Chapter 7: Architecture Design

# Teaching Tips and Strategies *(from Barbara Wixom)*

I find these topics to be important for students to appreciate, especially because of the way in which each topic influences the design of the system. By covering the many issues of architecture design, it adds to the students’ appreciation for the complexity involved in systems development. Depending on your curriculum, the topics (e.g., client-server) may be covered in other classes. I find that I gloss over some topics when this is the case, and spend more time on topics that are new to students. However, I have students address all the topics in their semester project by either writing a memo to the project manager or actually producing the architecture design deliverables.

Our students have a good knowledge of architectures by the time they get to this class, so I do not spend much time lecturing about this material. Instead, I spend the first class session of architecture design teaching how nonfunctional business requirements are refined and used to select the architecture design. I then have a technical person from our University IS department come in and verbally describe how a university system (e.g., the career services application that we have in place) is set up. After the guest leaves, the students get into groups and "work backwards" to define the nonfunctional requirements that produced the system described by our guest. It works really well. Usually, the students compile questions about additional information that they need, and we either make assumptions about the answers, or ask the technical person via email.

A fun exercise is to assign groups a component of the system our guest described and have each group come up with a hardware/software specification for the component. It makes for a great homework assignment and you can post all of the group answers on a Web site, or on a listserv for all to see. The students can get the technical information from the Web, or by visiting a local computer store. I find that having them do a specification is much more interesting than spending a lot of time lecturing about it.

I spend another class on architecture design handling the security requirements and cultural/political requirements. I start off with a lecture to present the key issues, and have students provide examples. Usually I also come prepared with some current events or system examples from *Computerworld* that exemplify each issue in the lecture.

I finish class with an exercise that drives home the importance of security. Before class, I come up with a list of 10 security threats. I tell the students that their rival school is hoping that their system crashes. In groups, they must come up with a list of 10 potential threats to their system and assess the risk of each one happening. Then, they need to create controls for the top 5 most risky threats. When they are finished, I unveil my list of threats, and we pretend that they actually transpired. To win as a class, they must show that they have warded off my threats. If any of my threats is not addressed, the rival school “wins.” I give high praise to groups who address the greatest number of my threats. We then discuss threats that they had as risky but did not occur.

# War Stories *(from Barbara Wixom)*

## Secure packaged systems?

My friend Graig works with a lot of packaged financial systems, and he was telling me how difficult it is to secure the human resource module for a packaged system like a PeopleSoft or SAP. The reason is that the security is controlled by password at the application-level. But, that does not keep IT people (like the DBA) from having access to data by going directly through the tables.

For example, if the DBA wanted to find out her boss’ salary, she could not access it through the human resource module of Peoplesoft. However, she *could* access the salary by going into the table using her database password.

On the one hand, you want your IT people to know system passwords so that they can maintain the system. On the other hand, you may not want them to have a password because the data in the tables is sensitive…

Graig says that many companies leave this security hole unpatched. They go ahead and give the system password to the DBA and trust that he or she won’t abuse the privilege. Other companies have tried some other approaches. For example, one implementation had the human resource manager be the keeper of the password. Whenever the DBA needed to make changes to the system, she would have to get the password from the human resource manager. The manager had to start wearing a beeper – in case the system went down and the DBA had to make emergency changes!

## Web security

Owens & Minor (OM) is a medical supplies company based in Richmond, Virginia, and they won the 1999 Best Practices Leadership Award from the Data Warehousing Institute for their Web-based data warehouse. The warehouse called VISION allows suppliers and customers to access their orders via the Web. Of course, this information can be highly sensitive – OM had to make sure that suppliers could not see other suppliers’ information or what individual customers are buying.

OM gives users passwords that change monthly to differentiate each user of the system. This password and login is affiliated with a customer or supplier ID that resides in a security table. Whenever the customer or supplier runs a query or report, their ID is appended as a WHERE clause in the SQL query generated, thus restricting the output to data pertinent to their own account only.

You can check out the warehouse using a virtual tour off of the OM web site – [www.owens-minor.com](http://www.owens-minor.com)

# Answer to Your Turn 7-1: University Course Registration System

Student answers will vary, but should include a consideration of the operational, performance, security, and cultural/political requirements as follows:

Operational:

Technical Environment, System Integration, Portability, and Maintenance requirements.

Performance:

Speed, Capacity, Availability and Reliability requirements.

