



› Chapter 5

The effects of using IT



IN THIS CHAPTER YOU WILL:

- discuss the positive and negative effects of using microprocessor-controlled devices for monitoring and controlling devices in the home
- understand the impact of microprocessor-controlled devices on lifestyle, leisure, physical fitness and social interaction
- discuss the security of data
- discuss the positive and negative effects of smart devices in monitoring and controlling transport including security of data, autonomous vehicles, transport safety
- discuss health issues including causes of and strategies for preventing such issues as repetitive strain injury (RSI), back problems, eye problems and headaches.

GETTING STARTED

Working with a partner, draw a computer in the middle of a piece of paper. On one side of it list the jobs that could be lost because of computers and on the other side list the jobs that could be created because of computers.

Circle some of the jobs and add some notes about why that job could be lost or created.

MY COMPUTER MADE ME ILL!

RSI is repetitive strain injury. Repetitive strain injury is part of a group of 100 injury types known as musculoskeletal disorders. Many employers take it very seriously because musculoskeletal disorders make up approximately 30 percent of all injuries in the workplace that result in loss of workdays through employees' absence.

Figure 5.1 shows good posture and equipment that could reduce the effects of RSI.

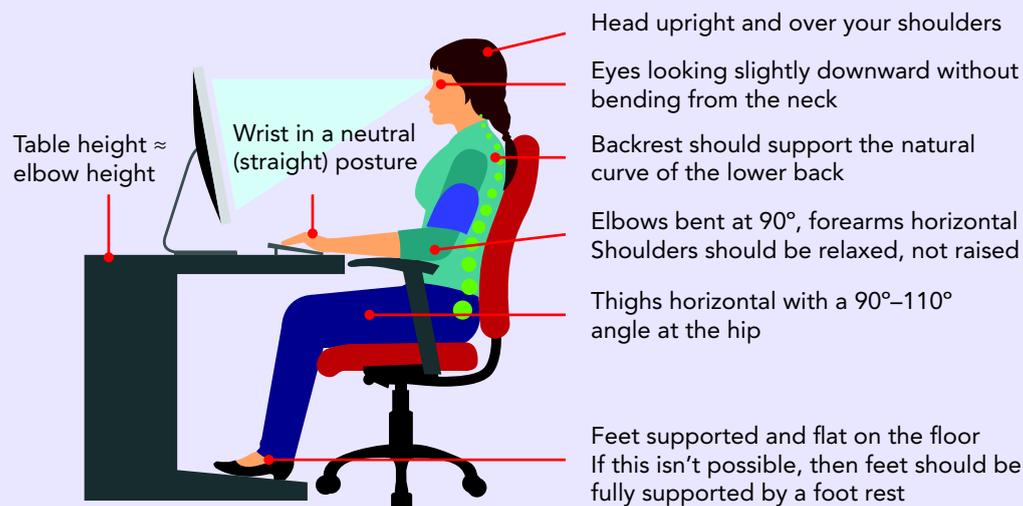


Figure 5.1: Good posture when using a computer

Approximately 60 percent of office workers using a computer all day suffer from wrist pain while at the computer and around 50 percent of computer workers say that they feel their keyboards are too high. Another part of the problem could be because employees say they ignore the recommendations to take short, regular breaks from their computers, or that their employer won't let them.

This is a wide-spread health hazard among computer workers and the most severe injuries mean that people may have to be away from work for months, or possibly have a permanent disability.

Discussion questions

- 1 Should employers be legally required to ensure that employees are using computer equipment correctly?
- 2 What are the specific hazards associated with laptop use?

5.1 Microprocessor-controlled devices

Microprocessor-controlled devices in the home

Microprocessors are the small programmable processors found inside computers. They accept digital data as input and process the instructions stored in memory to produce the output required. They need input and output devices to be connected to them to make them useful as computer systems.

The use of microprocessors in household devices has grown to the extent that they can be found in most households all over the world.

Processors have been embedded in household devices for years to monitor and control them. This has had enormous impacts on lifestyle such as not having to do the washing up or having to spend all day washing clothes or standing over a manual washing machine.

Increasingly, devices are becoming interconnected using the internet. Human-operated digital devices have been connected to form networks for years (that's what the internet actually is) but now the aim is to allow everything in the world to make connections



Figure 5.2: Microprocessor-controlled devices, such as a washing machine, oven and microwave, in a modern kitchen

and communicate without direct human involvement. These devices are called **smart devices**.

The **internet of things (IOT)** is the term that has been devised to describe this connection of all the objects in the world. It is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that provide the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

KEY WORDS

microprocessor: an electronic circuit or chip that makes the computer or electronic device work by processing data, performing calculations and issuing instructions based on the results

smart device: as the name suggests, an electronic gadget that is able to connect, share and interact with its user and other smart devices

internet of things (IOT): the interconnection via the internet of computing devices embedded in everyday objects, enabling them to send and receive data

ICT IN CONTEXT

Wi-Fi-enabled kettles are available now – however, one frustrated user once spent 11 hours trying to make a cup of tea! He was trying to get it to boil on command, but things didn't go to plan.

The main issue was that the base station could not communicate with the kettle and the kettle didn't come with software that would easily allow integration with other devices in his home, including Amazon Echo, which – like Apple's Siri – allows users to tell connected smart devices what to do. He spent all day trying to configure the unit before it eventually worked.

To use smart devices in a home, a user will require the hardware to create a Wi-Fi network and software apps to control them. Devices such as Amazon's Echo and Apple's Siri, which are themselves smart devices, allow users to use voice control to tell them what other devices to control.

The positive and negative effects of smart devices

In the home

Here are examples of the positive and negative effects of smart devices used in the home.

Positive effects:

- **Saving time and money:**
 - Some smart fridges can automatically update a user's electronic shopping list when things such as milk or eggs need to be restocked.
 - Lost items such as keys that can inform a smartphone where they are.
 - Smart utility meters can monitor usage and send details to a smartphone. Users can adjust the thermostat even when on holiday.
- **Improved home security:**
 - Home CCTV systems send data to a smartphone even when the homeowner is away so that they can monitor their home and its surroundings.
- **Improved care and protection:**
 - Smart baby monitors can monitor breathing movements, temperature, body position (on the back or on the stomach), fall detection and report to a smartphone.
 - Monitors can care for the elderly. Sensors monitor light, temperature and movement from room to room so that if the elderly person falls and can't get up, the carer can be remotely informed.

Negative effects:

- Smart devices are expensive.
- They depend on the internet which may fail.
- Security – they can be hacked.

ACTIVITY 5.1

With a partner, design an 'intelligent house'. You could draw plans of the rooms showing the smart devices and annotate the design to explain their use.

Lifestyle and leisure

Smart devices have had effects on the way we live.

Positive effects:

- Smart speakers allow us to speak commands when we need to adjust the temperature, or make a shopping list.
- Smart thermostats reduce the amount of energy used in homes.
- While cooking dinner, if you notice that you are out of olive oil, saying a command to your smart speaker and asking it to, 'Add olive oil to my shopping list,' is more efficient than stopping and writing a note on a piece of paper – or completely forgetting about it.
- The use of smart devices creates more leisure time as less time is spent working on everyday tasks.

Negative effects:

- The use of digital devices has affected how people use their leisure time. In the past, listening to the radio or watching television was a group affair but now each family member is more likely to be individually involved with their own device so that there is no family contact.
- Leisure time is now more likely to be spent indoors with a digital device than outside involving a physical activity.

Physical fitness

Smart devices can help improve our fitness in several ways but over reliance on them could have a detrimental effect.

Positive effects:

- Smart devices can be used to monitor heart rate and the amount and quality of sleep.
- Fitness trackers track physical activity such as the number of steps taken, stairs climbed, the pace and length of a run, including the use of GPS. They can also record workouts, bike rides and other physical activities.
- Apps are available for users of smart training equipment, such as running machines or static cycles, to allow them to compete with others in real time and so increasing motivation.
- They can calculate the number of calories a person is burning and number of calories a person has eaten.



- Apps are available to monitor a person's physical condition and then suggest or actually activate mechanisms to correct any problems. Examples include:
 - Wearable devices which when attached to people with back problems, can transmit data to an app on a smartphone which then analyses it and suggest how the person should modify their posture.
 - A wearable device to help people to stop smoking. It senses changes in the body and delivers medication to prevent the craving for nicotine.

Negative effects:

- In a home using smart devices, people have to walk around their homes less and do less exercise in washing, cleaning and washing up. Lack of exercise can have a detrimental effect on peoples' physical fitness.

ACTIVITY 5.2

Carry out research and make a report on how smart devices and apps are used to monitor two other health problems.

Questions

- 1 Explain what is meant by a smart device.
- 2 Describe *one* benefit of the use of smart devices in each of the following areas:
 - a Safety in the home.
 - b Physical fitness.

Security of data

Smart devices may gather personal information to make them more efficient but, as ever with personal data, it is important that this is kept secure.

Positive effects:

- As there is more concern and publicity about data security more people and organisations are aware of the problems and take action accordingly.

Negative effects:

- Privacy and security are of concern to experts as all of these devices and systems collect a lot of personal data such as to when people are at home,

the devices they possess, the medicines they take and any health problems they may have.

- The data generated by the IOT is available to many people and organisations who can use it for marketing purposes. For example, the creators of the devices and the apps used to control them will be able to capture data every time the device is used. This data will be available to them and any third party companies they nominate to store and analyse it.
- All of the devices are connected to the internet and therefore can be targeted by hackers. Security experts have demonstrated how easy it is to hack these devices by hacking everything from smart fridges to baby monitors and cars, and have stated that not enough is being done to build security and privacy into the IOT.

ICT IN CONTEXT

In 2016 hackers carried out a huge distributed denial of service (DDoS) attack on a major website. (A DDoS attack sends millions of coordinated messages to overwhelm websites.)

This particular attack used devices in the IOT such as kettles, printers, cameras and video recorders in homes. It caused the website of a major company to crash.

Social interaction

- Smart devices in the home save time and create more leisure time. For example, people do not have to do the washing up. But usually the washing up was done by two or three people who could talk and interact as they were doing a physical task.
- If you can ask a smart assistant to do something, then you are less likely to talk to another person and ask them to do it and engage in a social interaction (which could be a positive or negative interaction).
- Smart devices create a shopping list and transmit it to a shop and the items can then be delivered. People do not have to speak to each other. The 'shopper' does not have to leave their house and travel to a shop. No social interactions on the journey and no social interactions in the shop. A lack of social interaction can cause mental health problems.

- Smartphones are usually blamed for the loss of social interaction because more people are inclined to communicate using them rather than face-to-face encounters. Even a video call is less of a social interaction than meeting face-to-face.
- The devices have, however, encouraged social interactions at a distance. Using tablets and smartphones, people are able to communicate and interact with friends who don't live close by using:
 - voice and text messages
 - social networking sites
 - emails
 - video calls
 - electronic- and web-conferencing.

Transport

Microprocessor-controlled systems are used in many aspects of transport.

