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Introduction to information systems

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Undergraduate study in
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LSE THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

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Chapter 1: Information systems as a topic of study

1.1 Introduction

This 100 course provides an introduction to the study of information systems.

You might be expecting the phrase 'information systems' in the title to be just a synonym for a course about computers and their direct uses. However 'information systems', as you will discover, includes a rather broader set of topics and issues. The concerns we address here go beyond a narrow focus on this type of technology – that is a subject that might be better studied under the heading of computer science or computer engineering. Rather, this course investigates what we do with this particular technology in the world, why we choose to use it, who is affected or interested in its uses and how we organise ourselves to be able to get the best from it. We even go a bit further, beyond questions of what information and communication technologies (ICTs) are used for, to questions about the consequences that follow – what are often spoken of as the impacts or the 'so what?' questions.

Quite often you will return to these five basic questions – first **what**?, **who**? and **why**? and then **how**?; and finally, the consequences that follow (the **so what**?). These might include consequences for people (for example, at work or at home); for organisations (for example, firms and businesses, not-for-profit organisations and government bodies); and for wider society (for example, for social and economic development or for international patterns of trade).

When we do talk about computers and associated technologies we will generally use the phrase 'information and communication technology' (ICT). You will find that ICT is a common abbreviation in the academic world, and particularly in Europe. The other and older abbreviation is 'IT' standing for information technology. One of the earliest uses of this phrase is in a 1958 article by Harold J. Leavitt and Thomas L. Whistler listed under Background reading below. Despite this article being over 50 years old, it is well worth your while to read it and consider how many of their predictions have, or have not, come true.

1.1.1 Background reading

Leavitt, H.J. and T.L. Whistler 'Management in the 1980s', *Harvard Business Review* November/December 1958. This is available in the Online Library.

The subject matter of this course is sometimes discussed under the heading of the application of ICT, seeing ICT as something we apply to various human activities. Indeed, the word 'application' is often used in the business world to mean a particular use of technology or a particular type of software specific for a particular task. Thus we might say that word processors (for example, Microsoft Word or Open Office Writer) are one of the most important desktop 'applications'. You will find that that in this subject guide we will often talk about 'organisations'. This is used as a catch-all phrase to stand for all kinds of bodies and associations. Usually we will mean business organisations – firms or companies – or public sector organisations – a government ministry or some public agency such as a school or police body. Just sometimes we may consider non-governmental organisations (NGOs) or voluntary organisations – a church or a charity such as Oxfam or Save the Children. On some occasions these distinctions matter – business organisations seek profits, public bodies do not, at least directly; NGOs may have many volunteer workers; business and government workers are paid. However, for our purpose the distinctions usually do not matter and we emphasise the common characteristics of organisations as people working together and as places where technology is applied.

As a student, you need to understand from the start of this course – and at the start of the **BSc Information Systems and Management** if that is your degree programme – that we are concerned with more than just computers and networks and their most direct uses. Rather, we are studying the information systems which are found in, and are a fundamental part of, all manner of human organisations. It is hard to be an organisation (a business firm, a club, a school, or even a family) without having some information systems to store data and provide information to people who need to use it to guide their actions. Of course, these information systems may not use digital information and communications technology (i.e. computers). A paper notebook or diary, a notice board, a meeting room or a conversation can serve as a part of an information system too. However, here we are mostly concerned with the more formal and deliberately structured information systems found in organisations and that draw in large part on digital technology.

Quite often what we study is the move from a more traditional information system, for example based on paper records, to one based on digital records. Thus we have moved in many organisations from paper letters and memos typed by a secretary to emails and text messages typed by the main sender, or from paper catalogues sent out in the post to electronic catalogues on websites or DVDs. Another good example of change to more ICT-based information systems today is the move in healthcare all around the world from a paper-based patient record in a physical file, to an electronic record stored in a computer network and potentially easily available to multiple persons and at multiple locations. It is useful to think through this example under the headings of **what**?, **why**?, **how**? and '**so what**?'. Taking just the **why** question, it is interesting to think of how many reasons there may be to make this change from paper to digital records. Is it to deliver better care, safer care, to help doctors and/or patients make more informed decisions, to reorganise the way care is given by nurses, to allow more information sharing among doctors and nurses, or to make the giving of care cheaper? Is it a way to solve existing and well understood problems, or is it a way to achieve something new, radically different and better? One rather general way to answer this question is to say that it will make healthcare more efficient (or it is hoped it will), but what does this word 'efficient' really mean?

As in this case where doctors', nurses' and patients' interests are involved (just to start with), we should always see any information system as involving, including and serving people. Sometimes as individuals or as citizens (for example, patients), but often as members of (or workers within) organisations, for example, nurses, managers, clerks, doctors, engineers or accountants.

If we want an initial working description of the subject we study here (we call this a working description, not a definition; as you study information systems topics and gain new knowledge and insight you may want to change, rephrase or extend what is proposed here), it might be something along these lines:

The subject of information systems studies the uses made of ICT within human organisations and societies. In particular, we study how ICTs are applied to improve the way organisations operate and to help people to do their jobs. This is principally achieved by collecting, storing, processing and sharing data and information.

This description suggests that the study of information systems entails at least four slightly separate, but related objectives:

- the **digital technologies** that lie at the heart of computer-based information handling, their characteristics and capabilities
- the **people** who work with, become part of, or use information systems
- the **tasks** that they wish to undertake and their specific needs or requirements
- the social or organisational **structure** within which an information systems is established (for example, a firm, a factory or government department, a community or society).

We could choose to take just one of these four perspectives: the perspective of technology, the task it is applied to, the people who use it, or the organisational or social structure that all the above elements are embedded in.

However, so these four elements are all in relation to one another, we usually need to consider more than one perspective, and sometimes all four. This idea or 'model' of technology in organisations structured around four core elements was proposed in the 1960s by Harold Leavitt. It is known as 'Leavitt's diamond' and suggests that it is always possible to relate any one of these core elements to the others, and that when or if we change any one, it is very likely to have some consequence for the others. Understanding a dynamic relationship can often give us a clue to provide answers to the '**so what?**' questions.

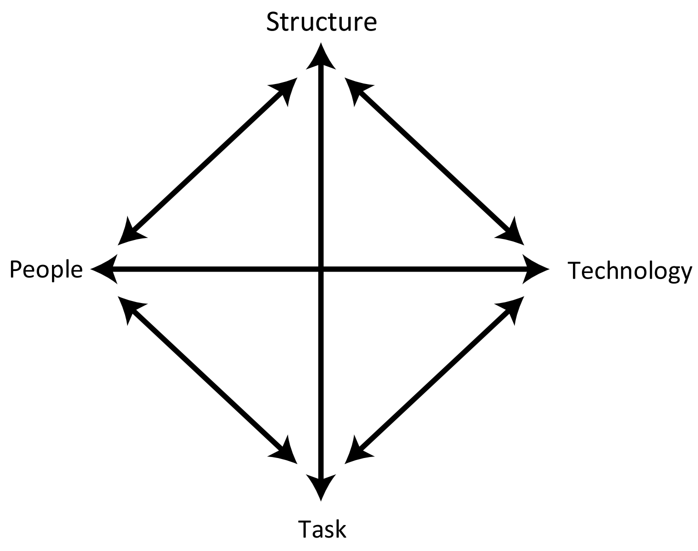

Figure 1.1: Leavitt's diamond: the basis for a sociotechnical view of information systems.

Leavitt's diamond expresses a fundamentally sociotechnical view of information systems. That is, it is in part social (about people and human organisations) and in part technical (technology is applied to specific tasks). This broad concept is important to grasp at the outset because it implies that, given any problem or situation that we study, we should ask both how the technology influences the people or the organisation, and how people may influence the technology choices and the way it is used. We cannot, as it were, privilege one element and ignore the others.

For the most part in this course we will consider formal organisations as the 'structure' referred to in Leavitt's diamond. For example, the uses of ICT, the people and the relevant task could be within businesses, such as a car manufacturer, a retail store, a bank or an airline, or they could be in public or not-for-profit bodies, such as a government department, a hospital, a school or a city council. In such cases the people will usually be the workers or employees of such organisations, and their customers or clients. But as citizens and in other parts of our lives beyond any work setting we also use information systems – for example as a student, when talking to friends on Facebook or by email, or when buying products and services over the internet. Thus in this course we will sometimes shift our understanding of the 'structure' we want to consider to include society at large, or some section of it. This is, for example, the case when we discuss issues such as personal privacy, data protection and rights of access to information.

Technology remains important even if it is not the exclusive focus and we certainly do consider it in this course. It is not possible to comprehend how organisations build and use information systems to serve their needs if we do not have a good level of understanding and experience of the technologies themselves. For this reason this course includes a part devoted to studying contemporary technologies, and awards 25 per cent of the final marks based on practical experience in developing simple information systems using standard software packages: a database and a spreadsheet. This is explained more in Chapter 2.

1.2 Aims of the course

This course provides a broad introductory understanding of information systems, seen within organisational and societal contexts. The aim is to provide students with an appropriate balance of technical and organisational perspectives to serve as the basis for further study in the field.

The aims of this chapter are to:

- introduce the subject of information systems and its scope and content
- give guidance as to the work expected of you and the appropriate approach
- specify the resources you will need to have available including textbooks and computer resources
- introduce the assessment methods used for the examination, including the coursework.

1.3 Learning outcomes for the course

By the end of this course, and having completed the Essential reading and the activities specified in this subject guide, you should be able to:

- explain fundamental assumptions made in studying information and communications technologies in organisations as sociotechnical systems in contrast to purely technical or managerial views
- debate the relevance of the sociotechnical approach and demonstrate this through the study of a number of practical business and administrative information systems within real organisations

- express a logical understanding of how the technical parts of computer-based information systems work, their principal structures and components including contemporary technologies for information processing and communications
- explain the various functions of systems and network software and various classes of business-oriented application packages
- describe fundamental principles that can be applied to ensure that security and personal privacy is respected in information systems
- explain the tasks required when undertaking the establishment of a new information system and be able to contrast alternative approaches to development
- describe and justify a range of professional roles in information systems development activity, and their changing nature reflecting in part changes in technology use in and between organisations
- discuss the social, organisational, legal and economic context of computer use and be able to debate the significance of information and communications technologies for the economy and society
- demonstrate, through project work, understanding of the analysis and design of small projects using database and spreadsheet programs, and the ability to write brief but informative reports on such work.

This set of learning outcomes provides a useful benchmark against which you can assess your progress throughout the subject and will help you to balance your workload of study and revision.

1.4 Syllabus

Information systems concepts: Information and data. Capture of data, storage, processing and display. Information systems in organisations, the digital economy. Introduction to systems ideas and their application to information handling activities. The sociotechnical character of information systems.

Information systems within organisations: The roles and functions of information systems within organisations including providing management information, supporting e-commerce, supporting knowledge work and undertaking transaction processing. Use of information by various types of people and as applied to various types of task. New models of organising. Information systems management roles and structures. Students are expected to undertake small investigative case studies of information systems within local organisations as part of their study.

Information and communications technologies: Introduction to computer hardware and software. Communications technologies and networks, the internet. Data storage systems, files and databases. Cloud computing. Operating software, applications packages and user written programs. Open source software. Social networking. (Note: this does not entail any particular knowledge of electronics, rather it is concerned with the major components and the logical structures of a computer as exemplified in popular personal computers and networks including the internet.)

Systems development: Information systems development approaches; life cycle, prototyping, incremental models. Systems analysis tasks, methodologies, modelling and agile methods. Data modelling. Systems implementation. Professional roles in systems development. Criteria for successful applications development. Systems implementation and the management of change.

Practical coursework: The coursework has two elements. A design and implementation of a small database, and design and implementation of a spreadsheet model. No specific brands of software are required to be used, but typical examples would be Excel for spreadsheets and Access for databases. (A student can equally use other software, for example the open source desktop software found in the package Open Office.)

In the coursework you are expected to demonstrate and document your ability to analyse and design these two small applications, as well as show your mastery of the relevant software. Coursework must be submitted in a word processed form. These two elements of coursework count for 25 per cent of the overall mark.

Note: Candidates taking this course are **required** to submit coursework.

1.5 How to use this subject guide

This subject can be thought of as comprising four interrelated components:

- practical experience in developing small systems using standard packages and writing short reports that document this work
- the characteristics of information and communication technologies (ICTs)
- knowledge of the established information systems concepts and models used in the academic literature of the subject and by those who work in the industries that support information systems
- the processes of information systems development in their full diversity.

This is the structure and sequence that this subject guide follows, but you do have some choice as to the exact order in which you approach the various components and study. Note also that each of the recommended books takes a slightly different route through this material.

As a general suggestion, and depending on your particular interests and any previous experience of or study in this area, it is probably most appropriate to tackle the ICT and information systems concepts to start with – and in parallel – and to leave the broad topics of information systems development until later. Work on the project element of the course should be systematically followed up throughout the period of study. Certainly the experience of doing your own projects, however small they may be, will help you to appreciate many of the issues that are found in larger and more complex development efforts.

The practical experience aspect of the course, and the projects that are a part of the course, are introduced in Chapter 2. This is presented early in the guide so that you can start to think about this work from the very beginning of your study and go on to relate it to the other components. Of course, completing and submitting the project work may come later in your studies, but the sooner you start thinking about this, the better your final work will be.

We must emphasise here that the four components of the course given above are very much interrelated and certainly should not be treated as wholly separate. Consider this example.

The storage of some data about a person within a computer-based system – for example, their medical records over their lifetime or the courses and examination marks achieved as a University of London student – is an issue that may be considered from all four perspectives.

1. From an **information systems** perspective, we need to ask:
    - Why are we storing this data?
    - What purpose or purposes does it serve?
    - What (and whose) information needs will it satisfy?
    - How will we know if these needs have been met?
2. From a **technology** perspective, we may want to ask:
    - How can this data be captured, stored, communicated and displayed?
    - What devices might be used?
    - What are their relevant characteristics – reliability, cost, speed, usability, and so on?
3. From a **systems development** perspective, we need to consider:
    - How might we design and build such a system?
    - What constraints are there to consider in terms of legal issues and the interests of the users and those whose data is stored and processed?
    - Who is going to undertake the development work and what tools or techniques will they need to use?
    - What exact items of data are to be collected and stored?
    - How long will the development take, and what will it cost?
4. Finally, from a **real world, getting things done** perspective, there is the need to:
    - Establish and resource a project to construct a system to do the job and deliver a working system within budget and on time.

1.6 Exercises and sample exercises

Each main section of this guide finishes with a set of exercises. These are intended to be rather more open-ended and time-consuming than examination questions, and to provide you with opportunities to explore the material in some depth.

The guide also contains two Sample examination papers in Appendix 1.

1.7 How much time should you spend on this subject?

You should divide your effort equally between the four main components. Effort does not simply equate to time, however, and the practical component particularly can absorb a lot of time as you master the software and the modelling techniques. This is not a problem in itself – doing analysis and design work and using software can be interesting, challenging and rewarding, but you need to be aware that this activity is intended to represent **only 25 per cent of the subject and 25 per cent of the final mark**. For this reason you must be sure to devote appropriate time and effort to the other components of the course, and thereby achieve good marks in the examination, and do well in the final combined assessment.

If you want to do well in your examinations and coursework then there are four key ideas that you can use to improve your performance:

1. Read about each topic that you study in at least two different textbooks. For the more technical topics, make use of a good online reference such as Wikipedia or the Free Online Dictionary of Computing (www.foldoc.org) to cross check your understanding. When you consult two or more sources they will, in all probability, not say exactly the same things. For example, it will often be the case that they will use different examples and even rather different technical language and jargon. You then have to judge and combine the various accounts, but in doing so you will become an active learner, you will understand more and you will remember more too. Certainly, you should never rely on just the subject guide or your lecture notes to give you an adequate understanding of any topic.
2. Talk about IS issues with your friends, family and fellow students. Keep on talking. If you can't talk about a subject then you are unlikely to be able to write about it in an examination. Best of all is when you can make jokes about the subject. To be able to joke about something usually requires a good depth of understanding.
3. Take your learning out into the world. Visit organisations and talk to people who work with or manage information systems, both technical professionals and users. Ask lots of questions and test your 'book learning' against what people in responsible jobs actually worry about and what they actually do. Keep a scrapbook of newspaper and magazine articles that relate to the various parts of this syllabus. Try to find one such story each week during the course.
4. Revise carefully what you know about writing essays and reports in English. What is a sentence and a paragraph? What are they for? How do you structure one? When writing, how can you ensure that you say all the things that you want to say, and don't repeat a single idea endlessly? Is your handwriting legible to other people and if not, is it your responsibility to improve it? Take time to identify your strengths and weaknesses as a writer and then work to emphasise the one and address the other. Reflection and effort to improve your writing skills will reap great benefits in the examination for this course and of course in many other aspects of your work life from now onwards.

