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CHERNIHIV NATIONAL UNIVERSITY OF TECHNOLOGY

INFORMATION SYSTEMS AND TECHNOLOGY IN THE MANAGEMENT OF ORGANIZATION

METHODICAL GUIDELINES
to practical classes and independent work
for training Masters
specialty 8 03060101 management of organizations and administration

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Preface

Information systems and technology in the management of the organization provides information that organizations require to manage themselves efficiently and effectively. Those information systems are typically computer systems used for managing five primary components: hardware, software, data (information for decision making), procedures (design, development and documentation), and people (individuals, groups, or organizations). Information systems and technology in the management of the organization are distinct from other information systems, in that they are used to analyze and facilitate strategic and operational activities.

Information systems and technology provide a variety of information products to managers. Periodic Scheduled Reports are a traditional form of providing information to managers via a specified format designed to provide managers with information on a regular basis. Exception Reports are produced only when exceptional conditions occur. Exception reporting reduces information overload instead of overwhelming decision makers with periodic detailed reports of business activity. Demand Reports and Responses are available when the managers require immediate access to vital information. Web browsers, DBMS query languages, and report generators enable managers to get this information and not force them to wait for periodic detailed reports of business activity.

In business people and organizations seek and use information mainly to make sound decisions and to solve problems—two closely related practices that form the foundation of every successful company. Information systems are integrated into our daily business activities as accounting, finance, operations management, marketing, human resource management, or any other major business function. Information systems and technologies are vital components of successful businesses and organizations. They thus constitute an essential field of study in business administration and management, which is why most business majors include a course in information systems.

Information technologies, including Internet-based information systems, are playing vital and expanding roles in business. Information technology can help all kinds of businesses improve the efficiency and effectiveness of their business processes, managerial decision making, and workgroup collaboration, which strengthens their competitive positions in rapidly changing marketplaces. This benefit occurs irrespective of whether the information technology is used to support product development teams, customer support processes, e-commerce transactions, or any other business activity.

Information technologies and systems are an essential ingredient for business success in today’s dynamic global environment.

The purpose of teaching the discipline “Information systems and technologies in the management of the organization" is the study of the theoretical foundations and obtaining practical skills for the creation, functioning and development of information systems and technology management in modern conditions of their functioning.

The practical sessions cover theoretical principles according to thematic lesson plan, detailed examples and practical problems. Each practice session contains the necessary theoretical information, the order of execution of work and the sample solution that facilitates the perception of the new material, contributes to a better assimilation of the theoretical material that is of interest to students more in-depth study of the course. Developed options allow you to efficiently organize knowledge tests, to effectively understand and objectively evaluate theoretical and practical training of students in the discipline.

1 Topic 1
Introduction to information systems

Learning aim: provide a real-world understanding of information systems for management of organizations

1.1 What is an Information System?

Most of us experience the effect of different systems every day - getting to work or school using a transport *system*, for example, or making a call using the telephone *system.*

Computerized systems have transformed the world in countless ways, not least in increased connectivity between people, as provided by the Internet and the World Wide Web, for example.

To many people, *information systems* means *computers* -- and computers are indeed part of the world of most information systems professionals. But there is more to the story than simple technology.

Information

Information is the universal commodity, available to all -- but information adds value only when it meets a real need and when it is acquired, organized and disseminated in a systematic fashion.

Consider the following figure 1.1:

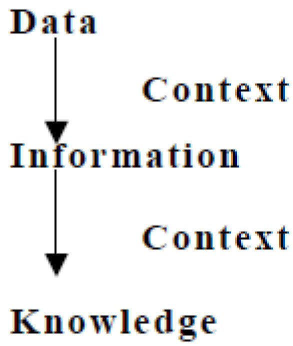

Figure 1.1

This suggests that there is a process by which Information and then Knowledge is produced, somewhat analogous to a manufacturing process whereby a raw material, in this case ‘Data’, is refined and worked on to produce an end-product. But what are the components, which convert data into information?

Data and information are an important part of a computer system. A computer exists to convert data into information.

Data are unprocessed, raw facts, figures, statistics, concepts or instructions. To be useful, they must be converted into information.

Information is processed data. Data have been analyzed, organized and summarized to create useful information. Information is data that has been processed so that an action or decision can be made from it. A computer exists to create this useful information by converting data into information through a process called data processing.

Data processing is the process of manipulation, organization and analysis that is used to convert data into information.

Data and information in a computer system are organized using a directory structure and stored in files on the storage medium in use.

Data becomes information when it is used for a purpose, which is of value to the individual or organization. That purpose may be to assist the effective management of the organization or it may have a wider purpose, for example, to produce information which can be 'sold' either as a product or a service. This is an important way of generating profits and, indeed, information related services account for a higher, percentage of Gross Domestic Product in the U.K. than the manufacturing sector.

In the same way that one manufacturer's product is more attractive to a customer because it has features which suit their specific requirements, so too, information will have characteristics which add value, depending upon the purpose for which it is required. Some of these are listed below:

Quantity The amount of information provided should be adequate for the purpose - not so much that the key information is lost, or so little that it does not present a complete picture.

Suitability It should be appropriate to the skills and competencies of the manager who will use it and in a form which makes it 'user friendly'.

Scope The breadth of information supplied will be in accord with the purpose for which it is to be used, for example, a population forecast will use census statistics over several decades.

Relevance The subject matter which the information covers is the same as that which the manager is addressing.

Accuracy As accurate as possible but, in some circumstances, not at the expense of timeliness - sometimes it's better to be 90% accurate than 100% out of date.

Timeliness It should be available when required.

Compatibility The information is based upon standards which also apply to other information systems, for example, the accounting year as opposed to the calendar year.

Presentation The information is presented in an appropriate style, for example, high quality printing and graphics in the case of an Annual Report.

Managing information is primarily a question of assessing the context and purpose for which it is to be used; and then deciding the relative importance of each of the above. For example, annual financial reports need to be both accurate and presented in a form that makes them intelligible to non-financial personnel. In the case of internal budgetary statements, presentation may be less important but timeliness increasingly critical if potential overspends are to be dealt with quickly and effectively.

Information Systems

Information systems collect, process, store, and distribute information so that it can be used by people. The information may be about people, places, things, or events inside an organization or in the environment that surrounds it. People use the information to make decisions, to keep track of resources, and to plan for the future. Information has attributes of accuracy, credibility, and timeliness - old news is not news!

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 addition to supporting decision making, coordination, and control, information systems may also help managers and workers analyze problems, visualize complex subjects, and create new products.

Information systems contain information about significant people, places, and things with the organization or in the environment surrounding it. By information we mean data that have been shaped into a form that is meaningful and useful to human beings. Data, in contrast, are streams of raw facts representing events occurring in organizations or the physical environment before they have been organized and arranged into a form that people can understand and use.

Three activities in an information system produce the information organizations need for making decisions, controlling operations, analyzing problems, and creating new products or services. These activities are input, processing, and output. Input captures or collects raw data from within the organization or from its external environment. Processing converts this raw input into a more meaningful form. Output transfers the processed information to the people or an activity where it will be used. Information systems also require feedback, which is output that is returned to appropriate members of the organization to help them evaluate or correct the input stage.

Formal information systems can be either computer-based or manual. Manual systems use paper and pencil technology. These manual systems serve important needs. Computer-based information systems (CBIS), in contrast, rely on computer hardware and software technology to process and disseminate information. From this point on, when we use the term information systems we will be referring to computer-based information systems -- formal organizational systems that rely on computer technology.

Although computer-based information systems use computer technology to process raw data into meaningful information, there is a sharp distinction between a computer and computer program on the one hand, and an information system on the other. Electronic computers and related software programs are the technical foundation, the tools and materials, of modern information systems. Computers provide the equipment for storing and processing information. Computer programs, or software, are sets of operating instructions that direct and control computer processing. Knowing how computers and computer programs work is important in designing solutions to organizational problems, but computers are only part of an information system.

Housing provides an appropriate analogy. Houses are built with hammers, nails, and wood, but these do not make a house. The architecture, design, setting, landscaping, and all of the decisions that lead to the creation of these features are part of the house and are crucial for finding a solution to the problem of putting a roof over one's head. Computers and programs are the hammer, nails, and lumber of CBIS, but alone they cannot produce the information a particular organization needs. To understand information systems, one must understand the problems they are designed to solve their architectural and design elements, and the organizational processes that lead to these solutions. Today's managers must combine computer literacy with information systems literacy.

1.2 Computer Information System

The ***Computer Information System*** *is* an ensemble of hardware and software applications. The ***Information system*** is an analysis of a problem domain. It is "information oriented". For example, a banking compensation system or telecommunication protocols are "information systems" in our sense. Their definition does not imply the use of specific software or hardware packages.