Vehicle safety

Microprocessor-controlled systems are used in all modern motor vehicles. The most common use is in the **electronic control unit (ECU)** for their engine management systems. Problems are diagnosed and fine tuning is done by computer. Gone are the days when a mechanic 'tinkered' with the engine to set the timing or ensured there was a correct mixture of petrol and air. Using an ECU for engine management leads to more efficient fuel consumption and less pollution.

The ECU has other, safety related functions such as:

- Anti-locking braking systems and electronic stability control (ESC) to automatically correct driver errors to maintain stability, prevent skidding and so reduce accidents.
- Using a video camera mounted near the car mirror, adaptive cruise control (ACC) maintains a correct distance from the car in front and automatically applies the brakes if it slows down.

Many cars now have collision avoidance systems which will warn of any objects in front of the car, including pedestrians and cyclists, and will apply the brakes, if necessary.

Control systems in vehicles improve safety but may malfunction. They are complicated devices and may need technological experts to fix.

ICT IN CONTEXT



Figure 5.3: 1968 Volkswagen 1600

The first use of computer control in a car was in 1968 when Volkswagen (Figure 5.3) introduced an electronic fuel injection system called Jetronic designed by Robert Bosch.

Traffic systems

Sensors, control systems and computers are used in **intelligent transport systems**, one of the features of **smart cities**.

KEY WORDS

electronic control unit (ECU): a device responsible for overseeing, regulating and altering the operation of a car's electronic systems

intelligent transport system: the use of communications devices, computers, control and sensing devices to improve the safety and efficiency of traffic movement through transmitting real-time information

smart city: a city where sensor-driven data collection and powerful computers are used to automate and coordinate a wide range of services in the interests of better performance, lower costs and lessened environmental impact

Intelligent transport systems use sensors to collect data from sensors such as cameras to monitor the amount of traffic, travel speed and traffic jams in various locations.



Figure 5.4: An integrated intelligent transport system

After the data has been analysed, optimum traffic flow can be maintained by:

- Control of traffic light systems.
- Informing travellers about travel times, travel speeds, accidents, delays, diversions through variable message signs, radio announcements, the internet and automated SMS calls to smartphones.
- Inform users of public transport when the buses will be arriving and the number of seats on each one.

An intelligent transport system improves traffic efficiency by minimising traffic problems. It reduces travel time of commuters as well as enhances their safety, comfort and mental health.

An obvious disadvantage is that the systems are expensive to implement and may malfunction or break down, leading to traffic chaos.

Also, the system relies on surveillance of vehicles and pedestrians and so impinges on their human rights of privacy and security.

Autonomous vehicles

Autonomous, or self-driving, **vehicles** are capable of sensing the environment and operating without human involvement. A human passenger is not required to take control of the vehicle at any time, nor is a human passenger required to be present in the vehicle at all. An autonomous car can go anywhere a traditional car can go and do everything that an experienced human driver does.

KEY WORD

autonomous vehicle: a vehicle capable of sensing its environment and operating without human involvement

Autonomous vehicles eliminate human driving error as they observe their surroundings and respond to situations with maximum efficiency, 24 hours a day.

There are, however, concerns about safety decisions that have to be made. What happens when the car needs to make a decision that could involve taking a human life, such as:

- If several people were suddenly on the road. Should the car swerve and possibly kill one pedestrian on the pavement. Should it save several people but kill one?
- If something else were in the road, should the car swerve and kill a single pedestrian to save the life of the driver?
- If something else were in the road, should the car swerve and kill several pedestrians to save the life of the driver?
- Should it make different decisions if children are involved?
- Are young people more worth saving than old people?

All of these moral and ethical decisions must be programmed into the vehicles, and rules and laws must be enacted to define correct procedures. What if different countries had different rules and you take your driverless car abroad and have a fatal accident?

Who will be legally responsible? The owner? The manufacturer? The programmers?

Question

- 3 Discuss the expected benefits and drawbacks of the use of autonomous or self-driving vehicles.

Security of data

As with all computerised systems there are concerns about security. Data on all user's journeys, whether using their own vehicle, using public transport or as a pedestrian, could be stored and used for other purposes

than helping to control traffic flow. Some people argue that this data could be misused by the state and lead to far greater surveillance and control.

It could also be stolen by hackers and sold to organisations who could benefit from it – for example, to target advertisements at people who use particular routes or travel at certain times.

The control systems used for intelligent transport and in the vehicles themselves are vulnerable to hackers who could take over traffic light systems and vehicles.

Computer experts have shown how wirelessly controlled traffic lights can be manipulated using a laptop so that they had all green lights on their way to work. They have also shown how easy it is to take over the steering, lights and wipers of internet connected cars.

PRACTICAL TASK 5.1

Getting started

- 1 With a partner, make a list of three applications of smart devices for monitoring and control in the home.

Practice

- 2 Create a presentation titled 'The Smart Home' to explain the uses and benefits of using smart technology in your house. For information about creating presentations, see Chapter 19.

Challenge

- 3 Carry out research and create a similar presentation on 'Smart Cities and Towns' to explain the uses and benefits of using smart technology in cities.

5.2 Health issues

There are a number of common safety issues that organisations and users must be aware of and know how to prevent, including physical conditions and safety when working with electrical equipment.

Health and safety experts have said that there is no evidence that using a computer is harmful to individual's health when used correctly. The use of computers may, however, make worse any pre-existing medical conditions and can lead to muscular and other physical problems. To reduce these risks, sensible precautions must be taken.

Most problems are caused by bad posture when using a computer, as shown in Table 5.1.

Safety issues	To reduce the risk, users should:
<p>Repetitive strain injury (RSI): a general term used to describe the pain felt in muscles, nerves and tendons caused by repetitive movement and overuse. It mostly occurs in forearms and elbows, wrists and hands, neck and shoulders and can be caused by using a keyboard and mouse for long periods or poor posture due to not adjusting a chair or monitor correctly.</p>	<ul style="list-style-type: none"> • Adopt a good posture. • Use an ergonomically designed keyboard. • Take regular breaks. • Use the mouse as little as possible, for example, by using keyboard shortcuts. Alternatively, using a wrist support or ergonomic mouse can help.

KEY WORD

Repetitive strain injury (RSI): pain felt in muscles, nerves and tendons caused by continuously making the same movements

Safety issues	To reduce the risk, users should:
<p>Back problems:</p> <ul style="list-style-type: none"> • Back pain: caused by working for too long without taking a break and sitting in front of a computer with a bad posture. • Back injuries caused by moving equipment: many injuries are caused by moving heavier items of computer hardware, for example, desktop computers, monitors and printers. 	<ul style="list-style-type: none"> • Adjust the chair to suit body type and height. • Adjust the height and angle of the screen. • Use a chair with a lumbar support and adjust it to suit body type. • Adjust the desk by bringing it closer or further away. • Use correct lifting techniques such as: <ul style="list-style-type: none"> • Reducing the amount of twisting, stooping and reaching. • Planning the lift to reduce the distance as much as possible. • Avoiding lifting from floor level or above shoulder height, especially for heavy loads. • Asking others to help.
<p>Eye strain: headaches, watery eyes, dry eyes and double vision can be caused by staring at a computer screen for too long.</p>	<ul style="list-style-type: none"> • Taking regular breaks. • Adjusting the brightness and contrast of the monitor. • Using suitable font and icon sizes. • Using suitable lighting in the room, for example, prevent sunlight hitting the screen.
<p>Headaches: headaches from computers are often caused by computer vision syndrome (CVS). If you spend extended periods of time on your computer you might get a headache due to glare on the screen, poor lighting in your workspace, improper computer brightness and colour, or a combination of these factors.</p> <p>Stress: headaches can also be caused by stress. A computer user may become stressed when:</p> <ul style="list-style-type: none"> • The computer malfunctions. • The software does not carry out the functions expected. • The user is rushing as they have too much work to do. 	<ul style="list-style-type: none"> • Take frequent breaks from the computer. • Work in a properly lit area. • Reduce computer screen glare. • Clean the computer display. • Keep hardware up to date and well maintained. • Keep software updated. • Ask for software training. • Take regular breaks. • Ask colleagues for help with the work. • Admit if it is too much for you.

Table 5.1: Safety issues when working with electrical equipment and strategies for preventing them

Figure 5.5 shows precautions that should be taken to prevent harmful effects when using a computer.



- a Use wrist rests to support hands. Take breaks from repeating actions.
- b Take regular breaks away from screen. Move the screen so that it is not reflecting light directly. Ask for an antiglare screen.
- c Adjust chair so feet are flat on the ground. Use a foot rest. Take regular breaks to stretch legs. If knees are touching desk, ask for a higher one.
- d Adjust the chair to suit body type, change height of the chair, adjust the lumbar support. Adjust the desk space by bringing the computer closer or further away, adjust the height of the screen, etc.
- e Take regular breaks to help relieve stress. Ask colleague to help deal with work. Delete emails that are no longer required. Ask for software training.

Figure 5.5: Precautions to take to prevent harmful effects when using a computer

ICT IN CONTEXT

Once symptoms of RSI are contracted, they can be extremely difficult to cure. Research has shown that 60% of IT professionals, who spend more than eight hours a day on the computer, are likely to suffer from the symptoms of RSI at some point.

RSI can occur even in the young and physically fit individuals. Some people are forced to quit their computer-dependent careers due to this disorder.

ACTIVITY 5.3

With a partner, create a poster illustrating the health risks of using a computer system incorrectly and how they can be prevented. You could do this on software like Paint or a word processor.

Questions

- 4 Using a keyboard for many hours every day is likely to cause health problems. Choose **one** of the following health problems that is most likely to occur:
 - a back problem
 - b RSI
 - c sore eyes.
- 5 Are the following statements true or false?

a	Back problems can be helped if you use a foot rest.
b	Having to learn how to use new software can cause stress.
c	Glare on a monitor does not affect health.
d	RSI only affects the wrists.

- 6 Computer users are advised to take frequent breaks. Explain which safety issues given in Table 5.1 will be addressed by doing this.

PRACTICAL TASK 5.2

Getting started

- 1 Make a list of the health problems that can be caused by not using a computer system correctly.

Practice

- 2 Design and create a safety poster for computer users giving details of potential health issues and examples of good practice.

Challenge

- 3 Using suitable software, create an interactive activity to test computer users' knowledge of health problems and how to prevent them.

REFLECTION

What strategies did you use to learn the harmful effects of using computer systems and how they can be prevented?

Were you able to relate these to your own experiences?

SUMMARY

Microprocessors are the small programmable processors found inside computers. They can be found in many different household devices and can be found in most households all over the world.

Household devices may be linked to a home network so that they can communicate with each other and with you. This is called the internet of things (IOT).

The impact of the microprocessors found in most household devices and appliances have many advantages and disadvantages on aspects such as lifestyle and leisure, physical fitness, security of data and our social interactions.

Smart devices are involved in transport in areas such as vehicle safety, traffic systems and autonomous vehicles.

The security of smart devices and their data is a major concern if they are connected to the internet without adequate security measures.

Computers bring with them threats to health, which must be understood in order to prevent discomfort or pain or loss of work days. Ensuring we sit and work at a computer in a correct manner can avoid these problems.

