ISYE482/582 Engineering Information Systems

Class Notes

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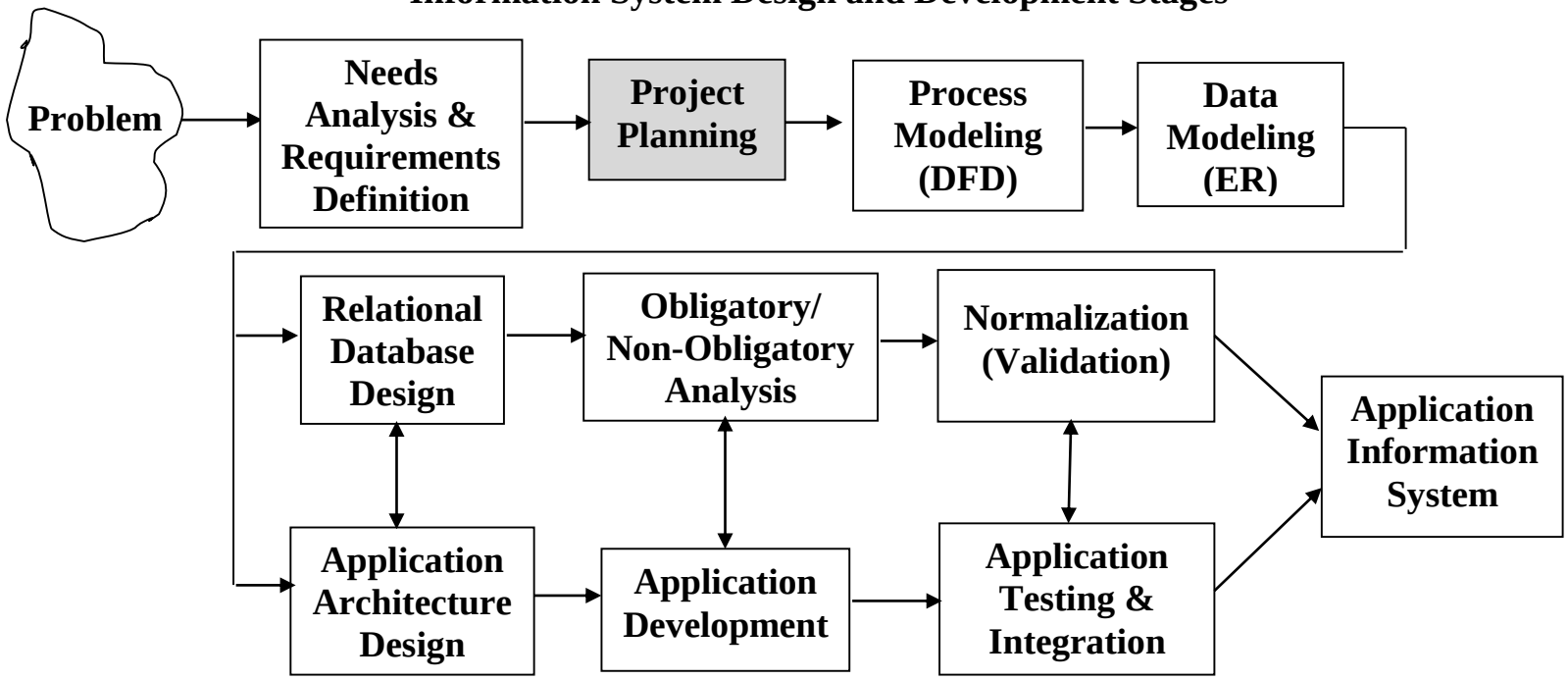
Note: The class notes were compiled from several sources listed under the References section of the course syllabus

Course Roadmap

Information System Design and Development Stages



Foundational and Background Information		
Introduction and Definitions	Indexes and Indexing Mechanisms	Ethics in Information Systems
Files and File Structures	Relational Algebra	Microsoft Access

Information systems project planning and hardware/software selection are outside the scope of this course.

Introduction to Information Systems

- **System**

  A system is a set of interacting components that operate together to accomplish a purpose.

  These components can be organizations, people, machines, hardware, software, and other systems.

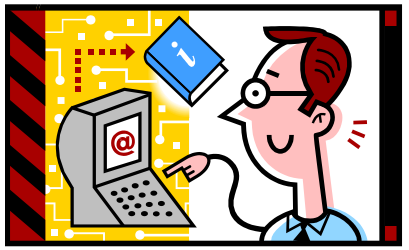
  A component of a system that is a system in its own right is called a subsystem. Each system should have a purpose for its existence.

