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# Information systems and organisations

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Undergraduate study in Economics, Management, Finance and the Social Sciences

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THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

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# Chapter 1: Introduction

The significance and role of technology in the economy and in society has become extremely important over the last decade. People, organisations and governments enthusiastically embrace all that technology has to offer, while others are more cautious or even positively resistant. With the benefit of an historical perspective, and building on our experience of earlier and highly significant constellations of technologies, people often suggest that a small number of key technologies are shaping and changing our society and our lives. The role of information and communication technologies in shaping human activity in our private and professional lives has become more and more prominent.

This course is concerned with these information and communication technologies (often abbreviated to ICT), shedding light on how they are understood, designed, applied and used within organisational settings, in particular in business organisations. The main focus of the course is on how we understand the potential of ICT to support organisational activities and hence how we design these technologies to achieve these goals. Further, this course discusses how different models used to analyse organisations' activities are affecting the shape of ICT. Here we argue that ICT designed to support organisations' activities are differently shaped as a consequence of the analytical model we have used to analyse the organisation and hence to identify what we can improve with the adoption of ICT. Thus the title of this course **Information systems and organisation** must be interpreted broadly.

Computers are but one part of a constellation of technologies that we will consider, to which we must certainly add communications and network technologies. These technologies are important and interesting to study, but we should appreciate at the outset that this course is not just (or even mainly) about these technologies in an isolated sense, but about what we do with them, why we become involved with them, how we proceed, and all the management problems and issues this raises. The phrase information systems and organisation, used in the title, is intended to express this concern with the uses we find for technology and the consequences of its adoption, rather than technology itself. That is, we build our technologies into organisational information systems, and these technologies support various ways of handling, communicating, consolidating and processing information, and in this way allow organisations (and even societies) to change the ways in which they operate. We focus in particular on how organisations of all types seek to use technologies to develop their own information activities for their own purposes.

To achieve this, available ICTs can be used to capture, store, manipulate and distribute information. When we see a collection of these technologies (or technical things – computers, networks, databases), linked together and working within an organisational setting, probably alongside and involving people, and providing some service or value to somebody, we can see an information system.

## Learning outcomes

By the end of this course, you should have achieved the following learning outcomes. By a learning outcome we mean an area of the subject in which you have acquired knowledge and skills, and are able to present relevant information, alternative analyses and hence to present reasoned arguments and exercise your own judgement. You should be able to:

- explain how different models used to analyse organisations are reflected in different information systems architectures
- differentiate various classes and types of information system developed and used in organisations, seen within an historical context
- describe contemporary information and communications technologies including computer hardware, software and networking
- present arguments for a strategic role for information systems within organisations, and alternative models to support this role and to establish such strategies
- explain how information and communication technologies change organisations and industrial structures, using appropriate models
- critically assess the place of people within organisational information systems, and the human interests such systems serve including automation of tasks, support for processes of management and decision-making
- achieve some practical experience with computers, software packages and the internet, sufficient to be able to reflect on significant problems of taking up and using unfamiliar technologies, as well as the opportunities they offer
- differentiate and evaluate alternative approaches to developing information systems based on, for example, in-house projects, end-user development, purchasing packaged software or outsourcing services
- describe the essential tasks needed to develop a new system and to set it to work in an organisational setting, and the professional roles for people who undertake these tasks
- assess new technologies and approaches for managing knowledge within organisational contexts and for supporting decision-making
- describe and evaluate changes in contemporary approaches to the management of the information systems function within organisations, the organisational structures used and the key issues for managers to address
- discuss relevant information systems issues with managers involved with information systems, and evaluate (some of) the course materials against the practitioner's view.

This set of learning outcomes is provided here as a high-level overview of the positive outcomes of your study. As you tackle the course you should return to this list from time to time and note down those that you feel you have made progress with, and those that you need to work on more. You must also remember that the overall aim of the subject is to develop a **critical** and **reflective** appreciation of the connections between information systems and organisations. Remember, there are few issues within this syllabus that do not allow for debate and distinctive and different perspectives.

## Essential reading

This subject guide is written to provide an interpretative guide for the study of the course's essential textbook. It is not, and cannot be, a substitute to the book itself. Students should purchase a copy of this book and be familiar with most of its contents. It is strongly recommended that you first read the guide and then the book:

Laudon, K.C. and J.P. Laudon *Management Information Systems: Managing the Digital Firm*. (Harlow: Pearson Education, 2012) twelfth edition [ISBN 9780273754596].

When buying this book do be careful to obtain the right text since Kenneth and Jane Laudon and their publishers have produced a number of introductory textbooks with similar sounding names. This book also has a website at www.prenhall.com/laudon with tests, suggested essay questions and further web links. This text provides the closest fit to the syllabus. This subject guide is written to accompany this text, emphasising particular elements and adding extra material.

For Chapter 4 you will also need to read:

Curtis, G. and D. Cobham *Business Information Systems: Analysis, Design and Practice.* (New Jersey: Pearson Education, 2005) fifth edition [ISBN 9780273687924] Chapters 10–16.

Detailed reading references in this subject guide refer to the editions of the set textbooks listed above. New editions of one or more of these textbooks may have been published by the time you study this course. You can use a more recent edition of any of the books; use the detailed chapter and section headings and the index to identify relevant readings. Also check the virtual learning environment (VLE) regularly for updated guidance on readings.

## Further reading

Please note that as long as you read the Essential reading you are then free to read around the subject area in any text, paper or online resource. You will need to support your learning by reading as widely as possible and by thinking about how these principles apply in the real world. To help you read extensively, you have free access to the VLE and University of London Online Library (see below).

It is strongly recommended that you also read:

Ciborra, C.U. *Teams, Markets and Systems: Business Innovation and Information Technology*. (Cambridge: Cambridge University Press, 1993) [ISBN 0521404630].

This book discusses most topics and many useful contrasting views for these topics.

You should certainly look for this book in your library and for some topics it will be the primary source.

### Full list of Further reading

For your ease of reference here is a full listing of all the Further reading mentioned in this subject guide.

#### Books

Alter, S. *Information Systems: A Management Perspective.* (Reading, Mass: Addison Wesley, 1999) third edition [ISBN 0201521083] Chapters 8–12.

Avgerou, C. and T. Cornford *Developing Information Systems: Concepts, Issues and Practice*. (Basingstoke: Macmillan, 1998) second edition [ISBN 0333732316].

Avison, D. and G. Fitzgerald *Information Systems Development: Methodologies, Techniques and Tools.* (Maidenhead: McGraw Hill, 2003) third edition [ISBN 0077096266] Chapters 3 and 6.

Bocij, P., D. Chaffey, A. Grasely and S. Hickie *Business Information Systems: Technology, Development and Management.* (London: Financial Times Pitman, 2006) [ISBN 0273688146] Chapters 3–5.

Ciborra, C.U. *Teams, Markets and Systems: Business Innovation and Information Technology*. (Cambridge: Cambridge University Press, 1993) [ISBN 0521404630] Chapters 1 and 6.

Curtis, G. and D. Cobham *Business Information Systems: Analysis, Design and Practice.* (New Jersey: Pearson Education, 2005) fifth edition [ISBN 0273687921] Chapters 1, 3 and 4.

Grey, C. *A very short, fairly interesting and reasonably cheap book about studying organizations.* (London: Sage, 2005) [ISBN 141290191X (pbk)].

Hammer, M. and J. Champy *Reengineering the Corporation. A Manifesto for Business Revolution*. (New York: Harper Collins Publishers, 2003) [ISBN 088730687X].

Jarvenpaa, S. and B. Ives 'Information systems and business strategy: an overview' in Galliers, R.D., D.E. Leidner and B.S.H Baker (eds) *Strategic Information Management*. (Oxford: Butterworth Heinemann, 1999) [ISBN 075063975X].

Lee, H.G. and T.H. Clark 'Strategies in response to the potential of electronic commerce' in Galliers, R.D., D.E. Leider and B.S.H. Baker (eds) *Strategic Information Management*. (Oxford: Butterworth Heinemann, 1999) [ISBN 075063975X].

March, J.G. and H.A. Simon *Organisations.* (New York: John Wiley & Sons, 1958) [ISBN 063118631X] Chapter 1.

Pearlson, K.E. and C.S. Saunders *Managing and Using Information Systems: A Strategic Approach*. (Hoboken, NJ: John Wiley & Sons, 2004) [ISBN 0471346446].

Simon, H.A. *Administrative Behavior: A Study of Decision-Making Processes in Administrative Organisations.* (New York: Free Press, 1997) fourth edition [ISBN 0029290007] Chapter 1.

Williamson, O.E. *The Economic Institutions of Capitalism*. (New York: Free Press, 1985) [ISBN 002934820X].

## Journal articles

Akerlof, G.A. 'The market for "lemons": qualitative uncertainty and the market mechanism', *Quarterly Journal of Economics* 84(3) 1970, pp. 488–500.