1.8 Practical assignments and coursework

For this subject, you must complete two practical assignments, one using each of the following types of software:

- databases
- spreadsheets.

You must submit these assignments by their due date and in accordance with the instructions provided in the *Completing and submitting coursework and projects* booklet available on the VLE. You must make sure that you have an up-to-date version of this booklet and follow its instructions about submission procedures. Further information on choosing the particular projects you will do, organising your work, and writing reports on this work is given in Chapter 2 of this subject guide.

1.9 Reading

1.9.1 Books

Bookshops are rich in books published on topics related to information systems, computing and business uses of ICT. Many of these books are adequate, some are excellent and some are poor. Never mind! For a keen student of information systems, there is certainly no shortage of materials to study, and you must expect to have to negotiate your way through this jungle.

There are also many resources online which you can use to widen your understanding of the topic. Of course not all online material is of high quality and quite a lot is simply marketing material. Still, even this type of material is useful as long as you approach it with a critical and questioning attitude. From time to time in this guide we suggest websites of this kind to visit. Their contents will almost inevitably change over time, and our suggestions may soon be out of date, but your job is then to make a sensible use of materials that you do discover.

For example, one of the oldest and most established companies in the ICT industry is IBM. Their website (www.ibm.com) contains a lot of material and information. As we write in 2013, the front page links directly to a section called 'Industries and solutions', which in turn has a section called 'Case studies'. There you should find details of the information systems of some IBM customers in various fields.

1.9.2 Essential reading

The principal textbook for this course is:

Laudon, K.C. and J.P. Laudon *Management information systems: managing the digital firm*. (Boston; London: Pearson, 2013) thirteenth edition [ISBN 9780273789970 (pbk)].

This subject guide is written to accompany Laudon and Laudon (2013); it is not a substitute for this textbook though it does add some extra material and offers some shifts in emphasis. Laudon and Laudon (2013) provides a close fit to the syllabus, and you should purchase a copy of this book and become familiar with most of its contents.

When you first look at this textbook, you should take some time to become familiar with the structure of the book and the way information is organised within each chapter. Note in particular the frequent use of case studies at the start, within, and at the end of chapters. Note also that each chapter's brief introductory case study has a summary diagram showing how issues in terms of management, technology and organisation (business challenges) lead to some innovation in information systems and thus to business solutions. At the end of each chapter there is a summary of the key ideas introduced in the chapter, review questions, key terms and ideas for further work. As you come to understand the structure of the book, you will be better able to monitor your developing understanding of the subject and to evaluate your progress.

The thirteenth edition of Laudon and Laudon does not have its own website, but at the time of writing there is one for the earlier 10th edition: http://wps.prenhall.com/bp_laudon_essmis_10/ This website is still compatible with the 2013 edition and provides a chapter-by-chapter resource of quizzes, tests and essay questions as well as further information on chapter topics and links to other websites. If you can, do visit and explore this site; however, this course is not limited to the material within the website, and the quizzes and tests there should be viewed simply as useful revision material. In many ways, the most valuable aspect of the website is the links it provides to further web resources.

A second text, within which most topics and useful contrasting treatments of topics can be found, is:

Curtis, G. and D. Cobham *Business information systems: analysis, design and practice*. (London: Prentice Hall, 2008) sixth edition [ISBN 9780273713821].

For some topics, this is the preferred text, and it certainly offers a deeper and more thorough treatment of systems development activities. This book is also helpful in supporting the practical assignments.

Another contrasting text that is useful for reference and to cross-check your understanding is:

Alter, S *The work system method: connecting people, processes, and IT for business results*. (Work System Press, 2006) [ISBN 9780977849703].

Not one of the books listed above provides, on its own, a full coverage of the whole subject. Indeed, as part of a university degree, it is assumed that you will study the subject using multiple sources and will base your understanding on as wide a reading base as possible.

It is always preferable that you have access to the **latest** editions of books. The world of information systems and information technology changes rapidly, as does our understanding of what is important and relevant in developing and managing information systems. If you are using this guide a couple of years after its publication, and new editions of the books mentioned have been produced, please use the new editions. Note that Laudon and Laudon (2013) and Curtis and Cobham (2008) are the thirteenth and sixth editions respectively, and new editions come out every two or three years. When new editions are produced they may have slightly different titles, so don't be confused.

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 and use this guide. If this is the case you should use the most recent edition; then use the detailed chapter and section headings and the index to identify or confirm the relevant reading sections. You can also check the virtual learning environment (VLE) for updated guidance on readings.

If you are told that any book is out of print, do not panic. As a first step, check with another source – some bookshop catalogues are more up-to-date than others, or check online with one of the large book selling sites such as Amazon.com. If a book seems to be completely unavailable, please tell us and we will suggest alternatives.

1.9.3 Further reading

Please note that when you have read the Essential reading you are then free to read around the subject area in any text, paper or online resource. Indeed you are positively encouraged to read widely. To help you read extensively, you have free access to the VLE and University of London Online Library (see below) and from time to time we do recommend papers published in academic journals as Further reading.

You may find the books listed below helpful as references or as back-ups for particular topics. Occasional reference is made to these books in the subject guide. Students taking the full **BSc Information Systems and Management** degree will find these titles useful and relevant in other subjects.

Avgerou, C. and T. Cornford *Developing information systems: concepts, issues and practice*. (London: Macmillan, 1998) second edition [ISBN 9780333732311]. Chapter 6 is Essential reading for Chapter 3 of the subject guide.

Avison, D. and G. Fitzgerald *Information systems development: methodologies, techniques and tools.* (London: McGraw-Hill, 2006) fourth edition [ISBN 9780077114176].

Fitzgerald, B., N. Russo and E. Stolterman *Information systems development: methods-in-action.* (Berkshire: McGraw Hill, 2002) [ISBN 9780077098360].

Pressman, R. *Software engineering: a practitioner's approach*. (London: McGraw-Hill, 2009) seventh edition [ISBN 9780071267823].

When undertaking the practical assignments, you will probably want to make use of some books to get to grips with using a particular word processor, spreadsheet or database. Because students have so many different computers and versions of software we cannot make any specific recommendations. However, one particularly useful reference series is the 'Mastering…' series published by Sybex. Another is the '…for Dummies' series published by Wiley.

1.9.4 Newspapers, magazines and trade papers

You should make a habit of consulting weekly and monthly journals as well as newspapers. Most serious newspapers have regular supplements or sections devoted to technology and computers, and you should become a regular reader. Most countries have some local publications devoted to computers and information systems, and these can provide very useful materials for study. Such publications will include news of the local and global information technology industries, examples or case studies of systems in use and discussion of systems development practices. A useful aid to your study on this course will be to keep a scrapbook of newspaper and magazine articles that relate to information systems and to review this material from time to time.

Hundreds of computer magazines are found on newsagents' shelves. Most are aimed at the home computer user and, as such, are of relatively little use for this subject. The magazines below, in contrast, all provide some coverage about computers and information systems within business organisations – the main focus of this subject.

- *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. A couple of times each year, they also publish special supplements on some aspect of ICT.
- *Datamation, InformationWeek*, *CIO magazine*, USA: these magazines, aimed at information systems' managers, report on many issues of effective use of information technology in organisations. There are websites for the magazines (noted below) from which articles can be downloaded.
- *Computing, Computer Weekly*, UK: Both of these weekly papers contain a mix of industry news, articles on particular organisations and descriptions of new and interesting developments. Other countries will have similar publications related to their own national marketplace.

When reading materials such as those listed here, you should spread your effort over issues of technology itself and issues related to the effective (or ineffective) use of the technology in organisations. It bears repeating once again that this subject intends not to study information and communications technologies for their own sake, but to better understand what they can achieve and how they can be exploited within business organisations, public administration and society as a whole.

1.10 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 have forgotten these login details, please click on the 'Forgotten your password' link on the login page.

1.10.1 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.

1.10.2 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

1.11 Access to computers

It is a requirement for this subject that students submit two practical computing assignments for the examination. Students must therefore have access to, and make use of, a variety of computing resources. The structure of the syllabus is built around the assumption that a student has good access to a modern microcomputer with a suite of standard software. In particular, a student will require access to the following:

- **A laptop or desktop computer**: It is most probable that this will be either a PC running some version of Microsoft Windows, an Apple Macintosh or perhaps a computer running the Linux operating system. While these are the most common 'standards' in the world, it may be that you have access to other computers that will allow you to undertake the assignments. For example, you may have access to multi-user or time-sharing systems that allow essentially the same facilities as a PC but accessed through online terminals. In theory at least you could complete the assignments on your smartphone – most have a spreadsheet of sorts, and simple database apps and modelling tools are available too – but we do not recommend it!
- Whatever type of computer you have access to and use, you will also need to have access to printing facilities in order to produce the required assignments on paper for assessment.
- **Database package**: A database package is software that allows a user to enter, store and retrieve regular items of data in a structured and coherent manner. A database allows its user to select and extract particular items of data or produce reports summarising collections of data. Databases can range from small – a mailing list of the members of a sports club – to huge – the 40 million or more national insurance records held by the UK's Department of Social Security. Common PC database software in use today includes Microsoft Access, OpenOffice Base and Oracle. Most database packages offer their own programming languages (or macro languages), which allow them to support the development of more sophisticated applications, though you are not expected to use such facilities. A database package suitable for this subject must support the relational model. In recent years, most database projects for this course have been produced using Microsoft Access, but some have used other software.
- **Spreadsheet package**: A spreadsheet package allows information arranged in rows and columns to be manipulated. The major focus of a spreadsheet is the manipulation of numerical information, although modern spreadsheets have a wider range of functionality and can, in some ways, emulate a simple database. The name 'spreadsheet'

comes from an analogy with the squared paper used by accountants to prepare tables of figures. Spreadsheets are one of the main reasons that everyday managers use computers, since they allow them to manipulate figures at will and both keep records and see the results of alternative assumptions regarding relevant items of information. Almost all spreadsheet programs are able to produce various types of charts and graphs. Some advanced functions supported by today's packages include optimisation, statistical processing and sensitivity analysis facilities. Among the best-known spreadsheets are Microsoft Excel and OpenOffice Calc.

- **Word processor package**: You need this to prepare your reports. A word processor is software that allows a user to prepare text documents. It provides facilities to enter and store text, to lay out text and graphics on the page and to print out the results. Other facilities offered by a word processor may include checking spelling, generating tables of contents or keeping track of footnotes. Among the most common word processing programs in use today are Microsoft Word, Apple Pages or OpenOffice Writer. This version of this subject guide was initially prepared using Microsoft Word 2007 and among the facilities that were used were the spelling checker, various typefaces and fonts, styles, automatic page numbering and the automatic preparation of the table of contents.

Major software producers usually offer their popular word processing, database and spreadsheet programs as a suite of software designed to work together. In such suites, each package is standalone in its functionality, but it can easily work with the other elements of the suite – Microsoft Office and OpenOffice are examples. If you are in a position to choose the software to use, then it will make very good sense to choose such a suite of programs. Such suites may also include other tools, such as electronic mail or a personal organiser that can be used as a sort of diary or address book.

When tackling the hands-on computing component of the subject and using software packages, you will need to have access to appropriate documentation. Since this syllabus does not prescribe the particular software that you should use, it is not possible to specify exact books. Most popular software comes with a set of manuals that will include both a reference manual and a tutorial, although these may well be just presented as files on a disk, rather than as physical books. Such tutorial guidance is often a good place to start to learn how to use a particular piece of software. In addition, many alternative guides to popular software have been published, and such texts can provide valuable extra advice and an alternative source of information. You may also find useful video tutorials online via YouTube or similar websites.

Activity

This is the first example of the kind of open-ended activity that you will find throughout this guide. It offers you the opportunity to reflect on some aspect of the subject and consolidate your knowledge. If you wish to perform well in the examination then you are strongly advised to complete these activities. When Examiners set the examination paper they will assume that you have undertaken all these tasks and can reflect on and write about them in the examination.

Describe the difference between a reference manual and a tutorial. If you were managing a project to develop a new software product for business users, which would you expect to write first? Which would be the more important?

Now make a list of the other main documents you would expect to prepare along the way as an idea is transformed into a software product that can be sold to people like you.

1.12 The internet

The assessed coursework does not require you to make any particular use of the internet. It is almost impossible, however, to have any understanding of what computers and networks do (or will do in the future) for governments, people and businesses, without some experience of the internet. This would usually mean some experience of using the world wide web – searching for and locating information resources of various types – as well as experience of using electronic mail (email) and other methods of communication, such as Facebook, Twitter, chat rooms or net meetings. As introductory exercises, the activities below offer a few suggestions of things to do using the internet – these will help you generally to develop your appreciation of such technology.

Activities

1. Visit the website of an online bookstore and find out how easy (or not) it is to buy books recommended for this University of London course. How do the online prices compare with those in your local bookshops? Are the comments or reviews left by other buyers useful or interesting to you?
2. Visit the main public website of your country's government and discover a recent policy statement or proposal for topics such as:
   - computers in schools
   - computers in healthcare
   - the promotion of e-commerce.

   In the UK, you should start a search at www.direct.gov.uk/
3. Try to use email to do something useful **beyond** your own circle of friends, teaching institution or workplace. For example, can you use email to communicate with your bank, a government office, the local library or the University of London? What are the advantages and disadvantages of this form of communication for you? What would you imagine are the advantages and disadvantages of email for large business organisations that deal with thousands of customers?
4. Look at the websites of three airlines that operate from your country. Evaluate from the perspective of a customer the quality of these sites by using them to gather information and prices for a trip to, say, London. Which is the best and the worst in terms of usability? What other criteria (perhaps three or four more) might you use for your evaluation? Is there a clear winner?
5. In a similar way, 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 that you have seen on the web.
6. Subscribe (for a week or so) to the Twitter feed of a government department, a transport company and an online retailer. How are these organisations using this medium to communicate? Who is it aimed at (for example, who is the intended audience)? Can you imagine new or alternative audiences that might be interested in some material delivered in this way?
7. Prepare a brief report describing the differences between three well-known general purpose internet search engines, for example Yahoo, Bing, Google or Ask Jeeves. In your country there may be other popular search sites. Can you suggest situations in which you would recommend each one of these search engines?

Since this publication will remain in print for some time, and as the internet is constantly evolving and updating, it is not helpful to list a large number of websites in this guide. However, a few sites are worth noting:

www.pearsonhighered.com/laudon
The site associated with the main textbook for this subject.

http://foldoc.org
The free online dictionary of computing – a useful source of brief definitions and descriptions. The master version originates at Imperial College London, but mirror copies are available at sites around the world.

www.isworld.org/isworld.html
A website shared by the academic information systems community.

www.datamation.com/
The site of the American magazine, *Datamation*. A good source of material on contemporary information systems topics.

www.informationweek.co.uk/
The site of the UK weekly publication *Information Week*. A good source of news about ICT and information systems.

www.computerweekly.com/ and www.computing.co.uk
The sites of the two most prominent UK weekly computing trade papers.

http://en.wikipedia.org/wiki/Main_Page
Wikipedia is the largest web-based encyclopaedia and is available in a number of languages. It is often a useful resource to check up on a concept or to get a second opinion about something. It is not, however, a substitute for a good textbook.

Unless otherwise stated, all websites in this subject guide were accessed in March 2013. We cannot guarantee that they will stay current and you may need to perform an internet search to find the relevant pages.

1.13 Examination

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.