- **Information System**

  An information system integrates methods, information, people, and information technologies to accomplish certain goals in an organization.

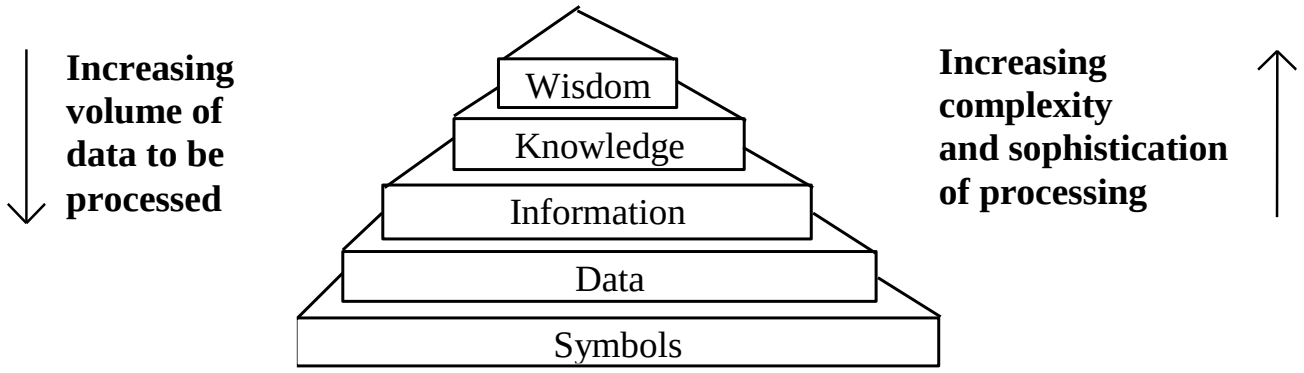
  Examples of information systems:

  Airline Reservation System
  Payroll System
  Student Registration System
  Shop Floor Information System



Note: The definition of information systems is very broad and information systems are not restricted to just database systems.

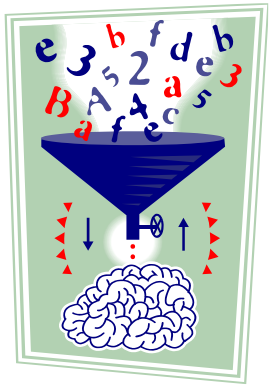
Introduction to Information Systems (Cont.)



Differences between data and information:

Data are

- stored facts
- inactive (they exist)
- technology-based
- gathered from various sources



Information is

- presented facts
- active (it enables you to do something)
- business-based
- transferred from data

Introduction to Information Systems (Cont.)

- **Components of an Information System**

  Methods – procedures and work practices used by people and technology to perform work.

  These include procedures prescribed by operations manuals, and the general ways in which people coordinate, communicate, make decisions, and perform tasks.

  Information – can include formatted data, text images, graphics, and sound.

  Information is nothing but an abstraction and application of data.

  The atomic (basic) element is a symbol e.g. A, ⊂, @, #.

  Data are a collection of symbols, e.g. Bob, Book, Part.

  Data can be formatted into a collection of data items.

  Information is data presented to an application or an action. That is, information is formatted data, that is meaningful for some purpose, e.g. Name = "Bob".

  Knowledge is the decision-making ability based on the information gathered.

  e.g. if credithours≥90, then status = "senior".

Introduction to Information Systems (Cont.)

