way it is delivered and the new role of information professionals in society.

It is a fact that library users no longer need to personally present themselves inside a library building before they can access and locate information in today's information society. Utilizing the platform of the Internet and WWW, academic libraries have also been expanding their specific information resources, services, instructions, and other programs outside the brick walls of the library building. Web search engines, such as AltaVista, Google, MSN, Yahoo, and so on, can provide web users with quick access to a large quantity of information at high speed. All in all, the Internet and the WWW have changed not only our ways of accessing and locating information, but also the functions of an academic library as well as the definition of an academic librarian in the modern information society.

For academic libraries and their users around the world, however, new advances in innovative cutting-edge and evolving emerging technologies are providing new media for locating, accessing, storing, and transforming information. Only through the efforts made by academic librarians will library users have a chance to utilize these diverse academic library information resources, services, tutorials, and other professional programs delivered via innovative cutting-edge and emerging technologies. In the

face of the information explosion, moreover, a simple web search cannot cover all the information generated in our modern information society. For example, academic library users will have to use alternative information resources, ranging from microfiches to microfilms and other special collections, to cover archival or historical information, in case they cannot retrieve sufficient information from their web searching. Mersky and Hankins (2004) explain:

> Information professionals know that popular search engines access only a fraction of the Web – Google, for example, accesses fewer than 6 billion of the 600 billion pages of information available electronically. To limit a search to Google means to settle for less than 1 percent of the total information available electronically.

At academic library settings, academic librarians are still playing a leading role in designing, developing, enhancing, integrating, implementing, maintaining, and supporting high-quality service-oriented and student-centered applications, programs, services, and systems for academic library users to locate and access information. Whenever academic library users have difficulty in locating, accessing, printing, storing, and transforming information, academic librarians will function as information consultants to help their patrons. The essential differences between academic librarians and public librarians are that academic librarians have a greater focus on academic instructions, scholarly researches, and departmental liaison programs while public librarians have a greater focus on community services, especially for amusement, entertainment, investment, learning, and reading, etc., for adults, teenagers, children, and other specific community residents as well as visitors.

In this chapter, we will primarily explore in which fields new advances in emerging technologies have impacted on academic librarians and which challenges such librarians will face in the modern information society.

## Academic librarians in the digital age

According to the *Dictionary for Library and Information Science*, a librarian is defined as:

> a professionally trained person responsible for the care of a library and its contents, including the selection, processing, and organization of materials and the delivery of information, instruction, and loan

> services to meet the needs of its users (to see examples, try a keyword search on the term in *Google Image Search*). In the online environment, the role of the librarian is to manage and mediate access to information that may exist only in electronic form.

As classified by their job descriptions in the modern information society, the *Occupational Outlook Handbook*, published by the Bureau of Labor Statistics of the US Department of Labor in 2006, defines three primary positions for librarians: 'user services, technical services, and administrative services.' The *Handbook* also stresses that:

> Librarians with computer and information systems skills can work as automated-systems librarians, planning and operating computer systems, and as information architects, designing information storage and retrieval systems and developing procedures for collecting, organizing, interpreting, and classifying information.

Impacted by new advances in cutting-edge and emerging technologies, in fact, academic librarians in the digital age are required to work independently or as a team to deliver service-oriented and user-centered applications, instructions, programs, projects, and services. In addition to general qualifications and requirements such as an accredited degree in library and information sciences, a commitment to excellent user-centered services, effective oral and written communication, as well as team collaboration, academic librarians must also possess additional capability, experience, knowledge, and skills in the following academic library categories.

## *Librarians for administrative services*

Librarians for administrative services are senior administrators who carry primary responsibility for ensuring the effective and efficient enhancement, integration, and utilization of the finances, facilities, human resources and services in an academic library (system). They are academic leaders with strategic visions of how to leverage information resources, services, tutorials, and other programs in the digital age. With their diverse working experience, knowledge, and skills in cutting-edge and emerging technologies, administrative services librarians will demonstrate strong leadership in the delivery and dissemination of user-centered information resources, services, instruction, and other related programs in dynamic academic library settings.

## Librarians for access and circulation services

Librarians for access and circulation services are responsible for providing easy and reliable user-centered services and operations to access local library collections and other information resources. The primary duties of librarians for access and circulation services include the conventional functions of circulation services, including basic search and reference services, stacks, electronic loaned items, print reserves, billing, and other specific access and circulation duties in an academic library.

## Librarians for cataloging and classification services

Librarians for cataloging and classification services are also called catalog librarians. They perform original and adaptive cataloging of library materials in all formats. Catalog librarians are required to be familiar with cataloging principles and practices. Catalog librarians must have excellent knowledge and practical experience of utilizing cataloging standards (AACRII, LCSH, MARC21), plus experience of using a specific library information management system (LIMS).

In addition, knowledge of and skills in computers, bibliographic databases, web design, and foreign languages are common requirements for catalog librarians.

## Librarians for library collection development

Librarians for library collection development take primary responsibility for library acquisitions, collection development, and other related technical services, including the development and implementation of collection development policies, resource allocations, vendor licence negotiations, gifts and endowment management, and other assigned duties, etc., in academic libraries.

## Librarians for interlibrary loan and document delivery services

Librarians for interlibrary loan and document delivery services will be primarily responsible for managing and supervising interlibrary loan and document delivery services, including the internal and external

system sharing of transactional-based content resources and 'pay-per-view' services. Librarians for interlibrary loan and document delivery services are required to provide on-time delivery of materials (borrowing, lending, and distance learning delivery) as per clients' requirements.

## Librarians for government document services

Librarians for government document services plan, develop, manage, and deliver innovative and user-oriented government information and data services in a state/federal/regional depository library. Librarians for government document services must demonstrate strong professional knowledge and practice of the State/Federal Depository Library Program guidelines and practices. Experience of evaluating and using print and electronic government information resources, bibliographic instructions, reference services, and web design are common job duties. Additional experience in and knowledge of international government organization resources, GIS (geographic information systems), SPSS (Statistical Package for the Social Sciences), and other data analysis software are preferred qualifications.

## Librarians for reference/public services

Librarians for reference/public services are responsible for a wide variety of public service areas, including distance learning services, electronic information services, instant messaging services, instructional services, reference services, and other specific public user services. Librarians for reference/public services often provide instruction and user services in group and one-to-one service scenarios. They are often required to have experience, knowledge, and skills in handling bibliographic instruction, departmental liaison, information literacy, web design, and other assigned duties to leverage library reference/public services and library collection development. To keep up with technology trends in the modern information society, different academic librarian job titles, such as distance learning librarians, e-learning librarians, instruction librarians, public service librarians, reference librarians, subject services librarians (for example, science and technology librarians), and user services librarians, etc., can all be classified under the heading library reference/public services.

## Librarians for special collections

Librarians for special collections acquire, develop, organize, and maintain through purchasing and gift endowments a broad range of archival and special collections, including books, ephemera, illustrations, manuscripts, maps, paintings, periodicals, photographs, realia, and other relevant electronic media. Working closely with librarians for library collection development, librarians for special collections are responsible for developing, prioritizing and implementing activities, policies, procedures, and regulations for archival and special collection development in academic libraries. Also required for these positions are experience in and knowledge of archival practices, book history and bibliography instruction, rare books and manuscripts, web page design, copy and scanning equipment operations, and digital content management (DCM), etc.

## Librarians for systems services

Librarians for systems services are responsible for the management and support of library information systems and related technologies via integrated WAN/LAN networked IT platforms. Librarians for systems services must demonstrate diverse experience, knowledge, and skills in client/server, ILS application, LDAP (Lightweight Directory Access Protocol) authentication, metadata harvesting, Open URL, operating systems (such as Mac OS X, Windows, and Unix), and web authoring tools (such as Dreamweaver), etc. To ensure the library intranet meets user information needs, librarians for systems services need to conduct, develop, and provide usability testing, ongoing intranet enhancement, integration, and maintenance, user statistics, and technical specifications for the development of library applications, databases, networks, programs, projects, and systems in academic libraries.

## Librarians for web services

Librarians for web services play a leading role in designing, developing, enhancing, implementing, integrating, and maintaining overall web-based applications, databases, programs, projects, and services in academic libraries. Extensive knowledge and skills are required in website construction and maintenance via web authorizing languages, web editing and authorizing software, and other relevant web

technologies. Demonstrable experience, knowledge, and skills in digital libraries, GUI, project management, relational database management systems (RDBMS), and server side scripting, etc. are essential qualifications for the position. In addition, librarians for web services are required to follow technology trends in academic libraries, especially for blogs, web portals, wikis, and XML-based content management systems.

### *Working as academic librarians*

In the digital age, innovative cutting-edge and evolving emerging technology will continue to expand the service areas provided by academic librarians. The existing job duties and job titles of academic librarians, at the same time, will be adjusted or changed in order to reflect the impact of innovative cutting-edge and emerging technologies applicable to dynamic and interactive academic learning environments. If you compare the job duties of academic librarians listed above, you will see that some of their existing duties overlap. For example, reference/public services librarians will have to learn how to design and develop web-based information resources, services, and instruction, while system librarians and web services librarians will have to coordinate and collaborate in order to launch, implement, and maintain the web-based applications, programs, and systems running in an academic library's intranet. Likewise, academic librarians responsible for library collection development will need to use different computer software to analyze the data collected from diverse databases if they intend to handle library resource allocations more effectively and efficiently.

Because of limited space, it is not possible to explore further the evolution of academic librarian job duties and the semantic changes in their job titles that will come in the twenty-first century. However, it is a fact that the various job duties and job titles of academic librarians have been impacted by innovative cutting-edge and evolving emerging technologies. In the following section, we will primarily focus on the impact of emerging technologies on reference/public services librarians working in academic libraries in the digital age.

## Impacts on academic librarians

With the rapid development of emerging technologies, academic libraries around the world will significantly change their ways of locating,

accessing, delivering, disseminating, and storing multi-format information across heterogeneous applications, databases, networks, platforms, and systems. As a result of the growth of the various e-databases and web searching engines available, whether or not we still need librarians to search for information becomes one of the hot topics in the digital age. To meet the challenges of the modern information society, academic librarians, especially reference and public services librarians, will be required to switch roles from general subject librarians to information services consultants with specific information technology skills. Kathryn Greenhill, a reference librarian working at Murdoch University Library in Australia (*http://wwwlib.murdoch.edu.au/*), listed in her blog 20 reasons why academic librarians need to keep up to date with emerging technologies. In this section, we will review how and where evolving cutting-edge and emerging technologies have impacted on academic librarians in dynamic and interactive academic learning environments.

## *Impact 1: New services with new titles*

In the digital age, revolutionary advances in science and technology have expanded the service areas of academic libraries around the world, and innovative services with new librarian titles have been emerging in academic libraries. With evolving emerging technologies, it is now possible for academic libraries to seek new innovative applications, instructions, programs, projects, resources, and services for faculty, students, and other community users. From the new librarian titles discussed further in the sections which follow, we can see clearly that some of the librarians' duties, such as those of information/learning commons librarian, information services librarians, and virtual services librarians, intersect and overlap. However, no matter how their job titles are changed in the future, the duties of academic librarians will always reflect new services promoted by evolving emerging technologies applicable to diverse academic libraries around the world.

### Emerging technology librarian

The emerging technology librarian is an expert in the use of innovative emerging technologies to design and develop web-based applications, programs, and services. In addition to their traditional reference and public services duties, the emerging technology librarian is expected to design, develop, launch, and implement new innovative library services,

ranging from library digitization, web-based instruction, virtual reference, and other related new technology initiatives and projects. The emerging technology librarian is required to have strong competency, knowledge, and skills in emerging technologies applicable to dynamic and interactive academic learning and teaching environments.

## Information commons/learning commons librarian

The information commons/learning commons librarian primarily assists users to locate, access, store, and transform electronic information resources, services, and instructions across multiple applications, databases, networks, platforms, and systems in an academic library's information/learning commons. In addition to general reference and public services, the information/learning commons librarian is responsible for planning, designing, developing, and maintaining the automated/integrated library information technology projects and systems. The information/learning commons librarian usually needs to have strong experience and knowledge of and skills in integrated library systems (ILS) such as ALEPH, SirsiDynix, Virtura, and Voyager, etc., as well as databases, networking, script languages, web browsers, web content management, web design, and so on.

## Information services librarian

The information services librarian is the specialist who assists library users to locate, access, process, and synthesize information. The information services librarian must be familiar with various electronic information resources, services, and teaching programs. Commonly preferred experience and qualifications include instruction, collection development, strong communication skills, web page design and development, and so on.

## Librarians for library digital initiatives and services

Librarians for library digital initiatives and services focus on the challenges of preserving the library's digital assets. They are responsible for designing, developing, launching, implementing, and maintaining ongoing library digital content management (DCM). They will assess, evaluate, recommend, and test various methodologies, policies, and standards for utilizing computer software in the process of creating and preserving digital collections and resources. Also, they are required to

participate in grant applications and staff training. Librarians for library digital initiatives and services must have strong knowledge of and skills in web design and RDBMS, metadata standards (such as METS, Dublin Core, and VRA Core), and text encoding (such as EAD and TEI), plus CSS, HTML, JavaScript, XML, and so on.

### Virtual services librarian

The virtual services librarian is primarily responsible for information consulting, knowledge management, online learning, web content management, user education, and other specific projects, plus duties ranging from e-mail and instant messaging to social networking, wiki services, and so on. The virtual services librarian must demonstrate strong experience and knowledge of and skills in the cutting-edge and emerging technologies evolving in academic libraries, especially with regard to access to and delivery, dissemination, and transformation of electronic information in multiple formats. In fact, academic reference/public services librarians and information services librarians share the job duties of virtual services librarians in most academic library settings.

## *Impact 2: Information literacy*

In the digital age, high-speed information exchange and sharing also require that information users should have the capability to utilize multi-format information resources across a variety of applications, channels, databases, networks, platforms, and systems. Thus information literacy has become a new challenge for every information user in today's information society. According to the definition set by the Association of Colleges and Research Libraries (ACRL) in the United States, information literacy is 'a set of abilities requiring individuals to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information.' In the printing age, information literacy basically referred to a person's reading and writing abilities, since they were essential competences for exchanging and sharing information. In the digital age, information literacy refers to a person's comprehensive ability, knowledge, and skills to obtain, synthesize, transform, and utilize information from distributed information resources and systems.

In fact, information literacy is a double-edged sword. In the digital age, information literacy has impacted on not only academic library users but also academic librarians at the same time. Academic librarians, especially information services librarians, are required to switch roles from subject

specialists to information technology specialists before they can effectively and efficiently assist library users to locate, access, process, store, and transform information delivered via the whole range of applications, channels, databases, networks, platforms, and systems. If they do not understand how information is delivered and disseminated in the modern information society, how can academic librarians innovatively enhance and integrate service-oriented and student-centered academic information resources, services, and instructions, to say nothing of leveraging skills for critical thinking, decision-making, and problem-solving in the increasingly integrated and competitive global economy?

## *Impact 3: Coordinating and collaborative service models*

In the digital age, the complexity and diversity of information delivery and dissemination requires coordination and collaboration among academic faculty, instructors, and librarians in dynamic and interactive academic learning environments. Also, new advances in emerging technologies have laid down a potential technological basis for academic libraries to expand and promote their services outside the library building. To achieve better effectiveness in instruction, academic librarians have launched more and more coordinating and collaborative service models across different departments, colleges, and consortiums, including the following.

### Library-wide information service models

The information/learning commons is a new innovative coordinating and collaborative information services model promoted by academic libraries and their information service departments, for example:

- Hong Kong University of Science and Technology (China) Library: *http://library.ust.hk/serv/ic/*
- University of British Columbia Library (Canada): *http://www.library.ubc.ca/chapmanlearningcommons/welcome.html*
- University of Waikato Library (New Zealand): *http://www.waikato.ac.nz/library/business/infocommons.shtml*
- University of Miami Library (USA): *http://www.library.miami.edu/about/news/ic_close_partially.html*

## University-wide information service models

The university-wide information service model is another new type of innovative information service model across campus. To better facilitate and support high demands for effective instruction, learning, research, administration, and information exchange as well as information sharing, some academic libraries and universities around the world have implemented joint information services for faculty and students. The following short list introduces some successful university-wide information services models:

- City University London (UK) – Information Services and Libraries: *http://www.city.ac.uk/isl/*
- University of Bristol (UK) – Information Services: *http://www.bristol.ac.uk/is/*
- University of Georgia (USA) – Student Learning Center: *http://www.slc.uga.edu/*
- University of Memphis (USA) – AskTom: *http://answercenter.memphis.edu/index.shtml*

## Consortium-wide information service models

A consortium is a common type of cooperative association among libraries to exchange and share information resources and services. To meet high demands for information exchange and sharing in the digital age, a variety of library consortia have been successful in the United States and other parts of the world. The following short list is only representative of the leading library consortia in the world:

- BUBL Information Service: *http://bubl.ac.uk/*
- Center for Research Libraries (CRL): *http://www.crl.edu/*
- China Academic Library and Information System (CALIS): *http://www.calis.edu.cn/calisnew/*
- GALILEO: *http://www.galileo.usg.edu*
- National and State Libraries Australasia (NSLA) Consortium: *http://www.caslconsortium.org/*
- OCLC (Online Computer Library Center): *http://www.oclc.org/ default.htm*
- South African National Library and Information Consortium (SANLiC): *http://www.cosalc.ac.za/*

- South Asia Library Consortia: *http://www.columbia.edu/cu/lweb/indiv/southasia/cuvl/consort.html*
- Southern European Libraries Link (SELL): *http://www.heal-link.gr/SELL/index.html*
- Statewide California Electronic Library Consortium: *http://scelc.org/*

## Impact 4: Competency, knowledge, and skills

As a result of new advances in emerging technologies, the competency, knowledge, and skills of academic librarians in the digital age have to be adjusted in order to meet the high demands of faculty and students in dynamic and interactive academic working environments. One of the greatest challenges for academic librarians is that they must assist faculty and students to obtain key information via innovative approaches. No matter how much the job titles of academic librarians have been changed, more and more academic libraries prefer new and experienced academic librarians to possess the following essential experience and skills:

- demonstrated experience and skills in using one integrated library management system;
- demonstrated experience and skills in the use of a variety of electronic information resources;
- demonstrated knowledge, experience, and skills in developing trends of cutting-edge and emerging technologies applicable to dynamic and interactive academic learning environments;
- demonstrated knowledge, experience, and skills in designing and developing web pages or web-based instructions;
- preferably additional qualifications in database management systems, script programming, and software project management, etc.

## Impact 5: Challenges and opportunities for academic instructions

In the digital age, academic librarians will have to face up to new challenges and opportunities for enhancing and integrating specific academic instructions in dynamic and interactive academic learning environments. On the one hand, academic librarians need to learn how to design, develop, enhance, integrate, maintain, and update academic information resources,

services, and instructions across diverse applications, databases, networks, platforms, and systems. On the other hand, academic librarians, like other faculty and instructors, need to train students in how to utilize future science and technology to solve future issues and puzzles. It is the greatest challenge for academic librarians to teach students how to use the experience, knowledge, and skills they have learned today to deal with their future career developments and life challenges. New and evolving emerging technologies not only provide academic librarians with new instructional media, but also promote the exploration of new innovative approaches to improving academic learning effectiveness in the digital age.

# Real-world examples

## *Example 8.1 Google Earth*

Library map collections make up an important geographic reference resource. With the Internet and WWW, it is now possible for library users to review digital and online map information without any geographical or time limitations. Designed and developed by Google, for example, Google Earth is flash-based software offering zoomable maps and satellite images. Once you have access to a broadband network or other high-speed Internet access, you can start your free travel around the world by running Google Earth. For more detailed information, visit the website of Google Earth (*http://earth.google.com/*), and take a free virtual tour from your computer.