Anthony, G.G. and M.S.S. Morton 'A framework for management information systems', *Sloan Management Review* 13(1) Fall 1971.

Ciborra, C.U. and G.F. Lanzara 'Formative contexts and information technology: understanding the dynamics of innovation', *Organisations, Accounting, Management and Information Technology* 4(2) 1994, pp. 61–86.

Cordella, A. 'Does information technology always lead to lower transaction costs?' The 9th European Conference on Information Systems, Bled, Slovenia, 2001.

Daft, R.L. and K.E. Weick 'Toward a model of organisations as interpretation systems', *Academy of Management Review* 9(2) 1984, pp. 284–295.

Gorry, A.G. and M.S.S. Morton 'A framework for management information systems', *Sloan Management Review* 13(1) Fall 1971.

Hammer, M. 'How process enterprises *really* work', *Harvard Business Review* 77(6) November/December 1999.

Hammer, M. 'Process management and the future of Six Sigma', *Sloan Management Review* 43(2) Winter 2002.

Malone, T.W., J.Yates and R.I. Benjamin 'Electronic markets and electronic hierarchies' *Communications of the ACM* 30(6) 1987, pp. 484–497.

Porter, M.E. 'Strategy and the Internet', *Harvard Business Review* 79(3) 2001, pp. 62–78.

Porter, M.E. and E.V. Millar 'How information gives you competitive advantage', *Harvard Business Review* 63(4) 1985, pp. 149–174.

Wigand, T.R. 'Electronic commerce: definition, theory and context', *The Information Society* 13(1) 1997, pp. 1–16.

## Additional reading and works cited

You may also find the following books helpful as references or as back-up for particular topics. Occasional references to these books are given in this subject guide.

Cornford, T. and S. Smithson *Project Research in Information Systems*. (London: Macmillan, 1996) [ISBN 0333644212].

Kendall, K. and J. Kendall *Systems Analysis and Design*. (New Jersey: Prentice Hall, 1998) fourth edition [ISBN 0136466214].

Scott-Morton, M. *The corporation of the 1990s: information technology and organisational transformation*. (New York: OUP, 1991) [ISBN 0195068068].

Targett, D., D. Grimsham and P. Powell *IT in Business: A Manager's Casebook*. (London: Butterworth, 1999) [ISBN 0750639512].

It is always preferable that you have access to the **latest** editions of books. The world of information systems and information technology moves on very rapidly, as does our understanding of what is important and relevant in developing information systems. If, during the period that this subject guide is in print, a new edition of any of these texts is produced, you should assume that the new edition is the valid edition for study.

You should also make a habit of **regularly** consulting weekly and monthly journals and newspapers and in this way 'keep up' with trends in the area. You must remember that new ideas, new technologies and new applications of technology are usually first reported in newspapers and magazines, sometimes years before they find their way into textbooks. Reading such contemporary accounts will also help you to develop your sense of judgement about all sorts of information systems issues, bearing in mind that you should not believe **everything** you read. Indeed, you should be rather sceptical when people in the IT industry promote their own products.

Most quality or business newspapers, such as the *Financial Times* or the *Wall Street Journal*, have regular technology and information systems articles. In recent years the *Financial Times* has published a regular series of supplements on Mastering Management, and these series have all included much relevant material on information systems. In addition, most countries have some local publications devoted to computers and information systems, and these can also provide very useful materials for study. This will include news of the local and global information technology industries, examples or case studies of systems in use, and discussion of systems development and management practices. Among the best-known publications that may be found in libraries are the following:

*The Economist*, UK. While this is not a computer magazine, it does contain regular articles on aspects of the computer industry, national policies relating to computers and telecommunications and issues of organisational use of technology.

*Byte Magazine* USA and international editions. The oldest, best known and most widely read magazine on all aspects of microcomputers.

*Datamation*, USA. This magazine reports on many issues of effective use of information technology in organisations. There is also a website for the magazine (http://itmanagement.earthweb.com/).

These three magazines are representative of three distinct types of reading that you may find. First, there are business newspapers and current affairs magazines that cover issues of information systems (IS) from time to time (e.g. *The Economist*). Then there are technology-focused publications (e.g. Byte), though many of these are more geared to personal computers and home users rather than providing organisational perspectives. Finally, there are magazines devoted to business information systems (e.g. *Datamation*). In your reading, and to develop a wider perspective on this subject, you should try to read regularly from all three types of publication. It is a very good practice to keep a file of cuttings, photocopies and articles collected throughout your period of study. When you come to the end of the course such a resource can be very valuable as a revision aid and as a panorama of contemporary IS issues and debates.

## Using the essential textbook

When you first look at the recommended text, Laudon and Laudon, *Management Information Systems: Managing the Digital Firm*, twelfth edition, you may be surprised at the quantity of information it contains and the complex layout of material. Because this book is quite large and complex it is very worthwhile as you start to study for this subject to take some time to explore this subject guide to know how to approach the rich and complex information you will find in the textbook.

The chapters of the book also contain many pictures, screen shots, tables, figures and diagrams. These are intended to be read along with the text, and to help a reader to understand and absorb key ideas. They are not a substitute for reading and thinking about the text. It should be obvious to you that there are too many such figures ever to memorise them all, so do not try! What you should be able to do is to understand and analyse these figures in the light of information provided by this subject guide.

The book's chapters finish with a number of sections to help you absorb and reflect on the material presented. These include a **Management Wrap-up**, briefly relating the material to the themes of Management, Organisation and Technology; a **Summary** of about a page structured around the **Learning Objectives** with which the chapter started; and **Review Questions**; **Group Projects**; and **Interactive Learning Suggestions**. Taken all together, these three pages provide a brief but challenging synopsis of the chapter and plenty of things to do or issues to reflect on. Considering that this book has 16 chapters, and a chapter summary section is less than three pages, it is possible to condense the whole book into less than 60 pages, but this condensed version would only really make sense if you had read the whole book. In other words, these sections are there to help you revise what you have already learned, not as a substitute for reading, discussion and study. Finally, at the very end of the chapter is a longer case study, again taken from a published source, with more questions for you to consider.

## Online study resources

In addition to the subject guide and the Essential reading, it is crucial that you take advantage of the study resources that are available online for this course, including the VLE and the Online Library.

You can access the VLE, the Online Library and your University of London email account via the Student Portal at:
http://my.londoninternational.ac.uk

You should have received your login details for the Student Portal with your official offer, which was emailed to the address that you gave on your application form. You have probably already logged in to the Student Portal in order to register! As soon as you registered, you will automatically have been granted access to the VLE, Online Library and your fully functional University of London email account.

If you forget your login details at any point, please email uolia.support@london.ac.uk quoting your student number.

## The VLE

The VLE, which complements this subject guide, has been designed to enhance your learning experience, providing additional support and a sense of community. It forms an important part of your study experience with the University of London and you should access it regularly.

The VLE provides a range of resources for EMFSS courses:

- Self-testing activities: Doing these allows you to test your own understanding of subject material.
- Electronic study materials: The printed materials that you receive from the University of London are available to download, including updated reading lists and references.
- Past examination papers and *Examiners' commentaries*: These provide advice on how each examination question might best be answered.
- A student discussion forum: This is an open space for you to discuss interests and experiences, seek support from your peers, work collaboratively to solve problems and discuss subject material.
- Videos: There are recorded academic introductions to the subject, interviews and debates and, for some courses, audio-visual tutorials and conclusions.
- Recorded lectures: For some courses, where appropriate, the sessions from previous years' Study Weekends have been recorded and made available.
- Study skills: Expert advice on preparing for examinations and developing your digital literacy skills.
- Feedback forms.

Some of these resources are available for certain courses only, but we are expanding our provision all the time and you should check the VLE regularly for updates.

## Making use of the Online Library

The Online Library contains a huge array of journal articles and other resources to help you read widely and extensively.

To access the majority of resources via the Online Library you will either need to use your University of London Student Portal login details, or you will be required to register and use an Athens login:
http://tinyurl.com/ollathens

The easiest way to locate relevant content and journal articles in the Online Library is to use the **Summon** search engine.

If you are having trouble finding an article listed in a reading list, try removing any punctuation from the title, such as single quotation marks, question marks and colons.

For further advice, please see the online help pages: www.external.shl.lon.ac.uk/summon/about.php

## Using the internet

As noted above, the set text has a website at www.prenhall.com/laudon and if you have access to the worldwide web you should take a look at the site and what it offers. You will also note that the book contains relatively few other web addresses. This is very sensible, since web addresses and resources change rapidly, and it does not make much sense to publish them in a book when they can be published from within the web itself. Thus the book's website contains links to other sites that relate to individual chapters. The same problems relate to providing web addresses in this guide – they may well change – but there are a few included here that you may find useful.

http://itmanagement.earthweb.com/ The website of the magazine *Datamation*.

http://foldoc.org/ The free online dictionary of computing maintained at Imperial College, University of London. This is mostly about computer technology, but it has a useful coverage of some information systems topics.

http://isworld.org/ This is the main website for the academic information systems community in universities around the world. Links to many other sites.

http://en.wikipedia.org/wiki/main-page Wikipedia – A good source for material on history, science and technology.