- **Components of an Information System (Cont.)**

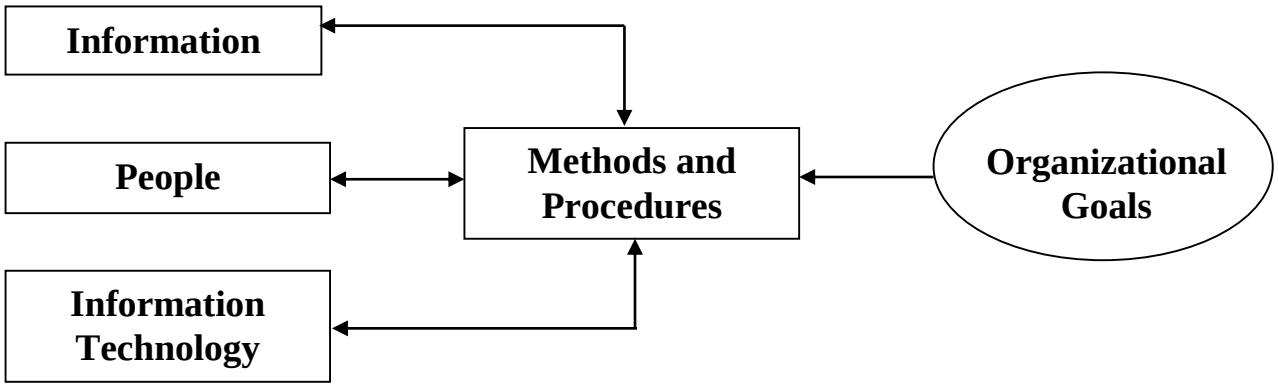
People – This is an essential component of information systems.

People are needed for designing, developing, using and maintaining information systems.

Information systems are designed to reduce the workload of people and simplify their tasks.

Information Technology – hardware and software that perform one or more data processing tasks.

Hardware and software alone do not make an information system, but they are essential parts of an information system.



Components of an Information System

Introduction to Information Systems (Cont.)

- **Scope of an information system**

  An information system developed to satisfy a particular goal can include:

  traditional programs (C++, Java, control programs)
  database systems
  expert systems
  decision support systems, etc.

- **Learning about each of the above may require a separate course, but central to almost all information systems is a database system. Therefore, the focus of this course will be on database systems.**

- **Database Systems**

  A database is a collection of records where their occurrences are interrelated.

  A database management system is a software system capable of supporting and managing a database.

- **Database systems are an integral part of most information systems and this course will give you an overview of analyzing, designing, developing, and implementing data base systems.**

  A database system also requires the same components of an information mentioned earlier.

- **An engineering information system is nothing but an information system designed for use in the engineering environment.**

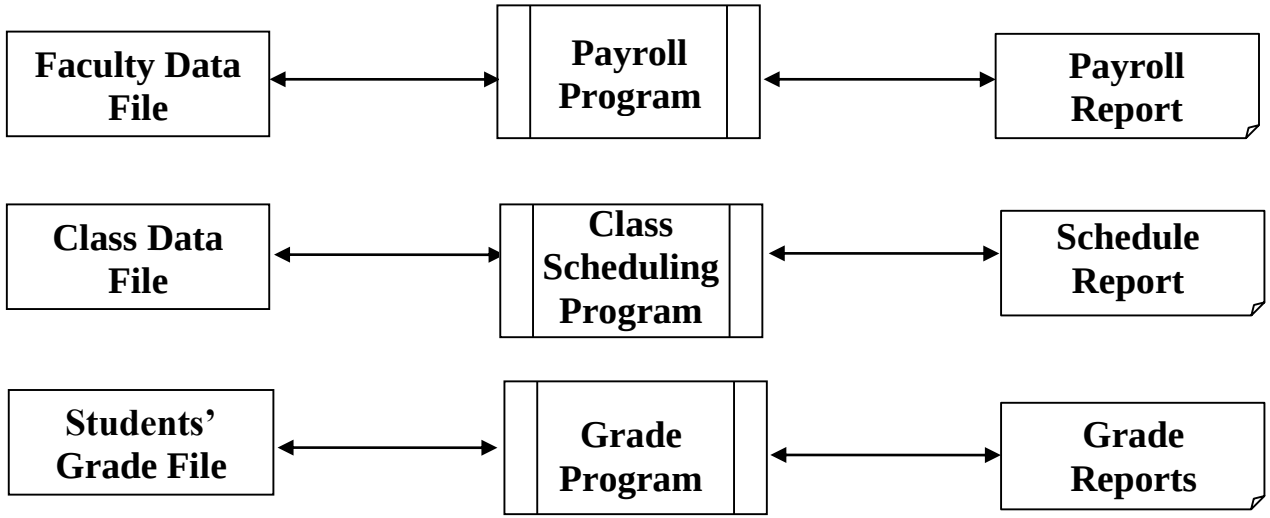
Introduction to Information Systems (Cont.)

- **Why do we need Database Technology?**

  1. **More information can be processed from a given amount of data.**

     For example, in traditional file processing systems we may have separate programs interacting with separate data files and generating reports.