## *Example 8.2 Free web portal*

It is always a challenge for academic librarians who want to set up their own web portal in order to provide a better service for faculty and students as well as other community users, especially for those academic librarians who are not so experienced in HTML, DHTML, JavaScript, and XML. Now you have your chance to set up your own web portal for free! Visit the website called Netvibes (*http://www.netvibes.com*) and create your own free account. What you have to do is to input your own e-mail address and password for your web portal. The whole registration process is simple and short. After you set up your account, you can personalize your free web portal based on the instructions provided by Netvibes.com.

### *Example 8.3 Ultra mobile PC (UMPC) in the future*

In the modern information society, computers are essential components in accessing and locating information. In the digital age, new advances in cutting-edge and emerging technologies are creating new ways of using mobile computing in our daily life and work. The video at the following site previews how we could use our ultra mobile PC (UMPC) in the near future: *http://www.youtube.com/watch?v=G_FS2TiK3AI&eurl=http%3A%2F%2Fpop%2E6park%2Ecom%2Fchan6%2Fmessages%2F24532%2Ehtml*.

## Summary

- In the modern information society, it is possible for academic libraries to deliver and disseminate information across disparate applications, channels, databases, networks, platforms, and systems as a result of new advances in emerging technologies. Although evolving emerging technologies are a potential technological basis for academic libraries to implement service-oriented and student-centered programs and services, academic librarians will still play key roles in enhancing and integrating information resources, services, and instructions for academic library users.
- While new advances in emerging technologies have had a great impact on the job titles and duties of academic librarians and their coordinating and collaborative service models, and so on, academic librarians will need to learn how to utilize cutting-edge and emerging technologies to meet the challenges posed by information literacy in the digital age. Current academic librarian positions require more and more competency, knowledge, and skills in information technologies, ranging from computer programming and client/server and IT architectures to relational database management systems, multimedia, networks, web design, and so on. Old-fashioned librarians who only know how to use Boolean operators will have a hard time serving today's information society.
- The rapid growth of emerging technologies has impacted academic librarians in the following ways:
  - new services with new titles;
  - information literacy;
  - coordinating and collaborative service models;

– competency, knowledge, and skills;
– challenges and opportunities for academic instructions.

## Exercises

1. How are academic librarians being changed in the digital age?
2. In your opinion, how will academic library positions be changed in the future?
3. Which cutting-edge and emerging technologies have impacted on academic library information services in the digital age?
4. Which cutting-edge and emerging technologies have impacted on academic library instruction in the digital age?
5. How will cutting-edge technologies and emerging technologies change academic librarians in the future?
6. What new innovative programs and services can academic librarians provide for their library users in the digital age?
7. Why will information literacy impact on academic library users in the digital age?
8. What will be your suggestions for academic librarians who would like to improve their specific information literacy instructions?
9. How will academic librarians successfully meet the challenges of cutting-edge and emerging technologies in the digital age?
10. In your opinion, what will be the greatest challenges and opportunities for academic librarians in the coming years of the twenty-first century?

## Case studies

### *Case study 8.1 The future of search*

In the networked world, web search engines have become primary tools for us to locate and access web-based information. Some people are therefore doubtful if librarians will still be needed when they search for information in the future. Answer the following questions after you have read the short statement by Michael Fry at *http://www.info-arch.org/lists/sigia-l/0207/0624.html*.

## Questions

1. Why do we often use web search engines to search for information today?
2. What cannot web search engines do for us today?
3. How do you evaluate information searched via web search engines?
4. Based on your personal experiences, do you think librarians will still be needed when you search for information? Why, or why not?
5. What will web search engines search for us in the future?

## *Case study 8.2 Information navigators: future professionals*

In the modern information society, new advances in science and technology will always impact on information professionals at the same time as they promote new innovative ways of delivering and disseminating information. In January 1998, Professor Judith Elkin, Dean of the Faculty of Computing and Information Studies at the University of Central England in Birmingham in the United Kingdom (*http://www.uce.ac.uk/*), wrote a paper entitled 'Information navigators: future professionals' (see: *http://www.cni.org/regconfs/1997/ukoln-content/repor~12.html*) to discuss which competency, knowledge, and skills information professionals must possess. It has been ten years since then. Read her paper before you answer the following questions.

## Questions

1. What has changed for information professionals in the past ten years?
2. In additional to the competency, knowledge, and skills mentioned by Professor Elkin, what additional new knowledge and skills do you think information professionals must have in the digital age?
3. In your opinion, what will change academic librarians in the digital age?
4. In your opinion, which job titles and job duties will reflect the new services for academic librarians in the future? Why?
5. In your opinion, what will change for information professionals in the coming years of the twenty-first century?

## *Case study 8.3 Web search engines*

In the modern information society, searching the Web is the fast way to look for information, using web search engines such as Google, Yahoo, MSN, etc. Also, web search is one of the common ways in which information services librarians help library users locate and access necessary information. However, your knowledge of and skills in using web search engines will definitely impact on the quality of your web search. Answer the following questions based on your individual web search experiences.

### Questions

1. Which web search engine do you usually use?
2. What do you do if your favorite web search engine does not provide the information you need?
3. Have you ever switched web browsers to search for information on the Web?
4. Have you ever tried to use the meta-search engines to search for information on the Web?
5. What do you think of the meta-search engines when you need additional web information?

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9

# The eve of drastic changes

### Chapter outline

In this chapter you will learn:

- what is happening on the eve of drastic changes;
- who is the new giant that will lead the new advances in IT;
- what is the real driving force behind the new advances in emerging technologies in the digital age.

### Learning objectives

After you have completed this chapter, you are expected to be able to:

- identify the driving force leading new advances in cutting-edge and emerging technologies in the digital age;
- understand the new competition between Google and Microsoft over the platform of the Internet and WWW;
- predict which technology may rise to the fore across campus in the coming years of the twenty-first century.

## Introduction

After experiencing the '9/11' terrorist attacks on the United States and the bursting of the Internet bubble, the consistent development of a strong global economy has been propelling a new round of technological evolution and revolution. In the free market economy, two important factors will ultimately decide the future direction taken by developments

in technology: (1) the market; and (2) the technology. Although the technology itself is no match for the market, the technology can monopolize the market while the market can eliminate the technology, too. The competition in the free market is the original driving force behind technology innovations, while interactions between new and old technologies will eventually open and reinforce new markets.

In the digital age, which new emerging technologies will go on to have an impact on our activities – the way we amuse ourselves, the way we communicate, exchange and share data, conduct e-commerce, disseminate information, make investments, undertake research, and so on – in the future? Which science and technology giant will lead new advances in innovative science and technology? To answer these questions, let's focus on the IT applicable to modern academic libraries. Since computers are essential components for information delivery and dissemination over the Internet and WWW, we need to review the way computers are used to locate, access, process, store, and transform information so as to find and follow current developing trends in information technologies in dynamic and interactive academic learning environments. In other words, we need to explore the fundamental power that will lead new advances in cutting-edge and emerging technologies applicable to academic learning environments in the coming years of the twenty-first century.

## Larry Ellison's dream: the collapse of the Microsoft empire

In the history of the computing world, no one can neglect the outstanding contributions made by the powerful software giant Microsoft, Inc. (*http://www.microsoft.com*). It is well known that the success of Microsoft arose from its monopoly of the PC operating system Microsoft Windows and its desktop business software Microsoft Office. On 31 May 2007, Microsoft had 71,000 employees in over 100 countries and regions around the world. The Microsoft empire today is set up in three divisions: Platforms and Services, Microsoft Business, and Entertainment and Devices. During the course of its rise, Microsoft incurred a great many competitors and enemies, including Apple, IBM, Netscape, Oracle, Sun Microsystems, and many other third-party companies.

In the face of increasing competition in the ever-changing market, Microsoft realized the importance of the Web in the modern information

society – that the Internet and the WWW would become the information highway for data communication and dissemination for competitive businesses worldwide. With new advances in the WWW, all business firms will virtually make their existence known, reach their potential customers, promote their products and sales, and expand their marketplaces over the Internet and the WWW. It is clear the fate of the Microsoft empire can no longer depend just on the operating system Windows and the Office software suite. Microsoft has therefore adjusted its business strategies and expanded its influence into further innovative fields closely connected with the Internet and the WWW.

The competition with Netscape in the web browser market and the sale of Internet Explorer tied up with the sale of Windows 95 revealed that Microsoft intended to keep its hold over the Internet and the WWW, as it has done with computer operating systems and desktop software. Utilizing its powerful advantage in the monopoly over PC operating systems, Microsoft tied sales of its PC operating system to sales of its web browser, so it could expand its monopoly over the Internet and the WWW. As long as it controlled the web browser market, Microsoft assumed that it could control access to the Internet and other web-based information resources, and that was the reason behind its attacks on Apple, Java, Linux, Lotus Notes, Netscape, Opera, Real Networks, and other third-party companies. Finally, the great expansion of the growing Microsoft empire triggered a great trial at the end of the twentieth century which shocked the entire world – the anti-trust case against Microsoft filed by the United States Department of Justice (DoJ) and another twenty US states on 18 May 1998.

By the end of the case Microsoft was lucky to remain intact and escape mutilation. Of course, the purpose of this chapter is not to unearth the reasons how and why Microsoft was able to survive this litigation at the end of the twentieth century. What this brief history reveals is the impact new advances in emerging technologies can have on a business's fate. The anti-trust case against Microsoft showed that the leading software giants and other third-party companies had already started new life-and-death struggles over the platform of the Internet and the WWW before 1998.

For a long time, the dream of Larry Ellison, CEO of Oracle (*http://www.oracle.com*), has been to topple Microsoft and become the biggest player in the field of middleware and applications. Led by Ellison, Oracle has become another powerful software giant pitted against Microsoft in the fields of databases, middleware, and software. To curb Microsoft's ambitions and expansions, Ellison had been looking

for the killer application that could thoroughly destroy the growing Microsoft empire. Following new advances in open-source software, Ellison declared in April 2003: 'Linux will wipe Microsoft out of the data center.' Since then some four years have passed and we still have not seen any signs that Linux will be in a position to shake the foundations of the Microsoft empire in the near future. Although Dell (*http://www.dell.com*) and Hewlett-Packard (*http://www.hp.com*) are selling personal computers with Linux installed, it will take time for Linux to make inroads into Microsoft's core business. It is a great pity for Larry Ellison that the giant killer of the Microsoft empire looks likely to be neither Linux nor Oracle. History has transferred the opportunity to undermine the foundations of the Microsoft empire to another newcomer in the digital age.

## Google: a new giant in the digital age

Founded on 7 September 1998, Google (*http://www.google.com*) declared publicly that its 'mission is to organize the world's information and make it universally accessible and useful.' The software giant Microsoft laughed scornfully, although it would soon be time for it to have to fight for its survival in the anti-trust case which spanned the centuries. Nevertheless, the growing Microsoft empire had more than enough power to kill off any competitors that dared to challenge its monopoly. However, Google was different from many of the other companies squeezed out by Microsoft. When it finally emerged from the anti-trust case, Microsoft had no way of preventing Google from leaping forward in the digital age. Within just a couple of years, Google has risen quietly as a web search giant over the Internet and WWW. When the stock market closed on 31 May 2007, Microsoft's stock price was $30.59 per share (having risen less than 10 percent in the previous five years), while Google's stock price was $500.40 per share (having shot sky high by 500 percent from Fall 2004 to May 2007).

Table 9.1 provides a simple comparison of the major products offered by Google and Microsoft. Google's power indeed lies in the fields of web search engines, online advertising, and other related services and tools running over the Internet and WWW, while Microsoft's strengths come from its PC operating systems, desktop office suite, servers, games and other related software and tools. Obviously, Google is launching a comprehensive attack against Microsoft. Google's Desktop, which consists of Docs & Spreadsheet, Calendar, Map, Gmail, and so on, has

**Table 9.1** **A comparative list of major products offered by Google and Microsoft**

| Products | Google | Microsoft |
|---|---|---|
| Top guns | Web search engines | Windows operating systems |
| Desktop | Google Desktop | Microsoft Office Suite |
| Calendar | Google Calendar | Outlook |
| Database | | Access/SQL Server |
| E-mail | Gmail | Hotmail |
| Games | | XBox |
| Instant Messaging (IM) | Google Talk | MSN Messenger |
| IPTV | | Microsoft TV (IPTV) |
| Map | Google Map | MSN Maps and Directions |
| Mobile | Google Mobile | Windows Mobile |
| News | Google News & Archived Search | MSN.com |
| Telecommunication | | Microsoft TV |
| Servers | | Servers: SQL Server and so on |
| Streaming media software | Picasa | Media Player |
| Web browser | | Internet Explorer |
| Video | Google Video/YouTube | |
| Virtual | Google Earth | Microsoft Virtual Earth 3-D |
| Word processing/ spreadsheets | Docs & Spreadsheets | Microsoft Word/Excel |
| Others | Blog, iGoogle, and Translate … | MSN Directory and Windows Live … |

already looked like the prototype of Microsoft's desktop Office Suite. To fight back against Google's attack, Microsoft is striving to develop its own web search engine Windows Live, while strengthening its expansion into the fields of streaming media, video, and telecommunications, etc. Meanwhile there has been a rumor in the market suggesting that Microsoft and Yahoo (*http://www.yahoo.com*) might either merge or set up some sort of strategic alliance against their deadly enemy Google.

I predict that Google may well bring down the Microsoft empire. In the past, no other company has been able to lead and compete comprehensively with Microsoft in so many core fields which Microsoft intends to dominate. I believe that the competition between Google and Microsoft will draw an outline for us of the future for trends in emerging technologies over the Internet and WWW.

## Google's super-weapon: the network operating system

For a while, there was a rumor doing the rounds in the computing industry about a Google operating system and Google PC. It was reported that the Internet search giant Google was negotiating with Wal-Mart Stores (*http://www.walmart.com/*) and other retailers about selling Google PCs. Google PCs would run a new operating system, not Microsoft's Windows, created by Google. To reduce the risk of computer viruses, it was expected that Google would use the network technology over the WWW to run computer software, such as centralized controlled word-processors, e-mails, and spreadsheets, via the Internet. On 3 January 2006, Google formally denied that it has such a plan to produce a low-cost PC.

Actually, it is wise for Google not to repeat the same process that Microsoft went through. In today's modern information society, PC makers are no longer in the forefront of new advances in emerging technologies. Consider what has happened to those ex-super American computer manufacturers such as Compaq, IBM, Dell and Gateway. In May 2002, Compaq was sold to Hewlett-Packard (*http://www.hp.com/*) for $19 billion. In 2004, IBM (*http://www.ibm.com*) gave up and sold its PC business to its Chinese rival Lenovo (*http://www.lenovo.com/*). On 31 May 2007, Dell (*http://www.dell.com/*), a well-known computer maker based in Austin, Texas, United States, declared that it was going to lay off 8,800 employees to restructure its business after its first-quarter earnings went down. When the Wall Street stock market finally closed on 1 June 2007, the stock price of Gateway (*http://www.gateway.com/*) hit $1.78 per share, down from its peak price of $80 per share at the end of 1999. Utilizing the principle of asymmetric strategies, therefore, Google launched its comprehensive attack in a field in which the giant Microsoft empire has not dominated – the Internet and the WWW.

Google's strategy is to set the new order for the dissemination of the world's web information and make it accessible only through Google's web search engine. However, what approach could be taken to build up

Google's position ahead of Microsoft over the Internet and WWW? Google's secret weapon is the network operating system (NOS), which is the only killer application that could completely defeat the Microsoft empire. A NOS is an operating system which controls, manages, and provides network data communications and network resources sharing for computers in the network. Since the NOS is running on a server, a network operating system is sometimes also called a server operating system. General computer users and IT specialists should be familiar with network operating systems. In a LAN, common network operating systems include Windows, Mac, Linux, NetWare, and Unix.

Once the network bandwidth and the Internet speed matches the requirements for high-speed data distribution, data exchange, and data telecommunication, it is possible for a NOS to control new advances in innovative technology over the Internet and the WWW. This is the secret weapon which Google has chosen to conquer the Web. In the coming years of the twenty-first century, new breakthroughs in emerging technologies over the Internet and the WWW should evolve in technology fields such as the next generation of the Internet (Ipv6), streaming media technology, third-generation wireless telecommunication, ultraband networking, video technology, WiMAX (Worldwide Interoperability for Microwave Access), and so on.

According to the 2007 BrandZ Top 100 Ranking released by the well-known global marketing research company Millward Brown (*http://www.millwardbrown.com*), among high-tech business firms around the world Google has replaced Microsoft in the top position, Microsoft occupies third place, China Mobile fifth, IBM ninth, Nokia twelfth, Hewlett-Packard fifteenth, Apple sixteenth, Vodafone twenty-second, Cisco twenty-fourth, Intel twenty-fifth, and Oracle thirtieth. I believe that this Top 100 list will help you understand the marketing power of new web giant Google over the Internet and WWW. I also believe that the comparative list of major products offered by Google and Microsoft in Table 9.1 will give us an indication of future trends in emerging technologies over the Internet and the WWW.

# Real-world examples

## *Example 9.1 Can Google get better?*

No doubt, Google is the web search giant in today's information world. While dominating the web search engine market, how is Google trying

to maintain its leading position? Maybe Rick Aristotle Munarriz's article from 2007 will shed some light on which way Google intends to enhance and integrate its web search power (see Munarriz, 2007).

### *Example 9.2 Microsoft's DigiDesk – the future of Office Desk*

In the digital age, digital technology combined with multimedia technology is having a great impact on the way we live and work. For academic faculty, instructors, librarians, staff, and other professionals, it is time to take a look at the future in Microsoft's DigiDesk, which demonstrates many innovative ways of exchanging and sharing information in a new and innovative GUI. The following link is to a YouTube video for review: *http://www.engadget.com/2007/05/04/microsoft-shows-off-digidesk-workstation-of-the-future/*.

### *Example 9.3 Microsoft surface computer – the future of the interface*

For a long time, a computer keyboard has been used as the primary interface for computer users to operate their desktops, laptops, and tablet computers. However, Microsoft unveiled a new coffee-table-shaped computer on 30 May 2007 which is built around a large multi-touch screen. Microsoft has called it a surface computer.

- Watch the following YouTube video to experience this new type of computer technology in the digital age: *http://www.youtube.com/watch?v=ttgx9ygMXz8*.
- In addition, readers who would like to know more about surface computing can access Microsoft's website for more detailed information: *http://www.microsoft.com/surface/*.

## Summary

- In the digital age, the web giant Google and the software giant Microsoft have locked horns over the Internet and WWW. A comparison of the list of major products offered by Google and

Microsoft clearly reveals that new innovative software focusing on multimedia, web search engines, and other related fields will have a dramatic impact on web-based information resources, services, and tutorials in diverse academic libraries.

- The competition between Google and Microsoft will provide academic libraries with new innovative options to enhance and integrate their web-based information technology infrastructures in the digital age.
- On the eve of these drastic changes, academic administrators, executives, faculty, instructors, IT specialists, librarians, and other related professionals will need to closely follow the transition from conventional client/server environments to the WWW in the coming years of the twenty-first century.

## Exercises

1. Identify five examples of web-based software in academic libraries.
2. Compare three of the most popular web search engines for the same web search subject.
3. Which new technology will have a brighter future over the Internet and the WWW? Why?
4. Which new features would you like to have in the future cellular phone? Why?
5. Which new web-based software would you like to use from Google's product list? Why?
6. Which new web-based software would you like to use from Microsoft's product list? Why?
7. Can you find out how and where Apple is building its markets in the digital age?
8. How do you expect Apple to compete with Google and Microsoft?
9. Why is it so important to protect personal privacy in today's digital world?
10. Which new advances in emerging technologies will enhance and integrate future web search engines?