Security:

System Value Estimates, Access Control, Encryption and Authentication, and Virus Control requirements.

Cultural/Political:

Multilingual, Customization, Making Unstated Norms Explicit, and Legal requirements.

Architectural design will vary based on the requirements the students have identified.

# Answer to Your Turn 7-2: Global e-Learning System

Student answers will vary, but should include a consideration of the operational, performance, security, and cultural/political requirements as follows:

Operational:

Technical Environment, System Integration, Portability, and Maintenance requirements.

Performance:

Speed, Capacity, Availability and Reliability requirements.

Security:

System Value Estimates, Access Control, Encryption and Authentication, and Virus Control requirements.

Cultural/Political:

Multilingual, Customization, Making Unstated Norms Explicit, and Legal requirements.

Architectural design will vary based on the requirements the students have identified.

# Answer to Your Turn 7-3: University Course Registration System

Student answers will vary depending upon the architectural design developed for Your Turn 7-1. Responses should include operating system software, hardware, software and network specification. Additionally, the students should ensure that the hardware and network specifications support the needs of the software specifications. For example if a specialized software specification requires a UNIX platform, that operating system should be included in the list.

# Answer to Your Turn 7-4: Global e-Learning System

Student answers will vary depending upon the architectural design developed for Your Turn 7-2. Responses should include operating system software, hardware, software and network specification. Additionally, the students should ensure that the hardware and network specifications support the needs of the software specifications. For example, if an Oracle Database is specified, students should ensure that there will be a large enough server to support the proposed data needs.

# Answer to Concepts in Action 7-A: When Performance Counts

There were no questions.

# Answer to Concepts in Action 7-B: Importance of Capacity Planning

Things to consider when conducting capacity planning include not only the number of proposed users, but the support of those users in their activities. In this case, the developers should have considered that an increased number of members interacting with the system will slow down response time. Additionally, an increased number of members also means an increase in the number of member records, which results in an increase in time to process those records.

# Answer to Concepts in Action 7-C: Securing the Environment

1. Student answers will vary, depending upon their experience with a campus network. However, typically students rely heavily on a campus network to communicate, conduct research and complete homework assignments. Staff and faculty rely on the network to interact with campus systems.
2. Tangible costs might include loss of productive time for staff and faculty and an increase in costs for staff to update records when the system comes back up. Intangible costs might include loss of student satisfaction with the system and a loss of reputation in the community.
3. Having an intrusion prevention system decreases the number of potential threats to the system. As depicted in the scenario, having the IPS in place resulted in no outages when the students came back from break. The end result was that there was no interruption in service to students, faculty, and staff.

# Answer to Concepts in Action 7-D: Power Outage Costs a Million Dollars

One way to ensure that the situation does not occur again is for the company to invest in a backup power system to support the business systems associated with sales. Conducting a cost analysis should prove that the one-time investment will certainly pay off when applied against the potential loss of revenue in sales.

# Answer to Concepts in Action 7-E: Developing Multilingual Systems

1. The decision to support non-English speaking users would depend upon a number of factors. The first of these is to determine how many users are in question. If only a small percentage do not speak English, it may not be cost effective to provide additional resources to support them. A second factor is to determine how many languages would be needed to support the users. If the majority of the non-speaking users speak German, then it may be cost-effective to support them in order not to lose their business.
2. Again, it would depend upon how many users were in question. Additionally, it might also depend upon the delivery of the application. If it is a standalone application, it is possible to develop languages models for the users to acquire. If it is a web-based application, it is possible to have multilingual web pages available and allow the user to choose which language is presented.

# Solutions to End of Chapter Questions

1. *List and describe the four primary functional components of a software application.*

The four general functions of any application are (1) data storage - storage of the system’s data; (2) data access logic - providing access to the system’s data; (3) application logic - the system’s processing functions; and (4) presentation logic - the appearance of the system to the user and the method used to give the system commands.

1. *List and describe the three primary hardware components of a system.*

The three main hardware components of an application architecture are client computers, servers, and networks. Client computers are the input–output devices employed by the user and are usually desktop or laptop computers, but can also be handheld devices, smartphones, tablet devices, special-purpose terminals, and so on. Servers typically are larger multi-user computers used to store software and data that can be accessed by anyone who has permission. The network that connects the computers can vary in speed from slow cell phones or modem connections that must be dialed, to medium-speed always-on frame relay networks, to fast always-on broadband connections such as cable modem, DSL, or T1 circuits, to high-speed always-on Ethernet, T3, or ATM circuits.