The examination for this course is made up of two parts – a three-hour written examination and coursework submitted to the University of London International Programmes ahead of the formal examination. As noted above, full information on how to submit coursework is given in the *Completing and submitting coursework and projects* booklet. Further information on the requirements for the assignments is given in Chapter 2 of this subject guide.

The format of the written examination is shown in Appendix 1. The examination has just one section with eight questions, of which you are required to answer three. These questions usually require either discursive answers between three and four pages in length (depending on handwriting and layout), or some structured problem-solving using a suitable technique such as data modelling.

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.

1.14 Glossary of abbreviations

In this area of study, as in many others, you will find that people use many acronyms and abbreviations. The following are the ones that we have used in this guide; you will undoubtedly come across others in the course of your reading and we have left some space for you to add them to this list.

ALU	arithmetic and logic unit
ATM	automatic teller machine
CAD	computer-aided design
CAM	computer-aided manufacturing
CASE	computer-aided software engineering
CD	compact disc
CIM	computer-integrated manufacturing
CIO	chief information officer
COTSS	commercial off the shelf software
CPU	central processing unit
CRM	customer relationship management
DBMS	database management system
DSS	decision support system
DVD	digital versatile disk
EIS	executive information system
ERM	entity–relationship model
ERP	enterprise resource planning
ESS	executive support system
FTP	file transfer protocol
GUI	graphical user interface
HTML	hypertext mark-up language
HTTP	hypertext transport protocol
HTTPS	hypertext transfer protocol secure
IaaS	infrastructure as a service
ICT	information and communication technology
IP	intellectual property
IP	internet protocol (see also TCP/IP)
IPR	intellectual property rights
IS	information system
ISP	internet service provider

IT	information technology
kB (K)	kilobyte
KMS	knowledge management system
KWS	knowledge work system
LAN	local area network
mB (M)	megabyte
MRPII	manufacturing resource planning II
NGO	non-governmental organisation
OIS	office information system
RAIDs	redundant arrays of inexpensive disks
RAM	random access memory
RFID	radio frequency identification
ROM	read-only memory
SaaS	software as a service
SAN	storage area network
SCM	supply chain management
TCP/IP	transmission control protocol/internet protocol
TPS	transaction processing system
UML	unified modeling language
VLE	virtual learning environment
VLSI	very large-scale integrated circuits
VOIP	voice over IP (internet protocol, see above)
VPN	virtual private network
WAN	wide area network
WIMP	window, icon, mouse, pull-down menu

Information systems is a subject with a lot of jargon, and a lot of abbreviations and three letter acronyms (TLAs). Further abbreviations and acronyms will undoubtedly be found during your study and we advise you to keep an updated list.

Chapter 2: Preparing for the project work

2.1 Introduction

In this chapter, we introduce the coursework assignments required for this subject. We do this early on in the guide so that you start to think about the assignments at the beginning of your studies. You will probably need to do some associated work before you start the final preparation of the assignments and you should not rush into the work. In particular, you need to spend some time thinking about the possible areas that your work will relate to and the real world context or problem that your database and spreadsheet will address. You will also need to develop some general skills in using your software and spend a bit of time exploring its capabilities. Modern spreadsheets and database systems can do many things – in the jargon of the field we would say that they have many functionalities and you cannot, and should not, try to use all the features they offer in your coursework. However, you do need to have a good general appreciation of what is possible before you focus on your particular project. Note that the word 'functionality' is often used to describe what we expect a system or item of software to be able to do. Later in this guide when considering systems development we will talk about the related concept of a 'requirement' as a statement of desired or needed functionality. A major task of systems analysis work – work to develop a new information system – is discovering the requirements of people in the real world, and specifying them as functionalities that the technology should provide. Thus we speak of a 'functional requirement'.

The syllabus requires you to submit two items of work for marking. Together, the two items of work count for 25 per cent of the marks:

- preparation of a database project report (12.5 per cent)
- preparation of a spreadsheet project report (12.5 per cent).

These assignments are intended to provide students with the opportunity to select and undertake small 'development' projects using common computer tools; spreadsheets and databases, but also a word processor and perhaps a graphics editor for diagrams. The submitted reports are intended to document your work and to show how you analysed a particular problem and designed and implemented a computer-based solution.

In each case, the work must meet certain requirements and must be submitted in the form requested. Note also that we specify that the marks for this work are based principally on the report; that is, the written document, and not on the spreadsheet or database itself. This is a subtle, but important, distinction. Your job is to write a good report that identifies and explains the work that you have done.

The exact choice of project is up to you, and you will need to work carefully on identifying and developing your project ideas. **Projects are intended to be individual works, so they must be different to those of any other student with whom you are studying. Make sure that your chosen project areas are distinct and in an area with which you are familiar and interested**. Thus our recommendation is that your project should be developed out of some experience or interest that you have or some application that you believe is needed in the world around you. It should not be just a textbook exercise.

In both database and spreadsheet projects the Examiners want to see evidence of the **originality** of the topic chosen as the basis for the work and for the data used. In our experience as Examiners we have seen too many students taking boring, abstract and over simple topics as the basis of their work, or just replicating work based on some standard textbook example. There is nothing wrong with reading textbooks on databases or spreadsheet modelling, or exploring examples provided with your software – indeed this is a good idea – but you must then go beyond any examples you have studied and create **your own** projects based on **your own** chosen application area.

2.1.1 Aims of the chapter

The aims of this chapter are to:

- introduce the two elements of coursework required to be submitted for assessment
- emphasise the need for you to choose suitable topics for this work from areas that are of interest to you
- indicate the methods and approaches we expect you to use in doing this work
- give guidance as to the content and structure of the reports you will prepare and the style of presentation we expect.

2.1.2 Learning outcomes

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

- develop and document small computer applications using basic packages (for example, word processor, database and spreadsheet)
- recognise the need to work methodically and to meet deadlines
- appreciate the distinction between analysis work and design work
- apply simple analytical and design techniques to systems development
- transform a paper design into a running application
- prepare a brief report on development work conveying a problem description, a design, and decisions taken with associated reasons
- reflect this experience back on to the other parts of this syllabus.

2.1.3 Background reading

To help you to appreciate the possibilities, it may be useful to look at the 'Hands on MIS Projects' sections of the various chapters of Laudon and Laudon (2013). For example, at the end of Chapter 2, an example is given of a spreadsheet of purchasing data to be used to help inform supply chain management.

It is very important for you to understand that the **written report** is what the Examiners mark. They do not receive any database or spreadsheet files to run on a computer. **Examiners do not expect any accompanying discs or files with the project work, and if you submit discs and files, they will not be looked at**. What Examiners do expect to receive, printed on paper, is a coherent account of the problem you tackled, the approach used and key details of how you analysed, designed and implemented your solution. Any accompanying printouts, screenshots, database tables, and so on are only intended to support the written report and should be carefully chosen and mentioned in the report. If you just rely on lots of 'printouts' and fail to write a coherent report, the Examiners cannot give you many marks.

In the **database project**, there are two central requirements – first, a carefully developed class diagram to show those aspects of the world that your databases will store data about. Second, a normalised data model that serves as the design that you will implement in software. The class diagram is the result of analysis work – you studying the world. The data model, which leads on from the class diagram, is the result of design work – taking the class diagram as its starting point. If the data model is well executed, with entities identified, relations clearly expressed and attributes specified, then the rest of the project – its implementation using the software – will follow smoothly. In preparing the data model students must show evidence that they have explicitly considered issues of normalisation. The details of class diagrams, data models and normalisation are topics covered in Chapter 8 of this subject guide.

For the **spreadsheet project**, it is less easy to identify a specific or linked set of fundamental requirements. To achieve a good mark, you need to select an appropriate problem to tackle – one that has a reasonable quantity of data and an underlying computational model that you can implement. The best projects draw on real data that relate to some area that you really understand or have researched. Weak projects are based on made-up data or examples from books that provide models that are too simple or too generic. Remember too, good spreadsheets are **designed according to sound principles**. You thus need to give careful consideration to who the user is and what they want, how the spreadsheet is structured, how it looks on the screen and on the page, and the clear separation of input data (independent variables) from formulae and parameters, intermediate results and final output (dependent variables). Equally, you should choose graphs and charts so as to provide particular and useful information to the user and not just generate them for the sake of showing off every feature of the spreadsheet package. For example, pie charts are easy to produce, but are you sure that a pie chart is relevant in providing the user of your spreadsheet with what they want or need?

2.1.4 Essential reading

Databases

Curtis, G. and D. Cobham *Business information systems: analysis, design and practice*. (London: Prentice Hall, 2008) sixth edition [ISBN 9780273713821] Chapter 13, Section 13.2.

Laudon, K.C. and J.P. Laudon *Management information systems: managing the digital firm*. (Boston; London: Pearson, 2013) thirteenth edition [ISBN 9780273789970 (pbk)] Chapter 6, Section 6.2.

Spreadsheets

Curtis, G. and D. Cobham *Business information systems: analysis, design and practice*. (London: Prentice Hall, 2008) sixth edition [ISBN 9780273713821] Chapter 7, Section 7.2.

Laudon, K.C. and J.P. Laudon *Management information systems: managing the digital firm*. (Boston; London: Pearson, 2013) thirteenth edition [ISBN 9780273789970 (pbk)] Chapter 12, Section 12.3.

2.2 General rules for submission of assignments

For detailed guidance on completing and submitting coursework, you should refer to the most up-to-date edition of the booklet entitled *Completing and submitting coursework and projects*. This will give you submission details for all the project work related to this subject and to other subjects in the degree programme. A copy of the booklet can be found on the course area of the VLE.

The booklet contains other useful and important information – for example, telling you that you must retain a copy of your work and that you should obtain a receipt from the post office or courier company when you send it to the University. The booklet also explains that the two work assignments for **Introduction to information systems** must all be bound together in a single volume in the sequence:

1. database assignment
2. spreadsheet assignment.

The form accompanying the project work (contained in the booklet) must be completely filled in and signed, and one copy should be used as the first page of **each** assignment. Among other things, the form asks for details of the hardware and software used in the preparation of the assignment. Simple straightforward answers are all that is required here; for example, Hardware: Samsung NC10 note book and HP LaserJet 2600n; Software: Microsoft Word 2007.

2.3 Database assignment

Reading activity

Read Section 13.2, Chapter 13 of Curtis and Cobham (2008), Chapter 6 of Laudon and Laudon (2013).

The aim of this assignment is to demonstrate an understanding of the basics of analysis and design for databases as well as to provide evidence of the use of the main features of a database package. In carrying out this assignment, you should refer to the class modelling section of this guide (Chapter 8) as well as the relevant bibliography. You will be expected to demonstrate the following through the analysis, design and construction of a small database application:

- selection of a suitable problem to be solved by a database application
- production of a class diagram using UML notation– this is a logical database design that reflects the aspects of the world that you store data about
- production of a set of normalised relations – a physical database design
- design of a data input screen or screens
- design of a query screen
- design of a report for use on screen and/or for printing on paper.

Two example assignments are given below. **These are intended to illustrate the type of problem that you are expected to tackle. You must choose your own database problems from the world around you – from your college or a local business or something associated with some hobby or pastime.** Suitable problems are those that require the recording of data on three or more related classes of things and allow the production of a number of contrasting reports. You should not attempt designs that exceed five classes. Two classes is probably too simple but may be the starting point for your work.

Consider this example. Develop a database that will allow a person to review all the films that are on in London this week and discover at which cinemas they are showing. The aim is to help people plan their entertainment and book tickets.

At first sight this suggests two classes of things about which a system will store data – various films and various cinemas – and of course the association between them (an association is the name we use for the link between things of one class and things of another. This usage comes from UML. Sometimes we express the same idea as a 'relationship'). *2001: A Space Odyssey* – a classic film from 1968 by Stanley Kubrick and in part about computers – is showing at five particular cinemas. A user of the database would want to know this to answer their query about **where** the film is showing. But, just knowing where is not enough. They will want to know **when**. This will lead us to add another class – another class of relevant thing in the world – which we might call a showing or screening. We will then need to reflect in our class diagram these three classes. Below are two simple examples of such class diagrams with the second one showing some of the attributes (data items) that we would want to store for items of each of the three classes.

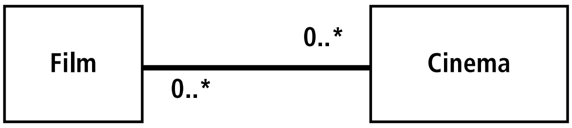

Figure 2.1: A simple class diagram for films and cinemas.

The label 0..* at each end of the association in Figure 2.1 means that there can be zero, 1 or more films showing at a particular cinema (the cinema may be closed this week for redecoration), and that there can be zero, 1 or more cinemas showing a particular film. The key to database analysis is to be able to think about such associations and how they are expressed accurately in the class diagram. The 'many to many' relationship in Figure 2.1 above, which is how the world looks at first sight, becomes resolved into the idea of a new class called 'Showing' which allows us to specify a particular film being shown at a particular cinema at a particular time– hence the simple 1 at one end of the associations shown in Figure 2.2 below.

As an exercise explain what change you would make to the diagram in Figure 2.2 if a single showing could include up to four separate films. To get to the full answer to this question will require that you have studied Chapter 8, but even if this is your first read through the subject guide, you should be able to take the first steps to allow for this detail to be faithfully recorded in the class diagram.

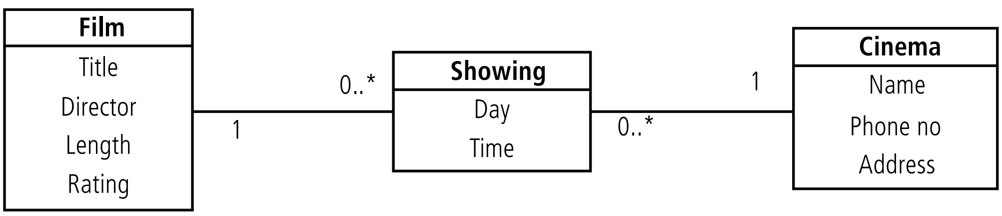

Figure 2.2: A class diagram for films, showings and cinemas.

Chapter 8 of this guide contains a lot more neccessary detail about analysing and designing databases, but the two diagrams above should give you a basic understanding of the task, and an informal introduction to the class diagram. Please note also that the example used in Chapter 8 of this guide (a database of customer orders for various products) is commonly used in textbooks (see for example Laudon and Laudon (2013) Section 6.2). It is a fairly complex class diagram but an excellent one for the purpose of illustrating the task of analysing and designing a database. It is not, however, appropriate as the main basis for your database project. This is for two reasons. First, you will have used it to understand the topic, it is not your own idea. Second, given that this is a complete 'solution' to a common database application (a business processing orders from customers), and is already fully worked out by somebody else, using it means that you do not have the opportunity to demonstrate your ability as a database analyst and designer. **Thus the Examiners will give low marks to any student who submits a database project that is just based on the customer-order model**.

Example 1

A database for the Human Resources department of a company to hold information on employees and the department they work for. Data to be held include the employee's:

- family and first names
- age
- sex
- address of residence
- date of joining the company
- department (administration, distribution, manufacturing)
- job title (assistant, technician, specialist, consultant, manager)
- head of their department (another employee)
- line manager to whom they report
- qualifications held
- training courses attended.

The system should have an input screen to allow new employees to be added to the database and a screen to allow employees who leave to be deleted. Similarly it should be possible to add or delete departments (this is an organisation that likes to reorganise itself) and to record when an employee moves from one department to another or from one job title to another (for example, a move or a promotion).

The system should produce the following reports on screen and on paper:

- A report that lists all female employees with an MSc.
- A report that shows, for each department, the employees sorted by family name.
- A report that shows all employees who joined the company before a given date in date order.
- A query to show an employee's line manager.

Example 2

A database is to hold information on students, the courses they take and the teachers who teach them. Data to be held will include a student's:

- name
- sex
- age
- address
- courses taken.

Each course has a name and meets up to three times during the week (for example, Tuesday 10–11, Wednesday 4–6). A course can have one or more teachers. The details of the teachers to be stored are:

- name
- telephone number
- qualification.

The system will allow a teacher to record homework marks for students.