# Case studies

## *Case study 9.1 Apple iPhone competition*

Based in Taiwan, China, the High Tech Computer Corporation (*http://www.htc.com*) declared on 12 June 2007 that it had planned to release its own new touch-screen smartphone in competition with Apple iPhone.

### Questions

1. Why do so many vendors intend to challenge the Apple iPhone?
2. Why will cell phones and personal digital assistants (PDAs) become more and more popular in dynamic and interactive academic learning environments?
3. What benefits will academic faculty and students have if they use the Apple iPhone or other similar products?
4. In your opinion, what new and innovative technologies will emerge in the next 10 to 15 years for cellular phone users?
5. Why do we monitor new advances in mobile computing and communication in the digital age?

## *Case study 9.2 Google vs Microsoft*

In the digital age, it is a fact that Google and Microsoft have locked horns for dominance of the Internet and the WWW. On 12 June 2007, Michael Liedtke reported: 'Google raises antitrust against Microsoft personal computer operating system Vista.' The article may be found on the Web through Google or Yahoo! or other search engines.

### Questions

1. Analyze why Google is strongly against Microsoft Vista.
2. Why does Google intend to compete with Microsoft in this field?
3. Why is an operating system so important for a web search engine?
4. In what areas could Google and Microsoft compete in the future? Why?
5. What benefits can academic libraries get from the competition between Google and Microsoft? Why?

## *Case study 9.3 Microsoft: Silverlight*

As defined by Microsoft, 'Silverlight is a cross-browser, cross-platform plug-in for delivering the next generation of media experiences and rich interactive applications (RIAs) for the Web.' Check out the related information about Microsoft Silverlight at *http://www.microsoft.com/silverlight/* and answer the following questions.

### Questions

1. What can Microsoft Silverlight do for us?
2. Do you like Microsoft Silverlight? Why, or why not?
3. Who will use Microsoft Silverlight?
4. Why does Microsoft want to promote Silverlight?
5. Why is streaming video so important for the modern information world?

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10

# Leveraging academic library information services in the digital age

## Chapter outline

In this chapter you will learn:

- the developing trends in information technology in academic libraries;
- the future of web-based information technology architectures in academic libraries;
- how to leverage academic library information services in the digital age.

## Learning objectives

After you have completed this chapter, you are expected to be able to:

- design and develop academic information resources, services, and programs following the developing trends in IT in academic libraries;
- assess and evaluate learning effectiveness in academic library settings;
- make a long-term strategic plan to meet new technological advances in academic libraries;
- leverage academic library information services in the coming years of the twenty-first century.

## Introduction

In the digital age, new advances in cutting-edge and emerging technologies are the driving forces behind further developments in academic library information services in dynamic and interactive academic learning environments. In this chapter, we will explore key issues about how to effectively and efficiently enhance, integrate, maintain, support, and utilize information technologies in academic library settings, and some practical suggestions will be made to leverage academic library information services. However, first we will overview the current trends in IT in academic libraries before we set up our ambitious long-term strategic plans and innovative library projects.

## Developing trends in information technology in academic libraries

The tremendous growth in IT in the 1990s prompted further developments in the technologies applicable to academic libraries around the whole world. Utilizing the platform of the Internet and WWW, more and more academic libraries have been exploring new and innovative ways of enhancing and integrating academic library information resources, services, and tutorials, ranging from computer-aided skills training and digital library projects to distance learning services, information commons, instant messaging (IM) services, the virtual classroom, virtual references, and so on.

If we take a general overview of the IT applicable to information technology infrastructures in academic libraries, we can clearly see that current trends in IT are utilizing computer technologies, digital technologies, instructional technologies, multimedia technologies, network technologies, video technologies, and web technologies, etc. to design and develop an integrated one-stop information gateway over the Internet and WWW. On the basis of multiple academic library IT architectures, the current trends in IT in academic libraries display the following characteristics:

- *Web-based*. Current trends in IT in academic libraries are focusing on how to build dynamic, scalable, and user-centered web-based information resources, services, and tutorials in diverse academic library information infrastructures.
- *24/7*. Web-based academic library information resources, services, and tutorials are 24/7, without time or geographic limitations.

However, some academic libraries worldwide can only offer time-limited instant messaging (IM) services because of tight staff and scheduling constraints. At the same time, more and more academic libraries, public libraries, government libraries, and special libraries around the world are able to join the Global Reference Network, led by the US Library of Congress (*http://www.loc.gov/index.html*), to provide global collaborative online reference services to meet growing global demands for information.

- *Enhancement and integration*. Current trends in IT in academic libraries are pursuing innovative enhancements to and integration of existing library information resources, services, and teaching programmes in student-centered and service-oriented library learning environments.
- *Library digitization*. Library digitization is the process of utilizing digital technology to convert printed library collections to electronic formats. In the digital age, more and more academic libraries are expanding their collections from printed formats to electronic formats. With new advances in digital technologies, academic libraries can copy, preserve, scan, transform, and store printed library collections in multiple electronic formats. To provide academic library users with access to these digitalized library collections, academic libraries need to set up and implement digital library projects which provide digitalized resources, network access, and distribution management via network technology.
- *Multi-formats*. Modern academic libraries now focus on delivering and disseminating heterogeneous information dynamically and seamlessly. Current web technologies have provided academic libraries with dynamic ways of accessing, retrieving, converting, processing, and storing information in multiple formats, such as text, Portable Document Format (PDF) files, images, slides, audio files, video files, etc. via the Internet platform.
- *Multi-language support*. Current developing trends in IT in academic libraries have made it possible for academic libraries to provide international users with multi-language support. Some academic library administrators, executives, IT specialists, librarians, managers, and staff, however, have not realized how important new multi-language support is for promoting information literacy in academic library learning environments, especially for non-English information delivery, dissemination, exchange, storage, and transformation.
- *Open access*. Current developing trends in IT in academic libraries are promoting open access to online information delivered and disseminated via the Internet and the WWW. While the field of software

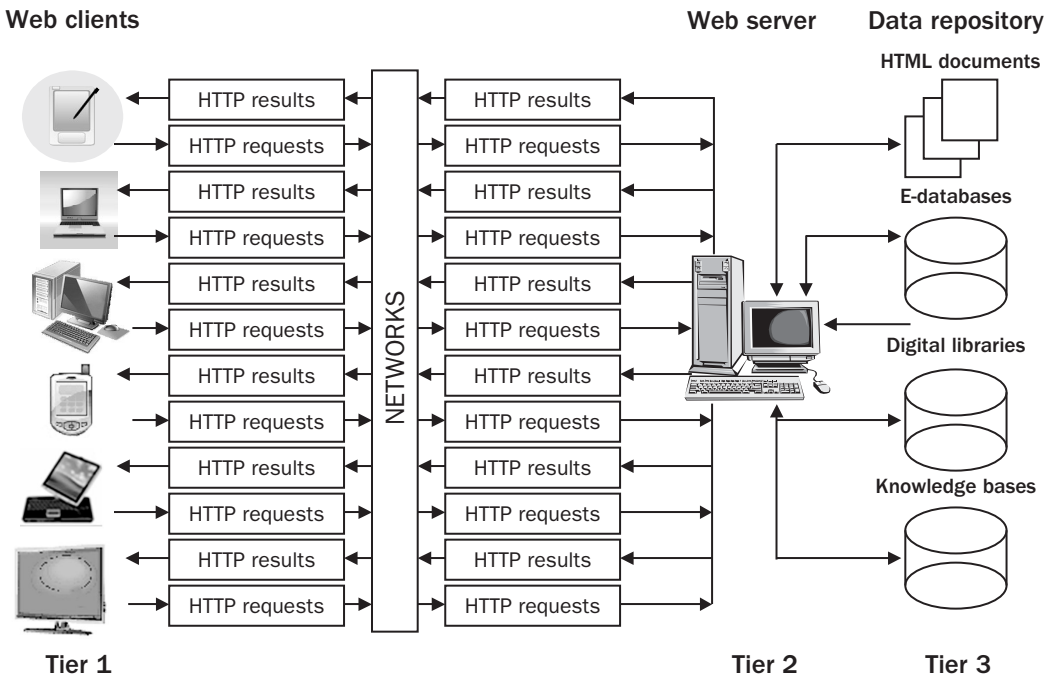
engineering is promoting open-source software, open access to information is also becoming a challenging issue in the dynamic and interactive academic learning environment, since it is one of the primary requirements for the further evolution of ubiquitous libraries in the twenty-first century. The basic concept of ubiquitous libraries is that libraries are accessible from anywhere anytime. The dream of ubiquitous libraries has become a reality as a result of rapid advances in cutting-edge and emerging technologies. The significance of ubiquitous libraries no longer lies in their physical existence today. Instead, the mission of ubiquitous libraries in the digital age is to promote global multi-format information exchange and sharing with multi-language support on the Internet and WWW.

- *Social networking services*. A social network is a virtual network to promote social activities and communications among various social groups. Social networking services promote social communication and understanding via the WWW. Utilizing web tools such as blogs and wikis, a lot of academic libraries worldwide are promoting social communications and social connections among faculty, instructors, staff, students, and other professionals or community users.
- *Global collaboration and understanding*. In the coming years of the twenty-first century, academic libraries worldwide will become central information gateways to the world's knowledge and information. To further promote global cooperation and mutual understanding, free access to, exchange of, and sharing of academic information and knowledge should not have any limits in the modern information society. Academic libraries worldwide should bear their primary responsibility to serve global users without regard to age, gender, color, race, religion, language capability, computer skills, or library literacy, etc. In the digital age, the ultimate objective for academic libraries worldwide is to promote information dissemination and sharing for the purpose of fostering global collaboration and understanding.

## Future web-based information technology architecture in academic libraries

The traditional n-tier client/server IT architecture is still evolving in the digital age. The rapid development of cutting-edge and emerging technologies has already shaped the next generation of web-based IT architecture in future academic libraries (see Figure 10.1).

**Figure 10.1** The next-generation web-based library information technology architecture



Obviously, the next generation of the Internet (IPv6), the Ultraband Network, and WiMAX technology will lay down solid foundations for future academic libraries to deliver and disseminate information resources, services, and programs to global users at faster speeds via multiple dynamic platforms. In addition to regular desktop computers, laptops, and tablets, cellular phones, hand-held computers, HDTVs (hi-definition televisions), and PDAs (personal digital assistants) will also be used widely to locate, access, process, and store academic library information resources, services, and instructions via the next generation of the Internet platform and wireless network technologies.

Working with JavaScript, XSL (Extensible Stylesheet Language), and XHTML (Extensible Hypertext Markup Language) at the front end (Tier 1), XML (Extensible Markup Language) will be widely used to define web page contents, data manipulation, and management from the object relational database management systems (ORDBMS) located at the back end (Tier 3). At Tier 2, interoperable middleware among enterprises and organizations, such as web services and DOM (Document Object Model), will handle server-side processes. In addition, the Ultraband Network, which can transmit data at 5–1,000 Mbps or even higher, and WiMAX, which represents the 802.16 wireless metropolitan area network standard, will make it possible for academic library users to access academic library information resources, services, and instructions dynamically and remotely within city or suburb areas.

In our discussions in the previous sections, we have drawn a clear picture of how future web-based IT architectures in academic libraries will continue to evolve in the digital age. Impacted by rapid advances in emerging technologies, wireless technology will definitely be in the forefront of new advances in technology for service-oriented and user-centered academic libraries. The Ultraband Network will speed up the location, access, exchange, dissemination, and transformation of academic library information resources, services, and instruction. One of the most obvious changes will be on the web client side. New advances in emerging technologies will provide academic library users with more dynamic means of accessing and locating the key information they need in innovative human–machine interfaces. It will no longer be a dream when more and more academic library users are able to access and locate information resources, services, and tutorials through their cellular phones, HDTVs, and PDAs in the coming years of the twenty-first century.

# Leveraging academic library information services in the digital age

It has been more than a decade since academic libraries worldwide began to deliver their information resources, services, and instructions via the Internet and WWW. In the light of new advances in cutting-edge and emerging technologies, we will have more innovative ways of enhancing and integrating academic library information resources, services, and teaching programs in the digital age. On the platform of the Internet and WWW, academic library administrators, executives, faculty, instructors, IT specialists, librarians, staff, and other professionals have been striving to leverage academic library information services. I believe that we should focus on the following fields in dynamic and interactive academic learning environments first.

## *Web design and web navigation*

User-centered web design and efficient web navigation are two primary keys for an academic library to build a high-quality information gateway in dynamic and interactive learning environments. The essence of web design is to link and organize web contents in a user-friendly GUI, while the purpose of web navigation is to provide a mechanism for library users to access and locate the key information they need. A user-centered GUI and a high-quality web navigation mechanism will be the basis for effectively and efficiently leveraging web-based academic library information resources, services, tutorials, and other programs in the digital age. Based on multiple user interface surveys tested at the Georgia Southern University Library, it has been recognized that a user-centered GUI and an efficient web navigation mechanism could impact on the learning effectiveness in an academic library.

Generally speaking, there are two common ways for academic libraries to link and organize their web contents. The first way is to create direct hyperlinks to lists of academic library information resources, services, instructions, and so on. The advantage of this web navigation mechanism is that it is easy to create and easy to use. The disadvantage is the 'information explosion,' especially for those large academic library systems with many branch libraries. Due to the rapidly increasing web content year after year, it is very difficult for webmasters to create direct hyperlinks within such a limited user-friendly GUI. Academic library users often need to click multiple times before they can reach the information they need.

Figure 10.2 shows a screenshot from the homepage of Georgia Institute of Technology Library in the United States.

The second way is to design a pull-down web menu-driven website to support a user's web navigation activities. More and more academic libraries are using this web navigation mechanism to link and organize their growing web contents. The advantage of this mechanism is that a lot of hyperlinks for high-quality academic information are clearly displayed one click away from a user's fingertips. It is so powerful that academic libraries can easily embed their specific information resources, services, tutorials, and other programs in different categories. The disadvantage is the complicated design process. Also, it may block out some of the web contents when a user pulls down a web menu vertically. The example in Figure 10.3 is taken from the website of Nova Southeastern University Library in the United States. Readers can see clearly how a pull-down web menu can categorize information. At the same time, a part of the web contents may be blocked when the web menu is pulled down vertically.

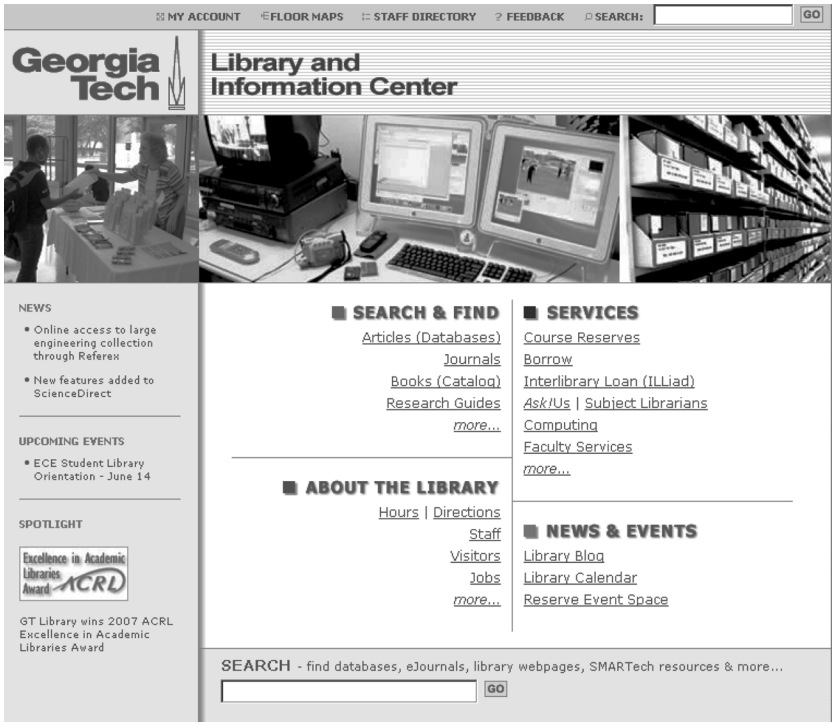
## *Enhancements and integrations*

Utilizing innovative emerging technologies in the fields of computer technology, digital technology, human-intelligence technology, multimedia technology, networking technology, and wireless technology, etc., academic library administrators, executives, IT specialists, librarians, managers, and staff should be able to enhance and integrate their existing library information resources and services via innovative approaches. The following real-world examples will give us some instructive suggestions.

### Library-wide enhancements and integrations

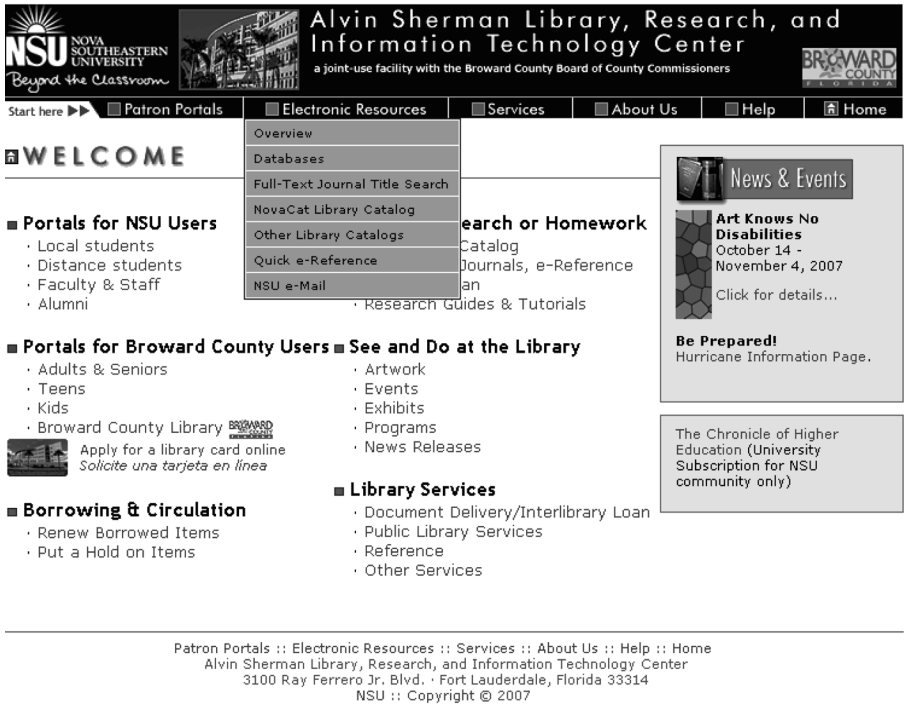
To meet the challenges of today's information exchange and sharing driven by the Internet and the World Wide Web, more and more academic libraries worldwide are seeking innovative and intelligent ways to enhance and integrate their specific information resources, services, and instructions in information commons to assist faculty, students, and other community users to dynamically and interactively access, locate, synthesize, store, transform, and transmit multi-format information in learner-centered and service-oriented academic libraries. Technically speaking, an academic library information commons is a new and evolving innovative collaborative library service model built in diverse networked academic interactive learning environments. One of the

**Figure 10.2** The website of Georgia Institute of Technology Library, USA




*Source*: *http://www.library.gatech.edu/*.

**Figure 10.3** The website of Nova Southeastern University Library, USA




Source: *http://www.nova.edu/library/main/*.

primary advantages of an information commons is to enhance and integrate existing library information resources, services, instructions, and other public service programs in one consistent, dynamic, interactive, and scalable student-centered interactive learning environment. Successful examples of library information commons include:

- Scotiabank Information Commons, University of Toronto, Canada: *http://www.utoronto.ca/ic/*;
- Information Commons, Hong Kong University of Science and Technology, China: *http://library.ust.hk/serv/ic/*;
- Information Commons, University of Auckland, New Zealand: *http://www.information-commons.auckland.ac.nz/*;
- Information Commons, University of Sheffield, United Kingdom: *http://www.shef.ac.uk/infocommons/*;
- Hardin Library, University of Iowa, United States: *http://www.lib.uiowa.edu/commons/*.