Unless otherwise stated, all websites in this subject guide were accessed in April 2011. We cannot guarantee, however, that they will stay current and you may need to perform an internet search to find the relevant pages.

## Overview of the subject guide

This course is concerned with how information and communication technologies (ICTs) are understood, designed, applied and used within organisational settings, with a particular focus on business organisations. To understand how best information technology can be applied and exploited by an organisation, we need a conceptual lens to study that particular organisation and develop an information system accordingly. Thus, after a lengthy premise concerning how computers work and their physical characteristics in terms of hardware and software (see Chapter 3), we paint the traditional view of information technology based on the technical school of management (see Chapters 4 and 5).

Chapter 4 delves into traditional models of software development such as prototyping, structured development methodologies and their particular techniques. Chapter 5 takes stock of these ideas and attempts to cast them into a broader theoretical fabric by arguing that the core ideas of conventional software design are based on the concept of data and information flows. Accordingly, the data model of information systems design is introduced and its social and organisational limitations are emphasised throughout the chapter to stress that information systems designers should take into account existing organisational structures and practices.

Chapter 6 subsequently portrays an alternative model of organisations and information systems according to which information systems should support decision-making processes, because organisations themselves are sets of decision flows. Instead of discarding the social side of information systems, therefore, this approach takes cognition in general and decisions in particular seriously. In further detail, the chapter identifies different types of decisions lying on a spectrum ranging from structured/programmed decisions to unstructured/non-programmed decisions and pinpoints the information systems associated with each type of decision. The overall argument is that the more one considers operational activities lying at the bottom of the hierarchy, the higher the level of programmability of the decisions themselves.

Chapter 7 develops an alternative model of organisations and information systems which moves from the assumption that organisations are bundles of transactions involving people who behave opportunistically. The crux of designing information systems, therefore, consists of reducing or even eliminating opportunism. According to this perspective, not only do information systems mediate the transactions between and among the parties; they also create, set up, control and maintain the organisation's constituent contracts so as to eliminate possible frictions that might emerge between and among the transacting parties. The transaction-cost approach suggests that there should be a fit between organisational form and information system. In particular, markets and teams should resort to distributed information systems while hierarchies should resort to centralised systems.

Chapter 8 shows that the transaction-cost approach is a useful heuristic to explain information systems strategies at the firm, business and industry level. Although ICTs reduce the transaction costs associated with business transactions, the chapter shows that firms might find it more beneficial to internalise those transactions that occur relatively more frequently with specific units or business partners. Strategic information systems and e-commerce are discussed in the final sections of the chapter by emphasising how the transaction-cost approach can help explain the strategic use of inter-organisational information systems, as well as the trend toward electronic markets.

## Experience with computers

You are not expected to undertake any particular work with computers as part of the syllabus for this course. There are no specific requirements, for example, to be able to use a word processor, build a spreadsheet, surf the net or develop a database. However, to the extent that it is possible, you should make some practical use of computers and reflect on what they can and cannot do. It is very hard to write convincingly about information systems if you do not have at least some experience of using computers. Note that examination questions may ask you to reflect on your own computer usage or experience with packages or the internet. As a starting point, here are eight activities that you might usefully undertake to 'brush up' your knowledge of using computers and to get you thinking. Attempt as many as you can, but students with limited access to computers need not feel too constrained – you will have more time for other forms of study!

1. Learn how to prepare and use a mail-merge feature of a word processor to prepare a personalised mailshot. Once you have figured out how to do this, try to write some instructions for a less computer-literate friend to explain how to do this. How easy is this? What does it tell you about the problems of introducing a new system to people in a work situation?

2. Visit the website of an online bookstore and discover how easy (or not) it is to buy recommended textbooks for University of London programmes. How do the online prices compare to those in your local bookshops?
3. Visit the main website of your government and discover a recent government policy statement or proposal for 1) computers in schools, 2) computers in health care and 3) the promotion of e-commerce. In the UK the place to start such a search is at www.direct.gov.uk
4. Try to use email to do something useful beyond your own circle of friends, college staff or workplace. For example, can you use email to communicate with your bank, a government office or your local library? What are the advantages and disadvantages of this form of communications for you? What would you imagine are the advantages and disadvantages for large business organisations?
5. Look at the websites of three e-commerce companies that operate from your country. Evaluate the quality of these sites by using them to gather information and prices for a good; for example a computer. What broad criteria will you use for your evaluation?
6. Use a spreadsheet to develop a simple decision support system (DSS) to work out the best deal available on broadband connections, based on advertisements in your local newspapers.
7. Use a word processor or graphics program to prepare a poster for a college event. Try to include some pictures downloaded from the web, scanned in, or taken with a digital camera. Do the same activity, but as a web page. To do this you can use software that comes free with your web browser – for example, Microsoft Front Page Express or Netscape Composer.
8. Using a spreadsheet, develop an application that helps you in some other area of study associated with your degree programme, for example in statistics, economics, sociology, management science or accounting.

## Syllabus

This course replaces, and cannot be taken with, course **37 Computer-based information systems**. There are no prerequisites for this course.

### Section 1. Background and models of information system design

#### A. Introduction

Overview of the basic functionalities of a computer; hardware functions; operating systems; application software; networks; internet and internet protocols.

#### B. Information systems design

Logics underpinning information systems design; prototyping; organisational analysis and requirement analysis; information systems design as outcome of organisational analysis; limits of the models.

#### C. Theory for information systems design and analysis

- Why and how people in organisations use, produce and communicate information.

- What is the role that information technology can play with respect to the human information processing identified above?
- How to design information technology applications that support the current or desired ways to process information.
- How to implement the designed systems and applications.

Three main theories are presented and discussed in the course: **data model**; **decision-making model** and **transaction-costs** model.

### Section 2. Information systems and business strategies

The following topics are approached from both the 'hard' technological view and from the 'softer' sociocultural view:

- Strategic management and use of information systems and technologies to help firms accrue a competitive advantage.
- Strategic information systems planning.
- Strategic use of data and knowledge management, change management and more.

## Examination advice and structure

**Important:** the information and advice given here are based on the examination structure used at the time this guide was written. Please note that subject guides may be used for several years. Because of this we strongly advise you to always check both the current *Regulations* for relevant information about the examination, and the VLE where you should be advised of any forthcoming changes. You should also carefully check the rubric/instructions on the paper you actually sit and follow those instructions.

Remember, it is important to check the VLE for:

- up-to-date information on examination and assessment arrangements for this course
- where available, past examination papers and *Examiners' commentaries* for the course which give advice on how each question might best be answered.

The examination for this course is a three-hour unseen written examination. You will be expected to answer THREE questions from a choice of SIX. All questions carry equal marks. You may be asked questions about anything that is in the syllabus. A sample examination paper is given at the back of the subject guide.

We expect answers to analyse in depth the problem addressed in the question.

The questions have to be answered in an essay format. We expect that a suitable length for an essay in answer to one of these questions would fill a minimum of four sides of your answer booklet.

We do not want to read pre-packaged answers to the questions; the answer to a question has to be related to the specific problem that is formulated in the question, and must analyse in depth to provide a proper overview and analytical perspective on the problem. Too often we find answers that are only minimally related to the question. An examination answer that does not answer the examination question is not going to be awarded a good mark.

You need to read the question carefully and formulate an answer that covers the different aspects addressed in the question. Every year the examination paper will cover almost all the topics of the syllabus; there is no standard sub-set of topics that are always chosen for the examination paper.

Some students spend far too much time writing a very long answer to one of the questions and so are not able to finish the examination by providing answers to the required number of questions. Often students fail the examination because they are not able to manage their time and write answers to the three questions required; please use your time very carefully. You need to use some of the examination time to reflect on how to structure the answer but you will need to be careful in how you divide the rest of the three hours. Good answers show that the problem has been clearly understood and analysed in light of the concepts discussed in the syllabus.

Every chapter of the subject guide proposes activities, mainly short questions that have to be answered to check if the concepts discussed in the individual chapters have been understood. These activities are not like examination questions. Examination questions are broad and necessarily cover concepts and notions that are discussed in more than one chapter of the subject guide. This is why the subject guide does not offer sample examination questions at the end of each chapter. To answer the examination questions properly it is necessary to understand the overall conceptual structure of the syllabus.

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**Activities**

1.1 Compare and contrast the benefits of a printed user guide or an online help system for the users of a software product. Which would be most use to a) a novice user, b) an occasional user with limited experience, or c) an expert and frequent user?