The system should have input screens to allow new students to be added to the database and a screen to allow students who leave to be deleted. Similarly, it should be possible to add or delete courses and teachers as well as to record a change in who is teaching or taking which courses.

The system must produce, on screen and on paper, a report that shows:

- a query of all the people who teach a certain student
- a report of all students who have done 60 per cent or less of their homework assignments
- a report, by course, of the students enrolled sorted by family name (for example, a register)
- a query as to all teachers who are teaching more than two courses
- a list of all students who should be in class at a given time (say, Friday between 9.00 am and 2.00 pm).

2.3.1 Reporting database assignments

When preparing your report for the database assignment, you are asked to include the following items.

- A description of the database problem tackled.
- A class diagram of the application, showing the various classes identified and their associations. You must use UML notation as shown in Chapter 8.
- The normalised relations that you will implement in the software, showing the attributes and keys together with their field type and 'picture' (for example, the type of data that is held – text, a date, a number, etc).
- A sample table of the basic relations set up in the database software together with a small amount of data.
- Designs for data input screens and reports and queries produced.
- Very brief description of how the system is operated and the commands used to undertake each task. (Note: it is assumed that this is done by using interactive commands of the database package, not by any programming.)
- Examples of the reports produced.

The total report should be about six pages of carefully laid out text, figures and diagrams, with an absolute maximum of eight pages including all examples of printouts or other necessary computer-generated reports. Reports must be permanently bound (for example, well stapled, not secured by paper clips or just slipped into plastic binders). Each page should be numbered and should have your student number on it. The report must be produced with the aid of a word processor and you are expected to insert relevant diagrams or screen shots into the text. Diagrams should either be prepared using a computer package, or perhaps done by hand and scanned in to the document.

2.4 Spreadsheet assignment

Reading activity

Read Chapter 7, Section 7.2 of Curtis and Cobham (2008) and Chapter 12, Section 12.3 of Laudon and Laudon (2013).

The aim of this assignment is to demonstrate an understanding of the basis of undertaking analysis and design for a spreadsheet, as well as to provide evidence of the use of some of the main features of a spreadsheet package. Spreadsheets are tools used for analytical modelling purposes; namely, the description of a situation by a set of quantifiable variables and their relations. One of the most common uses of spreadsheets is in accounting practices – for example, the calculation of the balance sheet of a company. However, spreadsheets have proved useful in a variety of contexts including, for example, project management, engineering, geology, statistics and operational research. From a management perspective spreadsheets can be seen as a type of decision support system (DSS) (see also Chapter 3 of this guide).

For this assignment we recommend that you approach it broadly as a decision support system intended to help somebody to use some data to make a decision or to gain some extra insight, rather than as a simple structured descriptive report like a balance sheet.

What we mean by this is that the spreadsheet should be able to help somebody by manipulating or modelling some data (you could say 'playing with' some data) and allowing the user to input their own choice of variables or parameters in order to assess the resulting outputs.

The basis of a spreadsheet developed in this style will be an analytical model that relates different types of data (probably mostly numerical data) in order to offer some insight.

Such a model may be built in six steps:

1. Framing the problem.
2. Identifying the variables and parameters that describe the problem – the input to the model.
3. Quantifying as many of these variables and parameters as possible.
4. Specifying the relations among variables and how they combine – in other words, the model you will use.
5. Specifying the required output from the model in terms of a user's interrogation of the model – reports.
6. Testing the spreadsheet with carefully chosen data and identifying and correcting errors.

Curtis and Cobham (2008, pp.236–38) provide a very useful brief design methodology for a spreadsheet along these lines, distinguishing five elements:

1. user information
2. input data
3. logic (for example, the model)
4. report (what the user wants to see or know)
5. errors.

The word 'methodology' is used to describe a framework for undertaking some task, combined with some tools to be used. In information systems, and in particular in development of systems, methodologies are often proposed, adopted and critiqued. In this case the methodology being proposed is contained in the two lists given here – one a set of sequential and necessary tasks, the other a proposed general structure or template for the spreadsheet itself.

In the example in Curtis and Cobham (2008), worksheets and the workbook feature of the Excel spreadsheet package are used to specify a separate worksheet for each of these five elements. Doing this may seem too complex for a simple project, but it can help you to concentrate on the core distinctions between input data, model and output.

The benefits of analytical modelling flow from the ability of the user to adjust and interrogate the model. Therefore, flexibility and robustness are required qualities for the model. A great deal of good modelling practice when developing spreadsheets is incorporated in the two fundamental laws of spreadsheet modelling.

- The first law specifies that any cell on the spreadsheet should contain either a variable (number or text string) or a formula, **but never a combination of the two**.
- The second law requires that any item of input data or model parameter should appear only **once**. This helps ensure that you will not have problems with inconsistent data or when updating some value.

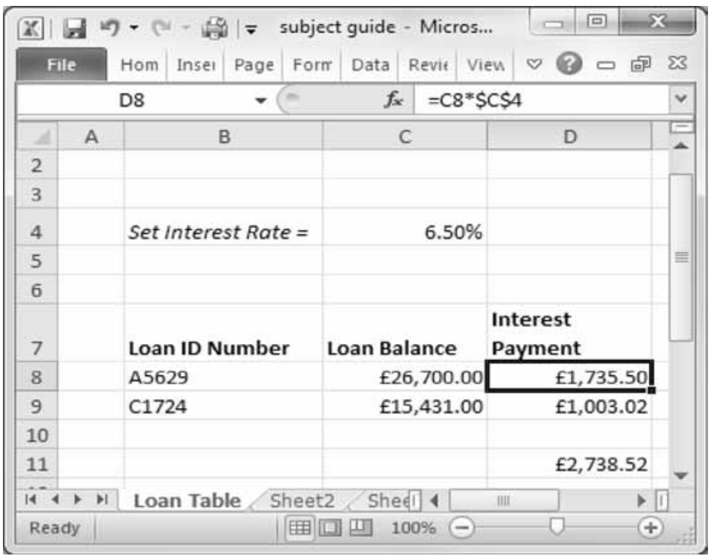

Figure 2.3: A spreadsheet abiding by the two laws of spreadsheet modelling.

Figure 2.3 gives a simple example of the application of these two laws. The spreadsheet problem uses the interest rate as an input variable or parameter and it is entered in one spreadsheet cell only (in cell C4). Thereafter the model makes reference to that cell to use the interest rate in any subsequent calculation. You should thus *never* write the cell formula for cell D8 as =C8*0.065 (assuming that the interest rate was 6.5 per cent) and you would certainly never replicate such a formula. The correct approach is to enter the formula in cell D8 as =C8*C4 – the use of the $ signs makes an absolute and unchanging reference to cell C4. This is a formula that can be copied or replicated down the column. In this way we can be sure that all the formulae in column D use the same reference to the interest rate. If and when we wish to change it we need only enter the new rate (say 8.5 per cent) once. The alternative approach of writing the formula as C8*0.065 would mean that we had to hunt down every use of 0.065 and change it and the potential for error in doing that would be very great.

Interrogation of an analytical model usually means the generation of numerical results, but it could be as textual data. More sophisticated interrogation practices include:

- What-if? analyses – What if the interest rate was to go up by 2 per cent?
- Sensitivity analyses – If the cost of one component of a manufactured product was to double, how much would the overall cost go up?
- Goal-seeking analyses – How much must the marketing budget be if we are to achieve a 4 per cent growth in market share? This spreadsheet would be based on a model that relates sales to marketing spend.
- Optimisation – What is the optimal mix of advertising spend as between newspaper advertisements and television commercials?

In each case, answers to these questions will require a particular style of interrogation of a basic model.

You are expected to consider the following areas in your project work and to write about this in your report:

- analysis of a problem domain in terms of variables and relationships incorporated in a model
- overall design of a spreadsheet for clarity and to support an appropriate style of interrogation (‘what-if?’, optimisation, etc.)
- use of appropriate functions for data manipulation (for example, sort, sum, average, look-up tables and other simple mathematical and statistical functions)
- formatting of cells for text and numbers
- design of an onscreen and printed report from the spreadsheet
- design of graphical reports including the choice of an appropriate graph type.

Activity

When choosing a graph as the output from a spreadsheet suggest the type of data that would be suitable for display using:

- a pie chart
- a bar chart or histogram
- an x/y plot or scatter plot.

Two example assignments are given below. These are intended to illustrate the type of problem that you are expected to tackle. As with the database project you must choose your own spreadsheet problems from the world around you – from your college or business or something associated with some hobby or pastime. Economic data, exchange rates, share prices, demographic data or even the weather report may provide appropriate data. Suitable problems are those that require you to summarise or model numerical data (say up to 80 raw data points), to show a result or a trend, to permit some 'what-if?' questions to be asked and to produce a printed report and a graphic chart. Our experience as Examiners suggests that projects based on basic accounting reports, balance sheets, flow of funds, etc. are not good topics for this project. They are usually so set in their format, and so reliant on simple addition and subtraction, that you have little opportunity to demonstrate your own analysis and design skills.

Example 1

A spreadsheet is to be used by a motor racing team to calculate the appropriate volume of fuel to have in the race car at the start of the race. A driver can have more fuel, but the car will be heavier and will travel more slowly. On the other hand, if the car is light on fuel, it will have to refuel more often – and that takes time. Other relevant issues are the length of the race, the running conditions (fast or slow, wet or dry), the air temperature and an estimate of what the competition is going to do. A spreadsheet is needed to let the team manager and the driver evaluate alternative approaches. During the race, the model can be updated with the actual fuel usage and refuelling times.

This example is probably of no interest to most readers, but to a car racing fanatic it is a fascinating and a welcome challenge. Your task is to find something as interesting to you to serve as the basis of your spreadsheet.

Example 2

A spreadsheet is used to analyse the tax position of an employed person in your country. This will need you to do some research into the exact details of the tax rules of your country and will include issues of income tax as well as health and other social insurances, pension contributions, etc. The circumstances of an individual – for example, married or with children – will also generally affect the amount of income taken in tax, as may other characteristics, such as age or student loans.

The spreadsheet can be used to generate a table and chart showing the marginal tax rate that applies at various levels of income – that is the percentage of income taken in tax and other deductions as income rises. The model may also answer the reverse question, 'How much do I need to earn gross to take home a given net amount?' This is an example of goal seeking. You might also use such a model to inform a politician about the marginal tax rate that various individuals face and as a way to model new and perhaps fairer policies.

2.4.1 Reporting spreadsheet assignments

When reporting your spreadsheet assignment, you need to produce the following items:

1. A description of the spreadsheet problem tackled.
2. A paper-based model of the problem representing the relations between the independent and dependent variables that you use. This may be in the form of a diagram or as arithmetical equations. For example, if a model was developed to cost products from a factory it might be based on formulae such as:

a. base cost = materials cost + handling charge;

b. manufacturing cost = (batch set-up cost/batch size) + (time on machine * hourly machine rate)

c. total cost = base cost + manufacturing cost

This can be shown as above as formulae, but might better be shown in a diagram.

3. The design criteria used in preparing the spreadsheet (choice of multiple spreadsheets in a workbook, layout, task breakdown, choices made in cell formatting, use of colour).
4. A description of the key formulae used in the model (for example, as written for the spreadsheet).
5. Steps taken to enforce data validation (input validation, cross-checking of calculations, reporting of error conditions), and overall integrity of the model (appropriate use of cell referencing, not mixing variables and numbers in the same formula, etc).
6. Very brief descriptions of how the system is operated – the commands used to undertake each major task.
7. One or more figures showing the spreadsheet as it appears on the screen in whole or in part.
8. Reports and appropriately annotated graphs.

Remember, the total report should not exceed six pages of carefully laid out text. As with the database work, examples of printouts and other necessary computer generated reports can be appended. The assignment should have a copy of the submission form as the front page. Reports must be permanently bound together with the database report (for example, well stapled, not secured by paper clips or just slipped into plastic binders). Each page should be numbered and have your student number on it. The report must be produced with the aid of a word processor and you are expected to insert relevant diagrams or screen shots into the text.

2.5 Reminder of learning outcomes

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

- develop and document small computer applications using basic packages (for example, word processor, graphics editor, database and spreadsheet)
- recognise the need to work methodically and to meet deadlines
- appreciate the distinction between analysis work and design work
- apply analytical and design techniques to systems development producing a paper design
- transform a paper design into a running application
- prepare a brief report on development work conveying decisions taken and associated reasons
- reflect this experience back on the other parts of this syllabus.

2.6 Test your knowledge and understanding

1. Sketch a class diagram for the following situations:
    a. A library database to include novels, their authors, the various editions available and the publishers. How would you handle multiple copies of the same edition of the same book, such as you might find in a college library?
    b. A database of music considering songs, albums, singers, producers, writers.

    Keep your class diagrams as simple as you can, but note all complexities or confusions that you might need to deal with later.
2. What spreadsheet chart would you use for the following situations:
    a. Monthly rainfall data over three years.
    b. Numbers in a country's population within age groups and by gender.
    c. Gold price in US$ over three years.
3. Sketch a paper model of a spreadsheet for the following situations:
    a. Calculating Body Mass Index (BMI). Weight data may come in pounds, grams or stones and pounds. Height data in inches, centimetres or feet and inches. (You can find the BMI formula online if need be.)
    b. The cost per student of a class trip to the theatre. This is to include tickets, hire of a bus, insurance and meals. The cost will depend on the number of students who choose to go; for example, bus hire is fixed for n= 1 to 50 while every 10th ticket is free from the theatre.
4. For each of the classes shown in the class diagrams sketched in Question 1 above add some essential attributes that you would want to store data about. Are you sure that you have always placed the data in the right class? Are there situations where it may be debatable?

Notes

Chapter 3: Core concepts: information, data and systems

3.1 Introduction

In this chapter we explore the core concepts that underlie the description of the use of information and communications technologies (ICT) in terms of 'information systems'. This requires an understanding of the concepts of information and data as well as an understanding of what the use of the word 'system' implies. You should be aware that considering the use of technologies (for example, computers and networks and software and stored data – what we call ICT) and the concept of an information system is different to an approach that looks simply at computers as exclusively technical devices or as direct and obvious routes to solving individual and isolated information-handling needs.

Thus we can contrast the 'information systems' view with what is often called a 'tool' view. Tools are devices designed to be used to undertake a particular task – they have specific functionalities we could say. Think of a hammer, a pair of scissors, a spade or a machine tool in a factory. Computers can be seen in this way too. People sometimes say, when trying to cut through a complex or difficult situation involving computers, 'Oh, in the end it's just a useful tool', implying that the technology is (or should be) suitable to some specific task, and subservient to its users – literally and metaphorically 'in their hands'.

The information systems view, sometimes called the 'ensemble view', sees the technology as part of a package of things including people (users, managers, customers) with skills, work practices, beliefs and assumptions, and who are organised in various ways. From this perspective, technology is not a 'tool' in somebody's hands, but a part of a complex set of arrangements of different types of people doing different tasks and using (sharing) different technical devices and resources. This shared emphasis on people and technology as bound up together (ensemble) is the basis for the sociotechnical view which we discuss further below. (When you read about sociotechnical ideas you will find the phrase spelled in different ways, as sociotechnical, socio-technical and socio technical. To some people the implications of these differences are substantial; but not for us in this course.)

3.1.1 Aims of the chapter

The aims of this chapter are to:

- understand the distinct meanings of the concepts of data, information and knowledge
- appreciate the relationships and distinctions between data work and knowledge work, data workers and knowledge workers
- explore the concept of a system and why it is particularly useful for the study of using information in organisations.

3.1.2 Learning outcomes

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

- explain the relationship between data and information and knowledge and give illustrative examples
- explain the concept of a knowledge worker and their needs
- explain the principal features and characteristics of a system, and apply these ideas to practical information systems examples
- describe how information systems are a combination of technical and social elements and the implications of this perspective.

3.1.3 Essential reading

Avgerou, C. and T. Cornford *Developing information systems: concepts, issues and practice*. (London: Macmillan, 1998) second edition [ISBN 9780333732311] Chapter 6.

Curtis, G. and D. Cobham *Business information systems: analysis, design and practice*. (London: Prentice Hall, 2008) sixth edition [ISBN 9780273713821] Chapter 1.