## University-wide enhancements and integrations

Working with RightNow Technologies (*http://www.rightnow.com/*), the University of Memphis in the United States successfully launched its first student-centered joint information service program across the university campus, named AskTom (*http://asktom.custhelp.com/cgi-bin/asktom.cfg/php/enduser/std_alp.php*). This new information service assists students and faculty to access and locate information via multiple interactive channels, including the Web, interactive voice, e-mail, chat, regular telephone, and the Internet.

## Consortium-wide enhancements and integrations

Participating in a consortium to exchange and share information is another effective and efficient way to integrate the various academic information resources and services provided in academic libraries. For example, over 200 academic libraries in America participated in the Center for Research Libraries (*http://www.crl.edu/*) to access its collection, which contains 16,000 newspaper titles in print and microform, 800,000 doctoral dissertation titles from universities outside America and Canada, government documents and publications, thousands of journals in English and other languages, archives, and other traditional and digital information resources.

## Digitization

In the digital age, the rapid development of computer technology, digital technology, multimedia technology, network technology, video technology, and web technology has made it possible for academic libraries to expand their conventional library collections. Taking advantage of advances in these technologies, academic libraries can dynamically convert specific printed library collections to multiple electronic formats, including audios, images, pictures, texts, and videos, etc. In the coming years of the twenty-first century, library digitization will lead future technological developments in academic library settings.

## Knowledge management and web content control

To leverage academic library information services in the digital age, academic library administrators, executives, IT specialists, librarians, managers, staff, and other professionals should pay more attention to knowledge management and web content control. Based on specific long-term and short-term strategic plans set by different academic libraries, administrators, executives, IT specialists, librarians, managers, and staff need to focus on the following operations:

- *Knowledge management*. Knowledge management refers to managing the process of identifying and utilizing intellectual assets in an organization for the purposes of leveraging business competition and promoting service goals. To enhance the high quality of services offered in academic libraries, it is absolutely necessary for such libraries to set up a knowledge base to collect, organize, preserve, share, and utilize essential and key knowledge about management, operations, services, and tutorials, such as budget control, e-learning and information services, faculty liaison, funding support, library collection development, licensing and managing electronic resources, and so on, in diverse academic library settings.
- *Web content management*. Web content management is the process of using software to design, develop, implement, modify, and store a website's contents, such as text, images, and audio/video files. An academic library should set up a web content steering committee to strengthen their web content management. With the rapid growth of web-based information resources and services, it is a tough challenge for academic librarians and IT specialists to design, develop, enhance, integrate, manage, and support a user-friendly website, the primary

information gateway for faculty, students, and other community users. The GUI and the web navigation mechanism should become a key focus for academic library web content management as discussed in the previous section. A web page's animations, colors, fonts, images, and layouts, etc. should support a website's GUI and the web navigation mechanism.

- *Information literacy model*. According to the Association of College and Research Libraries (ACRL), 'Information Literacy is the set of skills needed to find, retrieve, analyze, and use information.' To promote information literacy across campus, academic libraries need to regularly modify and update their existing information literacy models to improve student-centered learning activities involving the practical skills of critical thinking, decision-making, and problem-solving in interactive academic learning environments.

## Open-access databases and web search engines

Providing free online access to subject-related information resources is one of the long-term goals for building ubiquitous online services in academic libraries in the twenty-first century. Currently, most academic libraries around the world still only provide library users with online access to specific fee-based and password-protected information databases. Before the copyright issue is finally solved among authors, distributors, editors, libraries, publishers, users, and vendors, etc., however, it would be highly practical for academic libraries to provide users with subject-related open-source online databases and web search engines to promote free global information access and information exchange in the digital age. The following list is only presented to show how an academic library can effectively and efficiently assist academic students and faculty to access key information by the use of more dynamic open-source e-databases and web search engines, in case its fee-based and password-protected information databases become temporarily inaccessible because of unexpected networking problems:

- BioMed Central: *http://www.biomedcentral.com/*
- Directory of Open Access Journals (DOAJ): *http://www.doaj.org/*
- Free Medical Journals: *http://www.freemedicaljournals.com/*
- Google Scholar: *http://scholar.google.com/*
- Google News: *http://news.google.com/*
- Google News Archive Search: *http://news.google.com/archivesearch*

- Open Access Journals in the Field of Education: *http://aera-cr.asu.edu/ejournals/*
- Open J-Gate.com: *http://www.openj-gate.com/*
- Windows Live Academic Search: *http://academic.live.com/*

## Open-source software

More and more open source software has been applied to academic learning environments. In addition to well-known open source software such as Apache, JBoss, MySQL, and PostgreSQL, I believe that new open source software will attract more serious attention from academic library information commons around the world, especially for those academic libraries in developing countries and regions. To explore more detailed information about open-source software applicable to academic learning environments, the following websites are recommended as a quick reference:

- *DOMZ.org*. The Open Project Directory claims to be 'the largest, most comprehensive human-edited directory of the Web' maintained and supported by volunteer editors worldwide with a wide range of experience, knowledge, and skills (*http://dmoz.org/Reference/Libraries/Library_ and_Information_Science/Software/*).
- *JavaSource.net*. The Open Source Software in Java™ provides a list of leading open-source software running on the Java platform (*http://java-source.net/*).
- *KOHA* (*http://www.koha.org/*). KOHA is claimed to be the first fully featured open-source integrated library system (ILS) with comprehensive functionality covering circulation, cataloging, acquisitions, serials, reserves, patron management, branch relationships, and other library management processes.
- *NASA (National Aeronautics and Space Administration)*. NASA Open Source Software collects a list of innovative open-source software for NASA missions. Some of this open-source software, such as World Wind, can also be applied to academic learning environments to encourage more and more students to explore hi-tech fields (*http://opensource.arc.nasa.gov/*).
- *OpenOffice.org* (*http://www.openoffice.org/*). OpenOffice.org is one of the most well-known non-profit international organizations which

designs and develops open-source office software with multi-lingual and multi-platform supports. The latest version is OpenSource.org 2.0, released while this book is being written.

- *OpenSourceMac.org*. OpenSourceMac.org offers a list of the best open-source software for the Mac OS X. Academic libraries can use this list as a reference when they need to select software for Mac computers.
- *UNESCO (United Nationas Educational, Scientific, and Cultural Organization)*. The Free and Open Source Software Portal is one of the primary information gateways which recommends leading, innovative, and free open-source software technology (*http://www.unesco.org/cgi-bin/webworld/portal_freesoftware/cgi/page.cgi?d=1*). As one of the specialized United Nations agencies, UNESCO strives to promote global cooperation and mutual understanding via the dissemination and sharing of information and knowledge in the fields of education, science, culture, communication, etc.
- *W3C (World Wide Web Consortium)*. Open Source Software offers a list of recommended open-source software at *http://www.w3.org/Status.html*. Academic librarians and IT support staff can use this list to select qualified open-source software to enhance and integrate their web-based academic library information resources, services, and other programs.

## Multi-formats

In the digital age, it is no longer a dream to be able to exchange and share information via disparate applications, databases, networks, platforms, and systems. Utilizing all kinds of media available, academic libraries can deliver and disseminate multi-format information for faculty and students. In other words, library collections can be dynamically converted to multiple formats before they are delivered and disseminated. For example, the same printed library item, such as a Microsoft Word document, can be copied, scanned, and saved as an image or a PDF document in the process of conversion. At the same time, this Microsoft word document will be accessible to academic library users if it is converted into an HTML-based document or embedded into an HTML-based web page. With this unique feature of modern information dissemination, it should not be a technological problem for academic libraries to provide users with dynamic channels to access the key information they need.

## Multi-language support

Impacted by the rapid development of open-source software and the stringent operating budgets in academic learning environments, multiple-language support and open access will become more and more important for academic executives, IT specialists, librarians, and staff to promote the further development of the information commons in the twenty-first century. To promote information literacy around the world, moreover, an academic library should provide support for students and faculty to access information in languages other than English. To speed up the global information exchange and sharing, an academic library could provide faculty and students with multiple language supports when they locate, access, process, and utilize information. For example, it is not a technical problem for IT specialists in the system departments to install multiple-language fonts in different computer operating systems and web browsers, so that faculty and students can use multiple languages to search non-English information. It is impossible to build up high-quality, service-oriented, and student-centered academic library information resources, services, and tutorials if administrators, executives, librarians, managers, and IT specialists in an academic library (system) have not realized how important it is to enhance, integrate, and promote global information exchange and sharing via modern information technologies.

## Assessments and evaluations

Academic libraries often use assessments and evaluations to measure the learning effectiveness generated by academic library information services. Assessment focuses on the cognitive appraisal processes of data gathering and data analysis, while evaluation supports administrative decision-making based on collected assessment information and data analysis reports. Common academic library assessments and evaluations cover typical library service areas such as GUIs, public services, user needs, website navigation, and so on. No matter which mechanisms are used to analyze user feedback, academic library administrators, executives, librarians, managers, and staff should focus on the practical purposes of these assessments and evaluations. Academic library assessments and evaluations will lose their real significance if they cannot generate any practical solutions to enhance and integrate information services in real-world library scenarios. A general LIBQUAL survey, which attracts more and more academic library administrators and executives worldwide, may not be the only user service survey suitable for every specific academic library information service scenario. It is still necessary to design

customized user surveys to measure their progress and success in dynamic library learning environments.

### *Copyright vs collaborations and partnerships*

In the twenty-first century, the copyright issue has become one of the major blockages that is preventing free and open access to data and information across diverse applications, channels, databases, networks, platforms, and systems. At the present time, the primary information resources and databases offered by various academic libraries appear to be licence bound. Hundreds and thousands of papers have been published worldwide to discuss and explore innovative ways of solving the copyright issue. Historically, the primary function of libraries was to act as repositories of information and knowledge about the spiritual treasures of society. Although the advances in modern science and technology have greatly changed library functions in today's information society, few libraries have been playing important roles in the whole production chain of information and knowledge. Google's ambitious Library Project has provided academic research libraries and national libraries with one innovative way to solve copyright issues among authors, brokers, distributors, media producers, publishers, and other copyright holders by working together to create and produce new knowledge and share mutual benefits. As a matter of fact, academic libraries need to set up collaborations and partnerships with all the copyright holders before they can freely promote information exchange and global understanding in the twenty-first century. Otherwise, academic libraries worldwide will never be granted a clear right to decide how to deliver and distribute information and knowledge without imitation if they do not participate in the process of information and knowledge production. For other medium-sized and small academic libraries, the best solutions to break the deadlock of copyright issues should include participation in a variety of consortia to exchange and share information at affordable operating costs.

## Real-world examples

### *Example 10.1 Blog – a best library practice wiki*

A blog, also called a web log, is a new one-stop-shop web portal containing chronological web publications for personal or professional purposes. The websites carrying blogs also provide direct web links to

other websites and other blogs. To simulate the same functions as the free web encyclopedia *Wikipedia* (*http://www.wikipedia.org/*), a blog called Library Success (*http://www.libsuccess.org/*) has been designed for professional librarians who would like to discuss, exchange, and share different ideas and information about a variety of library issues.

### *Example 10.2 Apple's iPod in university libraries*

Apple's iPod is a hot digital media player device in the marketplace. A lot of university libraries around the world are paying more attention to the use of this new innovative device to deliver and disseminate academic library information and services. The University of Sheffield Library in the United Kingdom is using Apple's iPod to access the university library tour information (*http://www.shef.ac.uk/library/services/ipod.html*). Ohio University Libraries in the USA is also using iPods to assist students who need to know more about university libraries (*http://www.library.ohiou.edu/newsblog/?p=152*).

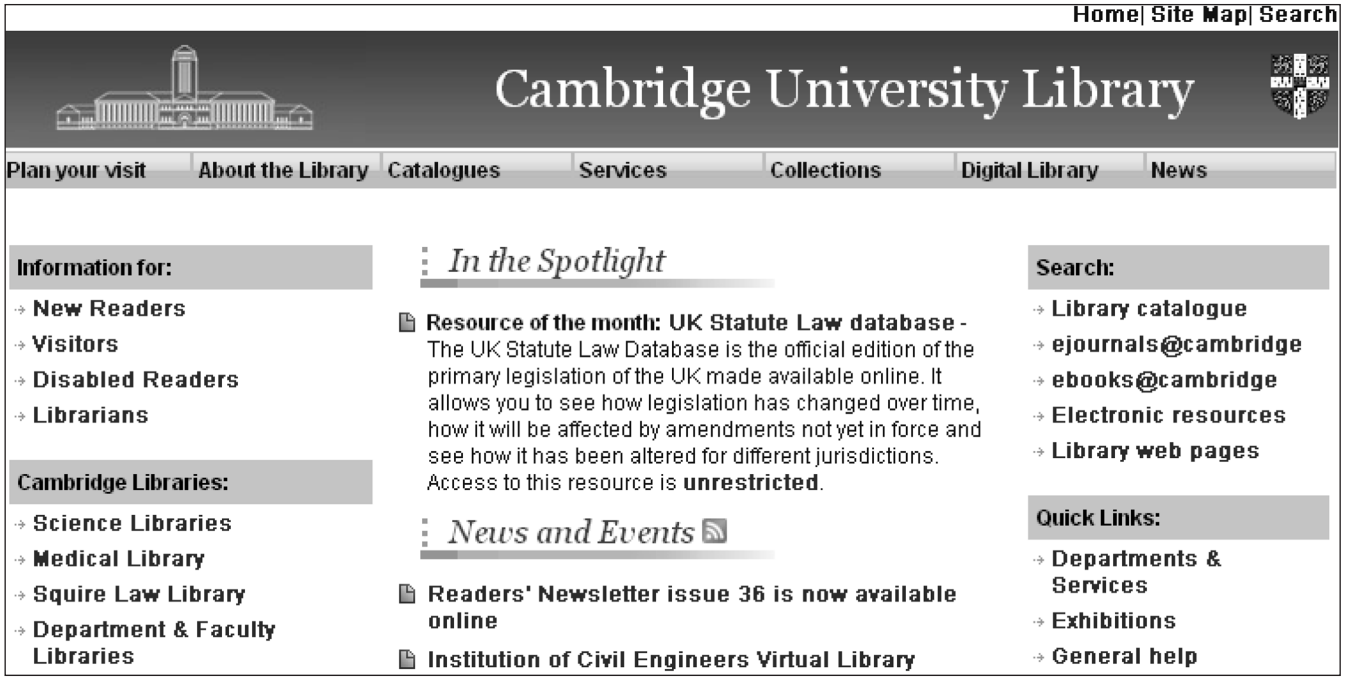
### *Example 10.3 Website design*

In the digital age, the Internet and WWW have become the primary information gateways in dynamic academic learning environments. One of the main challenges for many academic libraries is still how to effectively and efficiently embed diverse information resources, services, and instructions in one enhanced user-centered GUI. For example, the Cambridge University Library in United Kingdom is using a pull-down web menu to organize its information resources and services under different subject categories, such as 'Plan your visit,' 'About the Library,' 'Catalogues,' 'Services,' 'Collections,' 'Digital Library,' and 'News.' The vertical pull-down web menu opens as soon as a user's mouse is over the related web menu category. Figure 10.4 is a screenshot from the website of Cambridge University Library in the United Kingdom.

## Summary

- Throughout their historical development around the world, libraries have been primarily set up to collect and store the essence of human culture. Following the impact of new advances in innovative cutting-edge and emerging technologies, academic libraries in the digital age

**Figure 10.4** The website of Cambridge University Library in the UK




*Source*: *http://www.lib.cam.ac.uk/*.

will display a more active role as information gateways rather than die out altogether. New advances in computer technologies, digital technologies, network technologies, video technologies, web technologies, etc. merely enhance and integrate the academic library's functions of locating, accessing, delivering, synthesizing, transforming, and storing information.

- In the digital age, the developing trends in information technology in academic libraries will have the following nine characteristics:
  1. *Web-based*. Academic libraries worldwide are striving to deliver and disseminate more web-based information and services to the fingertips of library users via the Internet platform.
  2. *24/7*. Web-based academic library information services are accessible 24/7 without time or geographical constraint.
  3. *Enhancements and integrations*. Due to high user expectations, innovative information technologies, and stringent operating budgets, academic libraries worldwide have to keep enhancing and integrating their existing and new projects for information resources, services, tutorials, and other supporting programs.
  4. *Library digitization*. Academic libraries worldwide will provide users with more access to digitized library resources via the initialization and implementation of digital library projects.
  5. *Multi-formats*. In the digital age, dynamic information formats can be accessed, converted, delivered, processed, transmitted, and stored across applications, channels, databases, networks, platforms, and systems in academic libraries.
  6. *Multi-language support*. Academic libraries worldwide will provide users with multi-language support to promote information exchange and sharing in the digital age.
  7. *Open-source software*. More and more innovative open-source software will be widely used in academic library settings to realize the dream of the ubiquitous library in the coming years of the twenty-first century.
  8. *Social networking services*. Academic libraries worldwide will promote social networking connections and services to exchange and share information via innovative web applications and tools.
  9. *Global collaboration and understanding*. Academic libraries worldwide will promote the dissemination of information and the sharing of intelligence, innovation, and knowledge via global collaboration and understanding in the digital age.

- Impacted by new advances in innovative cutting-edge and emerging technologies, the Internet and WWW will continue to function as the primary platform for academic libraries worldwide to build up their specific web-based IT architectures in the coming years of the twenty-first century. The web-based n-tier client/server IT architecture will keep evolving at service-oriented and student-centered academic library settings. One of the most remarkable advances in this web-based IT architecture is that academic library users will have multiple new devices, including desktop computers, laptops, tablets, cellular phones, hand-held computers, HDTVs, and PDAs, etc., to access web-based academic library information resources, services, and instructions.
- Academic library administrators, executives, faculty, instructors, IT specialists, librarians, managers, staff, and other professionals will need to further enhance and integrate library information resources, services, and instructions in service-oriented and student-centered academic libraries.

## Exercises

1. Can you specify further developing trends in information technologies in academic libraries? If so, what are they?
2. Identify ten information technologies currently applicable to academic library information services.
3. Assess and estimate an academic library's web-based information services.
4. Can you suggest how an academic library should improve its instant messaging (IM) services? Why?
5. In your opinion, how will Web 2.0 impact on an academic library's information services in the digital age?
6. Discuss whether Library 2.0 will enhance and integrate innovative academic library information services in the digital age. Why? Or why not?
7. What is your opinion on copyright and fair use in academic learning environments?
8. Do you think that academic libraries will become extinct in the future, especially after the all of their printed library collections have been converted to electronic formats?

9. What are the major problems blocking further developments in academic libraries in the digital age? Why?
10. What are primary tasks for academic libraries in the coming years of the twenty-first century?

# Case studies

## *Case study 10.1 Global Reference Network*

Using the well-known virtual reference service management software QuestionPoint provided by the OCLC (Online Computer Library Center), the Library of Congress in the United States will be able to lead the Global Reference Network to provide 24/7 virtual reference services for users around the world. For further information, access the following web page: *http://www.loc.gov/rr/digiref/*.

### Questions

1. What is a virtual reference service (VRS)?
2. Why is QuestionPoint among the best virtual reference service management software?
3. In addition to QuestionPoint, can you specify additional virtual reference service software available?
4. Why will the Global Reference Network be able to promote information dissemination and global understanding in the digital age?
5. What else can we do to enhance and integrate the Global Reference Network?

## *Case study 10.2 iPod and university libraries*

To promote the instructional applications of digital technology in a dynamic academic learning environment, Duke University in the United States declared in 2004 that every new first-year Duke freshman would have an Apple iPod device from the Fall semester 2004. As reported by Lynne O'Brien, the director of Academic Technology and Instructional Services for Duke University Libraries, in 2006: 'Many people were simply puzzled. Was the academic use of iPods the beginning of an educational trend, or a fad that would quickly fade? Were iPods tools or toys?'