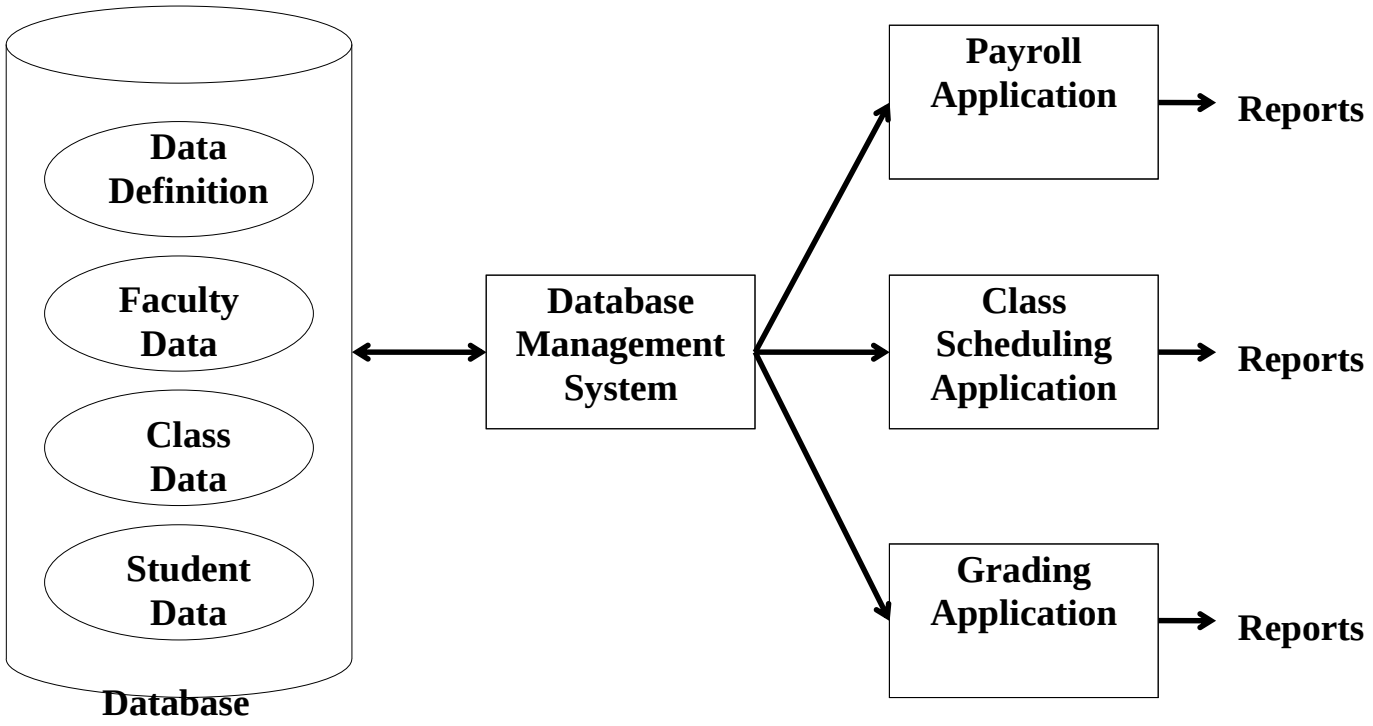
     In the system shown below, you can answer questions such as the average salary of a faculty but not the average salary of a faculty who teaches a particular course because the files are not related.



Traditional File Processing Systems

Introduction to Information Systems (Cont.)

In the system shown below, you can not only answer questions, such as the average salary of a faculty but also the average salary of a faculty who teaches a particular course, and any other unexpected queries, since the data files are related.



Database Management System

Introduction to Information Systems (Cont.)

- **Why do we need Database Technology? (Cont.)**

  2. Elimination of redundant data

  In a traditional file processing system, some data may have to be repeated in both class data and student data file.

  In a database, it needs to be recorded only once. Elimination of duplicate data helps to maintain the integrity of data.

  3. Data independence – "Central Concept" to the database approach

  a. Physical data independence – insulates the program from the actual storage of data.

  e.g. how the data are actually stored does not impact the database application.

  You can change storage devices or media, but the database application need not be changed. This is easy to accomplish compared to logical independence.

  b. Logical data independence – insulates the applications from the changes in the logical organization of data used.

  e.g. how the data are organized as data structures and how they relate to one another do not impact the application. This is desirable but hard to achieve.

