I. Introduction

Importance of Information Technology (IT)

Information Systems and Organizations

What is an Information System?

What is Information System Analysis?

What is Information System Design?

Roles and Tasks for the Information Systems Analyst

Notations, Methodologies and Tools

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Information Everywhere!

...As of 5 years ago...

- North American business generates over 1 billion documents per day.
- Managing these documents can cost up to 10% of a company’s revenues and take up to 60% of its time.
- Knowledge workers spend 15-40% seeking and gathering information.
- 3% of all documents are misplaced; it costs, on average, over $200 to recover a misplaced document.
- The average business document is copied 19 times during its lifetime.
- Today’s executives spend, on average, about 4 weeks per year waiting for documents to be located.
- Only 10% of corporate information was in computers (i.e., in databases, files, word processors,...)

All these statistics are changing rapidly, thanks to the Information Revolution!

The Information Revolution is Here!

- Spearheaded by advances in communications, hardware and software.
- Its impact is felt by organizations -- because it affects their way of doing business -- and individuals -- because it affects in profound ways everyday life.
- Over the next 20 years, we will move from a situation where most of the information we use was on paper or in people’s heads, to one where most information is computerized.
- Moreover, there will be 1-2 orders of magnitude more information than we have available now.

Coping with the Information Revolution

...there is a very widely shared view that intelligent use of information technology will be the key differentiator for the US (both DoD and corporate) in the future...

...a technologist...

- Organizations are increasing their budgets for information services, i.e., information systems and information specialists.
- Much emphasis on technology; the size of the Information Technology (IT) market is ~$700/yr in the US alone.
- Worldwide spending on IT is ~$2.1TUS.
- IT accounts for 6.6% of GDP worldwide; it’s 9% in the US.
- Systems analyst jobs grew by ~30% between 1985 and 2000; during the same period, overall job market grew by ~15%.

The Good News

- Many jobs available under labels such as systems analyst, database administrator, applications programmer, information officer...
- List of employers offering such jobs includes management consulting companies -- who sell consulting, development and maintenance services -- and large organizations such as banks, utilities, telephone companies, government departments,... who run and depend on information services.
- Most IT jobs are with small companies -- the majority of the ~10,000 Canadian software companies are in application development or other information system-related areas.
The Bad News

- 30% of large IT projects are cancelled before completion
- 50% of IT projects are overbudget by more than 200%
- The majority of completed projects deliver 60% or less of prescribed functionality
- Many delivered information systems are under-used because they don’t meet user needs and/or expectations
- Legacy systems are a serious and growing bottleneck to organizational evolution etc.

Information Technology is failing us!

Information in Organizations

- Organizations produce and access ever-growing amounts of information.
- For example, a telecommunications company maintains information on each customer (address, installation data, equipment rented), each account (billing, balance, past history), each call (type, who called, when, for how long,...), each piece of equipment (including telephone lines), each reported problem (type, who handled it,...)
- A power utility maintains information on its generating plants (schematic, equipment, failures, personnel,...), power generation (what was produced when), distribution (who consumed what, when,...), customers,...

Large organizations spend hundreds of millions of dollars handling this information
More often than not, this handling is inadequate and/or unsatisfactory to the organization!

Organizational Systems and Organizations

Organizational Information Systems consist of an (usually large) information base which includes one or more information sources, along with a collection of processes, which are carried out by humans and/or machines) for accessing, updating and processing information.

Example: A student record system -- Information base: student records; Processes: creating, archiving a student record, updating a student record, fetching a student record, recording new registration, course enrolments, course marks,...

Computerized Information Systems

(Computerized) Information Systems consist of one or several databases or files storing an information base, one or more applications programs for computer-based access and update of the information base, and one or more user interfaces for different user groups;

We focus in this course on computerized information systems built to improve an organizational information system

What is an Information System?
The Traditional View

Information System = Information Base(s) + Applications + Interfaces

- Information bases developed through File, Database or Web technology, using DBMSs, file, database and website design methodologies and tools.
- Applications developed in terms of programming languages, fourth generation languages (4GLs), using programming methodologies such as structured or object-oriented programming, and corresponding tools.
- Interfaces for end users and other systems developed in terms of generic programming tools (such as compilers), or, more recently, in terms of other sets of specialized tools (HCI tools and data servers)
Enhancements and new requirements are constantly requested, faster than they can be understood or accommodated. There is no understanding about the negative impact of massive change (e.g., 60% of System X's functions were not anticipated during its design and construction). There is no complete specification or documentation. Documentation of the old system is inadequate since changes are requested so quickly and so often that the requirements, specification, and documentation cannot (were/are not) kept up to date. The system itself is the only complete description.