## Questions

1. What is an iPod?
2. Why are more and more universities and university libraries using Apple iPods as means for students to access information about academic courses and library services?
3. What are the advantages of using iPods in academic learning environments?
4. What are the disadvantages of using iPods in academic learning environments?
5. What is the point of promoting digital audios, digital images, and digital videos in an interactive and student-centered academic learning environment?
6. In your opinion, will the academic use of iPods mark the beginning of a new innovative technical trend in the academic learning environment? Why? Or why not?

# *Case study 10.3 Website design*

In the digital age, the Internet and WWW have become the primary information gateways in dynamic academic learning environments. One of the primary challenges for many academic libraries is how to embed diverse information resources, services, and instructions in one enhanced and user-centered GUI. The quality of the user-centered web design determines if library users can effectively and efficiently access and locate key information they need. Use the knowledge and skills you have learned to review an academic library's home page of your choice. You should pay special attention to its GUI and means of web navigation.

## Questions

1. In your opinion, what are the primary requirements for a successful website design?
2. Which web navigation mechanisms do you prefer? Why?
3. Suppose you were a webmaster, what basic web contents do you need to link before you design and develop a university library's website?
4. How can you dynamically link all those web contents in one web page?

5. Why is it such a challenge to design a service-oriented and user-centered university library website?

## References and further information

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Spencer, M.E. (2006) 'Evolving a new model: the information commons,' *Reference Services Review*, 34 (2): 242–7.

# Appendix 1
# Selected guide to information resources for emerging technologies

This selected guide provides a list of comprehensive information resources for emerging technologies at academic library settings.

## Books

Gunther, R.E., Day, G.S., and Schoemaker, P.J.H. (2004) *Wharton on Managing Emerging Technologies*. Hoboken, NJ: Wiley & Sons.

Mike, A. (2005) 'The ten most important emerging technologies for humanity.' TruthPublishing.com. Retrieved 21 June 2007, from: *http://www.truthpublishing.com/topten_p/pdf-cat21263.htm*

## Conferences and shows

2007 International CES: emerging technologies: *http://www.cesweb.org/attendees/markets/emergtech.asp*

Emerging technologies: SIGGRAPH 2006: *http://www.siggraph.org/s2006/main.php?f=conference&p=etech*

Information Today: *http://www.infotoday.com/*

O'Reilly Emerging Technology Conference: *http://conferences.oreillynet.com/pub/w/52/about.html*

## Consortiums, organizations, and technology alliances

Center for Emerging Technologies: *http://www.emergingtech.org/*

Centre for Advanced Computing and Emerging Technologies (ACET): *http://www.acet.rdg.ac.uk/*

Digital Living Network Alliance (DLNA): *http://www.dlna.org/en/consumer/home*

Library and Information Technology Association (LITA): *http://www.ala.org/ala/lita/litamembership/litaigs/emergingtechnol/emergingtechnologies.cfm*
*Emerging technologies interest group.*

New Media Consortium (NMC): *http://www.nmc.org/*
Sparkling innovative learning and creativity.

## Emerging technologies and practice

EDUCAUSE: *http://www.educause.edu/content.asp?page_id=5673&bhcp=1*
Emerging technologies and practices.

Library and Information Technology Association (LITA): emerging technologies interest group: *http://www.ala.org/ala/lita/litamembership/litaigs/emergingtechnol/emergingtechnologies.cfm*

## Internet resources

2020Software.com: *http://www.2020software.com/default.asp?*
The short list for business software.

About.com: wireless and networking: *http://compnetworking.about.com/od/itinformationtechnology/IT_Information_Technology.htm*

AllBusiness: *http://www.allbusiness.com/technology/2976223-1.html?google=emerging%20technologies*
One-stop resource for growing technologies.

CampusTechnology: *http://www.campustechnology.com/*

CES: *http://www.cesweb.org/attendees/markets/emergtech.asp*
Emerging technologies.

ComputerWorld.com: *http://www.computerworld.com/*
Claims to be the 'Voice of IT Management.'

EmTech Consulting: *http://www.emtech.net/*
Over 15,000 resources organized by topics for teachers, students, and parents.

EPanorama.net: *http://www.epanorama.net/index.php*
Offers a subject list of electronic technologies and related information resources.

ExtremeTech: *http://www.extremetech.com/category2/0,1695,1593003,00.asp/*
Emerging technologies.

Google: library and information science: *http://directory.google.com/Top/Reference/Libraries/Library_and_Information_Science/*

Information Today: *http://www.infotoday.com/conferences.shtml*
Conferences.

ITtoolbox Emerging Technologies Knowledge Base: *http://emergingtech.ittoolbox.com/*

NetworkWorld.com: *http://www.networkworld.com/*

Rice University: *http://www.rice.edu/projects/code/emergtech.html*
Sources on emerging technology.

Streaming Media World: *http://streamingmediaworld.com/*

StreamingMedia.com: *http://www.streamingmedia.com/*

TechNewsWorld: All Tech, All the Time: *http://www.technewsworld.com/*

Technology Review: *http://www.technologyreview.com/*
Find out what the future of technology will be.

TechWeb: *http://www.techweb.com/*

Ultrawidebandplanet.com: *http://www.ultrawidebandplanet.com/*

## Online encyclopedias, dictionaries, guides, and handbooks

ODLIS: Online Dictionary for Library and Information Science: *http://lu.com/odlis/about.cfm*

TechWeb: TechEncyclopedia: *http://www.techweb.com/enclopedia*

Wikipedia: emerging technologies: *http://en.wikipedia.org/wiki/Emerging_technologies*

## Professional journals

*Australian Journal of Emerging Technologies and Society*: *http://www.swin.edu.au/sbs/ajets/*

## Web logs and websites to watch

Library Success: *http://www.libsuccess.org/*
A best practices wiki.

SearchNetworking.com: *http://searchnetworking.techtarget.com/home/0,289692,sid7,00.html*

Technology Review: *http://www.technologyreview.com/*
Emerging technologies and their impacts. (From MIT: 'Information on Emerging Technologies and Impact on Business and Society.')

Technology Review: *http://www.technologyreview.com/special/emerging/index.aspx*
Ten emerging technologies that will change the world.

WeBlogALot: *http://www.weblogalot.com/*

WhatIs.com: *http://whatis.techtarget.com/*
The leading IT encyclopedia and learning center

Wikipedia: Emerging Technology: *http://en.wikipedia.org/wiki/Emerging_technologies*

ZDNet: *http://blogs.zdnet.com/emergingtech/*
Emerging technology trends.

## Web search engines

IEEE: New Technology Connection Portal: *http://www.ieee.org/web/emergingtech/home/index.html*

Podzinger: *http://www.podzinger.com/*

# Appendix 2
# Academic libraries in 100 of the world's most famous universities

For the purpose of promoting web-based academic information resources, services, and teaching programs, I have compiled a list of academic libraries in 100 of the world's most famous universities. To clear potential misunderstandings, I would like to point out that the numerical order does not represent any library rankings in the list.

## Selection criteria

It has been difficult filtering academic libraries from the top 100 of the world's most famous universities based only on my own personal opinion. Due to the limited time available, it has only been possible for me to use the following fairly debatable criteria to select the academic libraries for inclusion in the list.

- *Size of library*. The first criterion is to focus on large academic library systems which include a primary library and other branch libraries in the same university library system, especially for academic libraries in America, Canada, and Western European countries.
- *Library collections*. The second criterion is the library collection – this is one of the more debatable selection criteria. For the list below, I chose two million printed volumes as a benchmark for academic libraries in the North American area, while for other academic libraries outside North America, one million printed volumes is used as a benchmark. It is a challenging and time-consuming process to collect such data. For example, the Oxford University Library System in the United Kingdom comprises over 100 university libraries across

the campus. Unfortunately, some of the academic libraries in this list did not respond to my inquiry about the most up-to-date statistics on their collections. If any readers are interested in the latest statistical data, please contact the individual academic libraries separately for more detailed information.

- *Historical background and scholarship*. The third selection standard is the historical background level of scholarship of a university. I began in America and Canada with academic research libraries which include a primary library and other branch libraries. For well-known European universities I focused on their historical significance and scholarly reputation. For academic libraries in America and Canada, I used the website of the Association of Research Libraries (ARL: *http://www.arl.org/index.shtml*) as a reference. For other academic libraries outside of the North America, I used Google's web search engine (*http://www.google.com*) and the free web encyclopedia Wikipedia (*http://www.wikipedia.org/*) as my major reference resources.
- *Geographic location*. The fourth selection criterion is the geographic location. Basically, the list of academic libraries in 100 of the world's most famous universities is designed to present leading academic libraries in world-famous universities. As a consequence of global economic integration and historic limitations, the leading academic libraries selected for this list are mainly in developed countries, such as Australia, Canada, France, Japan, Germany, the Netherlands, Russia, Sweden, Switzerland, the UK, and the USA, etc.
- *Website design*. The fifth selection criterion is the design of the library's website. Basically, I focus on the GUI of an academic library's website and the specific ways it links and organizes academic library information resources, services, and instructions.

In short, I believe that the list of academic libraries in 100 of the world's most famous universities will provide academic library administrators, executives, IT specialists, librarians, LIS students, and other professionals with a chance of reviewing how academic libraries in 100 world-famous universities are assisting faculty, instructors, and students via the Internet and WWW. Whatever these academic libraries in 100 of the world's most famous universities offer to their specific users will contribute to the further development of ubiquitous academic library services in the coming years of the twenty-first century.

# Academic libraries in 100 of the world's most famous universities

Below then is the list of academic libraries in 100 of the world's most famous universities arranged in alphabetical order.

| No. | University libraries and museums | Country |
|---|---|---|
| 1 | Australian National University Library | Australia |
| | Website: *http://anulib.anu.edu.au/lib_home.html*<br>Library collection:<br>2.4 million printed volumes | |
| 2 | Boston University Libraries | United States |
| | Website: *http://www.bu.edu/library/index.shtml*<br>Library collection:<br>2,449,521 printed volumes + 40,757 serial titles | |
| 3 | Brown University Library | United States |
| | Website: *http://dl.lib.brown.edu/libweb/index.php*<br>Library collection:<br>3,568,944 printed volumes + 40,082 serial titles | |
| 4 | California Institute of Technology Library Services | United States |
| | Website: *http://library.caltech.edu/*<br>Library collection:<br>874,789 print items + 2,420 Serial titles | |
| 5 | Carnegie Mellon University Libraries | United States |
| | Website: *http://www.library.cmu.edu/*<br>Library collection:<br>1,084,013 printed volumes + 26,694 serial titles | |
| 6 | Catholic University of Leuven Library | Belgium |
| | Website: *http://bib.kuleuven.be/english/index.html*<br>Library collection:<br>4,829,000 printed volumes + 12,800 serial titles | |
| 7 | Chinese University of Hong Kong | China |
| | Website: *http://www.lib.cuhk.edu.hk/*<br>Library collection:<br>1,778,499 printed volumes + 14,525 serial titles | |
| 8 | Columbia University Libraries | United States |
| | Website: *http://www.columbia.edu/cu/lweb/*<br>Library collection:<br>9,455,312 printed volumes + 117,264 serial titles | |

| No. | University libraries and museums | Country |
|---|---|---|
| 9 | Cornell University Libraries | United States |
| | Website: *http://www.cornell.edu/libraries/*<br>Library collection:<br>7,785,263 printed volumes + 77,392 serial titles | |
| 10 | Duke University Libraries | United States |
| | Website: *http://library.duke.edu/*<br>Library collection:<br>5,665,241 printed volumes + 58,282 serial titles | |
| 11 | Ecole Normale Super Paris Libraries | France |
| | Website: *http://www.bib.ens.fr/*<br>Library collection: | |
| 12 | Emory University Libraries | United States |
| | Website: *http://www.emory.edu/libraries.cfm*<br>Library collection:<br>3,184,754 printed volumes + 37,779 serial titles | |
| 13 | Georgia Institute of Technology Libraries | United States |
| | Website: *http://www.library.gatech.edu/*<br>Library collection:<br>2,449,323 printed volumes + 34,576 serial titles | |
| 14 | Harvard University Libraries | United States |
| | Website: *http://lib.harvard.edu/*<br>Library collection:<br>15,826,570 printed volumes + 98,988 serial titles | |
| 15 | Hebrew University of Jerusalem Libraries & Archives | Israel |
| | Website:<br>*http://www.huji.ac.il/huji/eng/library_e.htm*<br>Library collection:<br>> 5 million printed volumes | |
| 16 | Humboldt University of Berlin Library | Germany |
| | Website: *http://www.ub.hu-berlin.de/*<br>Library collection: | |
| 17 | Indiana University (at Bloomington) Libraries | United States |
| | Website: *http://www.libraries.iub.edu/*<br>Library collection:<br>7,374,784 printed volumes + 79,427 serial titles | |
| 18 | Johns Hopkins University Libraries | United States |
| | Website:<br>*http://webapps.jhu.edu/jhuniverse/libraries/*<br>Library collection:<br>3,686,575 printed volumes + 74,244 serial titles | |

| No. | University libraries and museums | Country |
|---|---|---|
| 19 | King's College London Libraries | United Kingdom |
| | Website: *http://www.kcl.ac.uk/iss/library*<br>Library collection:<br>Almost 3 million printed volumes | |
| 20 | Kyoto University Library | Japan |
| | Website: *http://www3.kulib.kyoto-u.ac.jp/index-e.html*<br>Library collection: | |
| 21 | Leiden University Libraries | Netherlands |
| | Website:<br>*http://www.leiden.edu/index.php3?m=3&c=799*<br>Library collection:<br>Over 3 million printed volumes + 87,000 serial titles | |
| 22 | London School of Economics Library | United Kingdom |
| | Website: *http://www.lse.ac.uk/library/*<br>Library collection:<br>1,270,564 printed volumes + 56,716 serial titles | |
| 23 | Lund University Libraries | Sweden |
| | Website: *http://www.lub.lu.se/en.html*<br>Library collection:<br>6.8 million printed volumes + 18,840 serial titles | |
| 24 | Massachusetts Institute of Technology (MIT) Libraries | United States |
| | Website: *http://libraries.mit.edu/*<br>Library collection:<br>2,807,568 printed volumes + 22,332 serial titles | |
| 25 | McGill University Library | Canada |
| | Website: *http://www.mcgill.ca/library/*<br>Library collections:<br>3,631,236 printed volumes + 81,772 serial titles | |
| 26 | Michigan State University (at East Lansing) Libraries | United States |
| | Website: *http://www2.lib.msu.edu/*<br>Library collection:<br>4,864,603 printed volumes + 40,082 serial titles | |
| 27 | Moscow State University | Russia |
| | Website: *http://www.msu.ru/en/resources/*<br>Library collection:<br>> 4 million printed volumes | |
| 28 | Nagoya University Library | Japan |
| | Website: *http://www.nul.nagoya-u.ac.jp/index_e.html*<br>Library collection: | |

| No. | University libraries and museums | Country |
|---|---|---|
| 29 | New York University Libraries | United States |
| | Website: *http://library.nyu.edu/*<br>Library collection:<br>5,144,879 printed volumes + 62,537 serial titles | |
| 30 | Northwestern University Libraries | United States |
| | Website: *http://www.northwestern.edu/libraries/*<br>Library collection:<br>4,687,828 printed volumes + 45,259 serial titles | |
| 31 | Ohio State University (at Columbus) Libraries | United States |
| | Website: *http://www.lib.ohio-state.edu/*<br>Library collection:<br>6,180,744 printed volumes + 36,813 serial titles | |
| 32 | Oxford University Libraries | United Kingdom |
| | Website: *http://www.ox.ac.uk/libraries*<br>Library collection:<br>Over 11 million printed volumes | |
| 33 | Pennsylvania State University (at State College) Libraries | United States |
| | Website: *http://www.libraries.psu.edu/*<br>Library collection:<br>5,069,854 printed volumes + 71,230 serial titles | |
| 34 | Princeton University Library | United States |
| | Website: *http://library.princeton.edu/*<br>Library collection:<br>6,618,464 printed volumes + 41,775 serial titles | |
| 35 | Purdue University (at West Lafayette) Libraries | United States |
| | Website: *http://www.lib.purdue.edu/*<br>Library collection:<br>2,511,097 printed volumes + 36,296 serial titles | |
| 36 | Rice University Library | United States |
| | Website: *http://library.rice.edu/*<br>Library collection:<br>2,474,352 printed volumes + 15,854 serial titles | |
| 37 | Stanford University Libraries & Academic Information Resources | United States |
| | Website: *http://www-sul.stanford.edu/*<br>Library collection:<br>About 9 million printed volumes + 82,000 serial titles | |

| No. | University libraries and museums | Country |
|---|---|---|
| 38 | Swiss Federal Institute of Technology (in Lausanne) Libraries | Switzerland |
| | Website: *http://library.epfl.ch/en/*<br>Library collection:<br>196,692 printed volumes + 7,767 serial titles | |
| 39 | Swiss Federal Institute of Technology (in Zurich) Libraries | Switzerland |
| | Website: *http://www.ethbib.ethz.ch/index_e.html*<br>Library collection:<br>6.8 million printed volumes + 5,200 serial titles | |
| 40 | Technical University of Munich Library | Germany |
| | Website: *http://www.ub.tum.de/start.jsp?lang=en*<br>Library collection: | |
| 41 | Texas A&M University (at College Station) Library | United States |
| | Website: *http://library.tamu.edu/portal/site/Library/*<br>Library collection:<br>3,581,226 printed volumes + 45,806 serial titles | |
| 42 | Tohoku University Libraries & Museums | Japan |
| | Website: *http://www.tohoku.ac.jp/english/library_museum/index.htm*<br>Library collection:<br>3,726,728 printed volumes + 72,285 serial titles | |
| 43 | Tokyo University Library | Japan |
| | Website: *http://www.lib.u-tokyo.ac.jp/index-e.html*<br>Library collection:<br>8,586,543 printed volumes + 142,369 serial titles | |
| 44 | Tulane University Libraries | United States |
| | Website: *http://www2.tulane.edu/resources_libraries.cfm*<br>Library collections:<br>3,076,954 million printed volumes + 19,716 serial titles | |
| 45 | University College London Library | United Kingdom |
| | Website: *http://www.ucl.ac.uk/Library/*<br>Library collection:<br>Almost 2 million items and subscriptions to over 12,000 journals in a combination of print and electronic formats | |
| 46 | University of Amsterdam Library | Netherlands |
| | Website: *http://www.uba.uva.nl/english/home.cfm/CFAEE654-997E-4D8B-80C7A58E75801C97*<br>Library collection: | |

| No. | University libraries and museums | Country |
|---|---|---|
| 47 | University of Arizona Libraries & Museums | United States |
| | Website: *http://www.arizona.edu/home/libraries.php*<br>Library collection:<br>5,533,482 printed volumes + 33,899 serial titles | |
| 48 | University of Basel Library | Switzerland |
| | Website: *http://www.ub.unibas.ch/indexeng.htm*<br>Library collection: | |
| 49 | University of Birmingham Library | United Kingdom |
| | Website: *http://www.is.bham.ac.uk/*<br>Library collection: | |
| 50 | University of Bonn Library | Germany |
| | Website: *http://www.ulb.uni-bonn.de/english/index.htm*<br>Library collection: | |
| 51 | University of Bristol Library | United Kingdom |
| | Website: *http://www.bris.ac.uk/is/*<br>Library collection:<br>1,424,536 volumes of printed books and journals | |
| 52 | University of British Columbia Library | Canada |
| | Website: *http://www.library.ubc.ca/*<br>Library collection:<br>5,820,527 printed volumes + 56,959 serial titles | |
| 53 | University of California (at Berkeley) Libraries, Museums, & Arts | United States |
| | Website: *http://www.berkeley.edu/libraries/*<br>Library collection:<br>10,094,417 printed volumes + 114,860 serial titles | |
| 54 | University of California (at Davis) Libraries | United States |
| | Website: *http://www.lib.ucdavis.edu/*<br>Library collection:<br>3,549,004 printed volumes + 47,008 serial titles | |
| 55 | University of California (at Los Angeles) Libraries | United States |
| | Website: *http://www.ucla.edu/library.html*<br>Library collection:<br>8,157,182 printed volumes + 77,509 serial titles | |
| 56 | University of California (at San Diego) Libraries | United States |
| | Website: *http://libraries.ucsd.edu*<br>Library collection:<br>3,236,219 printed volumes + 32,088 serial titles | |