Introduction to Information Systems (Cont.)

- **Why do we need Database Technology? (Cont.)**

4. **Data shareability**

   Several applications can share the same data without replicating the data.

5. **Relatability**

   Ability to define relationships between records at the logical level just as conveniently as defining records themselves.

6. **Integrity**
   Ability to maintain the consistency and correctness of data. i.e. propagation of updates, etc.

7. **Access Flexibility**

   This benefit is obvious and database provides access flexibility far beyond that of traditional programming languages.

8. **Security**

   Database systems provide mechanisms for controlling access to the database or certain portions of the database.

Introduction to Information Systems (Cont.)

- **Why do we need Database Technology? (Cont.)**

9. **Performance and Efficiency**

   Very fast and efficient for sorting and searching large volumes of data.

10. **Administration and Control**

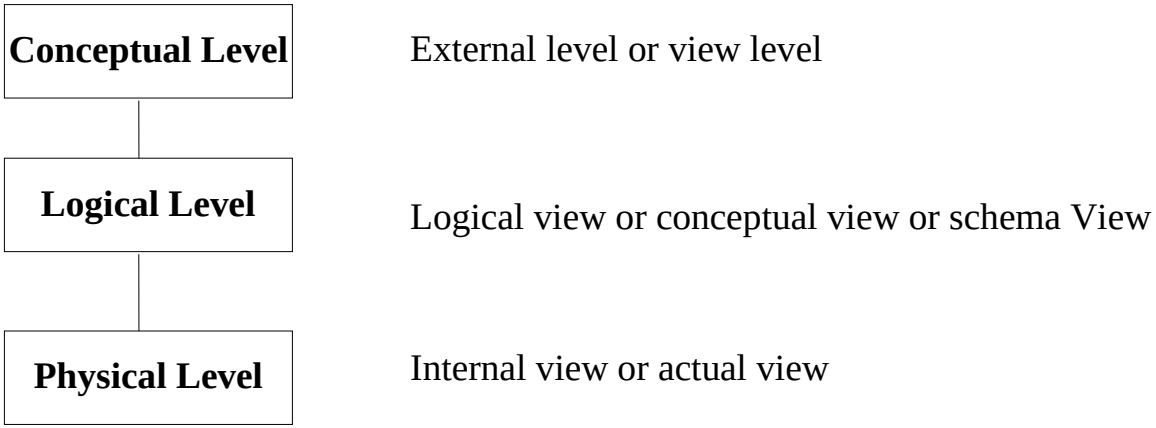
    Better management of data due to centralization.

- **Disadvantages of Database Systems**

1. **Expensive: hardware, software, maintenance**
2. **Complex: design, modeling, and programming are complex**
3. **Backup and recovery are complex**

Introduction to Information Systems (Cont.)

- **Architecture of Database Management Systems**



This is known as the 3-Schema architecture or the 3-Level architecture.

- **Physical Level**

This is the lowest level of abstraction.

Describes how data are actually stored and describes in terms of data and file structures.

Introduction to Information Systems (Cont.)

- **Logical Level**

  This level shows how the records are related, how data are defined, etc.

- **Conceptual Level**

  This level shows how the user/application looks at and interacts with the database system.

- **Interactions**

  Conceptual level – users and applications interact with the database system at this level.

  Logical level – modeler, i.e. database application designer interacts at this level.

  Physical level – database software designer interacts at this level of detail.

- **If you are an engineer or a modeler you may not have the opportunity to deal with the physical level. However, knowing about the physical level will help you to become better modelers and system developers.**

  A good analogy: To drive a car, you don't have to know a lot about the inner workings of a car. However, if you want to maintain the car well or work on the car, it is good to know something about the car more than just how to drive it.

Introduction to Information Systems (Cont.)

- **Need for engineering information systems**

1. Diversity and volume of data

The sheer volume and diversity of data itself is a major problem in the engineering environment.

Volume is easy to understand. But what is diversity? Diversity refers to the physical medium and structure of data.

There are a variety of ways in which data are used - from labor tickets to engineering drawings.

Mediums ranging from paper, CAD, to paper tapes, microfiche, optical disks, magnetic disks, etc.

Data can be represented as flowcharts, models, NC programs, drawings, specifications, manuals, etc.

Therefore, the voluminous and diverse data have to be maintained and controlled.