System X: Challenges

- Enhanced interoperability and integration with existing and new systems.
- A software system that supports Data Processing (DP) i.e., can store, manage and process large amounts of information for routine business transactions, e.g., a bank customer account system.
- An information system may also support one or more of the following functions:
  - Information Management (MISs) -- provide periodic reports for planning, control and decision making, e.g., generate end-of-the-month reports showing new accounts, transaction volume etc.
  - Decision Support (DSSs) -- provide information on demand, e.g., an on-line system that combines a spreadsheet with a database to help executives draw up a new budget.
  - Expert Systems (ESs) -- capture expertise of decision makers in interpreting information or solving problems and serve as assistants to the users of an information system e.g., a system that offers advise to a loan manager.

System X: Potential Solutions

- Incrementally, create one or more new ISs to replace parts of old IS; Make changes transparent to users and systems that use or interconnect to old IS by some interface.
- Keep old IS fully operational, including the components that are replaced with new ISs since it is impossible to understand the complex interdependencies between the replaced components and the rest of the old IS.
- (Sometime later...) Have the new IS completely take over from the old IS. Stop all enhancements to old IS and direct them to new IS.
- Old IS
- New IS
- User
The specification of the information system to be built. This specification
- People who knew the existing organizational information
  system retired or took employment elsewhere.
- The external environment for the organization was constantly
  changing, affecting different parts of the organization. Suddenly, the organization’s information system
  was no longer integrated.
- The external environment changed sufficiently that the
  techniques used for managing and processing information
  were no longer efficient
- Suddenly, there was no one person who knew exactly what
  the information processing in the organization were all about

The collection of notations, methodologies and tools used to gather
- Users interfaces
- Configuration of each module, i.e., what does each module do, i.e.,
  how the transformations it performs on its inputs.
- The database(s) that will be part of the information system, stored in
  database management systems (DBMSs) or in files.
- User interfaces that need to be in place to facilitate use of the
  system by different user groups

The result of an information system analysis is a
- Requirements definition
- Documentation as to what the processes were, was complete out
  of date or non-existent
- The information was available but it was in the heads of many
  employees
- The organization needed to respond to the external environment
  or its customers, or the analysis because the environment had
  changed, e.g., their competitors put in a new computerized system
  that served customers faster or better

Enter Princess System Analysis!

What is System Design?
The specification of the information system to be built. This specification
- Hardware configuration on which the system will run, including
  network interfaces.
- The software platform on which the system will run, i.e., operating
  system, DBMS, programming language, etc...
- The software architecture of the proposed system, including
  interfaces between the system modules.
- The function of each module, i.e., what does each module do, i.e.,
  how it performs on its inputs.
- The database(s) that will be part of the information system, stored in
  database management systems (DBMSs) or in files.
- User interfaces that need to be in place to facilitate use of the
  system by different user groups.
The Task of Information Systems Analysis: Define a Problem and Find a Solution

To figure out what an organizational information system is like, so that:
- The system can be made more efficient
- The system can take advantage of the speed, processing capacity and memory of computers to carry out or support its information processes
- The system can take advantage of electronic communication to improve communication between various divisions of the organization
- The system can provide new services
- The system can integrate several operations

The Tasks of the Systems Analyst

- Recommends software, hardware and communication equipment purchases for the organization to support its information processing systems
- Builds a graphical representation of any existing information system
- Requirements Analysis
- Uses the representation of the existing system to define requirements for a new system
- Based on the requirements document, designs a new system
- Systems Design
- Specifies the format of the data files, of the data entry screens and of the reports generated by the information systems
- Specifies the human processing procedures for the new information system
- Specifies the programs to be developed or purchased for the new information system and the security and control procedures that need to be in place
- Monitors the development and installation of the new information system and the effectiveness of the new system

The Pitfalls of Systems Analysis: A Tale

Once upon a time, in a kingdom not far from here, a king summoned two of his advisors for a test. The king placed a fully stocked metal box with two slots in the top, a control knob, and a lever. “What do you think this is?” he asked. The first advisor, an engineer, answered first. “It is a toaster,” he said. The king asked, “How would you design an embedded computer for it?” The engineer replied, “Using a four-bit microcontroller. I would write a simple program that reads the darkness knob and quantities its position to one of 16 shades of darkness, from zero white to coal black. The program would use the darkness level as the index to a 16-element table of either timer outputs or analog outputs, according to darkness level. I would use this value to turn on the heat and/or pop the toast. Come back next week, and I’ll show you a working prototype.”