1. *Explain the client-server architecture.*

In a client-server based architecture the responsibility for the applications functions are shared. The client is responsible for the presentation logic, whereas the server is responsible for the data access and data storage. The application logic may be split between the client and server, or may reside on the client **or** the server.

1. *Explain the server-based architecture.*

The very first computing architectures were *server-based,* with the server (usually, a central mainframe computer) performing all four application functions. The clients enabled users to send and receive messages to and from the server computer. The clients merely captured keystrokes and sent them to the server for processing, and accepted instructions from the server on what to display.

1. *Explain the mobile application architecture.*

In a mobile application architecture, the system architect must decide how much of the presentation logic, business logic, and data access logic will reside on the mobile device, and how much will reside on server devices.

1. *Distinguish between the two-tier, three-tier, and n-tier client-server architectures.*

The differences in these client-server architectures have to do with the allocation of the various components of the total application between the client and the server(s). In a two-tiered architecture, the server is responsible for the data and the client is responsible for the application and presentation. This is called a *two-tiered architecture* because it uses only two sets of computers—clients and servers. A *three-tiered architecture* uses three sets of computers. In this case, the software on the client computer is responsible for presentation logic, an application server(s) is responsible for the application logic, and a separate database server(s) is responsible for the data access logic and data storage. An *n-tiered architecture* distributes the work of the application (the middle tier) among multiple layers of more specialized server computers. .

1. *Compare and contrast server-based architectures, and client-server based architectures.*

In a server-based architecture, the server (generally a large mainframe) performs all four application functions. In a client-server architecture, the clients handle the presentation logic, while the server is responsible for data access logic and data storage. The application logic may be allocated entirely to the clients, entirely to the server, or split between the clients and server.

1. *What is meant by the term* ***scalable****? What is its importance in architecture selection?*

Scalability means it is easy to increase or decrease the storage and processing capabilities of the servers. If one server becomes overloaded, you simply add another server so that many servers are used to perform the application logic, data access logic, or data storage. The cost to upgrade is gradual, and you can upgrade in small increments.

1. *Explain the term virtualization.*

Virtualization refers to the creation of a virtual device or resource, such as a server or storage device. You may be familiar with this concept if you have partitioned your computer’s hard drive into more than one separate hard drive. While you only have one physical hard drive in your system, you treat each partitioned, “virtual” drive as if it is a distinct physical hard drive.

1. *Describe cloud computing and how it is impacting architecture choices.*

It is no longer necessary for organizations to own, manage, and administer their own computing infrastructure. We are in the midst of the rise of *cloud computing*, wherein everything, from computing power to computing infrastructure, applications, business processes to personal collaboration—can be delivered as a service wherever and whenever needed. The “cloud” in cloud computing can be defined as the set of hardware, networks, storage, services, and interfaces that combine to deliver aspects of computing as a service. Cloud services include the delivery of software, infrastructure, and storage over the Internet (either as separate components or a complete platform) based on user demand. Cloud computing can be implemented in three ways: private cloud, public cloud, and hybrid clouds. .

1. *Describe the types of operational requirements and how they influence architecture design.*

Operational requirements specify the operating environment(s) in which the system

must perform and how those may change over time. This usually refers to operating

systems, system software, and information systems with which the system must interact, but will on occasion also include the physical environment if the environment is important to the application. Four key operational requirements are technical environment, system integration, portability, and maintainability. ( .

1. *Describe the types of performance requirements and how they may influence architecture design.*

Performance requirements include:

Speed – response time (how long does it take for the system to respond to a user request?), and transaction delay (how long does it take for an event on one part of the system to be reflected in another part of the system?)

Capacity – how many users does the system support? The number of both internal (employees) and external users (customers) should be factored in.

Availability and Reliability – When does the system need to be available? 24x7? During the 40-hour work week only? Is it absolutely imperative that the system be up and running with no downtime? For medical and military operations, this may be the case.

1. *Describe the types of security requirements and how they may influence architecture design.*

Security requirements include:

System Value – estimated business value of the system and its data.