Today the computer information system is called by a growing number "Information system" - maybe they find that it sounds smarter! *So that company hires Oracle specialists for their "information system"!*

Whatever the name, the flavor is the same. Please note that in our definition information systems are not platform specific (hardware, software, language etc.). They might be called also *domain systems, abstract systems, general systems etc*. The interesting fact is that these systems may be seen also as "knowledge objects", one of the two views related to knowledge management. This view enables the way to "conceptual objects reuse".

The Computer Information System is derived from the Information System by taking into account the platform specifics.

1.3 Why does information have to be managed?

- *There is so much more of it these days!*

The sheer volume of information available through advances in computing and communications means that managers have to be clearly focused on what information is important to them and what is not. Recent articles in newspapers have commented on the problems associated with too much information and new medical conditions such as 'information fatigue' and 'information overload' have started to enter our vocabulary.

The latest lap-top computers can hold and process vast amounts of data but the capacity of our 'neck-top' computer has not altered over the last few hundred years!

♦ *It is a valuable asset in most organizations*

Information-based organizations now generate more wealth than manufacturing industries in the U.K. In some organizations the only product they sell is information - and that is often purchased by other organizations which add further value to the information before selling it on. It is essential; therefore, that such a valuable product is managed efficiently.

♦ *It can provide a competitive advantage in the market place*

Information facilitates chance

Exposure to new ideas and concepts from outside the business can stimulate managers to adopt and adapt these concepts in their own business environment. There is a danger for managers, who stay in one job with one company for a long time, that they become insular in their approach and resistant to change. The working environment requires a workforce that is multi-skilled and able to adapt and keep up to date with change. There is much that organizations themselves can do to ensure that their employees have access to new information and learning opportunities. It is also the case that employees will have to take greater charge of their own personal development in the new organization structures being created in the Information Age.

♦ *Information enables managers to manage effectively*

If managers do not have the right information about how the business is performing then they are unlikely to be able to make the right decisions (or are more likely to, make the wrong ones).

Managers need:

- Essential decision making information in a usable form
- Information when they want it (at a time that suits their workflow)
- Real-time information (so decisions are timely and relate directly to what is happening)
- To see trends developing (such as cost or time blowouts, teams not performing)
- Information to manage cross functional teams doing many projects and tasks
- To be notified of any changes those are likely to affect them.

1.4 Roles people play in an information environment

Applications support organizational goals and such goals are held by those for whom the success of the firm is critical; for this discussion, they are called *stakeholders.* This group includes boards of directors, shareholders, unions, communities, and suppliers. The goals represent desirable conclusions for *clients.* Clients may be inside or outside the organization. The classes of individuals that have direct interaction with the application are called *direct users.* Assisting these role players are *developers*, who may work for an organization, a client or a user, and they may be direct employees or contracted specialists.

Control questions

Question 1
What is a computerized Information System?

Question 2
What are the main reasons behind information management?

Question 3
What are the main characteristics of information?

Question 4
Explain in detail what an information system is. Give examples.

Question 5
Define CBIS. Explain why information has to be managed.

a) Information is a valuable asset in most organizations. So managers have to be clearly focused on what information is important to them and what in not. Explain with proper example.

b) What are the steps to be taken by managers to kept proper way valuable information for in most organizations?

c) Information is one of the most important in very sector, either commercial or noncommercial. Explain how and which ways it will be provide to keep proper information.

Question 6
Support for Strategic Planning Support for Management Control Support for Operational Control Improved Product Quality Improved Product Delivery. What is the main purpose of computer-based information systems?

2 Topic 2

Fundamental types of information system

Learning aim: describe and identify functions of different types of information systems in management of organization

2.1 Transaction Processing Systems (TPS)

Introduction

A transaction Processing System is an exceptionally powerful and flexible transaction processing environment for both mobile and fixed-base data collection equipment. It provides the sophisticated connectivity needed in today's complex industrial, warehousing, distribution, and other environments.

Transaction Processing System has numerous features important in creating systems and solutions for demanding transaction processing requirements. With Transaction Processing System, you can:

- Develop high-performance data collection and bar code printing systems across client/server networks.
- Revitalize legacy software and hardware in a state-of-the-art transaction processing and bar code environment Interface with different types of host and network computers at the same time.
- Access multiple local and remote distributed databases, concurrently and simultaneously.
- Select and use terminals and printers from multiple leading manufacturers, all in one system.
- Combine 5250 and 3270 intelligent terminal emulation with data collection functionality using a GUI development environment that involves no host code rewrites.
- Run the same transactions on your radio-frequency devices that you run on fixed devices and PCs, including intelligent emulation.
- Select from a variety of automatic, dynamic servers and data backup schemes, which are available to ensure minimum downtime and maximum productivity.

Transaction Processing System's modular architecture (refer to figure 2.1) allows you to choose the functionality that you need - you can always add on additional functionality as your requirements expand.

Transaction processing systems (TPS) support the organization's daily activities and maintain the majority of the organization's *internal data.* These systems usually employ simple but highly repetitive processes but require the capability to deal with high volumes of *transactions* with great accuracy and high security. In the past, transactions were completed using *batch processing,* but today most transactions are completed immediately using *on-line transaction processing (OLTP)* systems.

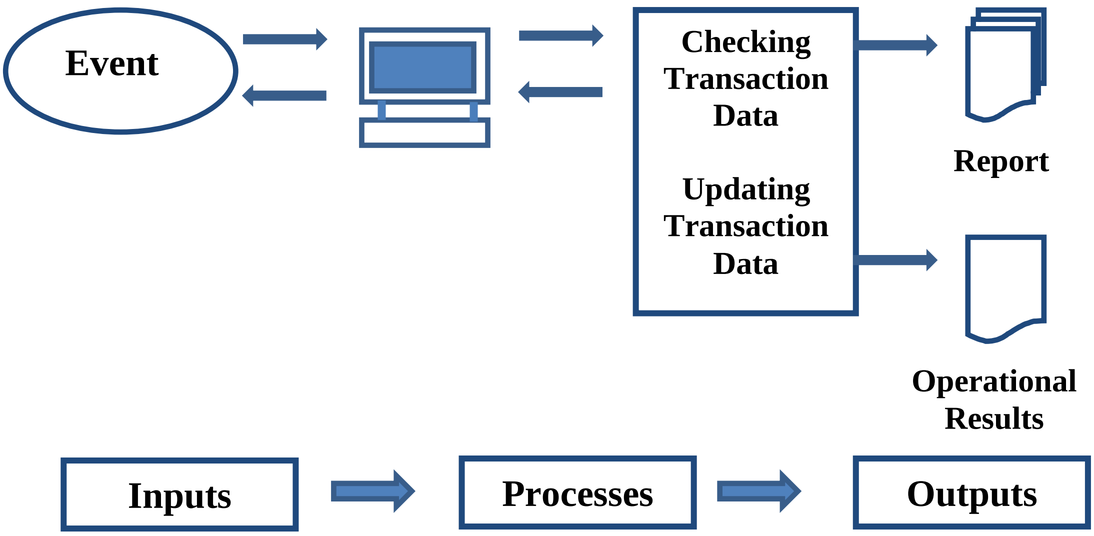

Figure 2.1 Transaction Processing Systems Architecture

To implement on-line transaction processing, *master files* containing key information about important business entities are placed on hard disk drives where they are directly accessible. The *transaction files* containing information about activity concerning these business entities, such as orders placed by customers, are also held in on-line files until they are no longer needed for everyday transaction processing activity.. This assures that the transaction data is available to all applications, and that all data is kept up-to-the-minute.

Users with the proper *database permissions* may *download* data from the database to another location and *upload* changes to these on-line files as soon as changes are required. When the transaction files are no longer being "actively" used, they are not deleted. Instead they are archived in a special data storage facility called a data warehouse.

A Transaction Processing System (TPS) is designed for Operating Management. It is also called Electronic Data Processing (EDP). It has a limited area of functionality, and is designed for one area of the business.

It uses only data that *is internal* to the company. There are some possible exceptions, however. Inter -branch banking uses TPS as well as direct deposit of employee's pay from various companies and government institutions.

Reports and other outputs from Transaction Processing Systems

The outputs of TPS provide operational details, summary reports, and exception reports, which help supervise and control routine operations. *Exception reporting* provides a feedback loop to the operational manager about any unusual or unexpected activity that may require attention. Transaction processing systems may be divided into major functional areas. Accounting provides systems to handle general ledger, payroll, and accounts. Marketing has TP systems to handle sales, promotion and advertising activity. Manufacturing requires transaction processing systems and operational feedback from production processes. Manufacturing reporting systems must often be designed as *real-time systems* to allow operational managers and supervisors to closely monitor on-going operations. Human resources need systems to support its daily operations in recruiting, maintaining employee records, providing benefits, and monitoring occupational conditions. Finance requires maintaining information on cash reserves and investment holdings, and the monitoring of changes to tax and fiscal regulations.