EXAM-STYLE QUESTIONS

- 1 **State** what is meant by a *smart device*. [1]
- 2 **Describe** *two* examples of the use of smart devices in the home. [4]
- 3 **Discuss** the effects of using smart devices on peoples' health and physical fitness. [6]
- 4 Describe *two* ways in which electronic control systems are used to improve the safety of driving by preventing accidents [4]
- 5 Discuss the concerns over and problems with data security when smart devices are used in the home, in cars and in cities. [6]
- 6 Discuss *three* health problems that could arise from not using computer systems correctly and how they could be prevented. [6]

[Total: 27]

COMMAND WORDS

state: express in clear terms

describe: state the points of a topic / give characteristics and main features

discuss: write about issue(s) or topic(s) in depth in a structured way

SELF-EVALUATION CHECKLIST

After studying this chapter, think about how confident you are with the different topics.

This will help you to see any gaps in your knowledge and help you to learn more effectively.

You might find it helpful to rate how confident you are for each of these statements when you are revising. You should revisit any sections that you rated 'Needs more work' or 'Getting there'.

I can ...	See section	Needs more work	Getting there	Confident to move on
discuss the positive and negative effects of using microprocessor-controlled devices for monitoring and controlling devices in the home	5.1			
understand the impact of microprocessor-controlled devices on lifestyle, leisure, physical fitness and social interaction	5.1			
discuss the security of data	5.1			
discuss the positive and negative effects of smart devices in monitoring and controlling transport including security of data, autonomous vehicles, transport safety	5.1			
discuss health issues including causes of and strategies for preventing such issues as repetitive strain injury (RSI), back problems, eye problems and headaches	5.2			

> Chapter 6

ICT applications

IN THIS CHAPTER YOU WILL:

- identify communication media and mobile communication devices and their uses
- describe computer modelling and computer-controlled systems such as robotics, and the advantages and disadvantages of their use
- discuss management systems for school management and computer aided learning
- describe online systems to make bookings for cinemas and concerts, etc.
- discuss different banking applications and the advantages and disadvantages of each
- describe the characteristics and uses of computers in medicine and understand the uses of expert systems for a variety of different applications
- explain the uses of expert systems
- explain how computers work in the retail industry, the uses of different payment methods, and understand the advantages and disadvantages of internet shopping
- be able to identify the characteristics and uses of recognition systems, including OMR, OCR, RFIDs and biometric recognition
- know and understand the uses, and advantages and disadvantages of satellite systems.

GETTING STARTED

Table 6.1 shows some ICT applications. Table 6.2 shows some uses of the ICT applications shown in Table 6.1. Match the applications with the correct uses.

a	Communication applications.
b	Recognition systems.
c	Booking systems.
d	School management systems.
e	Banking applications.
f	Computers in medicine.
g	Expert systems.
h	Computer modelling.
i	Satellite systems.
j	Computers in the retail industry.

Table 6.1: Some ICT applications

1	Keeping patient and pharmacy records.
2	Using the global positioning system (GPS) for navigation.
3	Checking passports at an airport.
4	Using electronic funds transfer (EFT) to pay bills.
5	Using text messages to keep in touch with friends.
6	Using software to diagnose an illness from a list of symptoms.
7	Using point of sale (POS) terminals in shops and supermarkets.
8	Recording of learner attendance and performance.
9	Planning the sequence of traffic lights in a city.
10	Buying tickets for a sporting event.

Table 6.2: Some uses of ICT applications

ONLINE SHOPPING WITH A LITTLE CHAOS!

Amazon is a retail giant with centres in around 175 countries around the world. Since 2019 Amazon has become the world's largest online retailer. The success of Amazon has been attributed partly to the fact that, using its Prime service, the time between a customer making an order online and receiving it at their house can be 24 hours or less, and in some cities they may have delivery in two hours!

To achieve this, Amazon needs to operate in its warehouses at speeds previously unknown in other retail businesses. You might think that this would demand perfect organisation of their stock on the shelves, the correct placing of every item in an exact place as soon as they arrive in the warehouse. This is not the case. Amazon achieve their super-fast turnover from order to delivery by using the chaos method of storing goods with complete randomness (see Figure 6.1).

When a box of goods arrives, such as a delivery of 100 mobile phones, the box is opened and each individual phone is placed on any shelf at random, wherever there is a space. It means that each of the 100 new mobile phones could be stored in up to 100 different places. You may wonder how this could possibly work! A system of bar coding is used to identify items and locations across all of its warehouses. When an item is placed on a shelf, a hand-held bar code scanner prints out two bar codes, one for the item, the other



Figure 6.1: An Amazon warehouse

CONTINUED

for the shelf: the management system can then inform the workers how many items of stock there are and their location.

So that the workers, whether humans or robots, can keep up with demand, they need to be able to find everything quickly. Management software tells the workers how many items need to be picked up, where the nearest one is, and the quickest route to it. The workers pick a number of items at one time that have been ordered by different people, therefore saving them time as they don't have to keep going back to the same location to pick up the same item which they would, if one order was prepared at a time.

Discussion questions

- 1 What could be the advantage of keeping a box of shampoo next to a pair of trousers on a shelf?
- 2 What is it about the system of chaos that makes it easier to train new warehouse staff?

6.1 Communication

Communication media

In the past it was traditional to communicate mainly by letter-writing, written reports, newsletters, telephone and face-to-face meetings, but the use of ICT has brought about major changes in the way we communicate with each other on a personal level, and also on the way that organisations communicate.

Newsletters

Organisations such as businesses, schools, universities and clubs produced printed or electronic **newsletters** for employees, customers, parents and students, or for their members.

They are used to give updates on progress and new developments and can be a single sheet or many pages long.

The use of word processing and desktop publishing software has allowed more sophisticated newsletters. Features include:

- using columns
- altering the margins and the spacing
- changing the character size
- using different typefaces (fonts), like Arial or Courier
- different effects, like *italic*, **bold** and ^{super}scripts
- indenting text

- automated bullet points and numbering systems
- justification of text
- inserting links
- use of headers, footers, automatic page numbering.

There is a skill in producing a newsletter, and part of the skill is to ensure that the document looks impressive, while remaining readable without too many distracting effects.

Posters

A **poster** contains less text and information than a newsletter and has a greater visual element so that it is eye catching.

Posters are intended to communicate one message rather than being a document containing lots of information on different topics. The difference is in the design of the finished product (Figures 6.2 and 6.3). Posters are usually used to advertise products and events.

KEY WORDS

newsletter: news, updates and information issued periodically to the members of a society or other organisation

poster: a large printed sheet containing text and pictures which is displayed in a public space



Figure 6.2: A newsletter

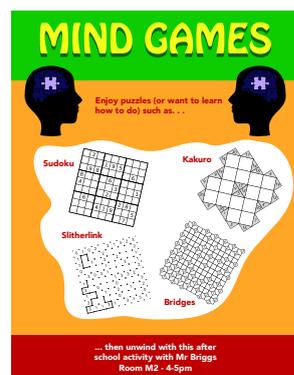


Figure 6.3: A poster

Websites

A **website** is a collection of interactive **web pages** containing text, graphics, audio, video and links to other pages. A website is hosted on a **web server** on the internet. The information on the website can be viewed by internet users using a **web browser**. Websites are used to raise the profile either of a person or an organisation and to communicate with others.

Websites can be used for various purposes:

- for entertainment
- to provide information about and organisation
- to advertise an organisation or product
- to allow users to upload and download files, e.g. application forms
- to allow users to order products advertised on the website.

For example, a school website is used to show information about the school, and to communicate with parents and other interested people to ensure that they feel fully involved with the school. The website is also used to advertise the school to people who currently have no connection with it, potential new parents in particular, and it is also used to advertise school events.

Multimedia presentations

A **multimedia presentation** is a standalone presentation that uses a mixture of different media such as text, video, audio and images to present information effectively and to maintain the interest of the viewer. Changes from one screen to another can use complex

transitions to catch attention. Hyperlinks can be included as part of a single-user presentation to give the user a choice of path through it.

KEY WORDS

website: a collection of web pages

web page: a document containing text, images, audio, video and links to other pages that can be viewed on a web browser

web server: the computer that the website is saved on

web browser: an application used to access websites on the world wide web

multimedia presentation: a presentation that uses a mix of media, for example, text, sound, photos, animations, videos and interactive content

Multimedia presentations can be used to:

- accompany a talk by a person
- run on their own for people to view, e.g. advertising products in shops or explaining exhibits in a museum or paintings in an art gallery
- create educational tutorials
- produce a digital portfolio of a person's work
- produce a photo slide show that can be left to run on its own
- create interactive stories and quizzes
- create animations.

ICT IN CONTEXT

Now that organisations communicate in so many different ways, it is important for each of their documents to bear the same branding so that it can be recognised immediately as coming from that organisation, whatever type of document. For instance, they will always use the same logo, font, colours and style: this is known as their 'corporate image' or 'house style'. This will project their brand or overall image of the organisation.

Audio and video communication

Audio (sound) and video (containing moving images) can be used to convey information to individuals or whole groups.

Audio communication without video is used when people must concentrate or cannot view a screen such as when they are running or exercising. They can listen to music or a podcast but keep watching where they are going.

Information is communicated using audio in shops and on railway stations so that it reaches as many people as possible as they do not have to stand in one place and look at a screen.

Many presenters now use audio on its own for comedy, storytelling and providing information through the use of **podcasts**. A podcast is a digital audio file that users can download from the internet and listen to on a mobile device such as a smartphone. They are typically available as a series with new instalments automatically downloading.

Podcasts are used for entertainment, education and also by organisations to provide information to customers.

Video communication combines moving images and sounds and is a successful method of providing information as the viewers are entertained by the moving pictures. Video is widely used in education, entertainment and by organisations to advertise and promote their products.

Media streaming

Media streaming refers to the continuous transmission of audio or video files to a user. The file being streamed is stored remotely and streaming happens in real-time (as it happens). This means that you don't need to wait for the whole file to download to begin watching. Streaming means you don't need to download the files and use space on the hard drive.

Audio and video data is broken down into data packets to be sent over the internet; you learnt about data packets in Chapter 4, Section 4.1, Networks.

For streaming high quality video, fast internet speeds are required.

Streaming is used for entertainment where users can watch films and listen to music stored on remote servers. Streaming is also used by television channels for live events such as football matches.

Live streaming is used by large and small organisations to broadcast meetings and events where new products are unveiled, across the internet.

E-publications

E-publications are the publishing of digital books, magazines, newsletters and newspapers online. The advantages of digital publications are:

- They can be shared globally.
- There are no printing costs.
- It is quicker to get published.
- You have constant access to your digital library where all of the items you have bought are kept, ready for you to read if you have internet access or downloaded them to your device.
- **E-Readers** are often less bulky than books, and constant access to your digital library means you just have to pack a small e-reader rather than many bulky books that you want to read if you're away from home.