Access Control – determining who is authorized to access which resource

Encryption and Authentication – determining what data will be encrypted and whether or no authentication will be required for user access

Virus Control – controlling viral spread

1. *What is meant by system value? Explain how various systems can have a different value to the organization.*

System value is an assessment of the costs to the organization that might be incurred if the system were unavailable or if the data was compromised. These costs are not the costs associated with replacing hardware and/or software, but are the costs associated with loss of business; potential lawsuits, decreased customer satisfaction, cost of rebuilding the organizational data structure, etc.

1. *Explain the difference between a symmetric encryption algorithm and an asymmetric encryption algorithm*

A symmetric encryption algorithm is one in which the same key is used to both encrypt the data and decrypt the data. An asymmetric encryption algorithm is one in which separate key are established; one to encrypt the data, and another to decrypt the data.

1. *What is meant by authentication? What is its role in securing transactions?*

Public key encryption permits *authentication* (or digital signatures). When one user sends a message to another, it is difficult to legally prove who actually sent the message. Legal proof is important in many communications, such as bank transfers and buy/sell orders in currency and stock trading, which normally require legal signatures. Public key encryption algorithms are *invertible*, meaning that text encrypted with either key can be decrypted by the other.

1. *Describe the usefulness of the Internet’s public key infrastructure (PKI).*

The PKI is a set of hardware, software, organizations, and policies designed to make public key encryption work on the Internet. PKI is useful in that it can act as an uninterested, third party in the encryption and authentication process. PKI uses certificates that each organization or individual applies for with a certificate authority (CA). The CA is responsible for authenticating the individual or organization before issuing the digital certificates, and then holds those certificates in trust. The organization or individual then uses those digital certificates to authenticate identity.

1. *Describe the types of cultural and political requirements and how they influence the architecture design.*

Cultural and Political requirements include:

Multilingual – Does the environment require the system to operate in more than one language?

Customization – Are there features that can be customized according to different national cultures?

Making Unstated Norms Explicit – Are there assumptions that may be ambiguous in different national cultures? If so, they need to be explicitly stated.

Legal – Are there national and/or international legal issues that need to be addressed?

1. *Explain the difference between concurrent multilingual systems and discrete multilingual systems.*

A concurrent multilingual system is one in which several languages are available simultaneously. Users can choose to use many languages at any time. A discrete multilingual system is one in which one of many languages is chosen at installation. Reinstallation is required for the system to operate in a different language.

1. *Why is it useful to define the nonfunctional requirements in more detail even if the technical environment requirements dictate the specific architecture?*

In the event that the technical environment requirements do not require the choice of a specific architecture, then the other nonfunctional requirements become important. Even in cases when the business requirements drive the architecture, it is still important to work through and refine the remaining nonfunctional requirements, because they are important in later stages of the design and implementation phases.

1. *What is the purpose of the hardware and software specification?*

The *hardware and software specification* is a document that describes what hardware and software are needed to support the application.

1. *What do you think are three common mistakes that novice analysts make in architecture design and hardware/ software specification?*

Architecture design is a difficult process, so it is easy for a novice analyst to make mistakes. Some likely mistakes include:

* not considering the future of the system; selecting a design based only on its current needs.
* Not considering all aspects of system security that need to be factored into the architecture design.
* Failing to include cultural, political, and legal requirements that may be important for the system

The hardware and software specification is also subject to some mistakes. For example:

* Omitting a key piece of software needed in the overall system
* Omitting some associated software issues (and costs) such as training, maintenance, and licensing agreements.
* Providing incomplete hardware specifications

1. *Are some nonfunctional requirements more important than others in influencing the architecture design and hardware and software specification?*

The technical environment requirements have the most influence on the architecture design and the hardware/software specification. These requirements follow directly from the business requirements for the system and generally dominate all other considerations.

1. *What do you think are the more important security issues for a system?*

It is difficult to rank security issues since all are important. In today’s environment, however, there are some issues that must be addressed. For example, protection from external access is increasingly important in our networked world. Since more and more business transactions are conducted over networked systems and the Internet, encryption and authentication controls are essential. Viruses are the most common security problems, so systems need to prevent the spread of viruses.