Laudon, K.C. and J.P. Laudon *Management information systems: managing the digital firm*. (Boston; London: Pearson, 2013) thirteenth edition [ISBN 9780273789970 (pbk)] Chapters 1, 2, 11 and 14.

3.1.4 Further reading

Avgerou, C. and T. Cornford *Developing information systems: concepts, issues and practice*. (London: Macmillan, 1998) second edition [ISBN 9780333732311] Chapter 1.

Curtis, G. and D. Cobham *Business information systems: analysis, design and practice*. (London: Prentice Hall, 2008) sixth edition [ISBN 9780273713821] Chapter 9.

3.1.5 Synopsis of chapter content

This chapter introduces the concepts of knowledge, information and data as linked but each distinct. Data is observation of phenomena; information is meaningful to people (users); while knowledge supports our accumulated ability to act in the world. The chapter consider why information has a cost or price and how it generates value. It considers what makes for 'good' information and the various forms it may come in. The chapter then introduces the concept of a system as a purposive ensemble working to some goals. It examines what the implications are of describing the way we use data and information, or accumulate and access knowledge, in terms of being a system.

3.2 Information and data

Information is a notoriously difficult concept to pin down. It is often suggested that we live today in an information age or an information society. For business organisations and governments, the use they make of information is critical to their success, to controlling their operations and achieving their goals. In particular, information is produced and used for decision making. Starting from the most basic decisions that a computer can happily make on its own – do we have this item in stock and available to sell, or a cash machine or ATM – should we issue £50 to this person (in response to the right PIN being keyed)?; to the most strategic – should we build a new factory in South America and if so where?; information is also traded as a commodity; for example, by business intelligence companies such as Reuters or Bloomburg who sell data on companies, stock and commodity prices and provide information to their clients around the world.

Our enhanced ability to use information resources (in part a result of the invention and refinement of information and communication technologies) has had a profound impact on the shape and structure of organisations and whole industries, and on how they are managed. For example, the rise of so called 'budget airlines' across the world is in part about developments in aeroplanes and airports, and the increasing desire of people to travel. However, key to the emergence of these new airlines has been their ability to make the sale of tickets efficient and directly accessible to customers via the world wide web. Cutting out the middle man (in this case, travel agents) helps to reduce the price and thus raise demand. The budget airline pioneers understood that they could manage information resources in new and disruptive ways.

Despite information's key role in all manner of organisations and social arrangements, we do not have a single universally accepted theory of information that explains the essence of the concept. Hence, we can offer no single definition here. Many academic disciplines are concerned with studying information, and various theories or accounts for the nature of information have been proposed. Linguistics studies the way in which meaning (information) is conveyed among people by the use of language. In communications engineering, transmission of information is studied – for example, the design of a telephone network to carry a certain volume of calls. Logicians and philosophers have an interest in information in the sense that information is truth or supports justified beliefs. Statisticians explore and extract meaning out of quantities of observations of events, and they seek to provide insight into the activities they study – information. Economists also study information, because individuals make economic decisions on the basis of what they know or believe to be true – again, information. Economists also talk about 'information asymmetry' when two parties to a transaction have very different access to information – one knowing more, and one knowing less.

We could investigate further the concept of information as it is used in this variety of disciplines. But we will not do so here. For the purposes of this subject a fairly simple underpinning for the concept can be utilised. Here is a candidate definition:

> Information is knowledge about the world that is sought by people in order to satisfy their psychological needs and on the basis of which they can take action or make decisions.

This candidate definition has a number of important themes:

- It suggests that people value information, because they actively seek it.
- It suggests that information tells us something about the world – that is, it communicates to us some state of affairs.
- It also suggests that people seek information because they will use it. This may be a direct satisfaction or a use in making decisions of some kind. This decision-making aspect of information is usually stressed in consideration of information systems in a business or organisational context.

Now contrast this definition of information with that given in Laudon and Laudon (2013) and in other textbooks. How similar are they?

3.2.1 Information work and information workers

Focusing on information's importance to people in their working lives leads us to emphasise the growing number and importance of the jobs and roles that rely on an advanced ability to use information. People who do such jobs and have such roles are often referred to as **knowledge workers** (sometimes contrasted with 'data workers').

Activity

Review the definition of knowledge work found in Laudon and Laudon (2013), Chapter 11. Review the kinds of tasks that knowledge workers perform in organisations, and the skills they bring to bear.

For example, an architect, a fashion designer, a doctor or a civil engineer, are all jobs that demand that people who do them have very specific skills – their specific and distinctive knowledge. This will include an ability to access information and to use it to achieve some understanding of a situation and then make appropriate decisions, be it a diagnosis, a drawing or plan, a design or specification – be it of a summer dress or of a concrete beam.

All these knowledge workers, in today's world, probably do some or even most of their work using computers and specialised software designed for their kinds of tasks. They will also usually work in teams and so information will be exchanged among their peers by technical means – sending an email, posting on a website, updating a blog or tweeting. Sometimes we talk about knowledge workers sharing their expertise through a 'knowledge base', which may be a specific type of database system focused on storing knowledge, insights or case experience. Thus a lawyer may access a knowledge base using an online database of laws and specific legal judgments; an engineer may search in a database of previous designs to find an example of a solution to a particular problem. In each case knowledge is being stored and then accessed.

3.2.2 The value and cost of information

We value information, we seek it out and we use it. However, the information we use in our daily lives is not in general freely available or free in terms of direct cost to us. We expect sometimes to pay for information (for example, to buy a newspaper to find out what is on at the cinema), although sometimes the cost is hidden. (Ask yourself: is the information you can obtain by using Google searches absolutely free to you?) If we look up on the internet what is on at the cinema this information may appear to come at zero cost, but remember, somebody paid for your smartphone, the network and the web design of the cinema site – probably you in some way or other. So too businesses and other organisations will spend considerable resources on ensuring that they have the information they need and that their use of information supports their business objectives. This leads them to build up suitable information resources and develop information systems.

Activity

Why do we speak about our society becoming an 'information society'? What do you understand as the primary characteristics of an information society? Is it just about the use of computers or does it signify more?

Provide, in your own words, a definition of the concept of a knowledge worker. Give four carefully chosen and contrasting examples and explain how each of these people work with information and suggest what formal information systems they might use.

Reading activity

Review the three contemporary approaches to information systems given in Section 1.3 of Laudon and Laudon (2013). Which one of these do you feel is closest to your understanding as you start this course?

Above we suggest that information has some value, and that it is hence worthwhile spending resources to improve the availability of information and its quality. The value of information may be based on a number of characteristics – whether the information is:

- reliable and accurate
- accessible
- up-to-date or timely
- conveniently presented
- at an appropriate level of detail
- reduces our uncertainty
- exclusive
- pleasing (for example, in the sense of a story, a cartoon or a song that evokes a direct response from the receiver)
- enables some other valued task.

In general, the cost of producing and delivering information will be significant. An organisation will need to use various types of resources, including people and technology, to produce, manage and distribute information. In this way, too, our approach to information systems is 'socio-technical' – a combination of concern and consideration for people – what they do and what they want – and concern for the technologies.

Reading activity

Review Section 1.3 in Curtis and Cobham (2008) on the value of information. Explain the linkage between the 'three contemporary approaches to information systems' studied in the previous Reading activity, and the ways in which we can value information.

3.2.3 Characteristics of information

We sometimes speak of information, describing it as intellectual property (IP) or intellectual property rights (IPR). IPR shows that information may be owned or controlled by somebody – for example, the owner of the copyright of a book or of a pharmaceutical patent. You can read the book and make use of what it says (for example, a cook book), but you cannot legally make photocopies of the book and sell them. Patents are another example of intellectual property rights and give a different sort of ownership to information – ownership of ways of doing things but for a limited period of time only. Patents are very important in research intensive industries such as the pharmaceutical industry, whose economics are based on undertaking costly research into new drugs with the potential for then exploiting them exclusively for the period of time they can claim patent protection. Patents can also be sold, licensed and traded; another example of information having monetary value.

Reading activity

Read Chapter 6 of Avgerou and Cornford (1998), which has a discussion of information as a theoretical theme in information systems.

Another way to categorise information is as being either **descriptive** or **probabilistic**. An example of descriptive information might be the layout of a city on a map or the number of items in stock in a warehouse. An example of probabilistic information would be an economic forecast of the pound–yen exchange rate in two years' time or the demand for items from the warehouse over the next two months. Descriptive information can be traced back to some real world thing or phenomenon, but probabilistic information can only be traced back to an abstract model that may use some descriptive data.

Information may be of high or low **quality**. A good team of economists (with University of London degrees) will be expected to produce better forecasts than a bad team (with degrees from other universities). How do we know which team is good? We need more information – the universities they studied at, or better still, their previous record at forecasting.

Is more information better than less information?

Often what we implicitly mean by good information is exactly the right information, with no wastage; not too much, not too little. A paper phone directory (something many of us use less and less) contains many names and phone numbers, and if they were randomly organised they would be of little use. So phone directories are organised systematically to enable a **particular** number to be found assuming we know the name. In this way we have potential access to a lot of information, but can home in quickly on what we need. In a managerial context, an excess of ill-organised information is often described as **information overload**. This is where a manager or user receives too much information and cannot determine which parts are important or relevant. Computer-based information systems should be designed based on a good understanding of people's particular information needs at different times, and their ability to handle information. Good systems should be able to deliver the appropriate information, appropriately organised to an appropriate level of detail (and know what 'appropriate' means in various circumstances).

This is easy to say...but far harder to do. How many times have you looked at a website desperate for a particular item of information, and cursed the designer who seemed to think that putting more information on the site would please more people!

Activity

Think of an example in your life when you suffer from information overload. What do you do about it?

Look at a selection of information presentations that you use in your everyday life. For example, a bus timetable or a film listing, a Facebook page, your college timetable or the contents page of this subject guide. Are these sources of information as well presented and useful to you as they could be? Suggest some improvements.

3.2.4 Data versus information

If information is approached in the manner introduced above – as useful, valued and relevant intelligence about the world – then data can be approached in a much more direct manner. (Data is strictly a plural noun (the plural of datum). It has become common to use it as if it were singular. So, rather than say 'these data are', we say 'this data is'. You will see that we have adopted this approach in this guide reflecting common usage in the English language. We apologise to purists who want to uphold the old distinction between datum and data.)

Data is just symbols stored or processed in a computer. Another way to describe data is as a medium for conveying information. Data can be the basis for information – but only if someone seeks it out and interprets it. This may require the person to specify what data is to be sought and then to apply some form of processing to the data, perhaps summarising it. If the data is in a computer system, it will then have to be extracted and displayed in an appropriate manner.

Example

The Bloomsbury branch of Multinational Bank has 20,000 customers, many of whom are staff and students of the University of London. Inside the bank are positions for 10 cashiers; each position has a computer terminal. All of the terminals are linked to a computer in the assistant manager's office. The computer runs a number of programs that control the various terminals, and it has computer discs that store information about the various transactions that take place. Customers can use the cash dispenser (ATM) in the outside wall, which is also part of the local system. All of these machines in the bank are linked through a computer network to the head office's computer centre, where the main database of customer records is held.

The bank's operations are based round the computer record kept for each customer and their transactions. This record consists of:

- the name and address of the account holder
- the balance of the account (positive or negative)
- a record of any allowed overdraft
- a record of all transactions for the past 10 years.

Taken overall, this arrangement can be seen as an information system – the customer accounts information system. In other words, it collects, processes and stores various items of data as individual transactions take place, and it allows various types of information to be provided for various classes of people.

If I am interested in the balance on my account and whether my salary has been paid in, I can go to the cash dispenser and ask for a mini-statement, which is printed while I wait. Alternatively, I can go inside to a cashier and ask a person for the same information or I can log on to the bank's website to access this information.

The manager of the branch may want to see some details of my account as well. They are more likely to be interested in an overall summary of information on all accounts – perhaps the sum of the balances in all accounts in order to compare it with the same figure for last year, and a graph, may be the best way to do this. The manager may also want a list of all the people who have exceeded their overdraft limit, so that a friendly letter can be sent to them. Well, once upon a time it worked like that, but today this is probably a task that is programmed and requires no human intervention.

Both the manager and I need some information – we are each looking for particular items stored on the computer or a summary of items. We both want the information to be displayed in an appropriate format. On the basis of the information we receive, we will be able to take some actions or make some decisions. The raw material of this process is the stored records on the computer – which we refer to as data – but what both the manager and I require is information.

Remember: computers hold data. People seek and use information. When we talk about information technology rather than computers, we are acknowledging that people are central to the overall task we seek to accomplish by using this technology.

Activity

Look through various textbooks and reference sources (for example, Wikipedia, a dictionary) and make a note of their definitions of information. How much variety is there to be found? Do you prefer some definitions to others?

A recent publication from the Royal Society offered the following definitions of Data, Information and Knowledge.

Data: Numbers, characters or images that designate an attribute of a phenomenon.

Information: Data becomes Information when they are combined together in ways that have the potential to reveal patterns in the phenomenon.

Knowledge: Information yields knowledge when it supports non-trivial, true claims about a phenomenon.

(See: The Royal Society, *Science as an Open Enterprise*, June 2012. Available at: http://royalsociety.org/policy/projects/science-public-enterprise/report/ Note that you are not being recommended to read this report. But it is always good practice to cite the sources you use when writing.)

This is a report written by scientists and it reflects the way that they saw the concepts we have discussed here. Do you see their definitions as fully compatible with the discussion here? To what extent do their definitions reflect their being scientists? How does this contrast with our status as 'managers' or 'social scientists'?

To be a knowledge worker, does your knowledge mostly come in the form of knowledge of some theory, or does it come in the form of practice and experience? Use examples to explain your answer.

3.3 Systems

Reading activity

Read Section 1.1, Chapter 1 of Laudon and Laudon (2013) and Section 1.4, Chapter 1 of Curtis and Cobham (2008).

You are also recommended to look at Chapter 6 of Avgerou and Cornford (1998).

Many introductory texts choose not to spend much time considering what a system is and why we speak about information **systems**. However, you should have a basic notion of the concept and you should be able to apply it to various situations. A common definition is that a system is a collection of components that interact together and can be seen as collectively undertaking a common purpose. Systems can be **closed systems** that have no interaction beyond themselves or **open systems** that interact with and change their environment (beyond their own boundary). Figure 3.1 schematically shows a system made up of interacting components and taking inputs from its environment and providing output to it. The system is controlled by some feedback process that ensures that as far as possible the desired output is produced.

Activity

Consider an air-conditioning system. Its main components are a compressor unit, a fan, ducting and a thermostat that senses the temperature and controls the compressor – turning it on or off. Explain this system in terms of it being an open or closed system, the inputs and outputs involved and the control process or feedback that steers the system. What would you see as the 'purpose' of the system…what does it strive to achieve? How does the output of the system change the environment and thus the input?

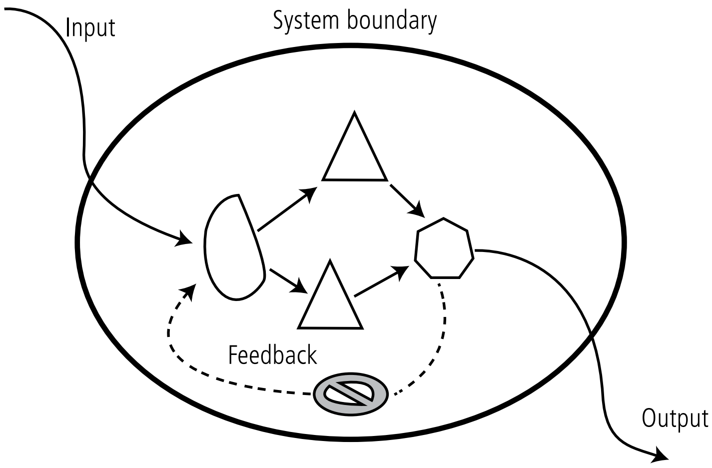

Figure 3.1: Systems environment.

Activity

Would you consider the economic system of your country as an open system or a closed system?