KEY WORDS

audio communication: any form of transmission that is based on sound, speaking and hearing

podcast: a digital audio file made available on the internet for downloading to a computer or mobile device

video communication: any form of transmission that is based on moving pictures as well as sound

media streaming: a method of transmitting or receiving data (especially video and audio material) over a computer network as a steady, continuous flow, allowing playback to start while the rest of the data is still being received

live streaming: when streamed video is sent over the internet in real time, without first being recorded and stored, e.g. many sporting events are live streamed

e-publications: digital materials published online such as e-books or digital magazines and e-newspapers

e-readers: a device on which you can read e-publications

Mobile communication

Smartphones are mobile devices that can be used for many methods of communication.

Like all other telephones, smartphones can be used for voice or phone calls. They allow two or more people to communicate by talking to each other. Phone calls can also be made between landlines and mobile phones.

SMS, which stands for **short message service**, allows users to send short text messages to each other. They are delivered very quickly and allow instantaneous text conversations.

Voice over internet protocol

The **voice over internet protocol (VOIP)** allows the use of the internet to carry voice data when making phone calls. When using VoIP technology, the voice data is broken into packets of data that are sent along different routes to arrive at the same destination where they are reassembled in the right order, (see Chapter 4, Section 4.1 Networks). VOIP technology is referred to as packet switching.

VOIP telephony is generally free for the actual calls. The only costs are those for attaching to the internet, but the person making the call will not pay for these if they are in a restaurant or coffee shop providing free internet access. VOIP telephony can be between a computer and a landline telephone, not just between two computers or smartphones.

VOIP is also used when making video calls over the internet using the device's camera, speaker and monitor. Various service such as WhatsApp and FaceTime allow users to make video calls. As more data has to be transmitted than just a voice call, the picture can sometimes lock so that no motion is shown.

Accessing the internet

Mobile devices can access the internet using either Wi-Fi or a mobile or cellular network, which is also a wireless network that is distributed through **cells**. Each cell includes a fixed location transceiver known as a **base station**. Working together, these cells provide wireless coverage over a large geographical area. Each cell offers coverage of between nine and 21 miles.

When a user moves out of range, the signal falls and the base station makes a request to transfer control to another base station that is receiving the strongest signals without notifying the subscriber. This is called **handover**. Over the years cellular technology has improved, with each improvement being called a 'generation'. Most people now use third generation (**3G**) or fourth generation (**4G**) technology, but this is due to be superseded very soon in some areas with **5G**.

KEY WORDS

short message service (SMS): system where users can send short text messages to each other from one mobile phone to another or from a computer to a mobile phone

voice over internet protocol (VOIP): allows the use of the internet to carry voice data when making phone calls

cell: a geographical area covered by one base station

base station: a fixed point of communication for cellular phones on a carrier network. The base station has an antenna (or multiple antennae) that receives and transmits the signals in the cellular network to customer phones and cellular devices

handover: the automatic transfer of a user's connection to a base station to another base station which is nearer to the user

3G and 4G: communication protocols used by smartphones to connect to the internet, 4G being much faster than 3G

5G: the 5th generation of wireless technologies for digital cellular networks

Question

- 'WeSellShoes' is a shop that sells various types of footwear to customers in their local town. Describe **two** advantages to them of designing and maintaining a website.

6.2 Modelling applications

Computer modelling uses **mathematical formulae** to describe actual, real-life situations. The model attempts to mirror the rules and mechanisms that control real-life systems and apply the rules in computer programs so that the models can simulate the real-life behaviour under different conditions.

There are three obvious reasons for modelling a situation:

- 1 To test situations without endangering anybody.
- 2 To test the situation's feasibility without spending large sums of money (building a prototype to find that it doesn't work is expensive).
- 3 If a computer model is produced of a new design – e.g. a car, ship or aeroplane – their behaviours under different conditions can be **simulated**, for example, how the ship should cope with different sized waves.

Real-life situations being modelled can be almost anything:

- personal finance
- bridge and building design
- flood water management
- traffic management
- weather forecasting.

Personal finance

A **personal financial model** predicts finances into the future. For example, it can show expected regular income and expenditure throughout the year such as rent, rates, food shopping, and allow a user to see how much they should have available at the end of each month. It can also allow a user to see what would happen if they changed something: for example, what would happen if they saved more each month? Or if they splashed out on a new car? They could check if they could afford the monthly payments for a media streaming contract.

Spreadsheets are very valuable for simple computer modelling because they allow 'what if . . . ?' questions to be asked.

ICT IN CONTEXT

For commercial and large-scale models, specialist **modelling software** is used to build simulations. The software uses sets of rules to predict the outcomes of different situations when data is entered.

Meteorological services use different models such as Seasonal and Climate (Figure 6.4) and Ocean models to predict the weather.

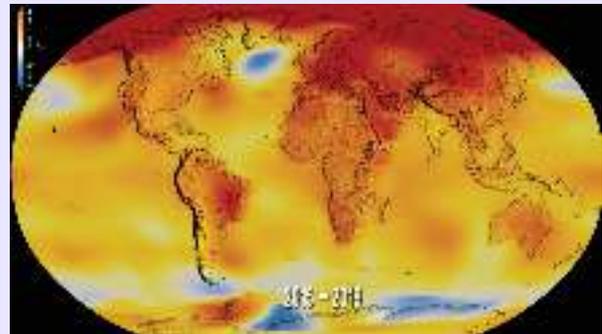


Figure 6.4: Seasonal and climate model

Supply-chain modelling software is used by organisations for planning the logistics of the transport of materials from all over the world.

KEY WORDS

computer modelling: an attempt to abstract the rules and mechanisms that control real-life systems and apply them in computer programs so that they can be used to simulate the behaviour of those systems

mathematical formula: an expression or equation that expresses the relationship between particular quantities. (Plural is formulae)

simulate: to make something that looks and acts like a real object or situation but isn't real

personal financial model: creating a plan to manage a person's budget

modelling software: programs used to create computer models

Bridge and building design

A computer model or simulation can be used to test the designs of bridges and buildings before they are built.

Bridges and buildings have to be able to survive adverse weather conditions, and the model can be used to test what happens under very extreme weather conditions, such as storms and hurricanes, without endangering anyone. Otherwise, the buildings would have to be built and then left until they were destroyed by extreme weather conditions.

A bridge model could be tested with different amounts of heavy traffic and a building could be tested to see how it behaves at different temperatures, such as those caused by a fire, or if there is an earthquake.

Flood water management

There are many areas of the world that are subject to flooding annually and modelling for future forecasts of flood patterns is extremely important. Models provide predictions of the extent and depth of flooding and can be used in the development of accurate **hazard maps** of a region.

The models also allow the assessment of risks to life and property and provide information in decision making, such as the maintenance of existing flood defences or the construction of new ones.

The models can be used to:

- show which vulnerable groups and communities are at risk
- provide **real-time** flood predictions to inform emergency services
- plan and develop exercises to test response to emergencies
- produce maps of flood and coastal risk
- design schemes to manage flood risk
- consider the long term effects of climate change.

Traffic management

Traffic modelling develops information that can support decisions about how to manage traffic systems, usually in towns and other urban areas. Traffic flow is the rate at which vehicles pass a given point on the road, and is normally given in terms of vehicles per hour. Usually the number is counted for 15 minutes and then

multiplied by 4. If there were 100 vehicles passing the point in 15 minutes then the traffic flow would be 400 vehicles per hour.

The type of decisions that traffic modelling can help with are to determine which type of control to use at road junctions – for example, traffic lights where the right of way is indicated gives opportunity for the side roads to enter the traffic flow on the main road; roundabouts keep traffic moving rather than causing all traffic to stop as for traffic lights. However, a roundabout on a busy main road can mean those cars in side roads will struggle to move out.

Traffic management can use modelling to aid decision making about these choices, as well as helping to determine the amount of time allowed to each road at urban traffic lights.

They also allow users to investigate the effects of building new roads, making more streets for pedestrians only or allowing only one-way traffic.

Weather forecasting

Weather forecasting is important because it helps to find out what the weather will be like in the near future. Weather forecasting involves using detailed models of the atmosphere to try to predict how the weather will be during the next weeks, or months. The data needing to be fed into the model include:

KEY WORDS

hazard map: a map that highlights areas that are vulnerable to particular adverse conditions

real-time: as things occur, with no delay. For example, the model would be updated with data as weather changed so everyone would know exactly what was happening at that moment

traffic modelling: using mathematical and computer simulations of real-world traffic situations to ensure optimal (best or most desirable) traffic flow with minimum traffic jams

traffic management: directing vehicles and pedestrians along certain routes to ensure optimal traffic flow with minimum traffic jams

weather forecasting: predicting weather conditions over the next few days

- how the air moves
- how heat and moisture are exchanged in the atmosphere
- air pressure
- wind strength
- temperature
- moisture.

Advantages and disadvantages of using computer modelling

Advantages of computer modelling:

- Safety: buildings can be remodelled without humans putting themselves at risk of construction accidents.
- Less expensive as new products can be tested without humans having to build physical prototypes.
- More situations can be tested: situations impossible for humans to test, as well as dangerous situations can be tested by modelling.
- Faster results: once all the data is in the model, it is much quicker to work out very complicated mathematical equations than humans would.
- Buildings can be perfected using a model before it is constructed which reduces the time, materials and costs of making an error, or not building to the customer's specification. Humans could design a building on paper or build a small-scale model but this would take more time and is not quick to make any necessary changes.

Disadvantages of computer modelling:

- The situations may be too complex to model successfully.
- It may be difficult to identify all of the rules correctly.
- The model is not reality so the answers may not be right; reality may turn out unexpectedly different.
- A lot of expense is required to set up the model in the first place even though it may be cheaper than building a physical model in the long run.
- Human programmers may make errors in inputting the information that the program uses for calculations, so the digital model may be inaccurate.

- However, if humans had to create the whole model mathematically (without using computer modelling), they could make errors in their calculations.

Question

- 2 An organisation created a computer model to assist it in designing and testing a new factory for producing chemicals. When the factory was actually built there were several production problems and a major accident.

Describe **three** reasons why the model was unsuccessful.

6.3 Computer-controlled systems

A computer-controlled system is a set of devices such as a processor, sensors and actuators that work together to achieve a set of objectives, for example, painting a car or controlling the temperature of a building. You have already learnt about processors, sensors and actuators in Chapter 2, Section 2.3 Output devices and their uses.

Advantages of computer-controlled systems include:

- They are quick to respond to change and can process data very quickly.
- They can run all day, every day without needing a break.
- They can operate in places dangerous to humans.
- They can carry out repetitive tasks error free, unlike humans.
- Unlike humans, they do not require wages.
- Can take account of hundreds of inputs at the same time and still make accurate decisions, unlike humans.

Disadvantages of computer-controlled systems include:

- The hardware and software can be very expensive to develop.
- If there is a power cut, the system will stop; people can keep working (in many circumstances).
- Cannot react to unexpected events as a human can.

Robotics in manufacture

Robots have a major role within the manufacturing industry where their main use is to carry out repetitive tasks and some can be re-programmed to do different tasks as necessary.

Robots learn how to carry out tasks in different ways: a programmer can write instructions for the robot, then observe the robot while it does the task, called the ‘teach and learn method’ or the robot can be guided through a task the first time, then it produces instructions itself!