Many systems, such as order processing, may involve processes that cross functional boundaries in the enterprise. For example, an order may concern sales, manufacturing, distribution, and accounting. Transaction processing systems may depend upon each other in intricate ways that are not always apparent to the users of these systems.

When transaction data grows old, it can still be of value to the organization. However, it is not used frequently and takes up valuable disk space, so such data is often moved to other lower cost storage areas. In the past, *archived data* was difficult to access because the *data archives* were not well organized. Today, such archives are placed in *data warehouses,* which are data storage facilities that are managed by special database programs designed for that purpose. Analysts can then make use of *on-line analytical processing (OLAP)* tools to investigate either the current transaction data or the data that has been retired to the data warehouse facility. Using the company's data archives to determine trends and to extract other useful information is often referred to as *data mining.*

2.2 Management Information Systems (MIS)

MIS stands for Management Information Systems. MIS is a branch of Management that involves the development, maintenance and understanding of Computer Information Systems from a business perspective. It is difficult to say exactly what this field of management entails because, like the computers and technology the field involves a rapidly changing and expanding area. Much like accounting, marketing and financing, the Management of Information Systems has become a crucial function in the operation of modern day business. Now and in the foreseeable future, the success of a company will increasingly depend on the quality of its Information Systems and technologies. MIS is a unique field in that it is able to combine the uses of technology while at the same time having an appreciation for the business environment as a whole.

A widely recognized device for organizing types of management information systems uses the *MIS Framework.* This framework is based upon two dimensions, the level of managerial responsibility and the degree of problem structure. *Structured problem* solving is handled by a variety of reporting levels. Detailed operational reports are produced by *transaction processing systems (TPS).* These in turn provide data to more highly summarized managerial reports used at higher levels. *Management information systems* produce standard "MIS" reports in printed and on-line "soft copy' versions to assist middle management in their tactical decision making roles involving the allocation of resources and the oversight of company operations. Executives at the top rung of the corporation may have executive information systems (EIS), also called *executive support systems (ESS)* to supply their special needs for structured reporting.

For less structured problems, and most often at higher management levels, decision support systems play a role in modeling from a wide variety of sources, both internal and external. Such problems are often called *unstructured problems* although that term can be misleading. The structuredness of a problem must be viewed as a continuum running from the fairly unstructured to the highly structured types of problems. No problem that can be analyzed by any technique can be considered as totally unstructured.

Management Information Systems is a career area which focuses on two related topics:

- Organizations - the business processes, and people as problem solvers and decision-makers.
- Technology - current information technology so vital for any organization.

The MIS field deals with all the information and problem solving activity of a modern, successful organization. The MIS discipline brings together the various business areas, computer science, and quantitative analysis techniques. This program provides the theory and methodology to analyze, design, implement, and manage an organization's information technology and systems.

Management Information Systems is a valuable new aspect of every business organization. Basically, MIS is looking at what types of computer systems organizations need and adapting the systems for their needs. The MIS field revolves around the fact that information and knowledge is one of the most valuable business assets. Without proper information channels, a business would lose its advantage over other companies.

In the past, many people were turned off by the idea of using a personal computer in the everyday workplace. Many more people are starting to get comfortable around computers. New programs are always emerging that combine powerful applications with ease of usage. For instance, Microsoft, easily the biggest computer software provider in the world, has numerous software programs that even a beginner can tackle without much commotion. MIS specialists must take and apply their knowledge of both computers and people to the common business. They need to design programs that appeal to and motivate employees. MIS specialists must learn an overview of the organizational, strategic, and technical issues surrounding the management of information in businesses today. By building a solid base at businesses everywhere, MIS specialists help prepare future managers to manage information as a resource and to identify opportunities for using information as a competitive advantage.

Management Information Systems are used in businesses to help make decisions. They are an implementation of computer based processing and/or manual procedures yielding useful and timely information for decision making.

A MIS is composed of procedures. In a MIS, procedures are sequences of steps to co-ordinate processing. Some are performed by staff and some by computer specialists. A business has many procedures; we refer to four of the common ones below:

- Payroll
- Personnel
- Accounting
- Inventory

A Management Information System MIS is designed to help Middle Management decisions.

It is an information reporting system, which receives data from all sections of the business. The system is connected to a more complex network than a Transaction Processing System.

A MIS uses *internal* data as well as some *external* data.

2.3 Decision Support Systems (DSS)

The group of tools and techniques, together with their definitions and descriptions of their interrelations, that assist in the specification and recording of an analyst's judgments about evidence, and inferences going into a hazard identification decision.

A DSS is a tool (e.g. computer program) or process (such as a best management practices procedure), whose utility is related to its ability to support decision-making in the real world situation and not to provide the solution itself by representing a system involving those real-world variables (physical, economic and social) and their interrelationships, whose complexities can be simplified for inclusion in the tool or process, where these variables and interrelationships can be customized to comply with individual situations and, where these variables and inter-relationships can be customized and/or interfaced with individual decision-makers, more particularly with their objectives, resources and constraints.

Decision Support Systems can be differentiated from other types of information system in that they are directed towards use by users who are skilled in their subject area and who are supported rather than placed by the use of the computer. Decision support system users have a good knowledge of the problems area of the system and therefore need to be able to interact effectively with a flexible system which provides the type of support required.

Decision Support Systems is a dynamic and rapidly changing field which touches on a wide range of computing topics. Decision Support Systems have been defined as:

Computer Based Systems are systems that help decision makers confront ill structured problems through direct interaction with data and analysis models.

The emphasis is on problem solving tasks, which are semi-structured, ie. they combine human judgment with the use of computing tools and techniques. DSS do not replace managerial judgment but rather provide support for decision making - the final agent remains the human.

Computer applications for management support are increasing and the availability of microcomputers has dramatically increased the number of systems on manager's desks.

2.4 Office Automation Systems (OAS)

Office Automation involves the planned application of integrated information handling tools and methods to improve the productivity of people in office operations. Although the handling of information by office people is the focus of this new technology, other aspects of the office will be affected. These include factors such as the organization of functions and lines of reporting, training for new methods, work space design, travel patterns, branch office location, and home vs office work, hours of work, employee morale, and job classifications. Organizations that harness office automation products will need to deal with many more than just technological issues.

About 22% of the US work force is now in the office, with that percentage rising. Labor costs account for about 70% of the total office costs in our economy and salary costs are increasing about 6% each year. During the past 15 years there has been relatively little increase in productivity of the office work force, in contrast with the manufacturing sector where the average productivity has more than doubled. The cost of new technology aimed at increasing the productivity of office workers is going down, while the capabilities of office automation systems have been rapidly increasing.

Office automation will impact industry and government organizations in very significant ways with both COST DISPLACEMENT and VALUE-ADDED results.

These two terms are now being used by people who are considering the potential payoffs of office automation to their organizations.

Cost displacement applications have the objective of achieving overall reductions in support staff costs or of increasing work volumes without adding support staff. Such applications typically center on WORD PROCESSING and provide the base for the more advanced value-added applications.

Value-added applications are viewed as being directed toward improving managerial and professional staff productivity (and effectiveness) through use of more integrated office automation systems that can directly affect their work.

The value-added approach deals with far more fundamental issues than the replacement of some support staff positions with word processing pools. Its focus upon individuals and groups of managers and professionals as targets for productivity improvement brings with it opportunities for significant increases in organizational effectiveness and major cost benefits in the largest segment of the office cost spectrum.

For any organization, management choices at many levels will affect the balance between reducing total office costs (cost displacement) and increasing the total office effectiveness (value-added effects).

Word processing applications have, until recently, been equated with the term office automation. It is interesting to note that, on the average, typing tasks comprise only 30% of the secretaries' and typists' work -- and thus account for only about 2% of the total office salaries. The next few years will see a very rapid growth in the introduction of advanced technology into offices and in applications with more impact on managers and other non-clerical people, bringing with it broadened perceptions of what office automation really includes.

Office Automation is likely to become one of the fastest-growing and most significant new industries of the century. It will apply electronic technology to a broad new set of applications and bring significant change to many of the ways in which people and organizations work -AUGMENTING their capabilities and increasing both the quantity and quality of their contributions.

2.5 Executive Support Systems (ESS)

An enterprise management information system encompasses the information flows in an entire organization. The applications for MIS fall into five categories; localized applications, interdepartmental applications, business process redesign, business network redesign, and business scope redefinition.

Interdepartmental information systems integrate the activities of different departments into a single business system that produces appropriate coordinated responses to the enterprise's environment. Both localized and interdepartmental systems involve little redesign of the underlying business processes; they support the existing processes.

Business process redesign requires the nature of business processes to be redesigned as the information system development progresses; it becomes a vehicle for change and improvement.