# Solutions to End of Chapter Exercises

1. *Using the Web (or past issues of computer industry magazines, such as Computerworld), locate a system that runs in a server-based environment. On the basis of your reading, why do you think the company chose that computing environment?*

Sample response: *NHS Fife Rolls out Citrix Server-Based Computing Architecture* (<http://pressbox.co.uk/Detailed/5859.html>)

This article discusses the rollout of a 900-user server-based computing architecture for Fife Acute Hospitals NHS Trust in Scotland. Benefits of this system stated in the article include replacement of an obsolete, unwieldy IT infrastructure, considerable reduction in total cost of ownership, faster software roll outs, reduced hardware and software maintenance and support costs.

1. *Using the Web (or past issues of computer industry magazines, such as Computerworld), locate a system that runs in a client-server environment. On the basis of your reading, why do you think the company chose that computing environment?*

Student answers will vary. Look for benefits of client-server that include the fact that clients can access information and services anywhere on the network. Flexibility and scalability are also key reasons to employ the client server architecture.

1. *Using the Web, investigate the term, virtual desktop infrastructure (VDI). Write a short memo explaining the concept to your boss.*

Student answers will probably contain items such as these:

Virtual Desktop Infrastructure (VDI) is a centralized desktop delivery solution. The concept of VDI is to store and run desktop workloads including the operating system, applications, and data in a server-based virtual machine (VM) in a data center; and allow a user to interact with the desktop presented onto a user device via Remote Desktop Protocol (RDP). VDI is not an isolated architecture, but one of the many technologies available to optimize enterprise desktops.

Users can get to their desktops from any authorized connected device, improving the ability to be productive even in the case of a disaster. VDI can provide remote users a rich, local-like experience on their virtual desktops from a broad range of services. VDI empowers enterprises with unified management of centralized desktops and it can extend existing management tools and processes to the virtual desktop environment as well, thereby reducing management overhead while still enabling rapid deployment and patching by managing images centrally.

1. *You have been selected to find the best client-server computing architecture for a Web-based order entry system that is being developed for L.L. Bean. Write a short memo that describes to the project manager your reason for selecting an n-tiered architecture over a two-tiered architecture. In the memo, give some idea as to what different components of the architecture you would include.*

In this situation, look for student answers that discuss the need for performance and scalability. It is likely that the system would need web-server(s) separate from database servers in order to provide satisfactory information and performance to the users. As load on the system grows, the ease of adding capability to the system would be a big advantage for the client-server architecture.

1. *Think about the system that your university currently uses for career services and pretend that you are in charge of developing a mobile app for students to use to access the system. Describe how you would decide on the architecture and development approach for the new app using the criteria presented in this chapter. What information will you need to find out before you can make an educated comparison of the alternatives?*

Student answers will vary. If the system in place is not web-based, any new system probably will be web-based. This suggests the client-server architecture. The expected volume of stored information and volume of transactions will be needed in order to select the 2-tier architecture or the 3-tier architecture.

1. *Locate a consumer products company on the Web and read its company description (so that you get a good understanding of the geographic locations of the company). Pretend that the company is about to create a new application to support retail sales over the Web. Create an architecture design that would support this application.*

This is likely to be some form of client-server architecture. The three-tier architecture is likely since web servers and database servers will be needed to handle the transaction volume expected for a large business.

1. *Pretend that your mother is a real estate agent and that she has decided to automate her daily tasks using a laptop computer. Consider her potential hardware and software needs and create a hardware and software specification that describes them. The specification should be developed to help your mother buy her hardware and software on her own.*

Software:

Windows OS, appointment calendar program, word processor, financial calculator software, photo editing software, desktop publishing software, web browser, virus protection software, firewall.

Hardware:

Laptop with 15" display, 8 GB memory, Wireless modem, 500GB hard drive, CD‑RW drive, digital camera card port. Good quality color printer.

1. *Pretend that the admissions office in your university has a Web-based application so that students can apply for admission online. Recently, there has been a push to admit more international students into the university. What do you recommend that the application include to ensure that it supports this global requirement?*

Multilingual capability may help. Although prospective students will probably have some English capability, they might be impressed and enthused about a university that provides them with information in their native language.