Although the initial costs of robots is very high, they can reduce overall costs in manufacturing industries through:

- Increased speed, being able to work continuously (no need for breaks).
- Reduced labour costs (no need to train and re-train or hire new staff).
- Higher product quality.
- The ability to carry out work in areas that may be too dangerous, too repetitive or too physically demanding for humans.

Some disadvantages of robots include the fact that:

- They cannot make independent decisions.

- If something happens that was not programmed for, they usually cannot change their actions to accommodate the new situation, although **machine learning** (computer algorithms that improve automatically the more times they are run) is an area of robotics that is attempting to change this.
- The initial setup costs can be very high and workers worry that robots cause unemployment for humans.
- Robots sometimes break down and contingency plans need to be in place to carry on with the work while the robot is being repaired.

KEY WORDS

robot: a machine controlled by a computer that is used to perform jobs automatically

machine learning: the ability of computers to learn without being explicitly programmed

After the initial worries that robots will make workers redundant, more benefits of using robots have emerged and manufacturers now claim that there are new job opportunities for human workers who can learn to program and maintain robots.

ICT IN CONTEXT

The use of industrial robots has grown enormously. The graph in Figure 6.5 shows the implementation of new units in each year.

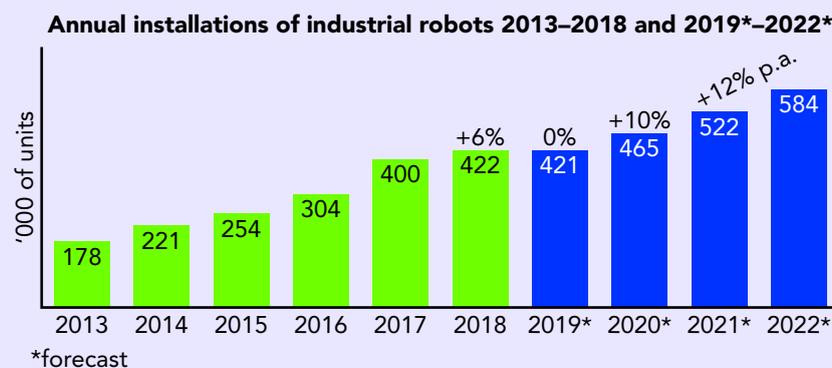
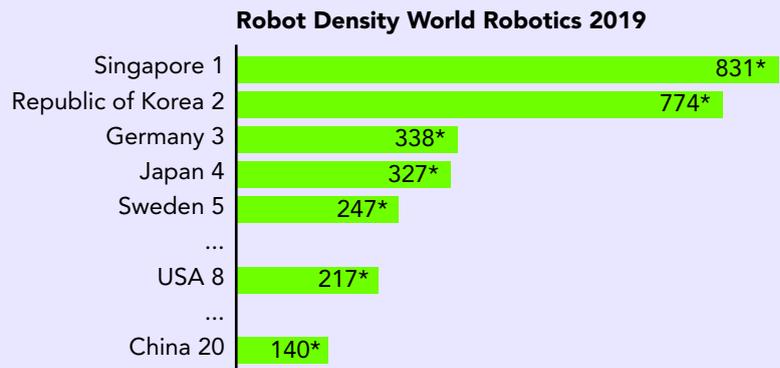


Figure 6.5: 422000 new robots were employed in 2018. The figures for 2019 to 2022 are projections and, of course, will be affected by financial problems caused by COVID-19

CONTINUED

The graph in Figure 6.6 shows the number of robots employed per 10000 industrial employees.

This information can be misleading because, although China is in 20th position, it is the world's largest user of industrial robots installing 154000 units in 2018. It's just that it has far more industrial workers.



*Robots per 10 000 employees in manufacturing

Figure 6.6: Number of robots employed per 10000 industrial employees

ACTIVITY 6.1

Carry out research into the effects of using industrial robots on employment around the world. Create a report explaining the effects.

Production line control

A **production line** is used to create an end product from raw materials or other components. Computers can be used to control the flow of materials along the whole production line.

KEY WORD

production line: a line of machines and workers in a factory that a product moves along while it is being produced. Each machine or worker performs a particular job that must be finished before the product moves to the next position in the line

Robots are important in the manufacturing industry where they perform complex assembly line tasks (see Figure 6.7) and even manage human workers. Many robotic arms can perform a range of different functions, and can also swap the tool they are using for



Figure 6.7: Robots at work in a factory making a car

a different, appropriate tool, with a minimum amount of human supervision.

ICT IN CONTEXT

Forklift drivers in some factories and warehouses take their instructions directly from a machine with a robotic voice; the driver obeys the voice, which tells him where he must go next. The instructions he follows also take account of the driver's safety because the orders prevent him from colliding with another human worker.

Autonomous vehicles

An **autonomous vehicle** is a vehicle without a driver that can sense its surroundings so that it can operate on its own to carry out the tasks necessary without any human having to be present. To do this, the vehicle can respond to the external conditions as a human driver normally would. It can drive in all conditions with no human intervention. It is guided by GPS, Wi-Fi and **spatial laser sensors**.

KEY WORDS

autonomous vehicle: a vehicle capable of sensing its environment and operating without human involvement

spatial laser sensors: sensors which are used with lasers to detect, measure and analyse the space and objects in an environment, in real time

A fully automated vehicle will be enabled by the use of 5G technology, which will allow vehicles to communicate with each other, with traffic lights, traffic signs and the road conditions. The information is processed and sent to actuators (for devices that automatically respond to sensors, see Chapter 2), which are in the vehicle. The actuators control steering, acceleration and braking.

Autonomous vehicles are probably safer because there isn't a driver to make the errors that cause accidents! Sensors are used to communicate with other driverless cars, so if all cars were driverless, they could go faster safely, giving people more time to carry on with other things, meaning that the economy could benefit. Also there may be less congestion on the roads if cars could interact with each other. In 2011, Google brought out a version of a driverless car. It can be seen driving around the streets in parts of the USA.

The logistics industry, which manages the movement of goods from their source to their destination, would benefit too. Companies often place time limits on their lorry drivers. These limitations could be avoided as driverless transport would be able to travel 24 hours a day; the journey would not need to include rest time for the driver either. This could result in reduced costs. Disabled people who cannot drive would also benefit from the use of driverless cars as they would gain more mobility and independence.

There are some disadvantages to this innovation: some people may lose their jobs, for example, people who depend upon driving to make a living; the software would have to be robust and safe from hackers; there may also be privacy concerns as self-drive cars depend on collecting and sharing location data. If something went wrong and a crash occurred there is no legal precedent yet to determine who would be responsible.

Table 6.3 shows the benefits and drawbacks of autonomous vehicles.

Advantages	Disadvantages
In the future, there could be fewer driving errors due to hundreds of calculations every second.	In the future, it may be that the expense of buying or renting would make it impossible to buy an autonomous vehicle to all but the super-rich.
Traffic congestion due to fewer accidents so fewer hold-ups.	The technology could go wrong which could cause malfunctions or accidents.
Easier to park as passengers can get out and leave the car to find a parking space and park itself.	In the future it may be difficult to get a licence or insurance cover.
Time-saving as the passenger has time to work or relax without worrying about road safety.	There could be even more pollution if the vehicle is not electric (but this is unlikely).
Disabled people who have difficulty driving are helped to be independent.	Safety and security as the system could be hacked.
Partly autonomous vehicles are sometimes used in warehouses to quickly locate or store items, so increasing efficiency.	Fewer job opportunities for traditional professional drivers such as taxi or delivery drivers and chauffeurs.
	The sensors could fail during severe weather.

Table 6.3: Advantages and disadvantages of autonomous vehicles

Question

3 A manufacturing company is planning to introduce industrial robots.

Describe **two** benefits and **two** drawbacks of this decision both for themselves and their workers.

6.4 School management systems

A **school management system** is an information management system for educational institutions to manage all student data. It provides facilities such as registration of students in classes, documenting of grades and evaluation of progress.

Learner registration and attendance

Some school registration systems are based on OMR system technologies (Figure 6.8). This type of input was described in Chapter 2, Section 2.2 Direct data entry and associated devices.

Laptops, tablets and smartphones can also be used for real-time registration over a network if the school management system provides this facility. It saves time as marked sheets do not have to be read by an optical mark reader.

Computer aided learning

Computer aided learning (CAL) is an integrated environment where computers are used to assist the learning of students.

The computers can be used for many things such as the development of online learning which includes:

- The separation of teachers and learners which distinguishes it from face-to-face education.
- The use of a computer network to present or distribute educational content.
- The provision of two-way communication via a computer network so that students benefit from communication with each other, teachers and staff.

Name	Week commencing: 4 April 2021									
	M		T		W		T		F	
	P	A	P	A	P	A	P	A	P	A
1. JOE	X		X		X		X		X	
2. ANDREW	X		X		X		X		X	
3. CHENG		X		X		X		X		X
4. FAIZAH	X		X		X		X		X	
5. RONALD	/		X		X		X		X	
6. JASMINE	X		X		X		X		X	
7. MERRY	X		X		/		X		X	
8. CHRISTIE	/		X		X		X		X	
9. LOREY		X		X		X		X		X
10. MARISAH	X		X		X		X		X	

Figure 6.8: Part of a school registration form for a class. The form has been designed for use with an OMR system. The teacher marks the appropriate box for a given student: P = present, A = absent

For example, a member of staff could post an assignment and the students could research, discuss with each other and submit it completely online. The assignment could be marked and returned with comments, both written and audio, again completely online.

- Online learning can be delivered using a website and communications using emails but greater benefits have been provided by the use of VLEs.

CAL also includes presentations and interactive tutorials which gives students the opportunity to manage their own learning by allowing them to:

- Learn at their own pace.
- Repeat sections that were difficult.

KEY WORDS

school management system: software designed to assist school administrative and educational tasks such as registration and predicting student progress

computer aided learning (CAL): the use of computer systems to aid the user in learning

- Omit sections that they already know and understand.
- They can also provide customised materials for each individual student so that they are not all expected to learn at the same rate and along the same route.

Most school management systems typically allow staff to record student grades and then automatically calculate the final grades to appear in the reports that go home to parents. The built-in functions enable teachers to filter student data in order to track student performance. Some more sophisticated systems will automatically alert staff to potential underperformers so that no underperforming students go undetected and all students can receive the assistance they may require when they need it the most. The analysis of the data is called 'learning analytics' and is intended to improve student learning.

Computer-based exams (CBEs) are organised by some examination boards and the school or college can enter students when they are ready and not at

certain, fixed points throughout the year. The school management system should be capable of carrying out all the tasks associated with this based on the data input into the system. Automated emails are sent to examination boards, staff, students and parents to remind everyone of an impending exam. Students only have to login to a computer with the secure login details to take them to the exam and in some cases they are informed of the results as soon as they are completed. However, not all examinations are conducted online and on demand yet.