Taking the online book store Amazon as a system embedded in an environment of potential purchasers, explain with an example how the control or feedback might work. First consider what the inputs and outputs are and what the purpose of the system is. Then try to show how information on outputs can ensure more or better inputs. (Hint: If outputs are books shipped to people, how can we use that data to improve the number of inputs (for example, orders)?

Information systems are by definition examples of open systems – although specifying the boundary (what is in and what is outside) can be tricky. Thus, information systems have some relations with the environment beyond their boundary – accepting inputs and generating outputs. For example, a payroll system for a company will:

- take in data about who worked how many days as inputs
- process this data in various ways to calculate how much to pay people and how much income tax to deduct
- generate instructions to a bank to transfer money to the workers' bank accounts as outputs, and tax to the government.

This process all has some effect on the company's environment. If people are paid on time and correctly there is one effect; if they are paid late or too little, there is another!

The principal interactions between an information system and its environment can be described as the:

- receipt of signs or signals from the environment as **inputs**
- storage of the inputs in an organised manner as **data**
- **processing** or manipulating the data
- passing of signs and signals back into the environment as **outputs**.

Outputs will in general be created in response to inputs – for example, a request for some stored data to be processed and displayed. Another example might be an order for goods as an input, and instructions to the warehouse to dispatch them as output (plus perhaps an instruction to the factory to make some more).

Overseeing this process to check that it operates correctly will be some form of **control mechanism**. Such controls are based on feedback – either positive or negative. Within the computer component of an information system, this control activity is one of the tasks of software, but it must be remembered that information systems are more than computers and that control activity (processing feedback) will also be undertaken by people. Control issues are discussed in more detail in Chapter 9 of Curtis and Cobham (2008).

3.3.1 Information systems

Reading activity

Read Sections 1.1 and 1.2, Chapter 1 of Laudon and Laudon (2013).

You are also recommended to read Chapter 1 of Avgerou and Cornford (1998).

Information systems are purposive systems. They are established for reasons and have objectives or goals, designed or established to achieve some stated end. In the case of computer-based information systems, the stated end will generally be to satisfy the information requirements of particular people or classes of people – for example, bank managers or bank customers. At a higher level we could say that information systems are established to serve the overall strategy of an organisation – to help it do what it wants or chooses to do.

Activity

Review the distinction made in Avgerou and Cornford (1998) Chapter 1 and Laudon and Laudon (2013) between a formal information system and an informal information system. Are informal information systems purposive?

In the example of the Bloomsbury Branch of Multinational Bank, the computer system was described as an information system, and it can be seen to satisfy the general requirements of a system:

- It is made up of a number of interconnected components.
- It is an open system, with inputs coming in the form of cheques to pay, deposits to credit and requests for information.
- The information is stored and processed within the system.
- Outputs will include various forms of report for customers and managers.
- Control will be exercised within the system by a combination of the logic of the computer programs **and** the actions of the bank staff. If I write a cheque for £10 more than my overdraft allowance, the computer alone may decide to let it through. If I write a cheque for £1,000,000 I do not really expect to get away with it, and the programs running on the computer should trap the transaction and probably pass it to a bank official for a decision (to suspend my account I imagine).

This last point is important. An information system is more than computers and their programs – that is just a computer system. Information systems include people, and when information systems are studied or designed, people, the organisations they belong to and the jobs they do are as central as the technology. Commercial businesses and other forms of organisation, such as government ministries or hospitals, are made up of and operated by people, so it is vital to remember from the outset that people are a part of any information system. We can then say that information systems are social systems (supported by technology). In this way, we again speak of our approach as being sociotechnical.

Reading activity

Review the section on the sociotechnical approach in Chapter 1 and Chapater 14 of Laudon and Laudon (2013).

3.4 Reminder of learning outcomes

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

- explain the distinction between data and information and knowledge and give illustrative examples
- explain the concept of a knowledge worker and their needs
- describe how information systems are a combination of technical and social elements and the implications of this perspective
- explain the principal features of a system, and apply these ideas to practical information systems examples.

3.5 Test your knowledge and understanding

1. Why do people sometimes pay for information – for example, when they buy a textbook, novel, map or daily newspaper? What may be the consequences when information that was once sold is now available freely – think of newspapers or music (is it really free?). Is there any information that you believe should always be available free to all people, or perhaps to citizens of a particular country?
2. Airlines maintain large computer systems and computer networks to allow travel agents, tour operators and individual customers around the world to check on the availability of flights, to make bookings and to print tickets or download them. Considering this as an information system, identify the main components in the system, the technology used, the various people and organisations involved, and the types of information that they require (their information requirements).
3. The quotation below is taken from a publication of the Institute of Chartered Accountants in England and Wales.

   > Management needs timely, high-quality information in order to run their businesses effectively and to facilitate compliance with statutory and regulatory requirements. Control of the quality of information is therefore a major function of management.

   a. What sorts of control do you think are appropriate in order to ensure the quality of information?

   (Note: It may be appropriate to take a systems perspective to this question. Chapter 9 of Curtis and Cobham (2008) would also provide a useful starting point.)

4. When you use the Google search engine or Facebook you are presented with adverts that are targeted at your interests as they have been revealed in your recent uses of these systems.

   Investigate how this is done and how these companies collect data about you and make money from it (see, for example, Laudon and Laudon (2013) Section 4.3).

   a. Do you have any concerns about your activities online being monitored and mined for data, and this data being used to select specific adverts to show you?

   b. Is there any data that you may reveal as you go about your life online that you think should never be captured and used by other businesses?

5. Explain how a sociotechnical approach to information systems differs from a purely technical or managerial approach. Using the systems model presented here show where the technical and the social elements are found. Use an example to illustrate this.

   a. If or when we adopt a sociotechnical approach for developing a new information system to satisfy certain peoples' information needs, what kinds of activities would need to be undertaken by the developers?

Chapter 4: Contemporary trends in information and communication technologies

4.1 Introduction

This course is about information systems, not about technology taken on its own. The technology we primarily consider, IT or ICT, is the subject of other academic fields such as electronics, computer science, software engineering, or communications engineering. Each of these fields is relevant to us at times, but they are in general at the edge of our primary concerns in this course. Thus for this course, it is not appropriate to see these technologies in isolation from their use by organisations and by people, the tasks they help us achieve, the reasons we use them, and the various services and infrastructures that they rely on.

And yet, it is hard to talk about information systems without at the very least making some fairly important assumptions about the technology that is present as part of the information system, and what it is expected to do. Even the most 'business' oriented discussion of, for example, e-commerce, will be based on an assumption that the internet is widely available, generally reliable, safe and secure, and that certain software (for example, web browsers) and various types of devices (PC, tablets, smartphones) are available and work.

Such a discussion may also need to reflect how the availability, characteristics and mode of use of all this technology changes over time. Ten or more years ago we had no really mobile devices as understood today – laptops in those days were known as 'luggables' and mobile phones in films from the late 1980s are the size of a house brick. Today in countries both rich and poor, we are used to using mobile phones to access information systems (or perhaps we should say as 'part of' information systems), and increasingly we are moving to multi-function tablet devices such as the Apple iPad. It is also fairly clear that in 10 more years (2023) things will have changed again, although the authors of this guide are not clever or confident enough to say exactly how.

Many introductory books provide an adequate coverage of basic technologies, and most students taking this course will have some experience of using some types of ICT – although more in their personal lives than in a business or organisational context. What you read about technology in textbooks may at times seem a little dated. This is not surprising. First, because it takes time for a text book author to conclude that something is important, to write about it with examples, for the manuscript to be edited and the book to appear in a shop. (Although these same technologies might be able to speed up this process a bit perhaps?) But it also reflects the need for people who study technologies in organisational settings to understand that, while our attention may be drawn to all things new in technology, real organisations with long histories will have lots of older technology within them. So a little history, or attention to past trends, is still relevant knowledge today. And the language we use to speak about information systems is very influenced by that past too.

Working with information systems today (in 2013) is not all about smartphones, iPads and social networking. It is a lot about managing the results of previous decisions and the technologies of previous generations. We even have a name for such systems and technology – we call them legacy systems or legacy technologies – that is, systems and technologies that are handed down from a previous generation. Often a project to develop a new information system is quite constrained by the legacy systems that surround it and which it will need to interact with.

4.1.1 Aims of the chapter

The aims of this chapter are to:

- introduce a broad survey of information technologies including hardware, networks and software
- describe the fundamental characteristics of this technology and how it works, its power and limitations
- balance a concern with the most recent and up-to-date or cutting edge technologies, and those that are older, well established but still in use.

4.1.2 Learning outcomes

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

- express a logical understanding of how the technical parts of a computer-based information system work, their principal structures and components including contemporary software technologies for information processing and communications
- demonstrate a good understanding of the significance of history for understanding contemporary information systems and the concept of legacy systems
- discuss the evolution of different types of information and communication technologies (eras) and the extent to which new technologies have led to changes in the way organisations use technology and are structured and operate
- explain client–server, enterprise and cloud computing and give examples of each
- describe the database approach and offer examples of its advantages over a file-based approach.

4.1.3 Essential reading

Laudon, K.C. and J.P. Laudon *Management information systems: managing the digital firm*. (Boston; London: Pearson, 2013) thirteenth edition [ISBN 9780273789970 (pbk)] Chapters 5, 6 and 7.

Curtis, G. and D. Cobham *Business information systems: analysis, design and practice*. (London: Prentice Hall, 2008) sixth edition [ISBN 9780273713821] Chapters 3, 4, 5, 6 and 8.

4.1.4 Synopsis of chapter content

The chapter introduces contemporary information and communications technology including computers of various forms, computer hardware and its logical structure, computer software and networking. The approach is in part historical, exploring the changes over time (eras) in the dominant model of computing and the way that this technology is deployed by organisations. The chapter also initiates a discussion over the possible impact that specific types of technology may have on how organisations are structured or how they go about their business.

4.2 The history of computers

4.2.1 Background reading

An excellent brief treatment of the history of computers is found in Wikipedia. Internet resources relating to the history of computing include http://ei.cs.vt.edu/~history/

The computer that we understand today is usually acknowledged to have been 'invented' during the Second World War (1940s). Both the ENIAC (Electronic Numerical Integrator and Computer) 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 developed the Colossus machine for deciphering intercepted military communications using electronic technology drawn from telephone exchanges. Of course, ideas of aiding or automating calculation and information storage are much older than that and, for example, the abacus (over 4,000 years old) is still in widespread use today in Asia.

The commercial computer industry started in earnest in the 1950s after the Second World War. For the first 30 years computers were large, slow (by today's standards), and effectively only available to large organisations. These computers were more or less 'centralised' (located in one place), and data was brought to them, and results (printed on paper) produced and distributed. Up until the 1970s a chain of shops, for example, or the branches of a bank, might have a delivery of printed paper every day or two, and send in stacks of punched cards for processing.

The second 30 years, from about 1980, were and are different. From the mid-1970s computers became small and smaller still, and communications networking became cheaper, faster and increasingly, for short distances, wireless. The combination of these two broad trends brings us to today where computers are ubiquitous – for example, found everywhere and in all kinds of devices, and usually networked to other devices and resources. We are also in the situation where many items have a unique computer identity and can be tracked and monitored. We even have a name for the super linked up assembly of technologies that track and identify just about everything – 'the internet of things'.

The key technology driving this change over the last 30 years has been the silicon chip or Very Large Scale Integrated Circuit (VLSI), but this has been accompanied by a range of other hardware technologies such as fibre optics for fast digital networks, optical disks for data storage (CDs), technologies allowing efficient use of the radio spectrum, new battery technologies, flat screens, etc. And behind each of these developments stand dedicated technology companies – large and small – who have driven the pace of development. The most successful companies that drive forward this market are a range of old established names and newcomers. They each have their own specialisms in design, manufacture, marketing etc., and their own business models that allow them to generate revenues and make profits. Some are very technical, some more marketing based, and others more service oriented.

Activity

Apple, Google, IBM, Intel, Microsoft, Oracle, Samsung, Dell, Acer, Arm, Lenovo, SAS and SAP

Choose three of the above global IT companies and briefly investigate and explain the primary expertise that each holds, and the business model (or models) that they use to generate revenues and make profits (for example, what they sell and to whom, and how).

Use the various company websites as the main basis for your research. In each case just add WWW. to the front, and .COM to the back of the name and you will probably find them!

4.2.2 A Simple model of basic computer hardware

Whether a computer is huge and powerful or small and portable, we can use the same general logical model to understand its structure. The elementary model of a computer is based on four interconnected elements:

- input device
- memory (or storage)
- central processing unit (CPU)
- output device.

In a small PC or mobile phone, the CPU will consist of a single microprocessor fabricated on a silicon chip. Instructions to the computer as to what it is to do (the software, a program) 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. Software allows the data stored in the memory to be 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 understand program instructions so they can be read and executed in sequence.
- Based on the program instructions, it must manipulate data items.

The concept of memory also needs to be explored a little more. It is essential to the character of any computer that it is a 'stored program' device with programs that 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. (In real life, computers big and small will often have multiple processors working in parallel and sharing access to some common storage.) Some memory – referred to as RAM (random access memory) or main memory – is plugged into the body of the computer with direct and high speed connection to the CPU. RAM is relatively expensive, and the amount of data it can store will be relatively small. When you turn off the computer's power, whatever is stored in RAM is lost. Thus, it is said to be volatile storage.

It is fundamental that a computer needs a program to follow in order to do anything useful – but there is a chicken and egg problem here. How do the instructions get into the memory if the volatile memory (RAM) is empty at start up and, hence, the computer has no program to follow to allow it to read some stored program from a secondary storage device? In practice, you know there must be an answer, because when you switch on your computer or phone it does spring into life. That answer is contained in a further form of memory – the ROM (read only memory). ROM is another form of chip memory, but one that will permanently hold the data that is written into it. A computer will have some small program permanently stored within itself, a program that is able to initiate the reading of further programs from the secondary storage devices (for example, discs on a PC, but other, slower chip memory on a phone). This is often referred to as the bootstrap ROM, since it 'pulls the computer up by its bootstraps'. Hence the everyday expression to 'boot' or 'reboot' the computer.

As the programs that computers execute have increased in size and complexity, two new approaches to managing memory have been used. Virtual memory uses portions of the secondary memory (e.g. hard disc) as if they were parts of the main RAM memory of the computer. Cache memory speeds up the process of communicating data to and from a secondary storage device, by guessing ahead of time what data is likely to be used by the CPU next and fetching it before it is actually requested.

The description here of computer hardware is brief and somewhat minimal. This is not, after all, the main focus of this course. However, these few basic ideas of how a computer works logically and schematically are needed to follow the wider discussions and when we come to discuss how computers are used and their consequences in the world.

4.2.3 Modern taxonomy of computers

Reading activity

Read Section 5.1, Chapter 5 of Laudon and Laudon (2013).

It has long been usual to classify computers as various distinct types. You need to be familiar with this terminology, even if today it is in some ways too limited to encompass all types of computer-like devices we find and use.

Personal computers (PCs), desktops, workstations: These are the computers we are most familiar with at home and at work – a box of electronics with keyboard and screen that can function as a computer on its own, but which is almost certainly connected to some network and thus to other computers and information resources – for example, the internet and the world wide web. These were far and away the most common type of computer until recently and the emergence of various new devices such as smartphones and tablets. These types of computer still allow all manner of people to have immediate and dedicated access to a computer with a big screen and a keyboard and mouse. Such a computer is usually only used by one person at a time, although they are able to run more than one program at a time.

Workstation is a name sometimes used for a powerful PC; for example, the computers used by scientists, engineers and computer professionals. This is in contrast to the general-purpose PC that an office worker may use.

Mobiles, tablets and palm tops: There is now a whole new generation of computers, which are portable, mobile and multifunctional. They may be based on mobile phones, laptops or tablet computers such as the iPad. Such devices use wireless networking (for example, WiFI and/or mobile phone networks) to connect to other computers and information resources. Of course, their small size is a great advantage, but it is also a challenge in providing suitable means of input and output. Today this is often solved (to some degree) by using touch screens and/or voice recognition.