# Answers to Textbook Minicases

1. *Operational Requirements*

*All locations should have access to an always-on network. Web-based portion of the system should be compatible with all major browsers and conform to future browser standards. Since mobile devices are much more popular in Japan than in the US, the system must be able to operate with handheld devices such and cell phones, PDAs, etc.*

*Performance Requirements*

*The design team needs to consider the volume of communication that will take place between the Japanese locations and corporate headquarters, so that an appropriate communication capability is created. The primary need in this case seems to be periodic transfer of information from the Japanese locations to headquarters. Networking specialists should be consulted to be sure that the best communication channels are established for the expected transmissions.*

*Response time must be acceptable to users (no more than 7 seconds). Reservations in classes and lessons must be updated in the database real-time. Confirmation of class and lesson reservations must be sent to student via email within 30 minutes of making the reservation. System must be available 24x7.*

*Security Requirements*

*This system is critical to the success of Birdie Masters. Data transmissions must be secure. Only registered students should be able to reserve classes and schedule lessons. Only instructors can update a student's confidential progress profile. A student can view his/her progress profile only.*

*Cultural and Political Requirements*

*The business expansion into Japan will raise several challenges associated with globalization. A primary issue here is the language difference. In this situation, when we know we will have locations in both the US and Japan, the best option seems to be developing a discrete multilingual system for the school locations. This way, the English version is installed and used in US locations, and the Japanese version is installed and used in the Japanese locations. System designers should work with someone who knows Japanese so that the user interface screens, inputs, and outputs are designed in parallel, using correct terminology for each culture.*

*The Internet part of the system is a little different story, since there could be English and Japanese speakers accessing the Internet at any time. In this case, the Internet part of the system should be developed as a concurrent multilingual system, enabling both languages to be supported simultaneously. Users of the Web pages will be able to select the language they wish the pages to present. Again, designers should develop the English and Japanese versions so that they are consistent with each other, but accommodate different cultural norms.*

*It is not clear in the case how much autonomy will be given to each school location, but some thought needs to be given to the issue of local versus centralized control. Given the great difference in the environment between Japan and the US, it may be necessary to design considerable customization into the Japanese version of the school location system to allow it to be adapted to local conditions.*

*2. With regard to the architecture design, Jerry should look to the standards already in place for this organization. It is likely that the existing technical environment will strongly influence the choice of architecture design. Since Jerry has not tackled this type of situation before, he should seek the help of experienced designers.*

*With regard to the hardware and software specification, Jerry should develop a list of the hardware components that will be needed. Review the description of the system to identify the type and quantity of components that will be used. Then, develop a required configuration for the various hardware elements. Next, list the software that will run on each hardware component. Finally, identify any additional costs that will be necessary.*

1. *Operational Requirements*

*This Web-based system should be compatible with all major browsers and conform to future browser standards. Methods should be incorporated so that companies and contractors can remain anonymous if desired.*

*Performance Requirements*

*Response to job search queries and contractor search queries should be fast: no more than 10 seconds. New job listings posted by companies should be posted within two hours of submission. New resumes submitted by contractors should be posted within two hours of submission. System should be available 24x7.*

*Security Requirements*

*Access to the system should be restricted to registered companies and contractors only. Security of submitted resumes and job listings must be assured.*

*Cultural and Political Requirements*

*It is conceivable that this system could draw the interest of global companies and contractors. If that is the case, multilingual versions of the system may be appropriate.*

*Architecture design*

*This is clearly a system requiring the client-server architecture. Depending on the volume of users, it could be a two-tier system, with a browser-based client and a web server that also stores the database. If the volume of users and data is large, a three-tier system that separates out the database server from the web server could be used.*

# Supplemental Minicases

1. The system development project team at Birdie Masters golf schools (see Supplemental Minicase #1, Chapter 7) has been working on defining the architecture design for the system. The major focus of the project is a networked school location operations system, allowing each school location to easily record and retrieve all school location transaction data. Another system element is the use of the Internet to enable current and prospective students to view class offerings at any of the Birdie Masters locations, schedule lessons and enroll in classes at any Birdie Master location, and maintain a student progress profile - a confidential analysis of the student’s golf skill development.

Assume that you are a member of the project team. You have been given the assignment of developing a memo for the Project Binder that addresses the major security requirements that should be factored into the architecture design. Develop this memo, discussing each security threat that you feel is relevant for the Birdie Masters project. Also, recommend controls that you feel will be important to include in the architecture design.