| No. | University libraries and museums | Country |
|---|---|---|
| 57 | University of California (at Santa Barbara) Libraries | United States |
| | Website: *http://www.library.ucsb.edu/*<br>Library collection:<br>2,880,294 printed volumes + 36,962 serial titles | |
| 58 | University of Cambridge Libraries & Museums | United Kingdom |
| | Website: *http://www.cam.ac.uk/cambuniv/libmuseums/ul.html*<br>Library collection:<br>> 7 million printed volumes | |
| 59 | University of Chicago Library | United States |
| | Website: *http://www1.lib.uchicago.edu/e/index.php3*<br>Library collections:<br>7,765,583 million printed volumes + 43,390 serial titles | |
| 60 | University of Colorado (at Boulder) Libraries | United States |
| | Website: *http://ucblibraries.colorado.edu/*<br>Library collection:<br>7,765,583 printed volumes + 43,390 serials | |
| 61 | University of Copenhagen Library | Denmark |
| | Website: *http://www.kb.dk/en/kub/index.html*<br>Library collection: | |
| 62 | University of Edinburgh Library | United Kingdom |
| | Website: *http://www.lib.ed.ac.uk/*<br>Library collection:<br>3,479,078 printed volumes | |
| 63 | University of Florida Libraries | United States |
| | Website: *http://www.ufl.edu/libraries/*<br>Library collection:<br>4,178,355 printed volumes + 85,169 serial titles | |
| 64 | University of Geneva Libraries | Switzerland |
| | Website: *http://www.unige.ch/biblio/index_en.html*<br>Library collection:<br>6.5 million printed volumes | |
| 65 | University of Heidelberg Library | Germany |
| | Website: *http://www.ub.uni-heidelberg.de/Englisch/*<br>Library collection: | |
| 66 | University of Helsinki Libraries | Finland |
| | Website: *http://www.helsinki.fi/kirjastot/english/*<br>Library collection:<br>>3.3 million printed volumes + 51,400 serial titles | |

| No. | University libraries and museums | Country |
|---|---|---|
| 67 | University of Illinois (at Urbana Champaign) Library | United States |
| | Website: *http://www.library.uiuc.edu/*<br>Library collection:<br>10,524,935 printed volumes + 63,413 serial titles | |
| 68 | University of Iowa Libraries | United States |
| | Website: *http://www.lib.uiowa.edu/index.html*<br>Library collection:<br>4,592,560 printed volumes + 51,374 serials | |
| 69 | University of Leiden Libraries | Netherlands |
| | Website: *http://www.leiden.edu/students/index.php3?m=18&c=116*<br>Library collection: | |
| 70 | University of Kansas Libraries | United States |
| | Website: *http://www.ku.edu/libraries/*<br>Library collection:<br>4,194,283 printed volumes + 48,037 serial titles | |
| 71 | University of Manchester Library | United Kingdom |
| | Website: *http://www.library.manchester.ac.uk/*<br>Library collection:<br>4,250,000 printed volumes + 45,000 e-journals | |
| 72 | University of Maryland (at College Park) Libraries | United States |
| | Website: *http://www.umd.edu/libraries/*<br>Library collection:<br>3,501,054 printed volumes + 32,777 serial titles | |
| 73 | University of Massachusetts at Amherst Library | United States |
| | Website: *http://www.library.umass.edu/*<br>Library collection:<br>3,230,697 printed volumes + 40,749 serial titles | |
| 74 | University of Melbourne Library | Australia |
| | Website: *http://www.lib.unimelb.edu.au/*<br>Library collection: | |
| 75 | University of Michigan (at Ann Arbor) Libraries & Archives | United States |
| | Website: *http://www.umich.edu/libraries.php#libraries*<br>Library collection:<br>8,273,050 printed volumes + 118,654 serial titles | |
| 76 | University of Minnesota (at Twin Cities) Libraries | United States |
| | Website: *http://www.lib.umn.edu/*<br>Library collection:<br>6,713,629 printed volumes + 72,573 serial titles | |

| No. | University libraries and museums | Country |
|---|---|---|
| 77 | University of Missouri (at Columbia) Libraries & Museums | United States |
| | Website: *http://www.missouri.edu/libraries-museums.php*<br>Library collection:<br>3,295,378 printed volumes + 36,244 serial titles | |
| 78 | University of Munich Library | Germany |
| | Website: *http://www.ub.uni-muenchen.de/index.php?id=1&L=1*<br>Library collection:<br>6,558,458 printed volumes + 13,362 serials | |
| 79 | University of North Carolina (at Chapel Hill) Libraries | United States |
| | Website: *http://www.lib.unc.edu/*<br>Library collection:<br>5,816,677 printed volumes + 54,591 serial titles | |
| 80 | University of Nottingham Libraries | United Kingdom |
| | Website: *http://www.nottingham.ac.uk/is/locations/library/*<br>Library collection: | |
| 81 | University of Pennsylvania Libraries | United States |
| | Website: *http://www.library.upenn.edu/*<br>Library collection:<br>5,880,460 printed volumes + 47,787 serial titles | |
| 82 | University of Pittsburgh Libraries | United States |
| | Website: *http://www.pitt.edu/libraries.html*<br>Library collection: ><br>4,909,264 printed volumes + 50,232 serial titles | |
| 83 | University of Oslo | Norway |
| | Website: *http://www.ub.uio.no/english/*<br>Library collection: | |
| 84 | University of Queensland Library | Australia |
| | Website: *http://www.library.uq.edu.au*<br>Library collection:<br>Over 2,500,000 printed volumes + 9,963 print journals + 51,288 electronic serial titles | |
| 85 | University of Rochester Libraries | United States |
| | Website: *http://www.rochester.edu/libraries*<br>Library collection:<br>3,607,310 printed volumes + 26,760 serial titles | |
| 86 | University of Sheffield Library | United Kingdom |
| | Website: *http://www.shef.ac.uk/library/*<br>Library collection:<br>1.3 million printed volumes | |

| No. | University libraries and museums | Country |
|---|---|---|
| 87 | University of Southern California Libraries | United States |
| | Website: *http://www.usc.edu/libraries/*<br>Library collection:<br>3,968,814 printed volumes + 60,718 serial titles | |
| 88 | University of Sussex Library | United Kingdom |
| | Website: *http://www.sussex.ac.uk/library/*<br>Library collection: | |
| 89 | University of Texas (at Austin) Libraries, Centers, & Museums | United States |
| | Website: *http://www.lib.utexas.edu/help/librarylist.html*<br>Library collection:<br>9,022,363 printed volumes + 46,880 serial titles | |
| 90 | University of Toronto Libraries | Canada |
| | Website: *http://main.library.utoronto.ca/*<br>Library collection:<br>10,536,868 printed volumes + 68,790 serial titles | |
| 91 | University of Vienna Libraries | Austria |
| | Website: *http://www.ub.univie.ac.at/english/*<br>Library collection:<br>6.5 million printed volumes + 11,624 serial titles | |
| 92 | University of Virginia Library | United States |
| | Website: *http://www.lib.virginia.edu/*<br>Library collection:<br>5,102,954 printed volumes + 71,832 serial titles | |
| 93 | University of Washington (at Seattle) Libraries | United States |
| | Website: *http://www.lib.washington.edu/*<br>Library collection:<br>7,111,065 printed volumes + 62,429 serial titles | |
| 94 | University of Wisconsin (at Madison) Libraries | United States |
| | Website: *http://www.library.wisc.edu/*<br>Library collection:<br>7.5 million volumes + 55,000 serial titles | |
| 95 | University of Zurich Libraries | Switzerland |
| | Website: *http://www.uzh.ch/services/libraries_en.html*<br>Library collection:<br>3,800,000 printed volumes and serial titles | |
| 96 | Uppsala University Library | Sweden |
| | Website: *http://www.ub.uu.se/eindex.cfm*<br>Library collection:<br>About 5 million printed volumes | |

| No. | University libraries and museums | Country |
|---|---|---|
| | (In Sweden the printed library collections are counted in running metres. The total printed collection of Uppsala University library is 133,742 running metres (or over 133 kilometres). That figure includes both serials and books. The total number of serial titles for Uppsala University Library is 18,237 (electronic 12,351, print 5,886).) | |
| 97 | Utrecht University Library | Netherlands |
| | Website: *http://www.library.uu.nl/library/12483main.html*<br>Library collection:<br>3,535,757 printed volumes of books and (printed) serial titles | |
| 98 | Vanderbilt University Libraries | United States |
| | Website: *http://www.library.vanderbilt.edu/*<br>Library collection:<br>3,264,231 printed volumes + 36,184 serial titles | |
| 99 | Washington University (in St Louis) Libraries | United States |
| | Website: *http://library.wustl.edu/*<br>Library collection:<br>3,947,725 printed volumes + 41,339 serial titles | |
| 100 | Yale University Libraries | United States |
| | Website: *http://www.library.yale.edu/*<br>Library collection:<br>12,368,757 printed volumes + 73,953 serial titles | |

# Glossary

**3G telecommunication** 3G telecommunication refers to third-generation wireless telecommunication for wide-area wireless cellular telephone networks.

**10-decimal computing method** The 10-decimal computing standard is a network standard which uses 10-digit numbers as numeral domain names for discussing China's IPv9 network.

**AACRII** AACRII is the famous rule and standard for cataloging and classifying library collections in general libraries. The full name of AACRII is the Anglo-American Cataloguing Rules, Second Edition, which was jointly designed and modified by the American Library Association, the Canadian Library Association, and the Chartered Institute of Library and Information Professionals (in the UK) in 1988.

**Academic library** An academic library (system) functions as a central gateway to locate, access, and store information across heterogeneous applications, databases, networks, platforms, and systems in dynamic and interactive academic learning environments.

**Academic library information services** Academic library information services assist users to access, retrieve, process, synthesize, store, and transform information effectively and efficiently. In accordance with the scope of the service, academic library information services can be divided into (1) academic library public services and (2) academic library technical services at the same time. In the digital age, academic library information services have also been evolving into two new categories: conventional library information services and electronic library information services.

See also: *Academic library information services* and *Academic library information services*.

**Academic library management process** The academic library management process is the process of analysis and utilization of information and/or its feedback to make critical decisions.

**Academic library mission statement** The academic library mission statement defines an academic library's unique existence in terms of its essential nature, roles, services, and values in today's dynamic and interactive academic learning environments. An academic library's mission statement will serve as a benchmark to measure an academic library's existing and projected information resources, services, instructions, and other relevant programs.

**Academic library public services** Academic library public services usually refer to access and circulation, bibliographic instruction, distance learning, government documentation, reference, and special collections, etc.
See also: *Academic library information services*.

**Academic library technical services** Academic library technical services focus on the procedures and operations with regard to maintaining, developing, and supporting library collections and services behind the scenes, including acquisition, cataloging and classification, interlibrary loan and document delivery, serials, and so on.
See also: *Academic library information services*.

**AltaVista Babel Fish Translation** AltaVista Babel Fish Translation, a leading example of multi-language translation software, offers inter-translation among 12 major foreign languages including Chinese, Dutch, English, French, German, Greek, Italian, Japanese, Korean, Portuguese, Russian, and Spanish.

**API (application program interface)** In the field of computer programming, the API is a set of commands, functions, protocols, and routines to design other software applications, components, and modules running in a specific computer operating system.

**Architecture** See also: *Information technology architecture*.

**Artificial intelligence (AI)** Artificial intelligence refers to science and engineering that explore how to simulate various aspects and functions in the field of human intelligence. AI technology fields cover perception, recognition, reasoning, the learning process, natural language, machine translation, games, chess, etc.

**Assessment** Assessment focuses on the cognitive appraisal processes of data gathering and data analysis.
See also: *Evaluation*.

**Automated storage and retrieval system (ASRS)** An automated storage and retrieval system is a kind of warehousing system which consists of

diverse electrical, mechanical, and management systems. Utilizing modern technologies such as motion control, process control, measurement, database management, network monitoring, and so on, an ASRS is widely used in all aspects of logistics. Some academic libraries have started using this technology innovatively to create new library collection management and storage systems.

**Bandwidth** Bandwidth refers to the difference between the upper and lower bounds of a frequency band. In a computer networking environment, bandwidth measures the amount of data transferred during one unit of time.

**Blog** See: *Web log*.

**Bluetooth** Bluetooth technology is an industrial standard for wireless personal area networks (PANs), and is the wireless technology specified to connect devices such as desktops, digital cameras, keyboards, laptops, mobile phones, mice, notebooks, PCs, PDAs (personal digital assistants), printers, remote controls, and scanners, etc. within short ranges.

**Broadband** Generally speaking, broadband refers to network telecommunication at speeds of more than 500 kbps, based on the current networking technology standards.

**Budgetary control** Budgetary control is one of the essential financial management tools used by academic library administrators and executives to control operating expenditures. The bottom line of budgetary control is to ensure that the library collection meets the high demands and expectations of teaching, learning, research, and scholarly development in a specific academic learning environment.

**Buzzword** As defined by Answers.com, a buzzword is 'a word or phrase connected with a specialized field or group that usually sounds important or technical and is used primarily to impress laypersons.'

**CDMA2000** CDMA2000 is one of three current 3G telecommunication standards supported by Japan, South Korea, and other countries and regions in North America.

**CGI (common gateway interface)** CGI is the standard method by which a web server provides the user application with the user requests and returns the requested data back to the user.

**China Education and Research Network 2 (CERNET2)** CERNET2 is China's first IPv6-based network.

**Client/server** Client/server refers to a computing structure in a computer network.

**ColdFusion** ColdFusion, also called ColdFusion Markup Language (CFML), is a scripting language applicable to Internet applications.

**Collaborative Online Reference Service** This is a cooperative online service among participating academic libraries, national libraries, and public libraries to provide users with a live around-the-clock reference service over the Internet platform.

**Collaborative software** Also called groupware, collaborative software promotes and supports teamwork in cooperative and collaborative working environments.

**Computer hardware** Computer hardware refers to the essential components required to build an information system, and includes central processing units (CPUs), keyboards, motherboards, microphones, mice, screens, scanners, printers, etc.

**Computer software** Computer software can be subdivided into three categories: (1) system software (such as the operating system software or database management software); (2) application software (such as digital content management software or word processing software); and (3) middleware (such as a web server). The major function of middleware is to link system and application software.

**Computer technologies** Computer technologies focus on designing, engineering and manufacturing computer hardware and software, and related applications, as well as developments in various fields. Computer technologies are widely used to locate, access, classify, process, store, synthesize, transform, and utilize data and information in today's information society.

**Consortium** A consortium is a common type of cooperative association among libraries to exchange and share information resources and services.

**CONTENTdm** CONTENTdm is among the leading software for digital content management (DCM) in academic library settings.

**Conventional library information services** Conventional library information services are backed up by: (1) public services and (2) technical services. Public services usually refer to access and circulation, bibliographic instruction, distance learning, government documentation, reference, special collections, and so on. Technical services focus on the

procedures and operations to maintain, develop, and support library collections and services behind the scenes, and include acquisition, cataloging and classification, interlibrary loan and document delivery, serials, and so on. Conventional library information services usually have the two characteristics of being provided on-site and face to face.
See also: *Electronic library information services*.

**Course management systems (CMS)** Also called learning managing systems (LMS), CMS are widely used in a variety of online environments.

**CPU (central processing unit)** The CPU is a computer's heart and controls, manages, and processes computer data. Generally, a computer's CPU consists of three modules: the logical CPU module, the control module, and storage units.

**CSS (cascading style sheets)** CSS is a mechanism to define the style of web-based document presentations.

**Cutting-edge technologies** Cutting-edge technologies are new leading innovative technologies given large-scale commercial production in a competitive market. Cutting-edge technologies represent the most advanced and state-of-the-art technologies with the potential for gigantic economic effects and epoch-making social changes to boost social productivity. Compared with emerging technologies, cutting-edge technologies are more mature and being better developed produce more direct economic effects within a short period. Based on market feedback, existing enhanced and updated cutting-edge technologies will become technological accumulations for the next generation of cutting-edge technologies, and could trigger new innovative emerging technologies in the future.

**Data** Data are original and raw facts or records of observed examinations, phenomena, operations, tests, transactions, etc. Data are also the core component of an information system. Without data, an information system will lose its existing functions.
See also: *Information*.

**Database management system (DBMS)** A DBMS is a computer software program to handle data definition, data manipulation, and data control.

**DaVinci technology** DaVinci technology, an innovative emerging technology designed and developed by Texas Instruments, Inc. (*http://www.ti.com/*) in the United States, could solve all the technical

problems for further enhancing and integrating digital video productions.

**Decimal network technology** Decimal network technology is an evolving network standard to promote China's IPv9.
See also: *10-decimal computing method*.

**Digital asset management (DAM) system** See: *Digital content management (DCM) system*.

**Digital content management (DCM)** DCM refers to computer hardware and software as well as related services for the control and management of authorized digital contents.

**Digital content management (DCM) system** A digital content management system, also called a digital asset management (DAM) system, is a system to locate, access, catalog, and store digital products, such as images, movies, music, and videos, etc.

**Digital library** A digital library (DL) is an electronic information system to deliver and disseminate digital library contents via computer technology, digital technology, multimedia technology, web technology, wireless technology, and video technology. The digital library is different from library digitization. The digital library is an electronic information platform to access, locate, manage, and store distributed digitized library information resources.
See also: *Library digitization*.

**Digital rights management (DRM) technology** Digital rights management (DRM) technology is the technology designed and developed by digital copyright owners, such as distributors and publishers, to control and limit the usage of protected digital products, such as movies, music, and software, etc.

**Digital technology** Simply speaking, digital technology is an electronic technology which collects, converts, disseminates, generates, processes, records, stores, and transmits data in digital form (logic number '1' or '0').

**Digital television (DTV)** Digital television (DTV) is a new generation of television system which utilizes digital encoding technology to process collections, recordings, broadcasts, and transmissions of television programs. Compared to traditional television, digital television provides the general public with large numbers of television channels, high-definition pictures, high-fidelity stereo sounds, and independent on-demand services.

**Digital video technology** Digital video technology is the technology which first uses the digital form (logic number '1' or '0') to encode, record, store, and transmit video signals and then decode, reconstruct, and display the video signals on a terminal. Digital video technology is a comprehensive system which combines digital encoding formats, digital signal processing, optical disk storage formats, digital tape formats, video compression technology, video connection formats, video display formats, video resolution standards, and so on.

**DNS (domain name system)** The DNS provides distributed network directory services, mainly for mutual conversion between domain names and IP addresses, as well as for control of Internet e-mail delivery.

**Document object model (DOM)** According to the specification defined by the World Wide Web Consortium (W3C) (*http://www.w3.org/DOM/*), the document object model (DOM) is a standard interface to allow scripts to access and modify different web documents via diverse browsers and platforms.

**Electronic library information services** Electronic library information services include bibliographic instructions, computerized library catalogs, digital libraries, distance learning services, e-databases, government documents, instant messaging services, interlibrary loan and document services, ready references, virtual classrooms, virtual references, and so on. Electronic library information services have the primary characteristics of being: (1) web-based; (2) on-site/off-site; (3) available 24/7.