1.2 Identify four key characteristics of successful sales-oriented websites, based on your web browsing experience. Justify each characteristic and give related examples of good and bad practice you have seen on the web.

1.3 Describe the basic functionality provided by **one** of: a) a web browser, b) a database package or c) a spreadsheet program. Explain, using examples from your own experience of using one of these types of software, how a user might format and prepare output for inclusion in a word processed report.

1.4 Prepare a report describing the differences between three well-known internet search engines, for example Yahoo, Google, or AskJeeves. Suggest situations in which you would recommend each of the search engines you have studied.

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# Chapter 2: Theories of information systems

## Essential reading

Laudon, K.C. and J.P. Laudon *Management Information Systems: Managing the Digital Firm*. (Harlow: Pearson Education, 2012) twelfth edition [ISBN 9780273754596], Chapters 1–3.

## Further reading

Ciborra, C.U. *Teams, Markets and Systems: Business Innovation and Information Technology*. (Cambridge: Cambridge University Press, 1993) [ISBN 0521404630] Chapters 1 and 6.

## Introduction and aim of the chapter

This chapter discusses the three perspectives on information systems that will inform this subject guide. Besides providing the logic behind every single perspective, the chapter attempts to show the perils deriving from an all-encompassing view of information systems as socio-technical systems. The final section portrays a detailed overview of the subject guide.

## Learning outcomes

By the end of this chapter, and having completed the Essential readings and activities, you should be able to:

- outline the pitfalls of an all-encompassing view of information systems as socio-technical systems
- comment upon the basic ideas behind the three different approaches to information systems, the data model, the decision-making model and the transaction cost model, and their managerial foundations.

## Perspectives on information systems

Information systems are sets of interrelated components that collect or retrieve, process, store and distribute information to support decision-making, coordination, control, analysis and visualisation.

The study of information systems is normally premised on the assumption that information systems are **socio-technical systems** that encompass both technical and social variables. Standard textbooks ordinarily assume that the design, development and deployment of information systems has far-reaching consequences that go well beyond the technical components of the information system in question. Yet information systems designers themselves seem incapable of dealing with all these variables simultaneously because of their limited ability to process information. It is as though there is an underlying theory of information systems that is explicitly or implicitly invoked to legitimise investments in IT by information systems managers and designers alike. We call a theory the complex set of answers that are given to four basic questions:

- Why and how do people in organisations use, produce and communicate information?

- What is the role that information technology can play in relation to the human information processing identified above?
- How to design information technology applications that support the current or desired ways to process information?
- How to implement the designed systems and applications?

The body of theory that is able to address all these concerns represents in our view a paradigm for the information systems (IS) discipline in the sense that it provides meaning about the role played by information in organisations; it identifies as well the role and impact for systems in organisations; it gives ideas and inspires the development of methodologies to design, develop and implement systems in organisations and predicts the pattern of use of such new systems by organisation members. The paradigm thus influences the ways in which information-processing systems are conceived, designed and used. It inspires the development and deployment of methods to carry out such activities and improve them. It sets the stage to carry out experiments and try out and compare new practices. It legitimises and gives meaning to practitioners of why and how systems ought to be built, and how they should be introduced and utilised.

Broadly speaking, there are three different paradigms on information systems, namely the technical, the cognitive and the behavioural perspectives. The technical approach emphasises mathematically based models to study information systems, as well as the physical technology and formal capabilities of these systems. It draws on management science, operation research and computer science. The cognitive approach draws on socio-psychological theories to study how decision-makers perceive and use information. Finally, the behavioural approach draws on economics to study the behavioural issues that arise in the development and long-term maintenance of information systems.

Throughout this subject guide we will refer to these three different perspectives on information systems as the **data model**, the **decision-making model** and the **transaction-cost model** respectively. These are three perspectives or lenses with which to look at the role played by systems and networks in organisations and will be the main themes of analysis in the following chapters.[1]

These lenses are filters that we use to analyse the organisation and its needs so as to design and implement the information systems that are proper for the specific organisation. These solutions are, however, proper in the sense that they match the requirements that have been identified throughout the use of the chosen lens, such as the data approach, the decision-making approach and the transaction-cost approach.

It should be noted that every analytical model, and hence our 'lenses' as well, cannot see everything that is needed to improve and maximise the organisational performance. A lens is able to magnify specific elements but, in so doing, is discarding other elements. This means that every approach used to inform the design of an information system is limited by the scope of the analytical model at hand. Here we clearly assume that it is not possible to have an analytical model, or lens, that is able to identify all the possible needs of an organisation. This means that we are always designing information systems that are, by definition, limited in scope by the chosen analytical model. Not only is any analytical lens incapable of capturing the full organisational richness; the ensuing information systems design will arguably be limited by the analytical lens so adopted. Figure 2.1 describes this process.

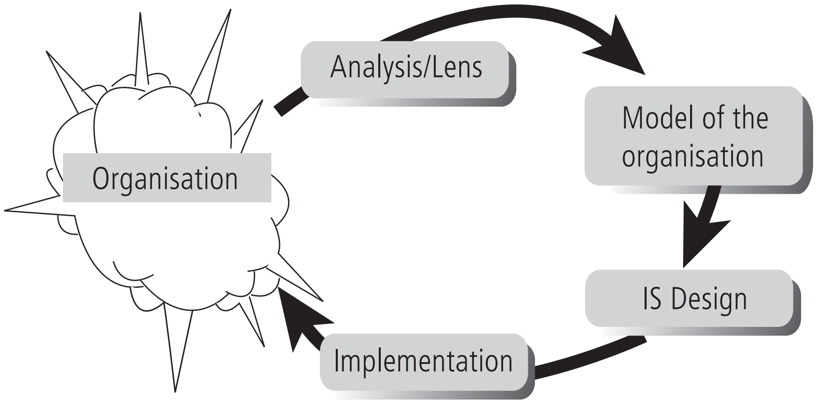


**Figure 2.1. IS design as a model-driven endeavour**

Despite the argument that information systems should be considered as **socio-technical systems** with social as well as technical components, we assume that systems designers themselves are **boundedly rational** because of their limited ability to process information. This assumption, in turn, calls for the use of a specific model to study organisations and design information systems accordingly. By choosing a specific model, information systems designers are implicitly discarding alternative conceptions of the organisation and information system at hand, thus highlighting certain variables rather than others. A brief description of these three models follows.

## The data model, the decision-making model and the transaction-cost model

Schematically, and briefly, the **data model** assumes that the organisation may be conceptualised as a data flow and, therefore, information systems should be designed to improve data flows rather than decisions or transactions. Hence, as an analyst, you should only consider the data flows and files in the organisation and you should use structured methods to capture and include them in formalised (computerised) routines regardless of existing organisational structures and practices. Although very helpful, you should note that these assumptions underestimate the importance of the socio-cultural elements that define the characteristics of the organisation and of the people working there because, as stated above, the data model belongs to the technical perspective which, by definition, does not account for the socio-cultural context.

While the data model assumes that, in applying an information system to an organisation, it is only necessary to consider the data flows and files in that organisation, the **decision-making model** starts from a different assumption: rather than looking at data flows, the organisation is conceptualised as a bundle of decisions. Hence, it is in relation to decision-making that information systems should be conceived and should prove their value because, according to this perspective, information systems should support decision-making. Although insightful, this view misses the fact that individuals might act **opportunistically** to maximise their objectives so as to distort, misrepresent or manipulate information to their own advantage. Obviously, the design of information systems will be more complicated whenever phenomena of opportunistic information processing occur because opportunism lowers the degree of mutual trust.

This insight is taken seriously by the **transaction-cost approach** to information systems because this approach is premised on two assumptions: first, organisations are conceptualised as bundles of transactions rather than decisions or data flows; second, in engaging in these transactions, individuals themselves will act opportunistically. Thus, information systems have to be designed in such a way that they will curb opportunistic behaviours. According to this perspective, not only do information systems mediate the transactions between and among the parties; they also create, set up, control and maintain the organisation's constituent contracts so as to eliminate possible frictions that might emerge between and among the transacting parties. Ultimately, these three approaches represent ways of magnifying specific aspects of the organisation so as to design information systems accordingly.

**Activities**

2.1 Suppose that you are a consultant whose job is to design a new information system in an organisation where people behave in an uncooperative fashion. Which approach to information systems would be more viable in this situation? Why?

2.2 Could you argue for and against the thesis that information systems are socio-technical systems?

## A reminder of your learning outcomes

Having completed this chapter, and the Essential readings and activities, you should be able to:

- outline the pitfalls of an all-encompassing view of information systems as socio-technical systems
- comment upon the basic ideas behind the three different approaches to information systems, the data model, the decision-making model and the transaction cost model, and their managerial foundations.

# Chapter 3: Information and communications technology

## Essential reading

Laudon, K.C. and J.P. Laudon *Management Information Systems: Managing the Digital Firm*. (Harlow: Pearson Education, 2012) twelfth edition [ISBN 9780273754596], Chapters 5, 9 and 13.