Business network redesign concerns itself with how multiple enterprises work together; consideration is given as to how information is structured and handled as it crosses organizational boundaries.

Business scope redefinition consists of applications that change the nature of the business. Interdepartmental information systems use a shared or corporate database facility. Procedures and practices are consistent and coordinated by the nature of the database structure. Departments are provided with different views of the information but the underlying data is consistent. Data captured in one department may be the source of information for the activities of another department. Because such systems are standardized, changes to data and the information produced have to be carefully controlled. There is a need for enterprise systems management.

Interdepartmental management information systems differ from workgroup systems in several ways. Workgroups will know each other whereas users of an interdepartmental system are distant and the only common factor may be the use of an information source, they are separated both physically and organizationally.

Workgroups may number in the tens of members; interdepartmental systems could supply the information needs of hundreds.

Data contained in interdepartmental systems tends to be more complex and heterogeneous in nature.

Whilst workgroup systems tend to be highly functional, indepartmental systems cross functional boundaries coordinating the information needs of several process related departments.

Business process design is emerging as a necessary step to optimize the use of information technology. Rather than automating existing processes, the underlying business processes are redesigned to take advantage of the new technologies.

Business process redesign can have dramatic impact for an enterprise; This is attributed to the change of culture, the redesign of work, the retraining or the loss of staff.

Business network redesign refers to the use of information systems to enable groups of enterprises to interact more productively. Four types of network redesign can be identified; *electronic data interchange* (EDI), in which organisations agree on a common set of data standards, *interenterprise system access* in which organizations use each other's systems, interenterprise system integration in which enterprises develop shared information systems and knowledge networks use information technology.

Business scope redefinition produces applications, which changes the nature of an enterprise's activities. New technologies can make it possible to enter new markets, enable new products or extend or enhance the capabilities of existing ones.

Control questions

Question 1

Write short notes on the following:

a) Transaction processing
b) Decision support system
c) Office automation system
d) Management Information
e) Systems Exception Reporting
f) Data Warehouses
g) On-line Analytical Processing

Question 2

Describe the five categories into which the applications of Management Information Systems fall.

Question 3

Describe the applications into which Management Information Systems fall.

Question 4

What is business network design? What are the four types of network redesign?

Question 5

What are the main uses of Transaction Processing Systems?

Question 6

Explain how on-line analytical processing tools assist in maintaining data archives?

Question 7

a) Discuss the features of Transaction Processing Systems, which are important in creating systems and solutions.

b) Explain the difference(s) in building Executive Support Systems and Traditional Management Information Systems?

3 Topic 3

Organizations and information system

Learning aim: study and analyze basic concepts, principles and applications of IS in the management of organization, the relationship between organizations and information systems.

It could be said that the role of the organization is to support creative individuals while providing an environment where they can create knowledge.

But why is it important for organizations to provide this supportive environment? Well, one only has to look at the changes that have taken place on a macro-economic scale, in the creation of wealth; the reduced contribution by the manufacturing-based industry sector and corresponding expansion of the service and information sectors. This shift was identified in the early 1960's, and the term "knowledge worker" was born. Since that time, knowledge has increasingly been viewed as a resource with knowledge workers playing a vital role in many organizations.

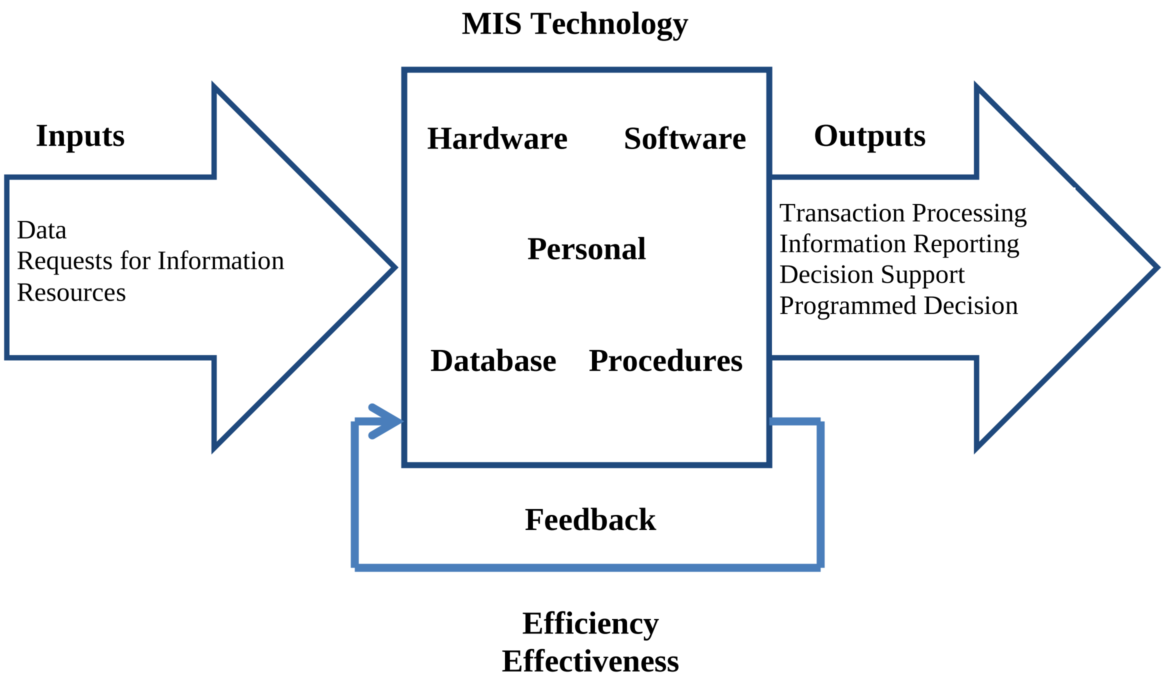

Figure 3.1 Effectiveness of Organizations

An organization is defined as a systematic arrangement of people to accomplish some specific purpose. Organizations share three common characteristics.

a. Has a distinct purpose.
b. Is composed of people.
c. Develops a systematic structure that defines and limits the behavior of organizational members.

All effective organizations are not necessarily efficient. Effectiveness is concerned with goal attainment, while efficiency is concerned with resource usage (refer to figure 3.1). An organization can achieve its goals, but do so by being wasteful and using an inordinate amount of input resources.

3.1 Workgroup Information Systems

A workgroup is a collection of people who work together to achieve a common goal.

In *homogeneous* workgroups, everyone in the workgroup fulfills the same role. As such workgroups grow so doe's productivity, in 'a" linear fashion. Providing information systems for these workgroups can be very cost effective since everyone carries out similar work.

In *heterogeneous* workgroups there are several roles and jobs covered by individuals within the group. For this reason productivity does not increase in a linear progression when additional people join the group. The increase in productivity is more related to the previous knowledge of the individuals joining the group. Training and communication becomes an important issue. Since there are many roles and jobs covered by a heterogeneous group the provision of information systems can be expensive and difficult to support.

Workgroup norms can play an information role in the acceptance or rejection of certain information systems. The influence of workgroup attitudes has a large part to play, peer pressure can persuade or deter acceptance, and fears can be allayed or reinforced.

Workgroups can be permanent or temporary. They can exist on single sites or be distributed throughout an organization.

Workgroup effectiveness can be measured by output, personal satisfaction of the members, and by the group capacity for further cooperation. Effectiveness is determined by group effort, knowledge and skill. The strategies and approaches used to perform work are important.

The major difference between personal and workgroup information systems is the need for workgroup systems to control the shared use of resources. This must be achieved without inconvenience to individual members of the group. Granularity refers to the size of the shared information resource. Large granularity means that group members share large information sources with the possibility of delays due to contention problems but with small information systems administration overheads. Conversely, small granularity produces few contentions but administration overheads rise accordingly.

The major categories of a workgroup information system are hardware sharing and data sharing facilities. Hardware sharing applications allow members of the workgroup to share many hardware devices, some of these devices may be uneconomical for a single user system.

Systems that focus on communications are applications such as group E-mail systems that provide a number of mailboxes that can be for individual mail or group and project mail. These systems can be passive or dynamic, the user or group has to access incoming mail in the static system, whereas, in the dynamic system the user is told that mail has arrived. Group E-mail systems are designed to enhance group coordination. Group conferencing including electronic bulletin boards, videoconferencing with white boarding, help to ensure coordination and often support group dynamics in problem-solving settings.

Collaborative writing systems let users share the writing of documents. These applications coordinate and control the users efforts. The tedious copying and altering of documents in a single user environment is avoided.

Analytical support for workgroups is typically provided by workgroup spreadsheets. These are often composed of spreadsheet templates, the coordination of these spreadsheets can be complex. To make this work effectively it is essential that good documentation and training is provided.