Data centres, enterprise servers and mainframes: A data centre is a large central computing resource for running programs and storing data. Big companies that operate across the world may have just a few such centres to service most of their corporate (enterprise) computing needs. 'Mainframe' is an older term to designate large general-purpose computers. Such machines were long the basis for large, centralised data-processing operations; the name mainframe has been used for at least 50 years. In practice today such a major computer resource would be made up of a number of computers all working in parallel and sharing a set of data storage devices – disks mostly. An example today would be the computers of a bank, which handle customer accounts, or of a government department supporting operations such as the issuing of passports, driving licences or paying people's pensions. In each case some of the 'transactions' supported might be done online and directly by a customer or citizen – probably via the internet and a website or perhaps from their phone (see Figure 5.2 in Laudon and Laudon, 2013).

Supercomputers: These are machines built to undertake high-speed computations that may involve vast amounts of data. They are used, for example, for performing engineering and scientific calculations. An example of a use for a supercomputer would be weather forecasting.

Data centres and supercomputers are for high-volume applications with extensive data storage requirements. They generally require special buildings with air-conditioning and cooling systems to keep the computers and storage devices running. One modern example of a supercomputing facility is a GRID. For example, the computing facility that supports the big CERN physics laboratory in Switzerland and in particular the Large Hadron Collider (LHC) where the Higgs boson has been detected, is known as the LHC Computing Grid (LCG) http://public.web.cern.ch. This GRID includes computers in over 100 sites across the world, including about 20 major data centres in different countries, all connected by networks and operating together to share out the work.

The way that CERN explains their GRID on their website is as follows:

> The grid is based on the same idea as the Web, which was invented at CERN in the beginning of the 90s: sharing resources between geographically distributed computers. But whereas the Web simply shares information on the computers, the Grid also shares computing power and storage capacity. This means that scientists can log on to the Grid from their PC, and the work they need to be done will be carried out by many machines across the planet. This allows scientists to carry out very complex calculations quickly and simply. (http://public.web.cern.ch/public/en/spotlight/SpotlightGrid-en.html)

Cloud computing: In the wider world beyond science and engineering, a similar idea to a GRID is today at the forefront of computing and the development of new information systems – called cloud computing. In this case, a large network of computing resources (processors and storage devices) is made available for multiple users to use by the minute or by the kilobyte of data – just as you pay for phone calls by the second or electricity by the kilowatt. Thus it is possible for a business organisation to 'rent' processing power and data storage capacity on an as-needed basis from a supplier of such services. There may be no need to build and manage a data centre of your own. Two well-known companies that offer such services for business users are Amazon and Microsoft, and they have many clients both big and small. Using the cloud (a public 'for rent' cloud) just to obtain processing power and storage (infrastructure in the jargon – hence Infrastructure as a Service or IaaS), or it may be to also rent the use of software or a specific service – called Software as a Service or SaaS (see Laudon and Laudon (2013), Sections 5.3 and 5.4). Individual people too may rent storage capacity and software services; for example, in photo sharing sites such as Picasa or general file sharing sites such as DropBox (www.picasa.com; www.dropbox.com). Another example of cloud services for providing software include Google Apps: www.google.com/apps/

4.2.4 Client server computing

As noted above, today all computers are usually connected to **networks**, and thus we can also describe them by their role within the network. It is usual to identify two roles – that of a **client computer**, which provides the interface to the user, and that of a **server computer**, which provides services across the network. Thus, my desktop PC is a client computer, when it connects to a mail server computer across the network at the university so I can send or receive email. Figures 5.2 and 5.3 in Laudon and Laudon (2013) show schematic descriptions of the client–server approach and more generally describe the period from about the mid-1980s as the 'client–server era', as networked units of computing resources were used to build the basic computing capacity, rather than relying on centralised mainframes. Of course, the internet itself is based on the principles of the client–server approach. This era is then overtaken by what Laudon and Laudon (2013) refer to as the 'enterprise Internet era' from the mid-1990s. For a more detailed description of client-server computing and the general distributed approach, see Curtis and Cobham (2008) Chapter 4.

Laudon and Laudon (2013) end up with the final era named as the 'Cloud and Mobile era', and that quite well categorises the contemporary leading edge in technology and infrastructure terms. Although, as they make clear, earlier generations of technology are in use and remain important, still. The cloud model is sometimes termed as a utility model, with a parallel drawn between the way we gain electricity or water from a utility company. Just plug in and use what you want. Use of cloud computing may also have some benefits in terms of global and local environmental impacts – noting that Laudon and Laudon (2013, Section 5.3) report that in the USA data centres use more than 2 per cent of all electrical power. If cloud computer centres are located where hydroelectricity is generated and cheap, and data and work is sent to them using networks, then we may save the pollution of running computers on expensive electricity that is generated using carbon fuels (oil, gas, coal). As with most issues associated with global warming, greenhouse gases and CO_2 levels, green computing is a contentious issue with many different viewpoints.

Activity

Find and describe three examples of client-server computing.

In each case, try to explain why this approach is used (for example, the benefits it brings) and what tasks (processing, data storage, etc.) are handled by the client and by the server.

Research the benefits and problems of using a commercial cloud service to provide computing resources for a medium sized business. Think in each case (both for benefits and problems) about issues associated with cost, control, security and flexibility. Do you imagine that one day almost all computing will be provided in this way?

4.3 Software: operating systems and applications

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 usual to differentiate between systems software, which helps the machine to operate, and applications software, which directly performs some useful task for those using the computer (for example, Microsoft Windows is an operating system; Microsoft Word is an application).

Reading activity

Read Section 3.3 of Curtis and Cobham (2008).

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 computer user communicates with the operating system in order to get the computer to undertake any 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 (window, icon, mouse, pull-down menu) concept, which combines these four features for effective communication with the user. Apple OS and Microsoft Windows are examples of operating systems that provide a common, consistent and sophisticated graphical user interface (GUI) for application programs to use. Linux is an example of an open source operating system developed by volunteers and freely available as source code, and users of Linux have a choice as to the style of interface they use.

All computers from phones to science GRIDs require an operating system of some description. One way to view the main task of an operating system is as allowing the initiation and running of other application programs. When someone wishes to run a program – for example, a spreadsheet – they tell the operating system the name of the program (by pointing and clicking) and ask that it be run. In order to run the program the operating system needs to manage and coordinate the hardware, software and network resources. We can think of these as six separate, but connected types of resource:

- memory management
- input–output management
- secondary storage management
- processor management
- program management
- network management.

4.3.1 Memory management

The operating system allocates some memory (RAM) to programs that are to be run and may alter this allocation as they run. For example, the spreadsheet has to be allocated some memory in which to locate itself (its code) and the data it manipulates. As more data is typed into the spreadsheet, more memory may be needed.

4.3.2 Input–output management

The operating system will manage input and output devices to enable programs to obtain input (for example, from a keyboard) and to produce outputs (for example, on screens or printers). For example, the spreadsheet will need input from the keyboard. It will ask the operating system for some keyboard input and will wait until it gets it. When the user types on 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, which it chooses to interpret and act upon itself, rather than passing on to the spreadsheet.

For example, the 'Caps Lock' key tells the operating system to pass all characters to the spreadsheet as capital letters.

4.3.3 Secondary storage management

Secondary storage management is done through a file system. The operating system allocates space on a disc to contain a file, and maintains a directory of file names and locations. This means that a file can be subsequently 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 load it into memory. Similarly, if when using the spreadsheet we decide to store the work that has been done, this results in a request to the operating system to find some free space on the disc, give it a designated file name and write the contents of our spreadsheet on to the disc.

4.3.4 Processor management

The operating system also needs to manage the other main hardware resource – 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 (real computers – even microcomputers have, in reality, a number of processors dedicated to various specific tasks such as controlling main memory, doing arithmetic, manipulating graphics images, etc.).

The operating system is also a program, so it needs to use the processor in order to achieve all the tasks described above. In the case of the spreadsheet, the operating system will undertake the task of loading the program into the main memory (when the processor is being used by the operating system), and then passing control to that program (when the processor is then 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.

4.3.5 Program management

The description given above suggests that the operating system actually manages one other resource – programs. In the example, there is just one processor, but two programs – the operating system and the spreadsheet. In a modern microcomputer, there can be many programs, all wishing to share the processor. Indeed, 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 be able to pre-empt any other program (for example, push to the front of the queue) and use the processor immediately when it needs to. In any case it should prioritise other programs to ensure that the most important ones get more of the processor resource. This is known as pre-emptive multi-tasking.

4.3.6 Network management

Another area for operating systems is 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 that gives access to wide area networks. More generally, operating systems provide basic connections to the internet and allow this to be shared among programs.

When many programs are running simultaneously in a computer, it does, of course, complicate all the other management tasks. Memory must be carefully shared between programs; input needs to be directed to the right program and output devices such as printers need careful management too. As you will gather from the above description, operating systems are complicated items of software. As hardware gets more powerful and users expect more, operating software gets more complex too, and today an operating system for a microcomputer or a mobile phone is a very substantial and sophisticated piece of software.

Activity

Pull up the task manager window on a windows-based PC when it is running (for example, press CTL-Alt-Del all at the same time).

Take a look at the Applications tab to see what 'user applications' are running. Then look at the Processes tab, and see how many actual bits of software (modules or processes) are running on the machine. A process is roughly equivalent to a separate program and in this case will include many separate parts of the operating system software as well as 'applications'.

Then click the Performance tab and see how much physical memory the computer has, how much main memory is in use and how much of the CPU power is being used. The graphs you see will show this for the recent past. Try loading a couple of other data-heavy or processor heavy programs such as a computer game or a big spreadsheet and see if these figures change.

4.4 Data technologies

Everything stored in a computer is data, and that includes programs, both systems software and applications. From the point of view of the storage devices of a computer, it is all the same. Data in a computer takes 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 technical 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 common to group 8 bits together as a byte. Bytes form the basis for measuring storage capacity, as in these approximations:

- a kilobyte (kB) 1000 = 10^3 bytes – which is close to 2^{10} (1024) bytes
- a megabyte (MB) 1,000,000 = 10^6 bytes – which is close to 2^{20} bytes (just over 1 million in decimal)
- a gigabyte – 10^9 bytes close to 2^{30}
- a terabyte – 10^{12} bytes close to 2^{40}
- a petabyte – 10^{15} bytes close to 2^{50}

kilobyte, megabyte, etc. should be abbreviated to kB, MB, GB, TB. MB and kB are often just left as M or K, etc.

Strictly speaking we should differentiate between quantities defined as powers of 2 and as powers of 10. Thus in the strict international definitions, 1 megabyte (1 MB) = 10^6 while 1 Mebibyte (1 MiB) = 2^{20}. However, most of the world uses megabytes and gigabytes without making any distinctions between powers of 2 or of 10.

Data in a computer can be of different types; for example: numeric data, textual data, graphical data (pictures), video, sound data, programs (program instructions).

Each form of data has its own way of using the raw storage capability (RAM or secondary storage). Just by looking 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 be decoded. For example, the pattern 01001011 represents the letter 'K' in the ASCII code for representing text; but it represents the decimal number 75 if this binary code is interpreted as a binary number. It might 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 (made up of eight individual bits). 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, etc.

Activity

A warehouse stores information on 3,000 products. Each product description comprises about 500 characters of data plus a photo of half a megabyte. How much disc space is needed to store this information? Express your answer in megabytes and kilobytes.

4.4.1 Interfaces with the computer

Reading activity

Read Chapter 3 of Curtis and Cobham (2008).

Information systems involve people, and many computers (client computers in particular) need to be easily accessible by people. All systems will have some form of input and output device to get data in, or to get it out. These include the basics of keyboards, screens and various types of printer. The machine upon which this is being written has a keyboard and a mouse as well as a scanner as inputs. For outputs, there are two colour flat screens and a colour laser printer. Using the operating systems and other software, all these devices work together to create a consistent and easy to use interface that uses windows on the screen, icons, pull-down menus and a mix of the keyboard and the mouse for interactive input.

Other forms of input device and input media might include:

- barcodes read by a scanner at a supermarket till, or QR codes read by a mobile phone
- a digital camera capturing video
- the magnetic ink character recognition (MICR) system used on bank cheques
- a smartcard used to access a bank account via an ATM (cash machine), or to identify, say, each specific doctor using a hospital computing system.

New input devices have become widely available and usable in recent years. For example, we now use voice-recognition systems, which take human speech as an input. One example of where this is used is by radiographers (specialist doctors) as they interpret and report on X-ray images and other types of digital scan. They can dictate their report while looking at the image, which makes good sense as it allows them to concentrate on the image.

Activity

You are designing an information system to be used by foreign exchange dealers of a bank as they rapidly trade currencies in a noisy dealing room, gathering information and making trades. What particular characteristics would you want of input and output devices used?

When considering input and output, it is useful to recognise that any output from a system may need to be subsequently input – data generated and output by one computer is often read into another one (the basis of client-server computing). Networks support this exchange, but technologies such as barcodes or QR codes are useful for this and can be printed by one computer and read by another. It may be appropriate, at times, to think of a usb key (pen drive/thumb drive/data stick) or CD-ROM as an output-input medium. The QR code here can be read by a scanner including many mobile phones.

Figure 4.1: A QR code for the website www.londoninternational.ac.uk

4.4.2 Data storage devices

Reading activity

Read Chapters 3 and 8 of Curtis and Cobham (2008). Read Chapter 6 of Laudon and Laudon (2013).

Main memory is volatile, but data (including software) needs to be stored permanently, securely and economically. Computers therefore have forms of non-volatile storage, referred to as secondary storage or backing store.

Files and file processing

Magnetic discs, and – to a lesser degree – magnetic tapes, have historically provided the basic storage capability for computer systems. The way in which data is organised and accessed using such devices is the topic of files and databases. A file is a named unit of data stored within a computer. For example, the word-processed version of this document is stored in a file. It is held as a sequence of characters and control codes. The organisation is vital – the characters must be retrieved in the same sequence they were stored; otherwise the document would be unreadable! For data-processing applications, we often think of files slightly differently – as structured in terms of records made up of fields. For example, one record per customer, with fields for name, address, phone number, etc.

Transaction processing applications (the back-office computing) may often revolve around a **master file** that maintains the essential data and which is updated by various types of transaction. These transactions may be stored in a **transaction file**.

For purposes of security and integrity, copies should be made of data stored on computers; hence another type of file is a **back-up file**. **Reminder: do remember to back up your project files. You are responsible for managing this data and keeping safety backups**.

Example

The customer accounts system of Multinational Bank has a file of customer account details – a sequence of records, each containing data on individual customers. Among the fields that occur within each record are:

- name
- customer number
- date of first opening an account
- address
- telephone number
- email address.

The file is used whenever a person is contacted in any way. In practice, these records will need to be accessed in any order, depending on which customer a bank employee wishes to contact (called random access). The customer number field has a special status as the key field, because the customer number allows the correct record to be uniquely identified and retrieved. Note that the bank has 25 customers called John Smith! And most of these have more than one account at the bank. The file is stored on disc, and we can go directly to read any record if we know where on the disc it is stored. In practice we would expect some database management software to take care of most of the detail of storage and retrieval of these records.

Before the creation of database software – and cheap computer power – organising files was an important technical issue. Today, with database software in common use, and with cheap computing power and fast storage devices of vast capacity, we seldom need to think in such technical detail about how exactly data is stored, accessed and retrieved for any given application. However, as you will see in undertaking your database assignment, designing databases is itself a task that needs to be carefully approached (see Chapter 8 of this subject guide).

4.5 Application software

Reading activity

Read Chapter 5 of Laudon and Laudon (2013) and Chapter 3 of Curtis and Cobham (2008).

All programs, including operating systems, need to be written before they can be run. In general, the programming languages in which programs are written are chosen because they make it easy for **people** to express what they wish to achieve. Computers cannot directly understand such a language or execute the program. It is necessary therefore to translate from the language that a program is written in (say Java or C++), to the language that the computer understands (machine code). This task is undertaken by language translator programs: **compilers** translate the entire program, producing a new version of the program – the object code; **interpreters** translate and execute one statement of the source program at a time.