## Further reading

Alter, S. *Information Systems: A Management Perspective.* (Reading, Mass: Addison Wesley, 1999) third edition [ISBN 0201521083] Chapters 8–10.

Bocij, P., D. Chaffey, A. Grasely and S. Hickie *Business Information Systems: Technology, Development and Management.* (London: Financial Times Pitman, 2006) [ISBN 0273688146] Chapters 3–5.

Curtis, G. and D. Cobham *Business Information Systems: Analysis, Design and Practice.* (New Jersey: Pearson Education, 2005) fifth edition [ISBN 0273687921] Chapters 1, 3 and 4.

## Introduction and aim of the chapter

In this chapter we consider the technologies available for building information systems. The chapter is structured in terms of hardware, software and networks, but an information system usually requires a mixture of all three working together. Most introductory books provide an adequate coverage of basic technologies, though only texts written since the late 1990s will cover the explosion in interest and significance of communications and the internet. The intention of this part of the course is to achieve a broad logical understanding of how a computer works, the principal component parts of a computer system and the physical characteristics of computer hardware that constrain its use. Beyond that we need to understand the potential of new technologies and the management challenges they pose.

## Learning outcomes

By the end of this chapter, and having completed the Essential readings and activities, you should be able to:

- outline the history of the development of computers
- describe how a modern computer works and its main component parts including storage and input/output devices
- list and describe the main types of software found on contemporary systems including the operating system
- classify various types of telecommunications network and evaluate their characteristics.

## The history of computers[1]

The computer is usually acknowledged to have been 'invented' during the Second World War. Both the ENIAC machine and the Harvard Mark 1 were developed by teams in the USA in order to undertake the intensive computations required for the calibration of artillery. At the same time in Britain engineers from the British post office, using technology that was drawn from telephone exchanges, developed the Colossus machine for deciphering intercepted military communications. Two names stand out from this period, those of the American John von Neumann, who worked on ENIAC and first wrote about the basic problems of computer design and explored the stored program concept. The other is the British mathematician Alan Turing who in the 1930s had provided a general mathematical model of a computing machine, and subsequently worked on the Colossus machine and other early British computers. Of course, ideas of aiding or automating calculation and information storage are much older than that and the abacus (over 4000 years old) is still in widespread use today.[2] Key names in the pre-history of computers include the French mathematician Blaise Pascal who developed an adding machine in 1642 and Gottfried von Leibnitz who developed a stepped-wheel calculator in 1671. The Victorian engineer and mathematician Charles Babbage designed two ambitious mechanical calculating machines – the analytical engine (1835) and the difference engine (1859). They were never completed in Babbage's lifetime and this is usually attributed not to a flawed design as much as to a lack of engineering skills.

*[1] An excellent brief treatment of the history of computers is found in the Encyclopaedia Britannica. Try their website.*

*[2] Internet resources relating to the history of computing include http://ei.cs.vt.edu/~history/*

The next development in the history of computing is generally attributed to the American engineer Herman Hollerith who developed tabulating machinery for the USA census of 1890. This was based on punch cards that held data in the form of holes, a technique that had previously been used in controlling patterns and colours in weaving looms. Joseph-Marie Jacquard, a Frenchman, had invented the Jacquard loom in the early 1800s. In Hollerith's machines, stacks of cards could be run through a machine to count the number of cards with holes in particular positions. The technology that Hollerith pioneered rapidly took off for census applications (counting) and quite soon for more general information handling that included multiplication. The company Hollerith founded went on to become a part of the present day IBM. By the early twentieth century such machinery was in fairly widespread use and punch cards or punched paper tape was a primary form of computer input well into the 1970s and is still used in some applications today.

## Hardware

The prehistory of the electronic computer is important to consider because it tells us that information handling is not a concept dreamed up in the late twentieth century but has been a part of our world for far longer. In this section we stay with history a bit longer to consider the recent past of computer hardware, usually spoken of in terms of generations of machines and technologies.

### Five generations of computer hardware

The first generation, from about 1946 to 1955, was experimental and exploratory as many technologies were developed and tried out. Building data storage devices reliable and fast enough to work alongside the actual processor was a particular problem. Among the technologies used for storage were vacuum tubes, as well as Williams tubes (CRT tubes), mercury delay lines and magnetic coated drums – forerunners of today's disks.

In the second generation, from 1956 to 1963, computers were being built in increasing volumes and were based not on vacuum tubes or valves but on the transistor which had been invented at Bell Laboratories in the USA in 1948. High-speed storage was developed based on magnetic cores threaded by a matrix of wires that permitted accurate, reliable and relatively high-speed storage of small amounts of data.

The third generation is generally understood to have commenced in about 1964 with the advent of the IBM 360 range. This was a mass-produced family of machines using small-scale integrated circuits (that is, more than one transistor per component) and later medium-scale integrated circuits. Main storage was based on magnetic cores. The basic secondary storage used was magnetic tapes. Disk storage was increasingly available in the form of expensive disk drives, some of which supported exchangeable disk packs.

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**Activity 3.1**

Why was it significant that disk packs were exchangeable?

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The fourth generation can be dated as starting from any time between 1975 and 1981. The key technology that distinguishes it is the use of very large-scale integrated (VLSI) circuits (chips), both for building the processor and, more importantly, for the main memory. At first, this technology was used in building mainframes and minicomputers, but from the early 1980s, with the development of the single-chip microprocessor that could be mass-produced, it provided the basis for the explosive development of microcomputers.

Technology is now developing so fast and in so many directions that a fifth generation of computer hardware is hard to delineate exactly. However, the phrase 'fifth generation' was taken up in the 1980s to describe parallel computer architectures supporting 'knowledge-based' systems. In particular, the Japanese government launched a major 'Fifth Generation' project in the early 1980s. Perhaps it is more useful to think of the fifth generation as being computers linked to networks and dating to about 1988.

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**Activity 3.2**

Read Chapter 5 of Laudon and Laudon (2012) with the following question in mind. How should a senior information systems manager evaluate new technologies as they arrive on the market?

## Modern taxonomy of computers

Today it is usual to classify computers into various distinct types and students should be familiar with this terminology.

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**Activity 3.3**

It is a useful exercise to crosscheck these technical definitions and descriptions with the Free Online Dictionary of Computing (FOLDOC) website (http://foldoc.org/).

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**Supercomputers** are machines designed to undertake high-speed computations. They are usually used for performing engineering and scientific calculations. An example of a supercomputer use would be weather forecasting, mapping human genes or simulating an aircraft in flight (for an engineer, not in a computer game).

**Mainframes** are the largest general-purpose computers. They are the basis for large centralised data-processing applications (transaction processing). An example would be the computers of an airline that handled seat bookings. Both mainframes and supercomputers generally require special buildings with air conditioning and cooling systems to keep the computers running. They are appropriate for high-volume applications with extensive data storage requirements. They are also often used as network servers.[3] The resurgence of demand for mainframe computers in the late 1990s can be traced to their new role as network servers within the developing uses of the internet.

*[3] A server is a computer on a network that provides some services to other computers. These services may be, for example, providing email, web pages, data, software or information processing.*

**Minicomputers**. In the 1970s smaller computers were developed that could be installed in ordinary rooms without extensive air conditioning, power supplies and so on. They were of limited power compared with mainframes but were substantially cheaper. They were typically used to provide interactive computing using terminals. Minicomputers are still used to provide computing shared power in individual locations (a bank's branches, a supermarket, a laboratory, etc.) linked by communications facilities. Such minicomputers are used often to perform the types of task that previously were undertaken by mainframes, and the distinction is today blurred. Indeed, for a business organisation which needs a powerful computing facility (for example, to service a website) there is a basic choice to be made between using a mainframe or a set of networked minicomputers.

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**Activity 3.4**

List the reasons for choosing a single powerful computer for a business website versus hosting it on a network of minicomputers.

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**Microcomputers**. These arrived in the late 1970s, based on the VLSI technology that allowed the development of the microprocessor. Today they are far and away the most common type of computer that we encounter and they allow all manners of people to have immediate and dedicated access to a computer. Hence their name has changed to the PC (personal computer). A microcomputer will generally only let one person use it at a time, though they may be able to run more than one program. Today the PC comes in many varieties, including portable and laptop computers, palm top computers and, before long, integrated mobile phones and computers giving 'internet everywhere'.

**Workstations**. A workstation is in one sense just a powerful microcomputer, but it has developed a distinct character as the computer used by scientists, engineers and computer professionals. This is in contrast to the general-purpose minicomputer and PC. Workstations have high-quality graphics screens and pioneered WIMP (Windows, Icons, Menus and Pointers) interfaces. Today it is hard to be sure of the distinction between a workstation and a powerful microcomputer.