Group Decision Support Systems are applications which allow individual users to use group workboards in their own decision making process. Group decision making can be facilitated by a controller with the group using support applications.

Another important category in workgroup information systems is the *retrieval of information*, including group database management systems, workflow automation systems, group scheduling systems, group project management systems and shared textbase systems.

Group database management systems have similar functionality to personal database systems but are more complex and tend to concentrate on workgroup coordination.

Workflow automation applications provide automatic routing of forms used in routine work processing. They also track the progress of forms. Groups can often improve processes by looking at the output from workflow systems.

Trucking and monitoring is provided by similar systems provided for personal information systems but they are more complex. Project management has more complexity with the focus on group coordination.

Group textbase systems are similar to personal systems but shared documents are indexed for group or individual retrieval.

3.2 Personal Information Systems

Personal computer systems are used to help an individual facilitate their work. This facilitation can be considered as support for communication, analysis and tracking and monitoring.

Typical *communication support* is provided by word processors, which can be used to produce simple text documents or more sophisticated documents containing a wide range of colors, fonts and even graphics. The functionality of these programs can often provide templates, boilerplate and automated document production. They also feature mail merge and support scripting and macro languages to extend the customization of document production. Within the scope of communication support lays the desk-top publishing application and the presentation application. Both can produce professional quality output that can be shown on computer slideshows or be printed.

Analytical support is given by such applications as the electronic spreadsheet capable of modeling quite complicated business activities. Many such programs are supported by scripting and macro languages and can support graphics and database type functionality. These applications are often enhanced to provide connectivity to various internal and external data sources to enable data extraction. Other types of analytical programs are the operational research ones providing linear programming and other methods.

Tracking and monitoring support is given by database and project management applications. A database application includes a database; some means of data entry, reporting facilities and possibly applications programs. Users can interface with many databases using default, customized or programmed access. A common interface standard is SQL, structured query language. Project management applications keep track of a project's progress with regard to the allocation of resources and the management of tasks. A variety of techniques are used, typically, Gantt charts, critical path graphs and the like.

Integrated application provides an environment in which all applications can work statically or dynamically with each other.

Changes made to database application will dynamically update spreadsheet models. In the Microsoft Windows environment this is achieved using DDE, dynamic data exchange and OLE, object linking and embedding.

3.3 The System Development Process

System Development Life Cycle

From concept to production, you can develop a database by using the system development life cycle, which contains multiple stages of development. This top - down, systematic approach to database development transforms business information requirements into an operational database. (Refer to figure 3.2)

Strategy and Analysis

Study and analyze the business requirements. Interview users and managers to identify the information requirements. Incorporate the enterprise and application mission statements as well as any future system specifications.

Build models of the system. Transfer the business narrative into a graphical representation of business information needs and rules. Confirm and refine the model with the analysts and experts.

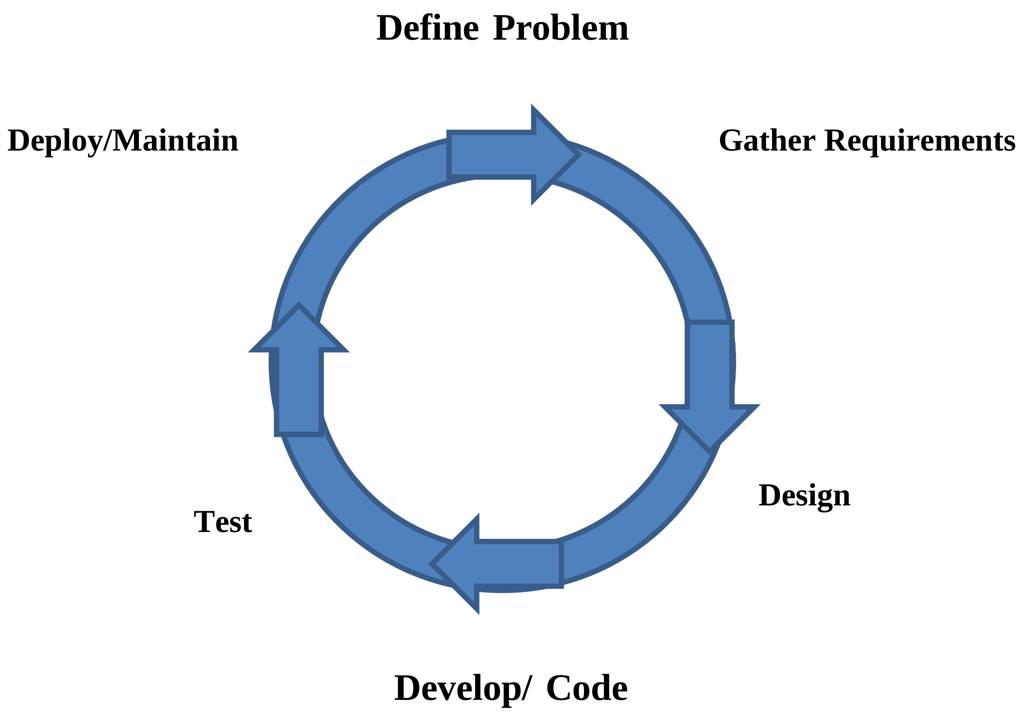

Figure 3.2 The System Development Life Cycle

Design

Design the database based on the model developed in the strategy and analysis phase.

Build and Document

Build the prototype system. Write and execute the commands to create the tables and supporting objects for the database.

Develop user documentation, help text, and operations manuals to support the use and operation of the system.

Transition

Refine the prototype. Move an application into production with user acceptance testing, conversion of existing data, and parallel operations. Make any modifications required.

Production

Roll out the system to the users. Operate the production system. Monitor its performance, and enhance and refine the system.

The SDLC procedures ensure that timely and accurate information concerning the progress of system development is available to stakeholders and others in the university community. System Development Life Cycle refers to a methodology for developing systems. It provides a consistent framework of tasks and deliverables needed to develop systems.

The SDLC methodology may be modified to include only those activities appropriate for a particular project, whether the system is automated or manual, whether it is a new system or an enhancement to existing systems.

The SDLC methodology tracks a project from an idea developed by the user, through a feasibility study, system analysis and design, programming, pilot testing implementation and post-implementation analysis. Documentation written during project development is used in the future when the system is reassessed for its continuation, modification, or deletion.

Alternative Quality Process - an alternative quality process is a systematic sequence of tasks for planning, organizing, and monitoring for quality performance improvement. It begins with customer requirements, focuses on root causes or barriers to improvements, and ensures that decisions and actions are based on real data; it includes problem solving processes such as the plan-do-check-act model. Detailed descriptions are available in the materials located in the quality center or available through team training.

System - an organized collection of independent tasks and processes that is designed to work together in order to accomplish specific objectives. The processes and tasks typically receive input(s) from and provide output(s) to other processes and tasks and even other systems. The tasks and processes may or may not be supported by automation.

The system development life cycle (SDLC) is an organized approach to obtaining an information system. The SDLC is formalized in many organizations, with detailed instructions outlining reporting requirements, specific tasks that must occur in each phase, and individual responsibilities. Major objectives of system development are to create a system: with the desired capabilities, within budget, and on time.

The SDLC assessment process involves three components:

1. Understanding the current level of achievement (baseline assessment),
2. Defining the goal or achievement objective, and
3. Developing a plan to achieve the defined goal.

The System Development Life Cycle (SDLC) is intended to provide a set of guidelines for the successful completion of application system development projects. The SDLC consists of seven distinct Phases as shown in Figure 3.3 below:

Phase 1	***Phase 2***	***Phase 3***	***Phase 4***	***Phase 5***	***Phase 6***	***Phase 7***
Planning	Definition	Analysis	Design	Build	Transition	Warehouse

Figure 3.3

Planning

This Phase of the SDLC is required to determine the feasibility of a particular project proceeding, or not. This Phase will produce a high-level overview document of the proposed project. It will contain information relating to the project's requirements and will enable the formalization and definition of the scope of the project.

This is the first Phase in the SDLC. The Project Charter deliverable is the first major deliverable in the project. The Project Charter is to be produced prior to the commencement of a project.

Definition

This Phase of the SDLC defines exactly what, who, when and how the project will be carried out. This Phase will take the deliverable from the previous Phase (Project Charter), expand on the high-level project outline and provide a specific and detailed project definition.

This Phase is the first activity of the project after obtaining approval and funding to proceed.

Analysis

This Phase of the SDLC is required to understand and document the users' needs for the system. This Phase will document, in significantly more detail than the Project Statement, the scope, business objectives and requirements of the current/proposed system.

The emphasis throughout this Phase is on what the system is to do. During the analysis and specification, the technical aspects and constraints should be considered, but should not be influenced by implementation characteristics. The technical aspects of the system are addressed in the Design Phase.