Similarly, creating timetables and organising teaching cover or substitution timetables is also handled by the school management system simply by inputting some important information into the system. The formulae and functions built into the system produce error-free timetables. When staff had to create similar timetables themselves, it often took several revisions before they managed to create a perfect version. Changes to the timetable are also made much more efficiently, and the system can inform all those concerned instantly using electronic communications such as email and mobile phone alerts.

PRACTICAL TASK 6.1

Getting started

- 1 Write down definitions for the following:
 - a school management system
 - computer aided learning.

Practice

- 2 With a partner, investigate how computer systems are used for administration and learning in your school or college.
- 3 Create a presentation of your findings to explain to potential parents how the systems are used.
For information about creating presentations, see Chapter 19.

Challenge

- 4 Create a written report for your school or college's management, stating which systems they should introduce and the benefits of each.

6.5 Online booking systems

Theatres, concerts and cinemas

Consider a concert being held in a theatre. It is necessary to sell the 1000 tickets that are available to people who want to buy a ticket in advance. The promoter of the concert decides that instead of just selling the tickets at the theatre they will be on sale at a number of different shops in the area. Each shop needs to be allocated blocks of seats to sell otherwise the same seat may get sold twice. The promoter decides to let each of the ten shops have 100 tickets to sell. The problem of the same ticket being sold twice will not happen now because each of the tickets is unique. However, there is now another problem. Some of the shops might sell out and have to send people away without a ticket, while other shops do not sell all of their allocation and this will mean empty seats on the night of the concert. This would not happen if there was a way of allowing the popular shops to sell the unwanted tickets from the other shops. This could be done by physically moving the tickets from one shop to another, or it could be done by leaving the tickets in one place and allowing the individual shops to have access to them via computer communications.

Online booking systems allow booking agents in different locations to be in communication with a central computer system, which can store details of the available seats for cinemas or theatres.

KEY WORD

online booking systems: systems that allow people to book tickets and make reservations over the internet

When a customer rings or goes into the agency or shop:

- The customer states their requirements, which will include the name of the show or concert, the date for which tickets are required and the number and type of tickets that are wanted.
- The agent will then go online to the computer system and search for suitable tickets.

While this is being done no other customers can be serviced because of the danger of selling the same ticket twice. This is called locking the file so that no one else can change anything. More sophisticated systems such as booking airline seats, just lock individual seats to avoid jamming the system up.

When the tickets required are agreed:

- The customer pays by card (or cash if the shop has that facility agreed with the cinema or theatre).
- The seats that have been bought are changed to show 'sold' on the computer system.
- The file of seats is unlocked so that other customers can make bookings.
- The ticket is printed out at the shop or a receipt (an eTicket) is printed out which will be exchanged for the full ticket at the cinema or theatre.

This is an example of a real-time computing application that allows the owners of the cinema or theatre to reduce their costs by employing fewer people than they would otherwise have to without the automated system.

This system can be extended to allow the same sort of booking on the internet.

The travel industry

The travel industry allows bookings to be made by individual customers using the internet, or by travel agents. It is just as easy for customers to do their own bookings as it is to use a travel agent, but many customers who are not confident in the use of a computer and worry they may make a mistake while booking, or those people who do not want to pay online, still go to travel agents. However, travel agents are closing down a lot of their outlets due to online bookings.

Sporting events

Tickets for sporting events can be bought online from reputable agents in exactly the same way as for concerts. There are many ticketing agents to choose from but it is important to make sure that the tickets are valid. You can buy tickets quite quickly if you know who has the tickets that you want, but most tickets can be bought, even if someone knows little about buying

tickets online. The best way is to find out when the tickets will first be available online. Some systems allow for the immediate downloading of your tickets, which is helpful if you decide to attend an event at the last minute.

Advantages and disadvantages of an online booking system

Advantages:

- Online booking saves time.
- The system is open around the clock, rather than only being available when the office or shop is open.
- The system gives immediate information about availability.
- Online booking systems can send an automatic email to the customer to confirm their booking.
- The system allows for immediate reselling of a ticket that has been returned, which means the customer is more likely to get a ticket last minute.

Disadvantages:

- The system is expensive to install initially.
- Cost of staff training.
- An online database and a website would both need to be created and have the ability to communicate with each other, in order for a customer to be able to search online for availability of the booking they require.
- In order to ensure absolute reliability, it will take time and money to keep the database up to date and the system functioning correctly.

Question

- 4 A school is developing an online booking system for parents to make appointments for their parent consultation evenings.
Discuss the benefits and drawbacks to both the parents and the school of this type of system.

6.6 Banking applications

Automated teller machines

An **automated teller machine (ATM)** is the machine outside banks and other locations that allows you to carry out transactions such as withdrawing and depositing cash or cheques, checking your balance and paying bills without actually going into the bank. There are many other services available at an ATM, such as paying income tax or applying for a loan.

KEY WORD

automated teller machine (ATM): this is a machine that allows you to carry out banking services in locations other than inside a bank

The customer needs to provide identification by using a plastic card with a chip provided by the bank and a PIN (personal identification number). Chip and PIN readers were discussed in Chapter 2, Section 2.2 Direct data entry and associated devices.

These processes are all real-time processes because the account needs to be checked and updated without delay.

Withdrawing cash and depositing cash or cheques

An ATM is very convenient because you can use it to get cash from just about anywhere in the world (see Figure 6.9).



Figure 6.9: It is possible to withdraw cash from any place in the world

Many banks allow you to deposit money via an ATM from the bank where you have your account. You can also check your account balance and print out statements at the ATM. A mini statement will print your last few transactions.

ACTIVITY 6.2

Work with another student. Create a list of all the services you can get using an ATM.

Bill paying and money transfers

You can pay a bill or make a **money transfer** at an ATM. The ATM does not have to belong to the bank where you have an account. If you can see a logo at the ATM showing the different banks or card providers that it is compatible with, and yours is one of them, you can use the machine.

ACTIVITY 6.3

Discuss with another student the actions to take to withdraw money from an ATM, then together, put the actions in the right order.

Advantages and disadvantages of ATMs

Advantages:

- Open all day, every day and are therefore more convenient for customers.
- Customers do not have to go to a specific bank or building.
- Accounts can be accessed by customers from anywhere in the world.
- There is less human involvement and is therefore cheaper for the banks.

Disadvantages:

- Customers could be charged fees for using them.
- There is usually a limit on how much cash can be withdrawn each day.
- There is the possibility of fraud. Criminals can fix devices known as 'skimmers' to ATMs and these record your card details including the PIN that has to be entered on the keypad. Hidden cameras can also be used to capture card details.

Electronic fund transfer

Individual customers can use **electronic fund transfer (EFT)** while carrying out their banking requirements using **internet banking**. The customer is asked for their identification checks and is then allowed to state specific accounts to which they want to transfer money from their own accounts. The only other details needed are the bank code and the account number that the funds should be sent to and the name of the account holder. The transfers are then carried out immediately. EFT is also used in supermarkets when the customer pays for goods and is discussed further in Section 6.9.

KEY WORDS

money transfer: the act of transferring money electronically from one place to another. A money transfer agent carries this out, for example, VITTA or Western Union

electronic fund transfer (EFT): this is the transfer of money electronically from one account to another

internet banking: a method of banking in which transactions are conducted electronically via the internet

EFT can be used for payment for goods and also for services, e.g. payment to a builder who has done work on a house. It is often used by businesses to pay their workers' wages.

Advantages of EFT:

- Faster payment than using a cheque or cash.
- Payment is immediate.
- Can be used for payments 24/7.
- Can be used for setting up regular, automatic payments.
- More secure than using cash.
- No time wasted in dealing with cheques that bounce – that is, cheques from people that do not have the required amount in their account.
- Payments can be made anywhere in the world.

Disadvantages of EFT:

- As it immediate, customers must have the funds available.
- If you send the money to the wrong person or account, you cannot recover it.
- Open to abuse by hackers who may set up fake accounts in the names of firms and people you are sending the money to.

Credit/debit cards and contactless payments

You will remember that the use of bank cards was discussed in Chapter 2. When a card is used, the same sort of funds transfer is carried out as described in EFT. There are slight differences over where the funds come from. If the card used is a **credit card** the message is sent to the credit card company. The credit card company then arranges for funds to be sent to the account of the organisation, which has accepted payment using the card.

The credit card company then stores the information that the card has been used, where it was used and how much was spent in the transaction. This information is collected together once a month and a statement is sent to the cardholder showing them how much they owe. Notice that the use of a credit card requires both real-time processing for payments and batch processing for the production of statements.

Debit cards are used in the same way but the customer is dealing with their bank when they use their debit card rather than a credit card company. The bank will debit the customer account immediately (a real-time process) rather than waiting to produce a statement at the end of the month. The transaction will simply be shown as a payment on the normal bank statement.

Advantages of debit cards:

- Can be used to withdraw cash at an ATM without charge.
- Easy to obtain from a bank.
- Convenience – purchases can be made with the swipe of a card.
- Security – do not have to carry large amounts of cash.
- Accepted in most shops for payment.

Disadvantages of debit cards:

- No time period to cancel a payment.
- May be hard to keep track of your spending.
- Fraud – criminals could steal your personal details and set up a card in your name.

Advantages of credit cards:

- Can be used to withdraw cash at an ATM but will have to pay a charge.
- Convenience – purchases can be made with the swipe of a card.
- Easier to cancel a payment than when using a debit card.
- Users can spread the cost of a large purchase over many months.
- Many credit cards offer benefits and rewards to tempt people to use them.

Disadvantages of credit cards:

- People may be tempted to spend too much money.
- When a person's borrowing is up to their credit limit, they will not be able to use it.
- There may be fees and charges.

Validity of cards

Credit and debit cards need to be valid to be used. On each card is the date that the card expires. Some cards have a 'valid from' date as well. The date of payment must be before the expiry date.

There is also a number on the back of every card, called the **CVV** number or card verification value, sometimes known as the security code. Different card types use

KEY WORDS

credit card: a card that allows a customer to borrow funds to pay for goods and services

debit card: a card allowing the holder to transfer money electronically from their bank account when making a purchase

CVV (card verification value): a 3-digit number on the back of a credit or debit card. Users have to give this number when they are ordering items online

different amounts of numbers, but it is the last three digits that you will often be asked for during online transactions to verify your card. The long number on the front needs to be a valid number for the card issuer. All of these points will be checked automatically when the card is used to ensure its validity.

Cheques

Before EFT and card payments, people transferred money using **cheques**.

Banks regularly issued customers with books of cheques which were printed with their names and bank account details. On these cheques they would write the name of the person they wanted to pay and the amount. They would give the cheque to the person who would then travel to their bank to pay it in, although some ATMs will accept cheques. The banks involved would negotiate with each other and the money would be transferred. It was a slow process, and took usually more than three days for the money to be transferred from the one account to the other.

Although there was a delay in ‘clearing’ cheques, they were often more convenient than using cash.

Advantages of cheques:

- People do not have to carry cash.
- They can be stopped from being paid by phoning the bank.
- They can be traced if lost and paid in by the wrong person.

Disadvantages of cheques:

- The person accepting the cheque will not know if the person paying it actually has that amount of money in their account.
- Not suitable for small amounts.