As we have already noted, computers are now usually connected to networks, and thus we can also describe them in terms of their role within a network. It is usual to identify two particular roles – that of the **client** computer that provides the interface to the human user and does local processing, and that of **server** computers that provide services across the network. Thus my desktop PC is a client computer, and it connects to a mail server computer across the network when I send or receive email. My incoming mail is held on the server computer until I collect it, and the server computer takes care of forwarding my outgoing email when I click on 'Send'. Client–server computing based around networks is the basis for most contemporary information systems (and the internet itself) and allows for distributed systems with distributed databases and distributed processing.

## Basic concepts of modern computer hardware

Whether a computer is large or small, an elementary model of a computer can be based on four interconnected elements: input device, output device, memory (or storage) and a central processing unit (CPU). In a microcomputer the CPU will consist of a single microprocessor fabricated on a silicon chip, while in a supercomputer the processor may be 100s or even 1,000s of processors working in parallel. Figure 5.1 in Laudon illustrates this, but adds a few refinements. Memory is split into primary and secondary storage, and they add communications devices as a further element. Thus, they arrive at six main elements in this 'logical' computer.

#### Activity 3.5

Locate the similar section in Curtis et al. (2005) and one or two other books and compare the basic description of a logical computer they give.

Instructions to the computer as to what it is to do (its program, software), as well as data, are entered via the input device and stored in the memory. From there the instructions can be fetched and executed by the CPU. As a result, the data stored in the memory are manipulated in various ways and the results can be displayed via the output device. This simple model needs to be fleshed out a bit in two directions. First, the processor can be seen as essentially having to perform two functions. It must follow program instructions and it must manipulate data items. It must understand when it is being told to add two numbers together, then it must go ahead and find the two numbers stored in the memory, perform the task, and place the result back into memory. Thus, the processor can be split into a control unit that understands program instructions and an arithmetic and logic unit (ALU) that carries them out. To perform this simple task, the control unit will coordinate the activities of fetching items from memory, performing actions in the ALU and returning a result to memory. More generally, the control unit communicates with all the component parts of the computer as it obeys instructions. The speed of the processor (measured in MegaHertz millions of cycles per second, MHz) is one of the fundamental limitations on the power of any computer, but only one. The larger task of managing the coordination of the component parts is largely left to software, in particular, the operating systems (see below).

### Data in the computer

The concept of memory also needs to be explored a little more. It is essential to the character of a computer that it is a stored program device and programs are stored in memory. The memory that holds the current program and the current data needs to be able to deliver this to the CPU at great speed. There is in this simple model only one CPU and it must not be kept waiting! This memory, referred to as RAM (random access memory), main memory or primary storage, is built today out of very large-scale integrated circuits (VLSI), more popularly known as microchips. Such memory is plugged into the body of the computer with direct connection to the CPU. RAM is relatively expensive and will be relatively small in terms of the amount of data it can store. When you turn off the computer power whatever is stored (the data) is lost. Thus, it is said to be volatile storage.

Everything stored in a computer is data and that includes programs. However, from the point of view of the storage devices of a computer it is all the same. Data are stored in a computer in the form of binary patterns, sequences of 1s and 0s. The one and the zero can be stored in terms of an electrical charge or a magnetic polarity. The details of such storage need not concern us. The basic unit of storage is the bit (one binary digit – a 0 or a 1), but it is more common to group eight bits together as a byte. Bytes form the basis for measuring storage capacity, as in a Kilobyte – $10^{24}$ bytes or $2^{10}$; a Megabyte – $2^{20}$ bytes (just over 1 million); a Gigabyte – $2^{30}$ bytes; and a Terabyte – $2^{40}$ bytes. Megabyte and Kilobyte are often abbreviated to Mb and Kb or even M or K.

Data in a computer can be thought of as being of different types. There are numeric data, textual data, graphical data (pictures), video and sound data, as well as programs (program instructions). Each form of data has its own way of using the storage capability (RAM or secondary storage). Just to look at a pattern of 1s and 0s it is not possible to tell what type of data is being stored, but once the type is known, then the pattern can more easily be decoded. For example, the binary pattern 01001011 represents the letter K in the ASCII code for representing text, as well as the decimal number 75 if interpreted as a binary number. It can also represent the machine code instruction 'add'. Text is stored in a computer according to standard systems of encoding, usually some version of the ASCII code. Each character is stored in one byte. Thus a name and address of 80 characters will use 80 bytes of storage. All the printing characters that you can generate from your keyboard have an equivalent representation in the ASCII code. In addition, there are some non-printing codes, such as end-of-line, backspace, line feed and so on.

Each design of processor will have its own machine code (its own instruction set), and specify the particular representations for those instructions in binary patterns. A typical instruction may take one, two or three bytes of storage, remembering that instructions need to say what to do and to which item(s) of data to do it.

## Secondary storage devices

Main memory is volatile but data (including programs) need to be stored permanently, securely and economically. Therefore, computers have further forms of non-volatile storage, referred to as secondary storage or backing store. Two classes of secondary storage can be identified: direct access devices (DASD) and serial access devices. A direct access device allows individual blocks of data to be selected and read as required. A serial access device allows data to be accessed most efficiently in one fixed sequence and not as requested. An analogy can be drawn with the contrast between a cassette tape or a compact disk (CD). On the tape the sequence of the music is fixed and searching for individual items takes time, whereas with a CD it is possible to select tracks at will and in any order with a minimum time penalty. Tapes are described then as serial access devices, while disks are described as direct access devices. Note that this usage leaves random access device as a phrase to describe the main memory of a computer.

The most common form of direct access secondary storage is the magnetic disk, ranging from the exchangeable floppy disk with modest storage capacity (say 1.4 to 2.88 Megabytes) to the fixed hard disks in microcomputers with perhaps 4 to 10 Gigabytes. In larger systems disks may have capacities of 100s of Gigabytes.[4] On a disk, data are stored in concentric tracks, and read or written by a moveable read/write head that

*[4] Remember, 1 Gigabyte = 230 bytes – a big number.*

shifts between tracks. As the disk spins the data can be read or written. Large-capacity disks have multiple disks rotating on a single spindle, and a comb-like structure of read/write heads that move in and out across the disks. The noise that you hear as the disks operate is these heads being moved and precisely positioned. Since it is a direct access device, data are written and read in fixed-size chunks, referred to as blocks.

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**Activity 3.6**

Find out as much as you can about the size of the ROM, RAM and secondary storage devices of any computer you use. Try to find out the costs of adding an extra 1 Megabyte of RAM, and 1 Megabyte of various forms of disk space. What is the ratio of cost of 1 byte of primary storage to 1 of secondary storage?

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Magnetic tapes are also still used as secondary storage. They have the advantage of having large capacity and being cheap, but a tape in contrast to a disk is only capable of being read in a serial manner and does not provide the direct access capability of a disk. For that reason tapes are generally seen as suitable only for certain tasks such as backing up data stored on disk or holding data files that will always be processed in a given sequence – for example, a payroll of employees, each of whom needs to be paid at the end of the month. There are also good standards agreed as to the format of data on tapes and this makes tape an acceptable medium for interchange between computers. Computer disks have the great advantage of permitting the direct access for a given item of data without requiring the reading of all items up to and including the items sought. The direct access capability of disks makes them the usual first choice for secondary storage. To achieve even greater storage capacity assemblies that hold multiple (tens or more) hard disks together are used and called RAIDs (redundancy arrays of inexpensive disks).

The most recent technology to be used for secondary storage is the optical disk, similar to the compact disk that is used for music recording. The optical disk (CD-ROM or DVD) has problems in that, while it has large capacity to store data (about 4 Gigabytes in standard DVD formats), it is not so easy or quick to write data to such a disk. Writing permanently to an optical disk may be very suitable for some situations where it is desirable that data cannot be erased once written – for example, for security reasons, for back-up or for distribution. Optical disks have been very successfully used in distributing high volumes of information that will only need to be read. Thus, dictionaries and other reference books are increasingly distributed in this form, as is computer software. One day even University of London subject guides may be distributed this way.

## Input and output devices

Computers need to be able to receive input and to display the results of their labours. Thus, all systems will have some form of input and output devices. Students should study a variety of such devices including the basics of keyboards, screens and various types of printer. The machine upon which this is being written has as input a keyboard and a mouse. For output there is a colour VDU screen and a laser printer. Other forms of input device and input media would include barcodes read by a scanner at a supermarket till, the magnetic ink character recognition (MICR) system used on bank cheques or a scanner used to enter a photograph or drawing into a computer.

**Activity 3.7**

Conduct a survey of the various types of input and output devices used in local shops and stores. Include the devices used to monitor stock arriving, on the shelves, the capture sales of goods, as well as those used to capture the means of payment.