Design

This Phase of the SDLC continues on from the Detailed System Analysis and describes how the proposed system is to be built. The Design is specific to the technical environment that the system will be required to operate in and the tools to be used in building the system. The results of this Phase will significantly impact the Build and Transition Phases of the system.

The Project Manager is responsible for producing the deliverables associated with the Detailed System Design.

Build

This Phase of the SDLC deals with the development, unit testing and integration testing of the system (application) modules, screens and reports. In addition, this Phase will address the preparation and establishment of the technical environment for development, testing and training of user representatives.

This Phase is usually carried out in parallel with the development of user procedures and user documentation from the Transition Phase. Both of these will be required for module testing, upon the completion of the Build Phase. Coordination of the activities of the Build and Transition Phases is a key responsibility of the Project Manager at this time.

Transition

This Phase of the SDLC is to prepare for and carry out the transition of the developed system through user and acceptance testing to a full production system.

This is the sixth (and in some cases last) Phase in the SDLC. This will be the last Phase only for those Business Systems that (for specific documented reasons) will not make its data available in the Data Warehouse.

This Phase will provide users with the documentation and training to effectively use the system. Although the Data Conversion will only to be done once, user documentation will also be required.

Warehouse

This Phase of the SDLC addresses the publication of the system's data into the Ministry's Data Warehouse for business manipulation and decision support. Although described as one Phase here, the Warehouse Phase actually comprises, as appropriate, all the deliverables associated with SDLC Phases 2 [Definition] through 6 [Transition].

This is the final Phase in the SDLC.

The Project Manager is responsible for producing the deliverables associated with the Warehouse Phase. However, the Project Manager usually delegates responsibility for some or all of these deliverables to the Development Team. In cases where the production of some or all of the Phase's deliverables have been delegated, the Project Manager will still maintain overall responsibility for the production of quality deliverable(s) submitted to the Business Champion, User Team and ISB for Quality Assurance.

The Project Manager will provide initial Quality Assurance of the deliverable(s) prior to review by ISB QA, User Team and the Business Champion.

The draft deliverables must be submitted to the Information Systems Branch for review and QA against standards.

Control questions

Question l

Distinguish between homogeneous and heterogeneous workgroups.

Question 2

Describe all the phases of the system development diagrams.

Question 3

Explain the terms

a) Analytical support
b) Communication support
c) Tracking and monitoring support in the context of personal information systems.

Question 4

What do you understand by the term organization? Outline the three that organizations share in common.

Question 5

Differentiate between personal and workgroup information systems.

Question 6

With the help of a diagram, illustrate the system development process.

Question 7

What is the system development life cycle? Briefly explain the different stages of the development life cycle.

Question 8

Write short notes on the following:

a) Alternative Quality Process
b) System
c) Functional Specification

4 Topic 4

Evolving applications of information technology

Learning aim: study the evolution of information systems, stages of IT development and critical dimensions of complexity.

The application of IT has evolved and is continuing to evolve through 3 stages: Automation of work, Information management and Business transformation.

This evolution involves major leaps in the complexity of tasks that it is being designed to perform. As we review this evolution, a consistent pattern of change emerges in the business application of IT. As we evolve automation of work through information management to business transformation, the strategic importance of IT applications increases and that amount of organizational change required to realize the benefits of an application is also greater. Specifically, an increasing number of changes are being made to elements of the business system beyond IT such as business processes, organizational structure and even business culture. At the same time, the number and complexity of applications (or potential applications) also increases. The three stages of evolution are summarized in the table 4.1 below.

4.1 Stages of IT Evolution

Table 4.1

The three stages of IT evolution

Stage	*Impact*	*Benefit*	*Examples*
Automation of work	• Getting work Done • Doing the same things more efficiently	Operational efficiency	• Payroll • Check processing • Basic order processing • Basic airline reservation systems
Information management	• Restructuring • Work and work processes • Doing things differently	Operational and Tactical effectiveness	• Customer information systems • Airline yield management systems • Executive information systems

Continuation of the table 4.1

Business transformation	• Defining the business • Doing different things • Changing the business/industry rules	Strategic effectiveness and positioning	• JIT inventory systems • Electronic commerce • OLAP

- **Automation of work**

The first application of IT in business involved the automation of work tasks such as census data calculations, check processing and payroll as well as basic order processing and reservation systems. An automation application such as payroll is not a strategic application, and while it is certainly necessary, and failure to pay employees would have serious consequences, it is not an application that provides strategic advantage. The benefits were largely in the area of operational efficiency. A few new jobs were created to program, operate and support the technology itself and some manual jobs, such as pay calculation and check processing, were replaced. There was also limited change to people's jobs or to business processes, but the overall change to the nature of work was not significant. Learning requirements were relatively simple and narrow, focused on how to use the technology. Change was generally limited to one or a small number of functional areas. In the case of payroll, little if any change was experienced outside of the payroll department. The most important thing was that the payroll application ran correctly.

The self-sufficiency of computerization was reflected by the physical reality of the mainframe, where computers were isolated behind data center walls - and operated invisibly by IT experts. Applications were often limited to those conceived by same experts, with little understanding of technology by broader business community, or how it could be applied.

- **Information Management**

Automation applications created information as a by-product of automating work. In the early years of the automation stage, this information was not generally used, certainly not in widespread format way. As we moved into the information stage, the opportunities to use this information began to be recognized. With the wider distribution of desktop computer terminals, IT was increasingly applied to provide information to support improved decision making, to move it "close to the customer" and to support new service and product design. Here the introduction of advanced order processing systems, airline yield management systems, customer information systems as well as the start of so-called executive information systems (EIS). Benefits moved beyond operational efficiency to operational and tactical effectiveness. Information could be used to make tactical, and in some cases, strategic decision. Initially, information was used to enable workers to do their jobs better. Their jobs changed somewhat, but primarily they were required, and had to be trained to take largely predetermined action based on the information provided.

As the information stage advanced, benefits were premised on workers improving how they analyzed and applied information to their work. In the case of order processing, seasonal variations in demand might be noticed, and adjustments made to order levels. In the case of customer information systems (or customer information files in financial institutions), information was used to increase the value of "customer moments" by cross-selling and target marketing of certain services. Airline systems moved beyond basic reservation systems to sophisticated yield management systems. In the later steps of the information stage, automation information bases provided opportunities to design new products, such as today's multitude of mutual funds and numerous volume-based discount plans for valued customers. It was no longer sufficient to simply provide the application and make sure that it worked as specified. For these benefits to be realized, the nature of people's work had to change. Business processes had to be restructured and better integrated. Reward systems had to change. Significant learning was required. The changes crossed functional boundaries, and in some cases, changed or eliminated them.

Physically, personal computers emerged from behind the walls of ¯the central data center. PCs began to appear everywhere in organizations and to be operated by nonexperts. The number of potential applications of technology increased dramatically. Many of these were conceived outside of the IT world, by the broader community of business managers and front-line technology users.

- **Business transformation**

Information management applications enable organizations to rethink and redesign their business processes and how they carry out their business. As more and more computing power is distributed, and as advanced communications capabilities continues to erase the constraints of time and distance, the very nature of businesses, and even entire industries, is being redefined. Benefits have moved beyond operational and tactical effectiveness to strategic effectiveness and positioning.

Business transformation applications, such as just-in-time (JIT) inventory systems and advanced electronic commerce, enable organizations to rethink not just how they do things, but also what they choose to do. For example, JIT ordering and inventory management systems are fundamentally changing the value/supply chain and shifting the balance of power among stakeholders.

The emergence of Internet and virtual banking is redefining the financial industry by removing century-old barriers to entry and blurring financial product boundaries. Airlines are now offering passengers direct access to reservations systems and more fighting for ownership of the client with travel agents, and thus redefining the travel agent business. Amazon.com is helping to redefine the book industry. It is not only selling books electronically and offering a wider selection than is possible in physical bookstores, it is using the power of computers to repackage - and eventually transform - a range of services that were historically spread across multiple businesses, including the reference capabilities of libraries, the retail display and selection expertise of bookstores, the efficiency of volume discount distributors and the knowledge of professional book reviewers.

All these applications have significant strategic implications. While technology enables these benefits, most of the required change is beyond the realm of IT. The organizations carrying out these changes will, in many cases, be redrawing traditional industry boundaries or, at minimum, changing industry structures and rewriting industry ground rules. In doing so, they will harness IT with the aim of "competing for the future".

The potential of transformational applications is tremendous, but to realize it will present organizations with new and significant challenges. Automating payroll processing was primarily an engineering question, whereas creating a virtual bank branch or bookstore is primarily a business one.