See also: *Conventional library information services*.

**Electronic paper** Electronic paper is also known as 'e-paper' or 'digital paper.' Electronic paper is an ultra-thin and ultra-light electronic display. In addition to having the same characteristics as traditional paper – being thin, light, flexible, mobile and readable – electronic paper has other super-digital features: easy information exchange and sharing, easy information retrieval, easy copy, scan, and transmission, large capacity information storage, plus embedded information navigation, hyperlinks, and relevant information security protection.

**Electronic whiteboard** The electronic whiteboard is a new type of interactive electronic instructional tool that integrates a computer, a blackboard, and a projector.

**Emerging technologies** Emerging technologies are new innovative technologies with great marketing potential to enhance, integrate, and reorganize existing products and industries or generate new advanced

products and new industries. Emerging technologies represent the latest developing trends in science and technology without the large-scale commercial production and marketing tests. The relationship between cutting-edge and emerging technology is that emerging technologies are emerging for the promotion of cutting-edge technologies while cutting-edge technologies are technological preparations for the emergence of new emerging technologies. This spiral is becoming the major driving force in the further development of social productivity and the new industrial revolution.

**Emerging technology librarian** The emerging technology librarian is an expert in the use of innovative emerging technologies to design and develop web-based applications, programs, and services in diverse academic libraries.

**Evaluation** Evaluation supports administrative decision-making based on the assessment of collected information and data analysis reports.
See also: *Assessment*.

**Format** In general, format refers to a particular way of delivering, disseminating, storing, synthesizing, transforming, and transmitting information.

**Framework** In the field of software engineering, the framework generally refers to a primary development structure. Different software languages have their own primary development frameworks.

**Georgia Southern University** Georgia Southern University (*http://www.usg.edu/inst/gsou/*) is one of the major public universities in the University System of Georgia (*http://www.usg.edu/inst/*). Located in Statesboro, Georgia, United States, Georgia Southern University offers more than 130 bachelor's degrees, master's degrees, and doctorates to over 17,000 students in its eight colleges.

**GIL Express** GIL Express is a document delivery and interlibrary loan service offered to faculty, students, and staff in the University System of Georgia. More detailed information is available at: *http://gilexpress.usg.edu/*.

**Global IP Sound (GIPS) Codec** The GIPS Codec, designed and developed by Global IP Solutions (GIPS), formerly called Global IP Sound, is a device or software program for decoding and/or encoding signals of VoIP (Voice-over-Internet Protocol) telecommunications over the Internet platform.
See also: *VoIP (Voice-over-Internet Protocol)*.

**Google Language Tools** Google Language Tools, designed and developed by Google, Inc., are comprehensive language translation tools to support inter-translation among 12 natural languages: Arabic, Chinese, Dutch, English, French, German, Italian, Japanese, Korean, Portuguese, Russian, and Spanish.

**Graphical user interface (GUI)** The GUI is an interface that provides users with an environment for human–machine interaction. In personal computing environments, the GUI often refers to a variety of diverse controls including buttons, icons, menus, pointers, and windows, etc.

**Hardware** In the field of information technology, hardware refers to all or part of the physical components for an information processing system, especially for peripheral computer equipment including computer mice, copiers, CD/DVD burners, fax machines, flash drives, keyboards, monitors, printers, scanners, and so on.

**HDTV (high definition television)** In accordance with current technology standards, HDTV is a high-quality digital television display. Taking advantage of digital rather than analog signal transmissions, the scanning images of the HDTV are either at least 720 lines progressive (720p) or 1080 lines interlaced (1080i). At the same time, the screen aspect ratio of an HDTV is 16:9 rather than 4:3 and its refresh frame rate can reach up to 60 frames per second. The audio sound quality is that of Dolby Digital 5.1.

**HTML (Hypertext Markup Language)** Primarily, HTML is used to link web contents and set up the web page layout using a variety of predefined tags.

See also: *SGML (Standard Generalized Markup Language)*, *XHTML (Extensible Hypertext Markup Language)*, and *XML (Extensible Hypertext Markup Language)*.

**HTTP (Hypertext Transport Protocol)** HTTP is a network communication protocol to transmit information for intranets and the World Wide Web (WWW). HTTP is also the protocol to execute web services.

**Human–computer interaction** Human–computer interaction refers to the exchange and transfer of information between computers and human beings.

**Human resources management** Human resources management refers to the administrative activities, procedures, and regulations of control, development, selection, retention, and utilization of human resources in a business or an organization.

**IEEE 802.11 Standard** The IEEE 802.11 Standard, defined by the Institute of Electrical and Electronics Engineers Standards Association (IEEE-SA), is the technology standard for current wireless local area network (WLAN) telecommunications.

**Information** Information refers to data that has been well collected, organized, and processed.
See also: *Data*.

**Information commons** An information commons, also called a learning commons, is a new evolving innovative academic library collaborative service model built in a variety of networked academic interactive learning environments. One of the primary advantages of an information commons is the enhancement and integration of existing academic library information resources, services, instructions, and other public service programs into one consistent, dynamic, and scalable student-centered academic interactive learning environment. An information commons is an integrated one-stop information gateway for academic students, faculty, instructors, staff, and other public users.

**Information commons/learning commons librarian** An information commons/learning commons librarian primarily assists users to locate, access, store, and transform electronic information resources, services, and instructions across multiple applications, networks, platforms, and systems in an academic library's information commons/learning commons. In addition to general reference and public services, an information/learning commons librarian is responsible for planning, designing, developing, and maintaining the library's automated/integrated information technology and systems. The information/learning commons librarian usually needs to have in-depth experience and knowledge of and skills in integrated library systems (ILS) such as ALEPH, SirsiDynix, Virtura, and Voyager, etc., as well as in databases, networking, script languages, web design, web server management, and so on.

**Information diversification** Information diversification is one of the technical features for information delivery and dissemination in the

current information society. Information diversification in the digital age covers two technological features: (1) information formats; and (2) information media.

**Information explosion** Generally, information explosion refers to excess amounts or an overload of multi-format and multi-language information via diverse applications, databases, channels, networks, platforms, and systems.

**Information gateway** The information gateway is a central location to access, collect, classify, process, retrieve, store, and transform data and information across various applications, channels, databases, networks, platforms, and systems.

**Information literacy** According to the definition set by the Association of Colleges and Research Libraries (ACRL), information literacy is 'a set of abilities requiring individuals to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information.' In the printing age, information literacy basically referred to a person's reading and writing abilities, since they were essential competences to exchange and share information. In the digital age, information literacy refers to a person's comprehensive ability, knowledge, and skills of obtaining, synthesizing, transforming, and utilizing information obtained from distributed information resources and systems.

**Information management** Information management refers to the administration, control, operation, and storage of information to support the administration's decisions.

**Information overload** See: *Information explosion*.

**Information process** Information process refers to the collection, classification, processing, transformation, and storage of information.

**Information repository** Information repository refers to the place where the information is stored.

**Information retrieval cycle** The information retrieval cycle usually refers to the entire process of locating, accessing, processing, synthesizing, transforming, and utilizing information.

**Information services librarian** The information services librarian is the specialist who assists library users to access, locate, process, and synthesize information. The information services librarian must be

familiar with various electronic information resources, services, and instructions. Common preferred experience and qualifications include instruction, library collection development, web page design and development, strong communication skills, etc.

**Information source** Information source refers to the origin of information across applications, channels, networks, platforms, and systems.

**Information system** An information system is a system that collects, classifies, disseminates, processes, retrieves, and stores information to support administrators' decisions on how to control, develop, and operate a business or an organization.

**Information technology** Information technology is the technology used to access, collect, classify, locate, process, store, and transform data and information across various applications, databases, networks, platforms, and systems. In the modern information society, information technology includes artificial intelligence, computer technology, digital technology, multimedia technology, network technology, telecommunication technology, video technology, and web technology, etc.

**Information technology architecture** Information technology architecture is an integrated framework for designing, developing, deploying, implementing, managing, and supporting the existing mission-critical business applications and operations of an organization. The components of an information technology architecture include business rules, data, database management systems (DBMS), the graphical user interface (GUI), hardware, middleware, networks, personnel, server, software, and so on.

**Information user** The information user refers to the end user who needs to access, analyze, process, transform, store, and utilize information. The information user also includes IT staff that design, develop, maintain, and support an information system.

**Infrastructure** In general, infrastructure refers to the basic attributes, components, frames, properties, and structures of objects in different classes. Infrastructure may encompass different meanings in different fields. In the field of IT management, for example, infrastructure may include essential computer data, hardware, software, staff, and related business rules, etc.

**Instant messaging (IM)** Instant messaging (IM) is the Internet protocol (IP)-based technology, which not only can be used for short text messages but can also be embedded with fixed and mobile access.

**Instant messaging (IM) reference service** An IM reference service is one of the real-time electronic consulting and reference services offered by academic libraries via specific software running on the Internet platform.

**Instructional technology** In their well-known book entitled *Instructional Technology: The Definition and Domains of the Field*, authors Barbara. B. Seels and Rita C. Richey (1994) stated that 'Instructional Technology is the theory and practice of design, development, utilization, management and evaluation of processes and resources for learning.' Since then, their classic research result has been used as a basis to assess and evaluate diverse paraphrases and definitions of instructional technology. In the digital age, instructional technology integrates artificial intelligence (AI), computer technology, digital technology, multimedia technology, networking technology, web technology, and video technology together to create various interactive teaching and learning environments. In academic libraries, instructional technology is widely used to promote and facilitate bibliographic instruction, distance learning programs, and virtual reference services over the Internet platform.

**Integrated library system (ILS)** An ILS is a computer-aided system that controls and manages the library catalog and the access to and circulation of a library's collections, including printed books, periodicals, government documents, maps, audio/video materials, theses, special collections, etc.

**Interactive electronic whiteboard** An interactive electronic whiteboard is a new of type interactive electronic instructional tool that integrates a computer, a blackboard, and a projector via computer touch-screen technology.

**Interlibrary loan (ILL)** ILL is a public service for exchanging and sharing information and library collections among libraries.

**Internet** The Internet is the global network connecting computers via the TCP/IP (Transmission Control Protocol/Internet Protocol).
See also: *World Wide Web (WWW)*.

**Internet 2** The well-known Internet 2 (*http://www.internet2.edu*) cannot represent the next generation of the Internet because Internet 2 does not create any Internet standards or protocols. Internet 2 is instead a

consortium that has attracted more than 200 American universities to design and deploy advanced networking applications to promote the next generation of the Internet in higher education environments.

**IP address** An IP address is the Internet protocol address which is connected to an Internet protocol (IP) network for access to or retrieval of web information.

**IPTV (Internet Protocol TV)** IPTV is a new innovative emerging technology which utilizes the broadband network to transmit and receive television programs. Combined with digital technology, multimedia technology, and telecommunication technology, IPTV provides consumers with the ability to view TV programs either via a computer workstation or via a set-top-box converter connected to an ordinary television set.

**IPv4** IPv4, Internet Protocol Version 4, is the technology standard for the current generation of the Internet, and in theory can only support about 4,294,967,296 (about 4.29 billion) 32-bit unique IP addresses.

**IPv6** IPv6, Internet Protocol Version 6, is the new standard for the next-generation Internet, and can support 128-bit next-generation IP addresses. In comparison with IPv4, IPv6 can provide more unique IP addresses and better mobile IP connections.

**IPv9** Built upon a 10-decimal computing method, China's IPv9 has its own independent address protocol, nameplate protocol, transitional protocol, and digital domain name regulations and standards. Compatible with existing IPv4 and IPv6, China's IPv9 utilizes 10-digit phone numbers (arabic numbers 0–9) instead of conventional English letters to handle web navigation. However, China's IPv9 does not represent the next generation of the Internet since it has not been accepted or recognized by the Internet Engineering Task Force (*http://www.ietf.org/*). However, China's IPv9 could be developed and deployed as an alternative to the global network.

**Java** Originally invented by Sun Microsystems in 1995, Java has become one of the leading computer programming languages in the design and development of Internet applications today.

**Knowledge management** Knowledge management refers to the process of identifying and utilizing the intellectual assets in an organization for the purposes of leveraging business competition and promoting service goals. In academic libraries, knowledge management is involved in setting up a knowledge base to collect, organize, preserve, share, and utilize essential

knowledge of the operation, enhancement, implementation, integration, management, and support in the library setting.

**KOHA** KOHA (*http://www.koha.org*) claims to be the world's first fully-featured enterprise-class open-source integrated library system (ILS), and was initially designed and developed by Horowhenua Library Trust and Katipo Communications in New Zealand.

**LAMP** LAMP is an abbreviation for four well-known examples of open-source software – Linux, Apache, MySQL, and PHP.

**LAN (local area network)** A LAN is a group of computers and their associated devices linked by a medium, in most cases a cable. Usually, a LAN is limited to a local area, such as an office or a building.

**LCD (liquid crystal display)** LCD is a device commonly used in academic libraries to display data and information.

**LCSH** LCSH stands for the Library of Congress Subject Headings. Originally it was the list of subject headings for the books and serial works collected by the Library of Congress in the United States. Today LCSH is used widely as a reference tool to retrieve subjects from the academic library catalogs.

**Learning commons** See also: *Information commons*.

**LibQual** LibQual is an organization which is committed to charting library service quality.

**Librarian** In the *Dictionary for Library and Information Science*, a librarian is defined as 'a professionally trained person responsible for the care of a library and its contents, including the selection, processing, and organization of materials and the delivery of information, instruction, and loan services to meet the needs of its users (to see examples, try a keyword search on the term in *Google Image Search*). In the online environment, the role of the librarian is to manage and mediate access to information that may exist only in electronic form.'

**Librarian for library digital initiatives and services** Librarians for library digital initiatives and services focus on the challenges of preserving a library's digital assets. Librarians for library digital initiatives and services are responsible for designing, developing, initializing, implementing, and maintaining the library's ongoing digital content management (DCM). Librarians for library digital initiatives and services will assess, evaluate, recommend, and test various methodologies, policies, and standards for utilizing computer software

in the process of creating and preserving a library's digital collections and resources. They are also required to participate in grant applications and staff training. Librarians for library digital initiatives and services must have in-depth knowledge of and skills in web design and relational database management systems (RDBMS), metadata standards (such as METS, Dublin Core, and VRA Core), and text encoding (such as EAD and TEI), plus CSS (Cascading Style Sheets), HTML (Hypertext Markup Language), JavaScript, XML (Extensible Markup Language), and so on.

**Library 2.0** With the explosion of interest in Web 2.0, some academic librarians, public librarians, school librarians, and other professionals are trying to transplant the concept of Web 2.0 into the field of the library. It is too ambiguous to define the concept of Library 2.0 simply as the formula 'Web 2.0 + Library 2.0.'

See also: *Web 2.0*.

**Library automation system** The library automation system includes various computer systems applicable to multiple operational settings in a library, including databases, interlibrary loan (ILL), library cataloging and classification, library circulation management, and the Online Public Access Catalog (OPAC), etc.

**Library catalog** The library catalog is the comprehensive holding list of a library collection. The library catalog is a common tool for library users to access and locate library items.

**Library digitization** Library digitization is the process of utilizing digital technology to electronically collect, compress, copy, scan, and transform digital information resources, including audio files, images, graphics, pictures, texts, and videos, etc. Library digitization is different from the digital library. Library digitization focuses on the process of making diverse library information resources electronically available, while a digital library is a platform to access, collect, manage, search, and store distributed electronic information resources over the Internet and the World Wide Web (WWW). Library digitization is the essential process for the initialization of a digital library.

See also: *Digital library*.

**Library information management system (LIMS)** The LIMS, also called an integrated library system (ILS), is a primary computer system to control and manage library circulations and collections over multiple platforms. The most well-known global LIMS include Endeavor, SirsiDynix, Tech Logic, and VTLS, etc.

**Library mission statement** An academic library's mission statement will serve as a benchmark against which to measure an academic library's existing and projected information resources, services, instructions, and other relevant programs.

**Local area network (LAN)** A LAN is a group of computers and related peripheral equipment, such as hard disks, keyboards, monitors, printers, and speakers, etc., distributed within a limited area to transmit data. A LAN is usually wired via cables or other media.

**Mac OS X Leopard** Mac OS X Leopard is the latest operating system released by Apple, Inc. for Mac computers. Like Windows Vista, the Mac OS X Leopard will accelerate the migration of computer software from 32-bit to full 64-bit processing. Claiming to have over 300 enhancements, Apple's Mac OS X Leopard is expected to snatch more market share from Microsoft's Windows Vista.

**Machine translation (MT) technology** Machine translation technology is the technology that converts and translates one natural language into another natural language using relevant computer technologies. In the digital age, MT has a wide range of potential applications for multi-language situations in individual communications, office operations, business translations, and government activities, etc.

**Management information system (MIS)** The MIS in an academic library focuses on the application and management of information technologies, including computer hardware, databases, multimedia, networks, software, systems, telecommunications, and the World Wide Web, etc. The purpose of an MIS in an academic library is to utilize information technologies and systems to enhance and integrate the library's administration, control, decision-making, operations, and plans to achieve specific strategic goals and service-oriented objectives. Management information systems have become an academic discipline which studies how information systems support the routine and strategic administration, control, decision-making, plans, and operation of a successful business. With the rapid developments in science and technology, management information systems have evolved into an integrated cross-discipline, involving computer programming, databases, broadband networks, wireless communications, and the World Wide Web, etc., as well as management, linear programming, operations research, statistics, and other disciplines. Driven by new waves of cutting-edge and emerging technologies, the scope of management information systems will be further expanded in the future.

More and more new disciplines and related cross-disciplines will come to be associated with management information systems (MIS).

**MARC21** MARC refers to Machine Readable Cataloging. MARC21 is a format for library catalogers to standardize library bibliographic data input.

**Meebo** Meebo (*http://www.meebo.com*) is open-source software to support instant messaging (IM) reference services. Meebo supports multiple IM users, including AIM, Google Talk, Meebo, MSN, and Yahoo. However, Meebo does not possess any functions for collecting IM reference statistics. Also, Meebo does not offer the advanced features of QuestionPoint.

See also: *QuestionPoint*.

**Microsoft SQL Server** Microsoft SQL Server is another world-class advanced relational database management system. To meet the growing challenges and dynamic need for information storage, Microsoft finally released its latest relational database management system (DBMS) SQL Server 2008 at the end of February 2008.

**Middleware** Simply speaking, middleware is independent system software or service procedures. In a client/server architecture, middleware runs between applications and the operating system to manage the computer's resources and network communications.

**Mission statement** The mission statement is a brief and succinct statement which lays down the purpose and service scope of a business or organization.

**Moodle** Moodle is free open-source software that has emerged to challenge Blackboard's dominating position in e-learning courseware applications and services.

**MPEG-4** MPEG-4 is one of the common international technology standards supporting multimedia telecommunication in many fields, such as electronic news, video e-mails, video telephone communication, web movies, etc.

**Multi-core CPU (central processing unit) technology** Multi-core CPU technology is an emerging technology to make a single computer processor containing two or more central processing units (CPU).

**Multimedia technology** Multimedia technology is an emerging technology which simultaneously collects, presents, records, stores, transforms, and utilizes more than one type of information

media, ranging from animations, audios, graphics, images, pictures, sounds, texts, videos, and so on. Multimedia technology refers to both the multimedia hardware and the multimedia software, including chips, 3D graphics software, computer workstations, DVD players, earphones, networks, speakers, webs, and so on.

**MySQL** MySQL is among the world's most successful open-source database software applicable to academic learning environments. For small- and medium-sized academic libraries, MySQL is recognized as one of the key components of LAMP (Linux, Apache, MySQL, PHP/Perl/Python) evolving in the fast-growing enterprise computing markets.