*Answer: The student’s memo should discuss the fact that the system being developed at Birdie Masters is subject to a number of threats. Every operating location faces the risk that some type of disaster could disrupt operations. The networking that links the school locations could fail, resulting in a loss of communication capability. The use of networks and the Internet in the system raises the issue of unauthorized access to system data. The system feature of maintaining confidential student profiles accessible from the Web also suggests the need to protect against unauthorized access to system data.*

*Students may suggest a number of controls for this system. Corporate headquarters and each school location should perform daily backups of operational data. Each location may want to maintain some redundancy in equipment in case of failure, or at least have a prompt service agreement arranged with a local vendor. Fault tolerant servers will be desirable at corporate headquarters. Corporate headquarters and each school location should develop and periodically rehearse a disaster recovery plan. All computers should be outfitted with virus detection programs, which should be frequently updated. This system will also require a significant component to protect against authorized access. Firewalls should be used to protect internal systems from access via the Internet. Encryption should be used to protect the data that is transferred from each location to corporate headquarters. Passwords should be implemented so that only authorized personnel can access the system at the school locations. Also, secure Internet access to student profiles will have to be established through user accounts and passwords.*

1. ComputerBuddies is a group that was formed in the Chicago metro area as an information exchange and social outlet for people with interests in computers. Members of ComputerBuddies range from veteran, big-system computer programmers and operators to young Web-heads. Over the years, members have come to rely on each other for honest, practical advice on a wide range of computer issues. People with a passion for computers in the Chicago area know that ComputerBuddies is the source of reliable answers for just about any type of computer question. Membership has grown, and the group sponsors an Internet information exchange forum as well as frequent social gatherings.

At a recent social event, a guest speaker was on the agenda. The speaker was a long time member of ComputerBuddies, and he asked to be given the chance to speak at a meeting in order to share a recent experience. The speaker is an IS project manager at a major Chicago area manufacturer, and was in charge of the firm’s first client-server implementation project. The project involved the development of a three-tiered client-server architecture for a major manufacturing application.

As the speaker made his remarks, his disillusionment with client-server was obvious. “This project has been a nightmare for me and my project team. We went way past our target date on the project. No one anticipated how difficult it would be to get all the pieces of this system to work together correctly. We chose this architecture in part because it seemed to be the least expensive option, but we’ve really blown whatever cost advantage we thought we’d have from the cheap hardware on labor costs. Now that we’ve got the system up and running, the users are constantly complaining about how slow it is. Right now, I wish we’d gone with our tried and true server-based architecture.” Upon hearing this, some of the younger audience members looked shocked. Other veteran systems people nodded in agreement with the speaker's words.

What has happened here? Why has the speaker experienced problems with the client-server architecture? Should the speaker’s organization have anticipated the problems they did experience?

*Answer: The client-server architecture has many advantages associated with it, and has become a very popular way of implementing new systems. The difficulty and complexity of making such systems work, however, is often underestimated because the technology in the systems seems straightforward. The challenge that is often unrecognized is the partitioning of the system functions to the various components. In this case, a three-tiered architecture implies that the presentation logic is stored on the clients, the application logic is stored on a server, and the data access logic and data are stored on another server. It is much more complicated to get this situation correctly set up than it was when every system component was found on the server. The speaker’s company used this project as its first experience with client-server, and probably found that its programmers had to be retrained, plus the systems analysts needed to learn to design an entirely new approach to the system. Consequently, there were many new skills that had to be used to make this a successful project. The team should have allowed for the necessary learning and experimentation in the project plan. It may have been a strategic error to have such a significant system be the ‘learning’ project for the organization. The current performance problems are probably a result of needing to reallocate some of the system logic to different servers or to increase the capacity of some of the system components.*

# Experiential Exercises

1. Purpose: to recognize and understand the role of various system architectures in a complex IS environment.

Have students brainstorm a list of all the computer applications they can identify on campus (e.g., registration, placement, financial aid, etc.). Divide students into small groups and assign each group to research one of these systems. Have the students identify the system’s underlying architecture (client-based, server-based, client-server-based). When each group reports its results to the class, try to identify similarities among the various systems in each category.

1. Purpose: to recognize various configurations of the client-server architecture.

For the client-server-based systems identified in Exercise 2 above, determine if the system uses two-tier, three-tier, or n-tier architecture. Try to discover the reasons underlying the choice of configuration.

1. Purpose: to review and evaluate a Disaster Recovery Plan.

Contact your campus’ head of IT and obtain a copy of the campus Disaster Recovery Plan (hopefully, there will be one!). Have the class discuss the document. What threats were considered significant? What controls were established for those threats? Can the students identify any omissions that seem significant?