Video cameras can now be hooked up to computers and the images manipulated by the computer. As technology has developed, new input devices have become widely available; for example, we can use voice recognition systems that take human speech as input or handwriting recognition systems.[5]

When considering input and output it is useful to recognise that any output from a system may need to be subsequently input. Thus, it is often desirable that data are generated and output by a computer only for it to be subsequently read into another one. Thus barcodes or magnetic ink characters can be printed by one computer and subsequently read by another, or it may be appropriate at times to think of a floppy disk as an input–output medium. Computer networks too can be a medium for linking the output of one system as the input for another.

[5] *If you were designing an information system to be used by foreign exchange dealers as they trade currencies in a busy dealing room, what particular characteristics would you want in input and output devices?*

**Activities**

3.8 What are the main benefits of adopting a client–server approach to providing computer hardware for a medium-sized government ministry with many regional offices?

3.9 Try to enumerate as many costs as you can which a company incurs when it places a personal computer on an employee's desk.

3.10 Describe the basic structure of a modern desktop computer in logical terms. Give examples of the technologies used to provide the different functions.

## Software

Computers require programs (software) in order to run; the computer hardware described above can do nothing useful unless it has some instructions to follow, some software. It is useful to delineate some general classes of software that would be found in a general-purpose computer. It is usual to differentiate between systems software that helps the machine to operate and applications software that performs some useful task for those using the computer.

**Activity 3.11**

Read Chapters 5, 6, 7 and 10 of Laudon and Laudon (2012) with the following question in mind. How can an IS manager keep up with the endless demand for more software to support new information systems?

### Operating systems

The operating system is the principal item of systems software. It is described in some detail here because studying the operating system is a useful way to understand the nature and functions of computer hardware. The operating system manages the hardware resources of the computer and organises the running of programs. It also provides the user with the means of controlling the computer, and a user of a computer communicates with the operating system in order to get the computer to undertake some task – for example, to run a program or print a file. In most of today's operating systems this user interface is based on the

WIMP concept (Window, Mouse, Icon, Pull-down menu) which combines these features for more effective communication with the user. The Apple Macintosh, Microsoft Windows and the IBM OS/2 are examples of operating systems providing a common, consistent and sophisticated graphical user interface (GUI) for application programs to use.

All computers require an operating system of some description. One way of viewing the main task of an operating system is that it allows the initiation and the running of other programs. When a person wishes to run a program, for example a spreadsheet, they tell the operating system the name of the program (or click on an icon) and ask that it be run. In order to do this the operating system has to do the things described below.

#### Memory management

The operating system allocates memory to programs that are to be run and while they run. The spreadsheet has to be allocated some main memory in which to locate itself and to locate the data it manipulates. As more data are typed in to the spreadsheet, more memory may be needed.

#### Input–output management

The operating system will manage input and output devices to enable programs to obtain input (e.g. from a keyboard) and to direct outputs (e.g. to a screen or printer). The spreadsheet will need input from the keyboard. It will ask the operating system for some keyboard input and wait. When the user types at the keyboard it is the operating system that directly reads the keystrokes and passes them on to the spreadsheet program. The operating system may detect some special keystrokes that it chooses to interpret and act upon, rather than pass on to the spreadsheet. For example, the CAPS LOCK key tells the operating systems to pass all characters to the spreadsheet as capital letters.

#### Secondary storage management

This is done through a file system. The operating system will allocate space on a disk to contain a file and maintain a directory of file names and locations, so that a file can subsequently be located and read. When the operating system is told to run the spreadsheet, it is in effect told to find a file of program code and to load it into memory. Similarly, if in using the spreadsheet we decide to store the work that has been done, this will result in a request to the operating system to find some space on the disk, to give it a designated file name, and to write the contents of our spreadsheet on to the disk.

#### Processor management

There is one other main hardware resource that the operating system needs to manage, and that is the processor itself. In the simple model of a computer that we are concerned with we assume that there is just one processor and that it can do just one thing at a time (we should note however that real computers, even microcomputers, have in reality a number of processors dedicated to various specific tasks, e.g. controlling main memory, doing arithmetic, manipulating graphics images, etc.).

The operating system is just a program, so it needs to use the processor in order to achieve all the tasks described above. In the case of using the spreadsheet, the operating system will undertake the task of loading the program into main memory and then passing control to that program. The processor was being used by the operating system but is now being used by the spreadsheet. When the spreadsheet wishes to achieve an input or output task, such as printing some information, it passes a request to the operating system.

### Program management

The description given above suggests that in fact the operating system manages one other resource: programs. In the example there is just one processor to manage but two programs (the operating system and the spreadsheet). In a modern microcomputer operating system there can well be more programs, all wishing to share the processor. In larger computers, minis or mainframes this is the standard way of operating and hundreds of separate programs may be running simultaneously. In such a case the operating system has to ensure that all the programs get an appropriate slice of processor time, using it in rotation, or when they have specific needs. In general the operating system should allow itself to pre-empt any other program and use the processor when it needs to. This approach is known as pre-emptive multitasking.

When many programs are running simultaneously in a computer it inevitably complicates the other management tasks too. Memory cannot be shared between two programs, input needs to be directed to the right program and output devices such as printers need careful management. As you will gather from the above description, operating systems are complicated items of software. As hardware gets more powerful the operating software needed to make use of it gets more complex, and today an operating system for a microcomputer is a substantial piece of work. Operating systems now also support window-based user interfaces for handling user input and output, using a mouse and point and click methods (e.g. OS/2, Windows 95, 98 and NT, Mac OS).

Another area into which operating systems have developed is in managing a computer's connection to a network. In a local area network, for example, this may involve the operating system being able to retrieve and store files on a separate file server computer, which is shared by a number of computers connected to the network. Similarly, a network operating system may allow shared use of a print server, or a communications server to give access to wide area networks. More generally, operating systems provide the basic connections to the internet.

## Language translators

Programs, including operating systems and spreadsheets, need to be written before they can be run. When people write programs they use a programming language. A programming language is designed to help people to express what they wish to achieve. In general, the languages that are chosen to write programs in are chosen because they make it easy for people to express what they wish to achieve. Because they are oriented to help people express their needs and desires they are not usually appropriate for computers to understand in the sense of executing them directly. There is therefore the need to translate from the language a program is written in (say C++ or COBOL), to the language that the computer understands (machine code). Language translator programs, compilers or interpreters, undertake this task. A compiler translates once and for all and produces a new version of the program, the object code. An interpreter takes one statement of the source program, translates and executes it.

## System development tools

Writing programs in third-generation programming languages, such as COBOL, ADA , C++ or Java provides great flexibility in what can be done and supports efficiency in the delivered product. However, it does not support great productivity in the actual writing of programs. It has therefore become increasingly common for all types of computer application to be written using tools that provide more help to the developer and require less detail to be specified. A good simple example of this are the many database packages on the market. They provide an easy route to setting up storage of data and also provide tools to allow the design of input screens, output reports and the logic of processing information. A database package will provide some of the flexibility of a programming language but also provide high-speed and prepackaged solutions to standard problems. Examples would be the provision of sorting facilities or report generation.

Another similar development tool is fourth-generation languages – a programming system that provides the user with ready-made facilities for undertaking standard activities. The programmer thus does not need to specify in fine detail all the procedures required but can express programs in 'high-level' chunks. Facilities of a fourth-generation language will include general-purpose file handling and database manipulation, interface-building tools and a library to store standard functions. The web, of course, has also developed its own development tools and languages such as HTML, Java and XML, but most web development is based on tools to allow a developer to specify **what** they want, but without doing any real coding.

## Utilities

There are a large number of programs that you would expect to find on a computer which are there to help you use it. Examples would be a web browser to search the world wide web or an email client program to send and receive emails. Other utilities may allow users to manage their files, list them, copy them, make back-ups of them or delete them. Modern operating systems provide more and more functionality, but there will always be some extra tasks that a user would like and that a separate utility program can offer. More examples: checking a disk for viruses, making and managing back-up copies of secondary storage, and providing an appointments diary. Computer magazines are full of adverts for helpful programs that are supposed to make using a computer easier.

## Application packages

If utilities are programs that aid the computer user in using the computer, then application packages are programs that actually perform information handling that is useful in the wider world. Application packages can be bought for many standard business tasks. Payroll programs are a good example. Most payrolls in a given country have to perform the same basic set of calculations in order to compute tax and insurance contributions; most organisations will wish to keep similar information on their employees. The result is that there is a lively market in such standard applications and it makes good sense for most organisations to consider buying rather than developing such systems from scratch.

### User-written programs

It may be possible for even a fairly large organisation to perform almost all its information-handling requirements using purchased application packages and it is even more likely that a small business could operate in this way. Using purchased application packages is easier if an organisation is prepared to alter its ways of doing things so that they fit in with the package's capabilities. However, in most organisations there are some things that need to be done in a special or particular way and for which packages are not available, or those available are not suitable. At this point organisations have to begin writing their own programs. Of course, this is a significant commitment, and the extensive process of developing bespoke information systems has advantages and disadvantages that need not concern us here.