As we moved beyond automation of work to information management and business transformation applications, sound management of IT projects remains necessary but is no longer by any means sufficient. In the case of financial customer information files, for example, employees have to learn new skills, assume new responsibilities and accept different reward systems. Cross-selling to banking customers means astutely interpreting customer profile information and cultivating personal relationships, rather than efficiently handling transactions and answering routine questions to shorten waiting time in a branch line-up. Such changes in management practice and work place culture are just as important as new IT - though perhaps less visible - to any organization's ability to make a successful transition to Knowledge Economy.

Organizations that have recognized this, and changed their management practices accordingly, have been relatively successful with their IT investments. In, those organizations that have not - the majority, unfortunately - the failure to recognize these changes has caused management practices to lag behind the evolving nature of the application of IT.

While the application of Information Technology has evolved significantly over the past three decades, our approach to managing it has not. When the primary application was automation, management thinking was still rooted in the industrial age. The mind-set meant that you were ahead and built the system, plugged it in and made sure it was running, like a new machine on a manufacturing assembly line.

Unfortunately, as the application of IT has moved beyond automation of work all the way to business transformation, our management approach has remained rooted in industrial-age thinking. Management thinking has failed to understand the implications of the evolving role of IT in business system beyond technology. Many still think in terms of payroll processing systems that can begin depositing money in employee accounts on day one. In fact, we are delivering customer information systems that will only produce results gradually on day 50, day 100 or day 365, after people are trained and motivated to use the new application when serving customers.

4.2 Management blind spots: Four critical dimensions of complexity

Current management practice fails to adequately address the impact and resource implications of four critical dimensions of complexity. These blind spots in traditional management mind-sets are: linkage, reach, people and time.

Linkage

This refers to the linkage between the expected results of an IT investment and business strategy, and between the IT investment and investments required in other areas of the business in order to realise the benefit. Understanding and addressing linkage requires a clear appreciation of the ultimate benefits and of the full scope of the investment required to achieve the benefits.

Reach

Reach refers to the breadth of change required by an IT investment, meaning how much of an organization is impacted. It also refers to the depth of change - the degree of impact and of organizational change required to realize the benefit. Addressing each requires understanding what areas of the organization, other organizations and stakeholders will be affected, what the impact will be and how it will be managed.

People

A large number and diversity of people must be motivated and prepared to change. This critical factor in business transformation is often underestimated. We need to understand who these people are today, how they will have to change and what interventions will be required to effect the change. We need to ask how these interventions will be managed for people with different starting points, attitudes and motivations.

Time

In business transformation, time is always of essence, but realistic time frames are notoriously hard to estimate. We need to ask - and ask again and again - what the realistic length of time is for all the necessary changes to occur and for the full benefits to be realized. We must base these estimates on understanding the previous three dimensions.

Evolving complexity of IT applications

These dimensions of change have become increasingly complex as the applications of IT have advanced through the stages of automation of work, information management and business transformation.

In the automation stage, the four dimensions were fairly straightforward and posed few problems. In the case of automated payroll systems, for example, there few linkages, organizational reach was limited and few people were affected. Time was required to deliver the benefits was short; or, at least, the time frames were easily predictable in advance. Finally, benefits were easy to measure. As we moved through the information stage, there were more linkages, not all of which were, obvious

4.3 Business transformation and the knowledge economy

The potential risks and rewards associated with such cases of business transformation show, what is involved in engineering out transition to a knowledge economy. The opportunities include expanding geographic scope, expanding electronic commerce and creating virtual companies. We are, moving toward an economy that is on-line, interactive, instantaneous, inter-networked and knowledge based. It is an economy that will require new organizational forms and which will dramatically change the nature of organizations and work.

The emergence of this new economy involves business transformation - fundamental change in value chain management and the application of new technologies to support "networked organizations that share knowledge, insight and experience effectively. Some experts predict chief executives will become knowledge capitalists who manage the knowledge assets of their organizations. Knowledge will not just be limited to your organization; it will come from outside well. In addition to managing investments in IT-enabled change in your own business system, you will have to manage change in an extended business system which includes customers, supplier financial institutions, regulators and many other intermediaries, all of whom will themselves be in state of change.

While the opportunities created by business transformation are awesome the risks can be daunting to investment decision-makers. Today's large-scale IT projects and organizational change programs will be viewed as relatively simple initiatives compared to the sophisticated business transformation ones that will be required in the knowledge economy. These will raise significant new issues of linkage, reach, people and time. To manage these dimensions of complexity successfully, business transformation initiatives can no longer be viewed as traditional projects. They will need to be treated almost like mid-size businesses within the business, as programs that are managed continuously and proactively over long periods of time.

Control questions

Question 1

With respect to the evolution of IT applications, explain what you understand by the automation of work.

Question 2

What are the possible benefits arising from information management?

Illustrate your answer with examples.

Question 3

Define the term business transformation. What is its impact on the enterprise?

Question 4

Briefly describe the stages through which IT has evolved.

Question 5

What has been the impact of the emergence of Internet and virtual banking on the financial industry?

Question 6

Explain why management thinking has failed to understand the implications of the evolving role of IT in business system.

Question 7

Current management practice fails to adequately address the impact and resource implications of four critical dimensions of complexity. Explain why.

Question 8

a) Organizations have had to make changes in their provision of Information Service to support End User Computing (EUC).
b) Describe one way in which support of EUC has changed the structure of an organization's information service provision.
c) Briefly describe the general changes in the nature of work undertaken by information services personnel that you would expect with the introduction of EUC into an organization.

A Data Centre may be centralized or de-centralized. Describe the issues you would consider when deciding between a centralized Data Centre provision and a decentralized Data Centre provision.

5 Topic 5

Knowledge representation

Learning aim: study of concepts principles and applications of artificial intelligence (AI), expert systems (ES) and knowledge based systems (KBS).

5.1 Introduction

Artificial intelligence techniques do not necessarily reproduce human thought processes. Rather, they seek to apply computers to problem solving tasks requiring intelligence. These techniques need to produce results consistent with human activity if they are to be useful, however, they do not necessarily reproduce the reasoning of an expert in their analysis. Expert systems represent the logical extreme of the trend away from large generalized artificial intelligence models. By adopting a specific problem domain, the tasks of knowledge representation and problem description are rendered as simple as possible. This enables a more powerful model to be developed, since the knowledge base applicable to the chosen problem domain can be made much more comprehensive.

A detailed and specific knowledge base is the source of the problem solving power of an expert system (Waterman [1986]). The manner in which the knowledge base is used will be determined by the system's Meta knowledge. Meta knowledge can be seen as a set of rules governing how the knowledge base is applied. Meta knowledge determines what case specific knowledge is obtained from the user and what knowledge from the knowledge base is incorporated in the problem solving process. It also provides the means to combine these two sources of knowledge for an expert system to generate its output.

Meta knowledge and knowledge complement one another. Knowledge cannot be applied in the absence of Meta knowledge. However, reliance on Meta knowledge may be offset to the degree of reliance on a knowledge base. An advanced expert systems shell facilitates the construction of expert systems based models that embody a high degree of declarative Meta knowledge. Such a model solves problems while making "economical" use of the system's knowledge base. It limits its use to those pieces of knowledge pertinent to the problem.

A model with a less advanced Meta knowledge structure may produce the same conclusion, but it would be less discriminating in its use of the knowledge base. As a result, it may incorporate many pieces of knowledge that were not strictly necessary in its analysis. A procedurally coded computer model will necessarily place a heavier reliance on its knowledge base than it will on a Meta knowledge structure. This is not necessarily a failing. Knowledge is typically easier to capture and represent than Meta knowledge. Expert systems are commonly constructed using proprietary shell packages. These packages provide the tools to construct the knowledge base required by an expert systems model and the inference engine and Meta knowledge required to access that knowledge base. The construction of an expert system requires the skills of a knowledge engineer, as opposed to a conventional programmer. In contrast, decision support systems can be constructed using only a conventional program code compiler. A compiler embodies less functionality than an expert system shell, but as a result, needs to be much less structured and can therefore allow the developer much more freedom over the form of a decision support system. The programming skills required to use a conventional program compiler are much more readily available and therefore potentially more cost effective than the skills of a knowledge engineer.

The remainder of this paper is organized as follows. The second section discusses the distinction between expert systems and decision support systems. The third section reviews the application of expert systems to audit risk assessment. The fourth outlines the construction of two computer models, one expert systems based and the other procedural. The final section provides a summary and conclusion.

A well-known definition of artificial intelligence (AI) is the following: AI *is the science of making machines does things that would require intelligence if done by humans.* An important branch of Al research is **expert systems** (ES) or more generally, **knowledge based systems** (KBS).

In the 1980s, there were a number of highly-publicized, successful expert systems put into operation around the world (e.g., MYCIN, XCON, Prospector) Despite these successes and the many operational expert systems in service today, the field is widely seen as having arrived, failed, and disappeared. However, it is important to keep in mind that much this perceived failure is due to unrealistic expectations fueled by hype rather than a lack of achievement by ES researchers and developers. In fact, such a fate is not uncommon in information technology.