ACTIVITY 6.4

Carry out research and list the countries around the world that still accept cheques and those that now do not.

Internet banking

Internet banking, also known as e-banking or online banking, is an electronic payment system that enables the customer of a bank or a financial institution to make financial or non-financial transactions online via the internet.

This service gives online access to almost every banking service that is traditionally available through a local branch including fund transfers, deposits and online bill payments to the customers.

Using a web browser or an app on a smartphone, a user can look at their account details, transfer cash, set up or cancel recurring payments and keep track of investments linked to their account.

As for all online transactions, users must ensure that they have a reliable password and adhere to all of the security features suggested by their bank as hackers could read their usernames and passwords, giving criminals access to the user’s bank account.

Advantages of internet banking:

- Customers can view the details of their accounts 24/7.
- They can make EFTs using their smartphone.
- They can move money between their accounts in real time.
- Easy to see when they have run out of money.

Disadvantages of internet banking:

- Security – hackers may find login and password details for their account.
- As it is very easy to transfer money it is easy to make a mistake and send it to the wrong person or account.

KEY WORD

cheque: a written document that orders a bank to pay a specific amount of money from a person’s account to the person in whose name the cheque has been issued

6.7 Computers in medicine

Expert and information systems in medicine

The study and practice of medicine is an enormous subject and continually growing. Computer technology is important in helping health professionals provide as reliable and efficient a service as possible and also in keeping them aware of medical advances.

Patient records

Your doctor, and the team of health professionals who care for you all keep records about your health and any treatment and the care you receive from them. For example, when someone is admitted to hospital, their details are entered into the **patient record system**. Once this information is on record, whenever that patient is admitted in the future, their records can be found very quickly. The typical information held on record for a patient could include:

- name, address and next of kin (a person's closest living relative)
- history of contact with the hospital, clinic or surgery
- notes and reports about health, treatment and care given
- results of X-rays and laboratory tests
- relevant information from other health professionals
- relatives or people who care for the patient.

Patient records are now stored digitally on computer and online. This makes it easier for various professionals who have been given access rights to view them if there is an emergency.

Pharmacy records

It is important that **pharmacy records** are kept so that doctors and medical workers can check the medicines that a patient has been taking and ensure there are no errors in the prescribing of their medication. All prescriptions used to be written on special forms by a doctor, given to the patient and taken to the pharmacy.

In many countries, most prescriptions are now signed, sent and processed electronically.

Patients can choose a pharmacy to which prescriptions are sent to and can collect their medicines or have them delivered without having to hand in a paper prescription.

As all prescriptions are electronic, details of the latest ones issued can easily be added to the patients' records automatically. Previously data had to be entered into the computer manually. Before that all paper records had to be stored in boxes for a number of years.

Security of patient records and systems

There are concerns about the implications of security, access and use of electronic patient information. Some of the concerns are:

- hacking, which can lead to the altering of patient data or destruction of the systems
- misuse of health information records by authorised users of the systems
- long term data management concerns about keeping data secure in the future
- the possibility of intrusion into personal health care matters by the police, insurers, social workers, other government or corporate institutions.

There are rules, laws and systems in place to prevent the threats given above.

3D printers for medical aids

You read about 3D printers in Chapter 2, Section 2.3 Output devices and their uses. But did you know that most hearing aids are already created using 3D printers, and that scientists have also worked out the theory of how to print blood vessels and skin, and even embryonic stem cells?

KEY WORDS

patient record system: a computer system used to keep an account of a patient's examinations and treatments

pharmacy records: details of medicines and drugs prescribed for each patient and the overall dispensed from a particular source

A major advance that led to 3D **bioprinting** was the development of **biomaterials**. Biomaterials are cells and other components to print living tissues that function as the original tissue would.

The categories of health care where 3D printing can be applied are for artificial body parts (**prosthetics**), medical devices and human tissues.

In medicine, 3D printers are having most success with prosthetics such as dental work and hearing aids (as mentioned above). These may all be made from either plastic or pliable materials. They need to be made for a specific patient, so each will be individual, rather than mass produced.

Medical 3D printing is expanding quickly in areas such as the creation of tissues and organs, customised prosthetics, implants, anatomical models and more. The benefits of 3D printing for medical tools and equipment include customising and personalising medical products, drugs and equipment; reducing costs; increasing productivity; extending the power of information in design and manufacturing; and enhanced teamwork.

Unlike inkjet printers, 3D printers have an additional axis, called the **z-axis** (see Figure 6.10). They have a mechanism called an elevator that moves a platform up and down to achieve printing on the z-axis. The cartridges of 3D printers are also filled with substances other than ink. If the cartridge were filled with plastic, it would output a three-dimensional plastic appliance according to the instructions given. If the cartridge were filled with cells, then it would output a mass of cells. In a similar way that an inkjet printer uses

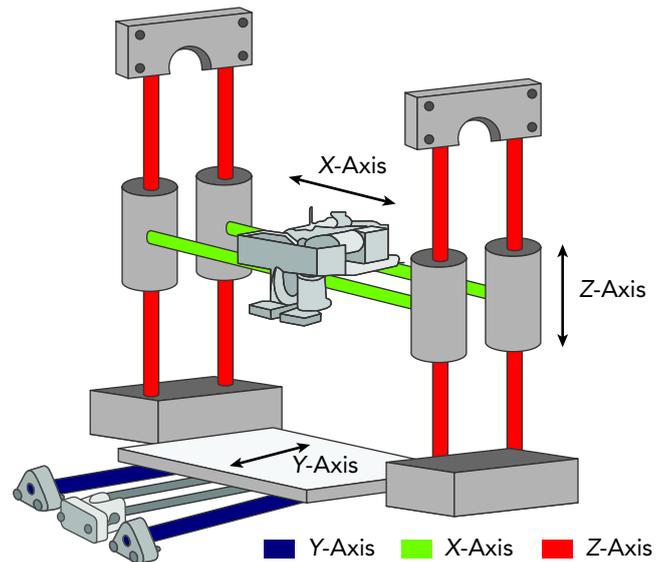


Figure 6.10: How a 3D printer works

cartridges filled with different colours, so a 3D printer can have cartridges filled with different types of materials.

Prosthetics

If a drawing is carried out using **computer aided design (CAD)** software, which allows the creation, modification and analysis of a design, and the cartridges are filled with the correct substances, then it is possible to print items such as prosthetic hands, arms and legs. Prosthetics can be printed for a specific surgery. This will make the prosthetic more effective than if it had been mass produced, and 3D printing will be able to respond quickly to the exact problem instead of waiting for a device to be manufactured.

KEY WORDS

bioprinting: the process of producing tissues and organs similar to natural body parts and containing living cells, using 3D printing

biomaterials: substances used to support, enhance or replace damaged tissue. They may be natural or synthetic, e.g. plastic used in contact lenses

prosthetics: an artificial body part

z-axis: the third axis in a three-dimensional graph to represent vertical coordinates

KEY WORD

computer aided design (CAD): software that allows the creation, modification and analysis of a design

Tissue engineering and artificial blood vessels

ICT IN CONTEXT

Rather than printing using plastic or metal, 3D bioprinters use a computer-guided pipette to layer living cells, referred to as **bio-ink**, on top of one another to create artificial living tissue (see Figure 6.11) in a laboratory.

These tissue constructs (or organoids) can be used for medical research as they mimic organs on a miniature scale. They are also being trialled as cheaper alternatives to human organ transplants.



Figure 6.11: A 3D bioprinter building tissue from living cells

Different tissues can be combined to produce organs such as blood vessels. Artificial blood vessels can be produced using a 3D printer loaded with two different bio-inks – smooth muscle cells and endothelial or lining cells.

Tissue engineering is also known as bioprinting. Bioprinting works similarly to traditional 3D printing methods where a digital model will be printed layer-on-layer, until the physical object is complete.

Customised medicines

Customised or personalised medicines are tailor-made or adapted for each patient with their individual needs and characteristics. 3D printed drugs have been developed to adapt to each patient's needs and could change treatments in a radical way in the long term.

In the future, patients with multiple chronic conditions will no longer have to take numerous drugs several times a day – instead they can take one tablet containing all the required medications at the right dose thanks to 3D printing.

Questions

- 5 **a** Describe how a 3D printer makes solid objects.
- b** Name the type of software that is used to create the designs for 3D printing.
- 6 Explain what is meant by bio-ink and how it is used in medicine.

6.8 Expert systems

An **expert system** is a computerised system that attempts to reproduce the decision-making process of an expert human being. It is designed to try and replicate the judgement of a human who has expert knowledge in a certain field. By doing this they can be used to replace or assist a human expert.

Expert systems gather data by asking the user questions about the problem. An initial set of questions can lead to further questions; which questions are asked depends on the user's responses. The expert system reasons what questions it needs to ask, based on the knowledge it is given. It will use the responses from the user to rule out various possibilities that will allow it to eventually reach a decision or diagnosis.

KEY WORDS

bio-ink: the material used to produce engineered (artificial) live tissue using 3D printing technology. It is usually composed only of cells, but in most cases, an additional carrier material is also added

customised medicine: (also called personalised medicine) a medicine that is specially formulated and created to meet the needs of one, unique person

expert system: a computerised system that attempts to reproduce the decision-making process of an expert human

Expert systems are made up of five parts:

- 1 The **user interface**: an interface that helps the user to communicate with the expert system. It takes the user's query and sends it to the inference engine. After that, it displays the results. It is an interface that helps find a way for the expert to ask questions and to get information out of the system. The user interface presents a user with questions and accepts the information that the user gives.
- 2 **Knowledge base**: all of the data, facts and conditions about the expert's particular subject. The knowledge base is prepared by a knowledge engineer who will be a skilled programmer.
- 3 A **rules base**: the set of rules and facts that must be applied to the knowledge base.
- 4 An **inference engine**: uses these facts and rules to apply to the knowledge base when selecting an answer to the user's query. It matches the information that the user inputs at the user interface with data held in the knowledge base to reach an appropriate response by using the inference rules
- 5 An **explanation system**: provides reasoning about the information in the knowledge base. It assists the user to understand the contents of the knowledge base and also the reasoning process that produced the solution to the user's question. It forms a conclusion.

KEY WORDS

user interface: the on-screen form through which the user interacts with the expert system

knowledge base: a database of related information about a particular subject

rules base: a set of rules that will be used to produce an output or decision by the expert system

inference engine: the program that can apply the rules to the data in order to get sensible judgements

explanation system: provides an explanation of the reasoning processes used to arrive at a particular decision

Expert systems use these five functional parts together in order to calculate solutions for different scenarios. For example,

- medical diagnosis
- mineral prospecting

- car engine fault diagnosis
- chess games
- financial planning
- route scheduling for delivery vehicles
- plant and animal identification.

Medical diagnosis

A medical expert system gives decision support in the form of an accurate diagnosis for the symptoms input. The system receives information (input) about the patient, usually by the patient's doctor.

A major characteristic of an expert system for medical diagnosis is that the sequence of steps used by the expert system in coming to a decision are designed to mimic steps used by a 'human doctor'.