**Nanotechnology** Nanotechnology refers to the science and technology that designs, develops, and produces devices, structures, and systems at the atomic, molecular, or macromolecular level (approximately 1–100 nanometers).

**.Net** To compete with Java, Microsoft promotes this set of software to design and develop web-based applications.

**Network** A network consists of a group of computers linked by cables or other media. The purpose of a network is to exchange and share data and information.

**Network operating system (NOS)** A networking operating system is an operating system which controls, manages, and provides network data communications and network resource sharing for computers in the network. Since the network operating system is running on a server, it is sometimes called a server operating system. General computer users and IT specialists should be familiar with network operating systems. In a local area network, common networking operating systems include Windows, Mac, Linux, NetWare, and Unix.

**Network technology** Network technology is the backbone of data communication and information dissemination in dynamic and interactive academic learning environments.

**Network telecommunications** Network telecommunications refer to various methods of information transmission, such as computer network communications, digital TV communications, instant messaging communications, telegraph communications, and wireless cellular phone communications, etc.

**n/tier** In the world of computer programming, n/tier is the software architecture to deliver flexible and reusable applications.

**OPAC (Online Public Access Catalog)** OPAC is a computerized library catalog to search and reserve specific items from a library's collection.

**OpenBiblio** OpenBiblio is a free and open-source integrated library system for managing school library collections. Designed and developed by PHP (Hypertext Preprocessor), the application covers functionalities which include OPAC, cataloging, circulation, related library staff management, and so on.

**OpenOffice.org 2** OpenOffice.org 2 is the innovative open-source office software suite developed by OpenOffice.org (*http://www.openoffice.org/index.html*), and is supported by Sun Microsystems (*http://www.sun.com/*).

**Open-source software** Open-source software provides free access to the source code, free software customization, and free software distribution.

**Operating system (OS)** An OS is a program to control and manage computer hardware and software. The OS is the heart of a computer system.

**Oracle** Recognized as the world's top relational database management system (RDBMS) Oracle has a high reputation for performance, reliability, scalability, and security for mission-critical enterprise applications running under computing environments.

**PC (personal computer)** A personal computer is a computer designed for individual use. A personal computer does not need to share other computer resources, such as data storage, printing, and word processing.

**PDA (personal digital assistant)** A PDA is a hand-held computing device for information access, retrieval, and storage. A PDA can function as a cellular phone, e-mail program, fax machine, personal organizer, and web browser, etc. Unlike a regular cellular phone, a PDA uses a pen-shaped input device called a stylus to handle the human–machine interactions instead of a keyboard. Some new PDA models can also utilize a keyboard, a touch screen, or speech recognition technology to process an instruction input.

See also: *Stylus*.

**PDF (Portable Document Format)** PDF is an electronic document format designed and developed by Adobe, Inc. Since it is fully compatible with different operating systems and platforms, PDF has become an ideal tool to disseminate digital information such as e-papers, product

specifications, web information, and word documents, etc. over the Internet platform.

**Perl** Perl is open-source software which enables cross-platform computing.

**Pervasive computing** Pervasive computing – also called ubiquitous computing – is a new innovative computing model which is involved with artificial intelligence, embedded systems, digital video/image technology, digital voice technology, distributed computing, human–computer interaction, information integration, mobile computing, and network awareness, etc.

**Pew Research Center** The Pew Research Center (*http://pewresearch.org/*) is a well-known non-partisan 'fact tank' located in Washington, DC.

**PHP** PHP is a well-known server-side scripting language.

**PhpMyLibrary** PhpMyLibrary (*http://www.phpmylibrary.org/*) is an integrated library system built by PHP and MySQL. Its automated application modules include cataloging, circulation, and WebPac.

**Picasa** Picasa is free photo management software from Google that helps you to access, edit, retrieve, share, and view your photographs. It is downloadable at: *http://picasa.google.com*.

**Platform** In the field of information technology, platform refers to a specific working environment for the control, design, development, enhancement, integration, implementation, management, storage, and support of computing applications, devices, equipment, programs, products, etc.

**PostgreSQL** PostgreSQL, like MySQL, is another example of open-source database software well known around the world.

**QuestionPoint** Designed and developed by the OCLC (Online Computer Library Center), QuestionPoint (*http://www.oclc.org/questionpoint/*) is a well-known fee-based advanced instant messaging (IM) reference service management software, which provides academic librarians with stronger technical features, such as application sharing, co-browsing, escorting, page pushing, reporting, and so on, to handle 24/7 live chat references.

See also: *Meebo*.

**Random access memory (RAM)** RAM is the primary internal data repository device for information in a computer. Since information

would be completely erased if a computer's RAM were to suddenly lose its power supply, a computer is also equipped with other internal and external data storage devices, such as hard drives, floppy disc drives, USB (universal serial bus) connectors, etc.

**Repository** A repository refers to the diverse locations where data can be stored, such as cache memory, compact disks (CDs), databases, floppy disks, flash drives, random access memory (RAM), storage cards, etc.

**Resource Description Framework (RDF)** RDF is an XML-based markup language for defining metadata about web information.

**RFID (radio frequency identification)** RFID, commonly known as electronic tagging, is a non-contact automatic wireless identification technology to track target objects at a distance (from a couple of inches to up to 20 or 30 feet away).

**Root server** A root server is a base server to authorize, control, and manage the master directories of the Internet. There are only 13 root servers running to manage the Internet (IPv4). Ten of them are located in the United States, one is in the Netherlands, one is in Sweden, and one is in Japan.

**Semantic Web** The Semantic Web refers to a highly intelligent web technology which fills the knowledge gap between a machine-readable language and a human natural language. According to the definition from the World Wide Web Consortium (W3C) led by the Internet founder Tim Berners-Lee, 'Semantic Web provides a common framework that allows data to be shared and reused across application, enterprise, and community boundaries.' The Semantic Web is designed to explore the hidden and implied relationships among data and information processed and synthesized via databases and web searching technologies. According to the 'Semantic Web Activity Statement' from the W3C, the core of the Semantic Web is the Resource Description Framework (RDF), which is an XML-based markup language for defining metadata about web information. The ultimate objective for the Semantic Web is to make web information more accessible and reusable across diverse applications and databases running on the Internet and WWW. The Semantic Web holds promise for the future development of web technologies and web search engines.

**Server** Located at a network node, a server is a high-performance computer, managing and processing most of the network data and information.

**SGML (Standard Generalized Markup Language)** SGML is a meta-language for describing markup languages such as HTML (Hypertext Markup Language) and XML (Extensible Hypertext Markup Language).

See also: *HTML (Hypertext Markup Language)* and *XML (Extensible Hypertext Markup Language)*.

**SMIL (Synchronized Multimedia Integration Language)** SMIL is a new markup language used by web developers to define and synchronize the sequential order of audios, animations, graphics, images, texts, and videos displayed on the Internet.

**SOAP (Simple Object Access Protocol)** SOAP is an XML-based protocol to handle communications between heterogeneous applications across diverse platforms or systems.

**Social network** Built on the World Wide Web, a social network is a virtual network to promote social activities and communications among various social groups.

**Social networking websites** Social networking websites are websites set up to promote social networking activities and communications in cyberspace.

**Software** In the computer world, software represents all kinds of applications and programs, such as operating systems (e.g. Windows Vista) or word-processing programs (e.g. Microsoft Office Word 2007).

**Software life cycle** The software life cycle is the entire process of designing, developing, initializing, testing, implanting, maintaining, and updating software until it is completely replaced by new software.

**Solid-state drive (SSD)** The SSD uses a flash-memory-based storage medium instead of rotating magnetic media for data storage. Since it does not contain any rotating platters, the SSD has specific features such as an anti-high temperature, anti-seismic structure, high-speed data access and storage, low power consumption, and higher reliability. However, the disadvantages of the SSD include high price and difficult data recovery. There is still a long way for the SSD to go, since the data storage capacity of the traditional hard disk has reached 1 TB.

**Speech recognition technology** Speech recognition technology, also called voice recognition technology, is advanced technology that transforms human speech signals into corresponding text through a process of interactive human–machine communication.

**Streaming media** Streaming media, also called streaming video, refers to the display and transmission of a sequence of specially compressed coding digital media contents – such as animations, audios, graphics, photographs, texts, and videos – to the end-user over the Internet.

**Stylus** A stylus is a pen-shaped input device to handle human–machine interactions for hand-held computer units.
See also: *PDA (personal digital assistant)*.

**Sync** Developed by Microsoft, Sync, an application driven by speech recognition technology, allows automobile drivers to play digital music and dial a mobile phone by means of voice instructions. Sync has been exclusively installed inside Ford, Lincoln and Mercury models sold in North America.

**System** A system is a collection of components, hardware, modules, parts, software, and other units which are combined to work as a whole.

**Tablet PC** A tablet PC is an enhanced laptop computer with innovative human–machine interactions. Traditional laptop users can only utilize a keyboard and a mouse to interact with computers. Tablet PC users can use an innovative rotating touch screen or a stylus to operate the computer.

**TCP/IP** (**Transmission Control Protocol/Internet Protocol**) TCP/IP refers to two communication protocols for the transmission of data among hosts over the Internet.

**TD-SCDMA** (**Time Division – Synchronous Code Division Multiple Access**) TD-SCDMA is one of three 3G telecommunication standards supported by the People's Republic of China (PRC).

**Telecommunication technology** Modern telecommunication technology refers to technologies for voice and video communication as well as data transmission, including audio, animations, graphics, images, numbers, texts, videos, and so forth, via cables, radios, satellites, telephones, and telegraphs, etc.

**Topology** In a computer network, the topology refers to the physical way computers and other peripherals are linked, including for a network's linkages and interconnections.

**Touch Wall** Touch Wall is one of the latest innovative computing devices invented by Microsoft to support multi-touch operations on the screen.

**Traditional library information services** Traditional library information services still start from the personal oral or written communications

between librarians and library users. Traditional library information services have the following two major features: they are (1) face-to-face; and (2) on-site.

See also: *Electronic library information services*.

**Ubiquitous computing** See: *Pervasive computing*.

**UDDI (Universal Discovery Description Integration)** UDDI is one of the core XML-based standards for web services to define, discover, and integrate business services over the Internet platform.

**Ultra mobile PC (UMPC)** The ultra mobile PC is a small – between a PDA and a laptop in size – personal computer focusing on the mobile office working environment. In the super-mobile working environment, a laptop is too heavy while a PDA does not have sufficiently strong functions for the mobile office and a cellular phone has too many amusing features. Strongly promoted by Microsoft and Intel, the new ultra mobile PC with high-performance functions, low power consumption, and ultra portability will lead the developmental trends in the computers of the future.

**Ultraband Network** The Ultraband Network is a broadband network that can provide sufficient bandwidth (scalable bandwidth from 5 to 1,000 Mbps or even higher) service. To solve the network bottlenecks, the Ultraband Network is the best technological solution for transmitting digital multimedia files, including high-definition DVD (digital video disk) quality streaming videos at high speed.

**University System of Georgia (USG)** See: *Georgia Southern University*.

**USB (universal serial bus)** The USB is an external serial bus standard supporting data transfer between a computer workstation and other computer peripherals, such as computer mice, digital cameras, flash drives, hard drives, keyboards, printers, scanners, and web cams, etc. The current USB 2.0 Standard supports data transfer up to 480 Mbps (short for **m**ega**b**its **p**er **s**econd).

**USB (universal serial bus) flash drive** The USB flash drive, also called the universal smart drive, is a lightweight, removable, and rewritable data storage device. The USB flash drive also has additional advantages: fast interface, simple connection, no external power supply, and good external compatibility.

**USB (universal serial bus) hard drive** The USB hard drive is a more powerful and more bulky external data storage device. In capacities of

40 GB, 80 GB, 100 GB, 120 GB, 160 GB, 250 GB, 300 GB, 500 GB, 750 GB, and 1 TB, the USB hard drive provides users with the freedom to back up, store, and transfer large amounts of data.

**User** User refers to the people who design, develop, maintain, process, and utilize an information system. An information system must be a user-centered system to satisfy dynamic user expectations and requirements. An information system without users has no reason to exist.

**User services** User services provide assistance to users for accessing, locating, processing, storing, synthesizing, and transforming information.

**USMARC standard** The USMARC (United States Machine-Readable Cataloging) standard is a technical format standard for bibliographical records in the library.

**UWB (Ultra-Wideband)** UWB refers to the most advanced short-range (up to 10 meters or 30 feet or so) wireless broadband personal area network (PAN) technology with a bandwidth over 500 MHz. Different from traditional wireless communication using radio waves, the UWB network uses short pulses to transmit up to 480 Mbps (megabits per second) for linked cellular phones, computers, digital cameras, modems, set-top boxes, televisions, and other devices.

**Video technology** Based on the definition set by Wepopedia.com, video technology refers to the recording, processing, and display of motion pictures and texts via a display unit, such as a computer monitor, television set, video recorder, or other device. In the digital age, video technology has been a very important part of multimedia technology. Combined with new advances in computer technology, digital technology, multimedia technology, telecommunication technology, and web technology, etc., video technology has brought us a brand new experience of locating, accessing, converting, transmitting, recording, storing, and displaying data information in the digital age.

**Virtual library** A virtual library is a library built up over the platform of the Internet and World Wide Web (WWW).

**Virtual Office** Virtual Office is a web-based office platform providing customers with remote access to general office services, such as a business address, e-mail, fax, teleconferencing, telephone, web hosting, etc.

**Virtual private network (VPN)** A VPN, which usually depends on an Internet service provider (ISP) and/or national service protocol (NSP), is built over a specified private intranet network to support

script-protected communications, information resources sharing, and operations, etc. for internal users between headquarters and branch offices in many companies, government agencies, institutes of higher education, organizations, and so on.

**Virtual reference service (VRS)** The virtual reference service is a modern web-based electronic reference information service over today's multiple information technology platforms, and includes e-mail, instant messaging (IM), and VoIP telephone services, etc.

**Virtual services librarian** The virtual services librarian is primarily responsible for virtual reference services, including e-mail, instant messaging, social networking, wiki services, and so on. The virtual services librarian must demonstrate his or her in-depth experience and knowledge of and skills in innovative cutting-edge and emerging technologies evolving in academic libraries, especially for the access to and delivery, dissemination, and transformation of electronic information in multiple formats.

**VoIP (Voice-over-Internet Protocol)** VoIP is the Internet-enabled technology which transfers digitalized voice signals over the broadband network.

**VRML (Virtual Reality Modeling Language)** VRML is an international standard defined by the International Organization for Standardization (ISO) for the display of 3D graphics on the World Wide Web.

**W3C (World Wide Web Consortium)** W3C is an international consortium for setting up Web standards and guidelines, including standards for CSS, HTML, SGML, XHTML, XML, and so on.

**W-CDMA** W-CDMA is one of three existing 3G telecommunication standards supported in Europe, Japan, and the United States.

**Web** See: *World Wide Web (WWW)*.

**Web 2.0** Web 2.0 is a debatable concept regarding web hosts and web services.
See: *Library 2.0*.

**Web API (application program interface)** Web API is the application program interface in a web-based computing environment.

**Web blog** See: *Web log*.

**Web browser** A web browser is software which executes the Hypertext Transport Protocol (HTTP) to obtain web pages from web servers.

**Web content control** See: *Web content management*.

**Web content management** Web content management is the process of using software to design, develop, implement, modify, and store a website's contents, such as texts, images, and audio/video files.
See also: *Web log*.

**Web log** A web log, sometimes also called a blog or web blog, is a new one-stop-shop web portal containing chronological web publications for personal or professional purposes.

**Web publishing** Web publishing is the process of designing, developing, initializing, and implementing a website through a web server.

**Web search engines** Web search engines are primary tools to search web information including audios, images, maps, music, people, texts, videos, and websites, etc. Well-known global web search engines include Google, MSN, and Yahoo, etc.

**Web services** According to the definition set by the W3C (World Wide Web Consortium), web services are Internet-oriented and standards-based web APIs (application program interfaces) using XML-based messages to assist application-to-application communication over the Internet. Web services function like a gateway for controlling and accessing local information systems.

**Web services technology** Web services technology refers to the mechanism of integrating diverse software with other software applications in order to build distributed and service-oriented web-based applications running over the Internet platform.

**WebCT** WebCT is the online learning software purchased by Blackboard in October 2005. Integrating the different instruction and learning activities in an innovative enhanced networked GUI, WebCT supports curriculum design, interactive learning design, online assessment, web content management, etc. over the Internet platform.

**Weblog** See: *Web log*.

**Wiki** A wiki is a hypertext web page for collaborative writing. The main features of a wiki are that it is easy to create, access, and change.

**WiMAX (Worldwide Interoperability for Microwave Access)** WiMAX is officially known as IEEE 802.16x. Specified as an alternative to cable and DSL (digital subscriber line), WiMAX is a real long-range (up to 30 miles) and high-throughput (approximately 75 Mbps in the

10–66 GHz band) broadband wireless metropolitan access network (MAN).

**Windows 7** Windows 7 is the next generation of Microsoft's Windows operating system to utilize surface computing technology.

**Windows 8: Midori** A successor to the Windows operating system, Midori is another new non-Windows-based operating system running on the Internet platform. Microsoft hopes to design and develop a new operating system to regain control of global information exchange and sharing in the coming years of the twenty-first century.

**Windows Vista** Windows Vista is the latest operating system released by Microsoft to upgrade current older operating systems such as Windows 2000 and Windows XP for personal computer (PC) users. Microsoft promised a lot of attractive features, such as an enhanced user interface, better system security, improved performance and reliability, Internet Explorer 7, and so on.

**Wireless local area network (WLAN)** Wireless local area network technology, which is currently defined in the IEEE 802.11 standard, is also used to transmit data and information over wireless media equipment. In diverse academic learning environments, a WLAN is primarily used to expand the service scope of existing information technology architectures.
See also: *Local area network (LAN)*.

**Wireless USB (WUSB)** Wireless USB, a new fast wireless connecting technology, is soon expected to connect personal computers (PCs) and their peripherals. Wireless USB devices possess the greatest convenience and mobility within a short range. Comparable to the regular USB 2.0, the wireless USB can transmit at 480 Mbps within a range of 10 meters.

**World Wide Web (WWW)** The World Wide Web is the means of accessing and disseminating hypertext documents via web browsers and web servers running over the Internet platform.
See also: *Internet*.

**World Wide Web Consortium (W3C)** The World Wide Web Consortium is an international consortium for defining and developing standards and technologies for the World Wide Web.

**WSDL (Web Services Description Language)** WSDL is one of the primary XML-based languages for web services.

**XHTML (Extensible Hypertext Markup Language)** XHTML is the latest version of HTML. XHTML combines the advantages of HTML and XML. In the future, XHTML will replace HTML step by step.

See also: *HTML (Hypertext Markup Language)*, *SGML (Standard Generalized Markup Language)*, and *XML (Extensible Hypertext Markup Language)*.

**XML (Extensible Hypertext Markup Language)** XML is a metadata language to define data for web-based applications, while HTML (Hypertext Markup Language) and XHTML (Extensible Hypertext Markup Language) are used to define a web page's layout.

See also: *HTML (Hypertext Markup Language)*, *SGML (Standard Generalized Markup Language)*, and *XHTML (Extensible Hypertext Markup Language)*.

**XPS (XML Paper Specification) format** XPS format is an electronic document format designed and developed by Microsoft. As a powerful tool in competition with the Adobe PDF format, Microsoft's Office 2007 Suite, comprising Word, Excel, PowerPoint, Access, Publisher, Visio, OneNote, and InfoPath applications, will provide XPS portable document format support. The XPS format also allows users to attach their digital signature and assert their digital rights with their documents.

**XSL (Extensible Stylesheet Language)** XSL is a transformation language for the display of XML (Extensible Hypertext Markup Language) documents.

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