4.5.1 System development tools

Writing programs in modern programming languages, such as C++ or Java, provides great flexibility in what can be done and supports efficiency in the delivered product. It does not, however, support great productivity in the actual writing of programs. It has become increasingly common, therefore, for all types of computer application to be written using tools that provide more help to the developer and need less detail to be specified. Good examples of this are the many database packages on the market, or spreadsheets. These provide, as you should discover doing your project work, an easy route to setting up storage of data and also provide tools to allow the design of input screens, models, output reports and the logic of processing information. A database package will provide some of the flexibility of a programming language, but also high-speed and pre-packaged solutions to standard problems. Examples would be the way a spreadsheet provides sorting facilities or a database package the ability to generate reports.

Programming for the web is a rather different activity to conventional programming, and has given rise to many new tools, languages and techniques. Many development tools are now available for developing web-based systems quickly; these usually generate hypertext mark-up language (HTML) – the language for web pages – but add newer techniques, such as extensible mark-up language (XML) and provide support for links to databases.

4.5.2 User-written programs and commercial software packages

We can write programs if we have the skills and the time, but most computer users rely on packaged software – sometimes called packed applications, or COTSS (commercial off the shelf software). It is possible for even large organisations to perform almost all of their information-handling requirements using purchased application packages, and it is even more likely that a small business will operate in this way. Application packages exist for all standard business tasks. Payroll programs are a good example – most payrolls in any given country have to perform the same basic set of calculations in order to compute tax and insurance contributions and most organisations will want to keep similar information about their employees. The result is a strong market in such standard applications – perhaps expanded to all aspects of human resources management and known as HR (human resource) packages. It makes good sense for most organisations – both big and small – to consider buying such packages rather than developing their own from scratch.

Activity

Go to the website of the software company SAP at www.SAP.com / This is one of the largest business software companies in the world.

Make a list of the types of organisation they target in their marketing, and all the main business areas and tasks they offer software for. At the time of writing you can find this information under the 'Solutions' and 'Lines of Business' tabs on the website. If they reorganise the website there will certainly be similar information available.

Choosing to use a purchased application package is easier if the organisation is prepared to alter their ways of doing things to fit in with the package's capabilities. If the package is a good one, it should express good ways of working, best practices, meeting legal requirements, and be easy and logical for staff to use. Some organisations, however, will want some things to be done in a special or particular way for which packages are not available or for which those that are available are not quite suitable.

At this point, organisations have a choice to make. Accept what the best available software package offers, and configure it as best they can to suit their needs. Alternatively, they can choose to spend time and money adapting the package (if possible) – known as customisation, or they can write their own programs or contract somebody else to do it. Of course, each of these latter options implies a more significant commitment of resources and higher costs. The challenge of developing bespoke (tailored or customised) information systems, which may or may not need bespoke software, is part of the topic of the third section of this syllabus – information systems development concepts (see Chapter 6 of this guide).

Activity

Draw up a table showing the advantages and disadvantages for a medium-sized business of:

1. Writing their own software for managing their financial accounts.
2. Purchasing and configuring a package for this task to run on their own computers.
3. Customising a package by adding extensive changes and extensions.
4. Outsourcing the whole information processing task to another company or contractor.

For each option, try to give an illustrative example of a type of information system need and/or circumstance that might make each choice appropriate.

Do some research online to allow you to explain the difference between configuration and customisation of a software package.

4.6 Communications technologies and distributed systems

Reading activity

Read Chapter 7 Laudon and Laudon (2013) and Chapters 4 and 5 of Curtis and Cobham (2008).

Modern information systems rely on the technology of communications as much as on the traditional technology of computers and data handling. It is common for the information systems of organisations to need multiple elements in many geographical locations – distributed systems. For example, an oil company with sites on five continents would expect to be able to share information and build common systems to help run the business. This would all be based on a set of interlocking networks in buildings, on oil rigs, in refineries and across oceans. The benefits of being able to develop such systems might be more efficient operations, more sharing of information and the use of standard procedures. The use of a distributed approach extends beyond one organisation, and networks become a part of the way organisations do business with each other. For example, through a B2B e-commerce application an oil company might take orders for chemicals from its main customers or reserve wharf space for its tankers in various ports.

The internet – the network of networks that we all have access to and through which we can all share information – has provided an even stronger impetus for using communications in information systems. (For information on the history of the internet try www.internetsociety.org/internet/what-internet/history-internet/) Today this communications medium – 'the net' – is seen by many as both the principal new challenge and the most exciting opportunity for building and using information systems. In the case above, the oil company may well use the internet as the basis for their distributed business systems, but they will almost certainly be concerned that the internet is too open and vulnerable to serve as a basis for their business. One means to provide secure communications across the internet is to use the technology of virtual private networks (VPN).

4.6.1 Wide area networks and local area networks

The basis of most wide area networking was, in the past, the old landline telephone system. Simple telephone connections were once used to transmit data with the aid of modems. But, since telephone networks were built to transmit voices in analogue form, not computer data in a digital form, they are not really suitable for high volumes and high-speed data transmission. The result was the establishment of special-purpose data communications networks that are able to provide far better performance characteristics – although they may use the telephone wires for the final link to the house or office – the 'last mile'. Today in most countries we expect to receive such data at speeds of, say, 5 to 20 megabits per second – maybe more if we are lucky and live in a big city.

But things have changed more fundamentally. Once it was a question of forcing data onto an essentially voice-oriented telephone network. Now we see the opposite. The most general network available to us is the digital network – the internet – and voice traffic can now be easily integrated into this. Thus we see a huge growth in Voice over IP technology (VOIP). The most common example is the service of Skype (www.skype.com), but there are many other VOIP providers and 4G mobile phones all work using VOIP. Of course, traditional telephone companies do not like their business being hijacked by new start-up internet companies that can offer international calls at zero cost.

Local area networks (LANs) are used to link computers within a restricted geographical range. A LAN will typically 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. (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!) If a dedicated computer is attached to a local area network to provide services, it is called a server. For example, a college computer system may have 20 microcomputers in a room connected by a 100 Mb/sec network to one print server and one file server. The file server would allow the sharing of data and programs among a class of students. Today such a network may well not be based on wired connections, but might use a wireless technology (WiFi) although probably slower than 100 Mb/sec, to allow machines to communicate.

We should also note that networks are usually described in terms of raw speed of transmission in terms of bits per second (MB/sec). But quantities of data are expressed in bytes (megabytes or kilobytes). So, if we need to answer a question about how long it would take to transmit a file measured in megabytes across a network whose speed is expressed in megabits per second, we need to multiply the file size by 8 – to convert bytes into bits – before dividing by the network speed.

Even then we may not have a very accurate answer.

First, because the raw capacity of a network may be being shared by many users – we don't have the full capacity available to us.

Second, because there are plenty of 'housekeeping' and control overheads that also need to be taken into account. In particular, assuming we are using the main network protocols of the internet – TCP/IP – we will have to add considerably more data to the total to transmit as the data is split up into separate packages; each one is numbered, and the destination address is added to each. What is more, a network may not be very reliable; we have to expect some packets of data will be lost, and we will need to identify these (through the packet numbers), and ensure that they are resent.

4.6.2 The internet and the world wide web

Reading activity

Read Chapter 7 of Laudon and Laudon (2013) and Chapters 5 and 6 of Curtis and Cobham (2008).

The internet came about through academic and military projects in the 1970s and 1980s. In the 1990s it mushroomed, becoming a great network of networks that spans the globe and provides services to the largest multinational corporation as well as to individual people. The internet is used to communicate – as in email or chat programs, to move data and files around – as well as to publish information to a worldwide community. The internet manages to operate around the world through the standard adoption of certain rules and protocols for addressing and passing messages. The principal such standard is known as TCP/IP (transmission control protocol/internet protocol). Access to the internet is usually made via an internet service provider (ISP), which is often part of a telecommunications or media company.

The basis of the universal and worldwide acceptance of the internet as the basis for digital communication has been the establishment of certain standard protocols (rules and conventions) for exchanging data. We have already briefly discussed the two main protocols that are at the heart of the internet – TCP, the transmission control protocol that ensures data is sent completely from one point to another, and IP – the internet protocol that ensures that each individual packet of data is routed through the internet to the right destination. There are a number of other protocols that are in common use, for example for the world wide web HTTP – hyper text transfer protocol, which allows web pages to be located and retrieved.

From a user's point of view, the main technologies they see as they use the internet are perhaps an email client, which prepares, sends and receives messages, and a browser program such as Firefox, Chrome or Internet Explorer, through which they navigate around the world wide web. Other applications could include instant messaging, file transfer or voice over IP telephony (e.g. Skype).

To find information, world wide web users usually need to access some kind of search engine such as Google or Bing to provide a list of relevant sites based on some key words. If and when a user wishes to trust the internet with sensitive information – for example, to send a credit card number to a company – then a user may need to become aware of the various means of securing information, such as encryption and the protocols that secure servers use such as HTTPS; a protocol enabling the secured transmission of web pages. Finally, when we come to publish our own information, we will need to master the simple language used to prepare web pages – HTML (hypertext mark-up language).

The existence of the internet has also given rise to new areas of business, including ISPs, and the vast range of old and new companies 'do business' over the internet – so called e-commerce. As one example, Amazon has pioneered selling books over the internet. Likewise, airlines now sell tickets over the net, and most banks offer 'online' banking services. Other types of organisation also use the internet – for example, most governments around the world now publish much of their material on the web and allow all manner of transactions to be processed by citizens directly – what is commonly known as e-government.

Activity

The UK government's main presence on the web in terms of services to citizens is www.direct.gov.uk/

Find your own government's main website or portal.

In this way, it is argued, all manner of services can become more accessible and available to their population. There are, however, some problems, and not everybody can access the web, has the skills to do so, or even the right equipment.

Activity

Research and write up a brief description of what each of the following internet related protocols and standards do and how they work:

TCP, IP (often combined with TCP), FTP, SMTP, HTTP and HTTPS, HTML and XML.

Individuals and large corporations use the internet. However, for companies, the example of publishing information – using browsers to find what is needed and generally sharing information – has led them to consider using the same model for their internal communication needs. These are known as intranets (**intra** means inside).

The internet has very significant consequences in breaking down national boundaries and jurisdictions. A business may be registered in country A, operate from country B and sell goods to consumers in country C – perhaps avoiding any tax liability in any of the three countries. Information of all kinds can flow into and out of countries with almost no effective control. Some see this as a good thing, bringing the world together; others see it as a significant risk. For these reasons the question of 'regulating the internet' is often raised in international fora and by some governments.

Activity

Find out how many different types of business from your country offer their products or services over the internet. Are any targeted to overseas clients? Which are most successful? Why do you think that is? Are there any obvious missing types of business – what do you think this may be? There may be some cultural or developmental explanations for lack of take up; for example, the desire to bargain and haggle, or lack of credit cards or the desire to keep transactions 'informal'.

What is the most successful e-government service in your country? What do you think lies behind this success? What benefits do people, and the government, obtain from these services? Do they both obtain benefits equally?

What are the main issues that arise in your country about the way that the internet opens up information and allows it to flow across borders?

Are there any controls on information accessed through the web in your country? Are they effective? Do you believe this situation should be changed in any way?

4.6.3 Databases and the database approach

Reading activity

Read Chapter 6 of Laudon and Laudon (2013) and Chapter 8 of Curtis and Cobham (2008).

In a traditional file-based approach as mentioned above, each application has its own separate files to store relevant data. This may make it easier to develop each individual application, but it may cause longer term problems. It is likely that data will need to be shared between applications, and storing it many times will be wasteful and will lead to inconsistencies. It has therefore become standard in business to approach data storage using a database approach rather than a file-based approach.

The principles behind this are to store data in an integrated and coordinated manner, so that many users or application programs can share it. Items of data should be stored only once. This will allow improved control of information, avoid inconsistencies and allow security to be carefully managed. On the negative side, a database approach requires careful design, and if done poorly, may allow data errors to propagate among every application that uses the database. If your bank stores your email address just once, and all applications use that single record when they want to contact you, but it is not entered correctly or is corrupted, then you will get no email from the bank.

When designing a database the data to store has to be carefully assessed and the way it is stored carefully designed to take into account the needs of all the various users and the various requirements they may have. Such design is also important to ensure that as data is updated (added to, deleted, changed, etc.), the overall database still remains consistent.

As a simple example of this kind of problem of updating, one which we will return to in Chapter 8 of the subject guide, if a company deletes a customer firm from their database (for example, because the customer has gone out of business), they should probably also delete all the outstanding orders from this customer. But should they delete all the orders that have been supplied in the past, or all the payments that have been made? Probably not if they want the accounts to add up at the end of the year, and the stock records to be accurate.

The database approach is supported by using software called a database management system (DBMS). This software takes care of the details of storage of data, and provides the user or the application programs with a simple interface through which they can request items of data and return them for storage. Such interfaces are provided for programs to use as they run and for individual users who wish to extract some information directly from a database on an ad hoc basis – a query language – one example of which is SQL (Structured Query Language). Database software can also be slower and less efficient than file-based processing if absolute speed is of the essence (which it usually is not these days).

Various models have been used to structure data in databases, including the network model, hierarchical model and object model. **For this syllabus, we only consider the relational model for design of a database although we do use an object oriented style of diagramming for undertaking analysis – see Chapter 8 of the subject guide for more detail**.

Big enterprise scale databases can be centralised or distributed. That is, they can pull all the data together and store it in a single location. Users then access it as they need to, probably by using networks. The alternative is to distribute the database. We could store, for example, all data relating to motor cars in England in one place, and all data relating to Scotland in another. Logically it might be one database, but operationally data is stored closer to where it is used. Software might take care of all this detail as seen by any user – in the case of photos stored on Picasa or Dropbox you and I have no idea where in the world they really are, or where there are backup copies of the photos! We just trust the service supplier.

We may also choose to replicate a database, with a full copy of the database held in two or more locations. This could be a way to ensure security and integrity. If one datacentre is out of action, another is available, but there is the problem of ensuring that updates and changes made in one copy are reproduced on the others and that the copies remain synchronised. Again, software can help, but this is more complex to do and may at times fail.

4.7 Reminder of learning outcomes

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

- express a logical understanding of how the technical parts of a computer-based information system work, their principal structures and components including contemporary software technologies for information processing and communications
- demonstrate a good understanding of the significance of history for understanding contemporary information systems and the concept of legacy systems
- discuss the evolution of different types of information and communication technologies (eras) and the extent to which new technologies have led to changes in the way organisations use technology and are structured and operate
- explain client–server, enterprise and cloud computing and give examples of each
- describe the database approach and offer examples of its advantages over a file-based approach.

4.8 Test your knowledge and understanding

1. Describe what is meant by the phrase 'the database approach'? What benefits should an organisation get from adopting such an approach? What problems or specific issues do you foresee if a database approach is combined with a distributed approach (for example, a distributed database)?
2. Conduct a survey of the various types of input and output devices used in shops, stores and businesses where you live. Include the devices used to monitor stock and capture sales of goods as well as those used to capture the means of payment. Can you find any local examples of the use of RFID tags? (If you do not know what RFID tags are research the topic in Laudon and Laudon (2013) Chapter 7 and online). What kinds of changes to how businesses operate or the jobs people do might result from widespread use of RFID tags?

3. Based on your own online research, prepare a brief report for the senior management of a medium sized chain of department stores on the potential benefits and challenges of moving a substantial share of the company's data processing and data storage to a cloud provider, and scaling down dramatically the company's in-house data processing facilities and staff.
4. In Laudon and Laudon (2013) Chapter 5 they differentiate the 'Cloud and Mobile era' and the 'Enterprise internet era'. Explain what each of these exemplifies in terms of specific technologies, what they are used for, and the social, business or work-place situations they are embedded in.
5. 'New types of Information and Communication Technology will often drive really substantial and necessary change in how business or governments operate. For this reason information systems professionals need to know a lot about technology and keep abreast of new trends, while managers and executives need to work hard to keep their businesses on the leading edge of technology innovation. Employees and workers too have a responsibility to accept technology and willingly adapt to these changes – the world does not stand still.'

   Critically assess the ideas in this quotation; do you agree fully, fully disagree, or do you have reservations or nuances to add? In answering this question use modern and relevant examples to illustrate your points.

Notes