2. Multi-user, multi-organization environment

Engineering data are used by different people for different functions in different organizations.

For example, a manufacturing organization can have several divisions, such as marketing and sales, design, production control, etc.

A given piece of data may be used differently by different people in different divisions of a company.

Introduction to Information Systems (Cont.)

- **Need for engineering information systems (Cont.)**

  2. Multi-user, multi-organization environment (Cont.)

  For example, a part can be a raw material for some department, a part for another department, a subsystem for another department, and a system for another.

  This creates a lot of redundancy, confusion, and incompatible communication between departments.

  3. Multi-application environment

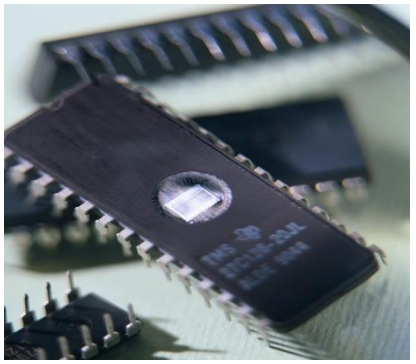
  Most engineering environments, especially manufacturing environments, require multi-applications to interact together to perform a task.

  4. Multiple data definitions

  A piece of data may have different data definitions at different stages

  what is called a raw material for one department, may be finished part for another department, assembly for another department.

  You may have different part numbers attached to the same part as it goes through a series of operations in manufacturing environment.



Introduction to Information Systems (Cont.)

- **Need for engineering information systems (Cont.)**

5. Multiple representations of data

Different users may want to work with different representations of data.

Data can be represented in a hierarchical level or in a network level.

You can look at data in binary, hex, microcode form, audio, or video formats.

Some departments may need 2-D data and some departments may need 3-D information.

6. Multiple versions of data

The engineering environment is typified by many versions and alternatives.

Products are made in different models, versions, options, releases, updates, and design changes. This results in multiple versions of data.

7. Multiple relationships between data

There are many types of relationships: between products and parts, between parts and data, between one part and another, and between parts and workflow

e.g. for a part, there may be a detailed drawing, tool specification, assembly specifications, torque calculations, etc.

Introduction to Information Systems (Cont.)

- **Need for engineering information systems (Cont.)**

  8. Meaning of data

  When data are created, their meaning is also implicitly attached to it. Unless the meaning is passed onto users and other application programs, the data are useless.

  A data dictionary is often created for documenting and conveying the meaning of data.

  9. Life cycle data

  All the information related to a product from its conception stage to product maintenance and support has to be maintained.

  This is necessary for maintaining and servicing a product and making design changes.

  10. Complexity in the environment

  Overlap of people, products, processes, and objectives create complexity in the environment.

- **The mentioned issues emphasize the need for information systems for creating, using, and managing information in any engineering/business environment.**

Introduction to Information Systems (Cont.)

- **Benefits of Information Systems**

  1. **Operational efficiency – doing routine tasks through information systems is better, cheaper, and faster.**

     e.g. large volume of transactions processed by banks, universities, IRS, etc.

  2. **Functional effectiveness – improve the functions of an organization. e.g. by generating reports.**

  3. **Recognizing and taking advantage of opportunities – by having the information available, you can provide better service by identifying problems or opportunities that were not anticipated.**

     e.g. Airline flight reservation System

  4. **Product creation and enhancement – using information you can tailor a product or service.**

     e.g. in banking, financial service, etc.

  5. **Altering the basis of competition – by creating new products through information technology, some businesses change the basis of competition. e.g. internet-based marketing**

  6. **Client lock-in – by providing information to clients they can be locked-in.**

     e.g. banks allow their customers to view their accounts online and banks lock-in with their services.

  7. **Leveraging your investment in information technology – identify other opportunities using the already invested technology. e.g. big corporations starting their own credit card companies to leverage the information they already have**

Introduction to Information Systems (Cont.)

- **Summary – So far we looked at:**

  System, data, and information definitions

  Components of an information systems (Methods, Information, People, and Technology)

  Scope of information systems

  Advantages and disadvantages of database technology including physical and logical independence

  Three schema architecture (Physical, Logical and Conceptual)

  Need for engineering information systems

  Benefits of engineering information systems

- **Remember the following as we go through the rest of the modules**

  Three schema architecture of a database system

  Components of an information system as we design, develop and implement a database system