The second advisor, a computer scientist, immediately recognized the danger of such shortsighted thinking. He said, “Toasters don’t just turn bread into toast; they are also used to warm frozen waffles. What you see before you is really a breakfast food cooker. As the subjects of your kingdom become more sophisticated, they will demand more capabilities. They will need a breakfast food cooker that can also cook sausage, fry bacon, and make scrambled eggs. A toaster that only makes toast will soon be obsolete. If we don’t look to the future, we will have to completely redesign the toaster in just a few years.”

With this in mind, we can formulate a more intelligent solution to the problem. First, create a class of breakfast foods. Specialize this class into subclasses: grains, pork, and poultry. The specialization process should be repeated with grains divided into toast, muffins, pancakes, and waffles; pork divided into sausage, links, and bacon; and poultry divided into scrambled eggs, hard-boiled eggs, poached eggs, fried eggs, and various omelet classes.

The Background of the Systems Analyst

- Social Perspective
- Professional Perspective
- Technological Perspective

...The ham and cheese omelet class is worth special attention because it must inherit characteristics from the pork, dairy, and poultry classes. Thus, we see that the problem cannot be properly solved without multiple inheritances. At run time, the program must create the proper object and send a message to the object that says, “Cook yourself.” The semantics of this message depend, of course, on the kind of subject, the personality of the message, and the vocabulary of the message. As the user becomes more sophisticated, he will demand the ability to create and send more complicated messages. The only way to meet this demand is to support multiple inheritances.

The system can integrate several operations
- The system can provide new services
- The system can improve communication between various divisions of the organization
The Three Perspectives

- Technological perspective -- IT tools, such as hardware, computer networks, databases, compilers, CASE tools...and methods for using them.
- Social perspective -- applied sociology, anthropology, psychology etc., looking at issues such as: how do individuals and organizations use information, how are they affected by increased availability of information...
- Professional perspective -- professional practices and standards in performing information service-related tasks, such as communication protocol standards, software standards, government policies on privacy, security, accuracy etc. of information, professional standards on information acquisition, cataloguing, selection,...

Technologies for System Analysis

- Personal computers (PCs), Workstations, Mainframes;
- Hardware components: CPUs, memory, disk Peripherals, Monitors
- Palmtops, Word processing, Spreadsheets, Presentation software
- E-mail, fax Wireless communication telephone network, internet
- Telephone switches, Web search engines, e-mail, fax
- COTS, DBMSs, Compilers, OS Platforms

Trends

- Hardware, connectivity, portability increasingly taken for granted.
- Less emphasis on implementation, more emphasis on design and analysis, for work processes and information services, not just information systems!
- Greater demand for “people skills” as opposed to “technological skills”
- More packaged applications (Enterprise Resource Planning, or ERP, systems) sold by companies like SAP, PeopleSoft and Oracle.

Information Systems and Information Technologies Strategies

Problems

1. Collect newspaper ads for systems analysis jobs. Compare these to the textbook’s description of required skills and job description. Synthesize your own ad and explain its features.
2. Visit your local library and make a list of magazines or newspapers on PCs, data communications, data applications and management issues. Choose one magazine/newspaper in each category and describe the kinds of topics it covers.

Notations, Methodologies and Tools for Information System Development

Systematic information system development is based on notations, a methodologies and associated tools

- Notation -- used to describe the information captured during different phases; notations range from natural language, to diagrammatic notations (such as entity-relationship or data flow diagrams), or formal languages, such as programming languages.
- Methodology -- this determines the process whereby the software developer creates, refines, analyzes and validates a software system; methodologies are often project- or situation-specific
- Tools -- introduced to support the creation, refinement, analysis and validation of software (such as CASE tools).

Generally, software engineering practice does poorly with respect to all of the above!