**Activities**

3.12 Describe the main functions of an operating system and a compiler. In each case do it first from the 'machine's' perspective and then from that of a user.

3.13 Prepare a brief report for an IS manager entitled 'Object-oriented systems development, the way ahead'.

3.14 Which is most important in a programming language: getting the best out of the hardware, getting the best out of the programmer or doing the best for the program's user?

## Communications technologies and distributed systems

**Activity 3.15**

Read Chapter 7 of Laudon and Laudon (2012) with the following question in mind. As networks are more and more central to information systems, what new issues are raised for IS managers? See also Alter (1999) Chapter 10.

Modern information systems rely on the technology of communications as much as they do on the traditional technology of computers and data handling. It is common practice for the information systems of organisations to require that multiple components be in many geographical locations – distributed systems. This calls for the communication of data across offices, cities, oceans and continents. For example, an oil company with offices and facilities on five continents would expect today to be able to share information and build common systems to help run the business. This would all be based on a complex set of interlocking networks in buildings, on oilrigs, in refineries and on ships at sea. The benefits of being able to use such systems might be more efficient operations, more sharing of information and the use of standard procedures. The use of a distributed approach may extend beyond one organisation, and networks can become a part of the way organisations do business with each other. The internet has provided an even stronger impetus for using communications in information systems.[6] Today this communications capability – 'the net' – is seen by many as the principal new challenge and opportunity for organisations as they build and use information systems, and it has not come to an end either. For example, the marriage of mobile phones with computers and the internet promises many more interesting and challenging applications in the future.

[6] *For information on the history of the internet try www.isoc.org/internet/history/*

## Wide area networks and local area networks

The basis of most wide area networking has, in the past, been the telephone system. Simple telephone connections can be used to transmit data, with the aid of a modem. Even so, telephone networks were built to transmit voices in analogue form, not computer data in a digital form, and they are not really suitable for high volumes and high-speed data transmission. The result has been the establishment of various special-purpose data communications networks able to provide better performance characteristics, including what we know as the internet. But even so, most home users and many business users still access the internet over a phone line and at modest speeds.

Projects for the modernisation of the telephone network to allow for efficient traffic of digital signals do allow computer users to share the same basic transmission facilities and achieve better levels of performance. In some countries and cities the cable television network is also being used to expand network coverage and speeds for domestic users. The general term to describe the modern digital network which supports voice communications as well as data communications is the integrated services digital network, or ISDN. Many countries have a programme for the establishment of ISDN as a means of communication, at least for business users. Nevertheless, the wholesale upgrading of the telephone system is a long-term project for many countries, and meanwhile business users may have little choice but to resort to special (and private) data networks based on leased lines.

Not all networks are for wide area use or rely on telephone technologies. Local area networks (LANs) are used to link computers within a restricted geographical range. Typically a LAN will connect computers in one building or one city block. They use special cabling, often based on fibre optics, and can transfer data at speeds in excess of 100 Megabits per second.[7] Microcomputers and workstations are usually linked by LANs and in this way can share resources. For example, a laser printer may be shared, or a database. If a dedicated computer is attached to a local area network to provide such services it is called a server. Thus a college computer system may have 200 PCs connected to one print server and four file servers. The file servers would then allow access to data and programs for a class of students.

*[7] 100 Megabits per second may be a conservative figure. Whatever figure we write here is bound to be exceeded before this subject guide is revised again!*

For information systems managers the rise in significance of networks has posed some new and challenging issues. Networks are not cheap and they pose particular security and reliability problems. They are also potentially powerful agents for change in how organisations operate and are managed.

## Internet

The internet is a hierarchical network that allows any connected device in one geographic location to talk to another connected device in another geographic location. To communicate, these devices need to be named in a univocal way so that it is possible to identify the computer we want to connect to. Every device connected to the internet is identified by a unique sequence of numbers.

On the internet, numbers, or internet addresses, are used to allocate and address each device on the network. These numbers are called internet Protocol addresses, or IP addresses. The current standard 'IPV4' is usually separated into four units, such as 161.184.138.36, as a 'dotted decimal'. These IP addresses are subdivided into three classes: a class A network, a class B network, and a class C network. Class A is the largest, class B is smaller and class C is yet smaller. If we look at the four digit numbers in an IPV4 address, each network of class A will have a different first number, and then its network will be addressed by the rest of the three numbers, or three bytes.

When communication occurs among different computers connected to the internet, data are exchanged. To facilitate the communication and to speed up the exchange process, these data are packed. An internet protocol packet, or datagram, is a set of information that is sent out on the net. For example, if you send an email, then your computer will break that email message into small pieces and 'encapsulate' them into packets with the destination address. This encapsulation means that your message, or more likely a small part of your message, will be put inside an internet packet.

The internet is a network of computers that makes it possible to exchange information. Different protocols are used to support and facilitate the exchange of this information. The most common protocol used in the internet is the one that makes it possible to access the world wide web, the HTTP protocol.

### The HTTP protocol

When you browse the web you access documents that are stored on computers that, like your own, are connected to the internet. As previously described, these computers are identified by a unique number. To facilitate the identification of these computers, the unique IP addresses are translated in to URL, that is the simplest representation of the numerical address of the internet protocol. The simplest way to navigate the internet and to get access to documents is the use of a browser, such as internet Explorer, or Netscape. To get access to a document located somewhere on the web, you must know the name of the computer, the URL, where the document is located and type it in the browser.

However, the picture is still not complete, as the browser can't read the document directly from the hard drive of the computer where it's stored. So to be able to read the document the computer that contains the document must run a web server. A **web server** is a just a computer program that listens for requests from browsers and then executes them.

Your browser contacts the server and requests that the server deliver the document to it. The server then gives a response which contains the document so that you are now able to get access to the document. These requests and responses are issued in a special language called **HTTP**, which is short for HyperText Transfer Protocol. It's worth noting that HTTP only defines what the browser and web server say to each other, not how they communicate.

The actual work of moving bits and bytes back and forth across the network is done by TCP (transport control protocol) that extends IP with features useful to support most higher-level protocols such as HTTP.

HTTP is the protocol used for document exchange in the world wide web. Everything that happens on the web, happens via HTTP transactions.

## Wireless communication networks

Since the beginning of the century a new way of connecting computers to the internet has been available. Wireless communication allows users to connect to and get access to information located on the internet without the need of a wire connection to the global network.

The wireless communication has introduced a new concept for the study and development of the use of the internet: the mobile internet.

Until the end of the twentieth century the only way to access information on the internet was to connect a computer physically to the network – the internet was a physical network of connected cables. ISDN, LAN and WAN connections created a web of cable that interconnected the computers to the internet.

Wireless connections are made available by mobile phones and Wi-fi networks.

Mobile phone networks make it possible to connect a computer to the internet via a modem that, as in the case of the ISDN technology, allows the transfer of data among computers located in different geographical locations. The speed of the connection now made available by the mobile phone network is up to 2 Megabits per second. Different compression and communication standards can be used to facilitate the data transfer between computers. The most common standards are the GPRS (Genral Packet Radio Service)and the UMTS (Universal Mobile Telecommunications System)

In the case of Wi-fi the communication is not supported by the mobile phone network but is mediated by a wireless router. The wireless router is physically connected to the wired internet. The wireless router allows, via a specific communication standard, the 802.11 standard, to exchange data up to 54 Megabits per second in a radius of 30 meters from the so-called hotspot (the place where the wireless router is located).

The Wi-fi router builds up a wireless bridge between the physical network that creates the internet infrastructure and the computer that connects to the wireless hotspot using a radio frequency connection.

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**Activities**

3.16 A company has a need for a network to link people in offices in London and New York. Evaluate the three following options to provide this: dial-up telephone connection using a modem, using the internet, leasing a private and permanent network connection from a telecommunications company to hook up local area networks in both locations.

3.17 A report contains 40 pages of 240 words each. How long would it take to transmit this letter over a computer network if the transmission speed was:

i. 50K bits per second (a modem connected to a standard telephone line)?
ii. 128K bits per second (a common standard for individual ISDN connections)?
iii. 100 Megabits per second (a local area network)?

Remember that each word is made up of characters (say 10 per word on average), and each character in the report is stored as one byte of 8 bits. State any assumptions or limitations of your answer.

3.18 What options exist in your country for an individual citizen or a small company to link up to the internet? Is there an ISDN option available or is there any option via cable television?

3.19 A page of information on a company intranet should be available to a user 8 seconds after being requested. If a typical page is 25K bytes, how fast must the network operate to meet this standard? Answer in bits per second and state any assumptions.

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## A reminder of your learning outcomes

Having completed this chapter, and the Essential reading and activities, you should be able to:

- outline the history of the development of computers
- describe how a modern computer works and its main component parts including storage and input/output devices
- list and describe the main types of software found on contemporary systems including the operating system
- classify various types of telecommunications networks and evaluate their characteristics.