The basic idea behind expert systems is to create small, practical "intelligent" systems by eliciting **a knowledge base** of rules from experts in a particular field and providing non-expert users with means of accessing this knowledge easily. For example, an early (circa 1975) expert system called MYCIN helps physicians to diagnosis infectious blood diseases and prescribes medication. The knowledge base of MYCIN was elicited from a large number of experts in the field and contained an enormous amount of information about different types of bacteria associated with blood diseases. Although MYCIN provided diagnosis as good or better than any human expert, the technology itself never achieved widespread acceptance in the medical community.

5.2 Knowledge Representation

Knowledge representation is crucial. One of the clearest results of artificial intelligence research so far is that solving even apparently simple problems requires lots of knowledge. Really understanding a single sentence requires extensive knowledge both of language and of the context. For example, today's (4th Nov) headline "It's President Clinton" can only be interpreted reasonably if you know it's the day after the American elections. (Yes, these notes are a bit out of date). Really understanding a visual scene similarly requires knowledge of the kinds of objects in the scene. Solving problems in a particular domain generally requires knowledge of the objects in the domain and knowledge of how to reason in that domain - both these types of knowledge must be represented.

Knowledge must be represented efficiently, and in a meaningful way. Efficiency is important, as it would be impossible (or at least impractical) to explicitly represent every fact that you might ever need. There are just so many potentially useful facts, most of which you would never even think of. You have to be able to infer new facts from your existing knowledge, as and when needed, and capture general abstractions, which represent general features of sets of objects in the world.

Knowledge must be meaningfully represented so that we know how it relates back to the real world. A knowledge representation scheme provides a mapping from features of the world to a formal language. (The formal language will just capture certain aspects of the world, which we believe are important to our problem - we may of course miss out crucial aspects and so fail to really solve our problem, like ignoring friction in a mechanics problem). Anyway, when we manipulate that formal language using a computer we want to make sure that we still have meaningful expressions, which can be mapped back to the real world.

5.3 What is Artificial Intelligence?

Artificial intelligence (AI) is a broad field, and means different things to different people. It is concerned with getting computers to do tasks that require human intelligence. However, having said that, there are many tasks, which we might reasonably think require intelligence - such as complex arithmetic - which computers can do very easily. Conversely, there are many tasks that people do without even thinking - such as recognizing a face - which are extremely complex to automate. Al is concerned with these difficult tasks, which seem to require complex and sophisticated reasoning processes and knowledge.

People might want to automate human intelligence for a number of different reasons. One reason is simply to understand human intelligence better. For example, we may be able to test and refine psychological and linguistic theories by writing programs, which attempt to simulate aspects of human behavior. Another reason is simply so that we have smarter programs. We may not care if the programs accurately simulate human reasoning, but by studying human reasoning we may develop useful techniques for solving difficult problems.

AI is a field that overlaps with computer science rather than being a strict subfield. Different areas of Al are more closely related to psychology, philosophy, logic, linguistics, and even neurophysiology.

5.4 Is AI Possible?

Artificial intelligence research makes the assumption that human intelligence can be reduced to the (complex) manipulation of symbols, and that it does not matter what medium is used to manipulate these symbols - it does not have to be a biological brain! This assumption does not go unchallenged among philosophers etc. Some argue that true intelligence can never be achieved by a computer, but requires some human property which cannot be simulated. There are endless philosophical debates on this issue (some on comp.ai.philosophy), brought recently to public attention again in Penrose's book.

The most well-known contributions to the philosophical debate are Turing's "Turing test" paper, and Searle's "Chinese room". Very roughly, Turing considered how you would be able to conclude that a machine was really intelligent. He argued that the only reasonable way was to do a test. The test involves a human communicating with a human and with a computer in other rooms, using a computer for the communication. The first human can ask the other human/computer any questions they like, including very subjective questions like "What do you think of this Poem". If the computer answers so well that the first human can't tell which of the two others is human, then we say that the computer is intelligent.

Searle argued that just *behaving* intelligently wasn't enough. He tried to demonstrate this by suggesting a thought experiment (the "Chinese room"). Imagine that you don't speak any Chinese, but that you have a huge rule book which allows you to look up Chinese sentences and tells you how to reply to them in Chinese. You don't understand Chinese, but can behave in an apparently intelligent way. He claimed that computers, even if they appeared intelligent, wouldn't really be, as they'd be just using something like the rule book of the Chinese room.

Many people go further than Searle, and claim that computers will never even be able to appear to be really intelligent (so will never pass the Turing test). There are therefore a number of positions that you might adopt:

- Computers will never even appear to be really intelligent, though they might do a few useful tasks that conventionally require intelligence.
- Computers may eventually appear to be intelligent, but in fact they will just be simulating intelligent behavior, and not really be intelligent.
- Computers will eventually be really intelligent.
- Computers will not only be intelligent, they'll be conscious and have emotions.

Computers can clearly behave intelligently in performing certain limited tasks, full intelligence is a very long way off and hard to imagine. However, these philosophical issues rarely impinge on Al practice and research. It is clear that AI techniques can be used to produce useful programs that conventionally require human intelligence, and that this work helps us understand the nature of our own intelligence.

5.5 Some AI Tasks

Human intelligence involves both "mundane" and "expert" reasoning. By mundane reasoning I mean all those things which (nearly) all of us can routinely do (to various abilities) in order to act and interact in the world. This will include:

- Vision: The ability to make sense of what we see.
- *Natural Language:* The ability to communicate with others in English or another natural language.
- *Planning:* The ability to decide on a good sequence of actions to achieve your goals.
- *Robotics:* The ability to move and act in the world, possibly responding to new perceptions.

By expert reasoning I mean things that only some people are good at, and which require extensive training. It can be especially useful to automate these tasks, as there may be a shortage of human experts. Expert reasoning includes:

- Medical diagnosis.
- Equipment repair.
- Computer configuration.
- Financial planning.

Expert Systems are concerned with the automation of these sorts of tasks.

AI research is concerned with automating both these kinds of reasoning. It turns out, however, that it is the mundane tasks that are by far the hardest to automate.

5.6 Knowledge Engineering

Having decided that your problem is suitable you need to extract the knowledge from the expert and represent it using your expert system shell. This is the job of the *knowledge engineer,* but involves close collaboration with the *expert(s)* and the *end user(s).*

The knowledge engineer is the AI language and representation expert. He/she should be able to select a suitable expert system shell (and other tools) for the project, extract the knowledge from the expert, and implement the knowledge in a correct and efficient knowledge base. The knowledge engineer may initially have no knowledge of the application domain.

To extract knowledge from the expert the knowledge engineer must first become at least somewhat familiar with the problem domain, maybe by reading introductory texts or talking to the expert. After this, more systematic interviewing of the expert begins. Typically experts are set a series of example problems, and will explain aloud their reasoning in solving the problem. The knowledge engineer will abstract general rules from these explanations, and check them with the expert.

As in most applications, the system is wasted if the user is not happy with it, so development must involve close collaboration with potential users. As mentioned in the introduction, the basic development cycle should involve the rapid development of an initial prototype and iterative testing and modification of that prototype with both experts (to check the validity of the rules) and users (to check that they can provide the necessary information, are satisfied with the systems performance and explanations, and that it actually makes their life easier rather than harder!).

In order to develop the initial prototype the knowledge engineer must make provisional decisions about appropriate knowledge representation and inference methods (e.g., rules, or rules+frames; forward chaining or backward chaining). To test these basic design decisions, the first prototype may only solve a small part of the overall problem. If the methods used seem to work well for that small part it's worth investing the effort in representing the rest of the knowledge in the same form.

Expert system development was very trendy around 5-10 years ago, with unrealistic expectations about the potential benefits. Now some cynicism has set in. Expert system shells are in fairly wide use, but are often used to solve fairly simple problems, and are chosen as much for their user interface and development environments as for their inferential abilities.

Control questions

Question 1

Write short notes on the following:

a) Knowledge representation
b) Artificial Intelligence
c) Knowledge Engineering
d) Knowledge Base
e) Expert Systems

Question 2

a) List and briefly describe the disciplines that constitute the subject of artificial intelligence (AI).
b) List the three ways in which knowledge is represented in expert systems.
c) Do most expert systems in use today replicate the abilities of a human expert? What do they do?
d) Explain the problems with the term artificial intelligence.

Question 3

What are the main components of human intelligence?

Question 4

Discuss whether Artificial Intelligence is possible

Question 5

Define the term meta knowledge and what is its importance in the field of artificial intelligence.

Question 6
Knowledge must be represented efficiently, and in a meaningful way. Discuss this statement.

Question 7
What are the components of expert reasoning?

Recommended literature

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