A medical diagnosis is never a certainty and expert systems have the capability of expressing their conclusions as a probability. For example, it could decide that it is only 50% sure that it has reached the correct diagnosis.

It is generally agreed that expert system software must contain a large number of facts and rules about the disease or condition in question in order to deliver accurate answers. It has been estimated that two general internal medicine textbooks and three specialty textbooks would require two million rules.

Mineral prospecting

Another use for an expert system is in mineral prospecting. This is when different sites are tested for the probability of minerals, such as ore, being present at a site before mining starts. The expert system can collect its data from:

- 1 An expert.
- 2 Directly from sensors that are put in place at the site.
- 3 Images taken from satellites showing composition of the area such as hills, mountains, lakes and rivers.

Data will have to be entered into the system through the user interface. This will include:

- The types of rocks that are in the area.
- The types of minerals present in the area.
- The type of mineral required.

Using the information, the GIS builds a mathematical model (see Section 6.2) which can predict if the target mineral should be present in association with the features that have been entered. This type of model is called a ‘predictive model’ as it is making a prediction about the likely occurrence of a mineral.

Car engine fault diagnosis

Cars have symbols on their dashboards which light up when a sensor detects a problem with a component such as in the engine or the brakes. This is all part of the electronic management system which was discussed in Chapter 5, Section 5.1 Microprocessor-controlled devices.

When the driver takes the car to a garage it is plugged into an expert system, which will interrogate the car’s electronic management system to discover the possible cause of the fault.

It may provide several suggestions that the mechanic should investigate.

The knowledge in these expert systems can be easily updated online by the vehicle manufacturer, saving time and ensuring it is up to date. It also means that the mechanics do not necessarily need all of the knowledge in the expert system so saving money and time on advanced training courses.

Chess games

A chess player can play a game of chess against the computer; this really means that they can play against an expert system. This can help chess players train without the need for another person as there will be many levels – from easy to very difficult – for the player to choose from. The system will have been made by putting information from many expert chess players into the knowledge base. Playing against the computer means that there is no time pressure to make the next chess move. On the other hand, a player may be able to cheat by using the ‘undo’ button to help them to try a different move.

Financial planning

Expert systems can be very useful for helping individuals and large companies with financial planning.

Information about financial situations and personal circumstances is entered via the user interface, and based on each user’s answers, the expert system can suggest a financial plan and give advice on how best they can organise their investments, manage their debts or pay less taxes.

Route scheduling for delivery vehicles

This type of expert system would calculate the most efficient route for a delivery vehicle, taking into consideration the areas for delivery. The user interface would need to ask for:

- The amount of individual deliveries.
- The distance between each delivery drop-off point.
- Details of the delivery vehicle’s type and speed.
- The amount of time available altogether.
- Layout of the area such as if it is hilly, so that if the system is the type that can also find the most economical route by calculating fuel economy, it can produce the choice of options between fastest route and most economical route.

Plant and animal identification

These expert systems can be used by individuals, scientists and farmers to identify plants and animals. They could help them identify harmful insects and weeds and help to prevent crop failures. If there is a plant or an animal that isn’t recognised, an expert system will ask the user, in the case of an animal, how many legs it has, how long its legs are, does it eat meat or vegetation, its approximate size and colour, etc.

Questions

An expert system is specialised software that attempts to act as if it is a human expert in a particular subject or field.

- 7 All expert systems are made up of different parts.
 - a Name the **five** parts.
 - b Explain what is held in the knowledge base.
 - c Describe the role of the inference engine.
- 8
 - a State what would be used as the query for a medical expert system.
 - b What would be held in the knowledge base of a chess computer?
- 9 Human beings who are experts sometimes forget something or make mistakes. Discuss whether expert systems can make mistakes and the type of problems that may occur.

PRACTICAL TASK 6.2

You are going to use your desktop publishing software to create a three-fold brochure to give out to the class one year below yours for a presentation on expert systems.

Getting started

1 Work with another student to draw a plan on paper of what will be on every side of the three-fold brochure – what piece of information is going to go where and what information you will need to make sure it is explained properly. The outside back of the brochure will contain nothing except for your names. Make sure that you have noted your plans for:

- fonts
- colours
- images
- content, including images and text, suitable for the year group.

Practice

2 Work together to create the three-fold brochure on desktop publishing software exactly as you had planned it. For more information about creating a brochure, see Chapter 12 (Images), Chapter 13 (Layout) and Chapter 17 (Document production).

Challenge

3 Using suitable software, prepare a slide presentation describing the advantages and disadvantages of using expert systems.

For information about creating presentations, see Chapter 19.

Peer assessment:

Ask for feedback from the class and discuss any points they make with them. Show your presentation to another two students and let them look at your brochure. Think about how you could improve the way you do this kind of task for next time.

6.9 Computers in the retail industry

In the retail industry, computers are used for **point of sale (POS)** terminals (Figure 6.12) and automatic stock up-dating.

POS terminals are set up at the exits of supermarkets to allow shoppers to pay for their goods. In many stores,

KEY WORD

point of sale (POS): the place where you pay for goods or services, e.g. a cash register



Figure 6.12: point of sale (POS) terminals

the point of sale system at the checkout is linked to the **stock control system**. This means that as soon as an item is sold the stock levels are automatically adjusted.

The stock of a business is the items that it either manufactures, sells or uses. To keep track of their stock as items are bought in, sold or used, a business needs a stock control system.

In a supermarket, the stock will include everything on the shelves and in the storerooms.

The advantages are:

- Saves money by not keeping too much stock of any item.
- Prevents fresh stock from going off before it is sold.
- Prevents running out of stock.
- Saves time by employees not having to go around checking the shelves.

When items arrive at the store, they are added to the stock levels in the stock control system, usually using a bar code scanner, and the stock level is increased.

When a customer buys an item, they pay for it at the POS terminal, which tells the system that the stock level has decreased. With such a system, it is very easy for stock levels to be monitored. This enables stock to be reordered when it is running low.

This is affected by the stock control system checking if the stock level for every item is less than the minimum stock level required to be kept. The appropriate stock is then reordered from the supplier.

This system of automatically reordering as soon as the minimum reorder level is met is a real-time system (happens immediately, without any delays). However, if the manager requires to see all of the necessary orders before they are sent out, they will be collected for them to consider together and to give them approval. This collection of the information is what turns the system into a **batch process**. So this has become a batch system rather than a real-time system.

POS/EFTPOS

Electronic fund transfer (EFT) is used at checkouts in supermarkets. Although it is still possible to pay with cash, many people use a debit or credit card to pay for goods. The card is inserted into the card reader at the point of sale (POS) terminal, and the funds are then transferred electronically from the card holder's account to the supermarket's account in the same way as a worker's pay is transferred.

POS terminals allow shoppers to pay for their goods in the following way:

- The shopper presents their purchases.
- The items are scanned using a bar code reader.
- The stock file is searched for the bar code.
- When it is found:
 - The number in the stock file has one subtracted from it.
 - The number in the stock file is checked against the minimum stock level and the need to order more of this stock is added to the list to be sent to the manager at the end of the day if necessary.
 - The description and price of the article is sent to the terminal.
- The price and description are displayed on the screen.
- The price and description are printed on a till receipt.
- The price is added to the total so far.

This means that shoppers have a printed record of their purchases and are able to check for errors. The system proves to be very popular with shoppers, which pleases the management of the supermarket because more people come to shop in the store.

Electronic fund transfers point of sale (EFTPOS)

If there is a chip and PIN reader added to the POS it becomes an electronic funds transfer at the **electronic fund transfers point of sale (EFTPOS)** terminal. Not only does the system control stock levels and produce itemised receipts, but it also controls the way that payment is made. Customers are encouraged to pay

KEY WORDS

stock control system: a computerised system to automatically maintain records of stock levels. They are automatically informed of the numbers sold to customers and delivered from suppliers. They can automatically order new items when they get below a certain level

batch process: a group of jobs executed together, either sequentially or at the same time

electronic fund transfers point of sale (EFTPOS): a POS with a chip and PIN reader

by card because this will reduce the amount of cash being handled at the tills. Chip and PIN readers were discussed in Chapter 2, Section 2.2 Direct data entry and associated devices.

Contactless payment

Contactless payment is offered in many shops worldwide. You can pay by swiping your credit or debit card, or pay using your mobile phone, smart watch, key fob, wristband and more.

If you pay by the contactless system, there are four steps:

- 1 Look for the contactless payment symbol (see Figure 6.13).
- 2 Wait for the retailer to put the amount into the terminal.
- 3 Touch your card or device against the terminal.
- 4 Wait for the green light or beep confirming the payment is approved.

ACTIVITY 6.5

For contactless payments where you don't need to sign anything, or enter your PIN for verification, your purchases are limited to a set maximum amount for each transaction. This amount is known as a floor limit. Limits may vary between banks and countries.

Find out what the floor limit is in the country where you live, or in a shop near to you.

Communication between supermarket and bank computers

When paying for goods at an EFTPOS in a supermarket, the customer enters the payment card into the reader and enters their PIN:

- The EFTPOS automatically or the cashier manually enters the total of the purchases made.
- Then the supermarket's computer system connects to the computer at the bank, sending a message.



Figure 6.13: Contactless payment symbols

- The bank's computer will take the account number and access the customer's account at the bank to check their balance.
- The bank's computer will automatically send a message back to the supermarket's computer to confirm that there is enough money in the customer's account to pay, or not!
- The cashier confirms the purchase amount and the bank takes the money from the customer's account and sends it to the supermarket's account.
- The customer receives a printed receipt from the cashier.

Near field communication (NFC) and payment using a smart device

Smartphones and smart watches use **near field communication (NFC)** when communicating contactlessly with the terminal. NFC uses radio waves over a very short distance, usually up to 4 cm.

Near field communication (NFC) gives a way for your smartphone to interact with something that is close by. This requires a transmitting device and another device to receive the signal. Devices that use NFC are either passive, which do not have their own power supply, or active. The passive devices, such as credit and debit cards, have a small antenna to receive radio waves from the powered terminal. An active device, such as a smartphone, can receive and send data and communicate with other active devices in the nearby area.

KEY WORDS

contactless payment: a transaction that require no physical contact between the consumer's payment device, e.g. credit card or smartphone, and the physical terminal

near field communication (NFC): a short-range wireless method for devices to communicate with each other without needing a power supply

Internet shopping

Internet or online shopping means that you can visit web stores while sitting in front of your computer. Just about anything can be bought online. Products available include books, clothing, household appliances, toys, hardware, software, health insurance, cars and

PRACTICAL TASK 6.3**Getting started**

You are going to create an illustration or a flowchart of the series of communications between a supermarket's or a shop's bank and the customer's bank, shown above.

- 1 Work on your own to plan your illustration or flowchart, including, for an illustration the type of images you want to use.
- 2 For both the illustration or the flowchart, you should use arrows to show which way the information is passing between the supermarket's computer and the customer's bank.
- 3 Every arrow should clearly state what information is passing between the computers.

Practice

- 4 Using either the word processor, desktop publishing software or a freely downloadable flowchart generator, create your illustration or flowchart as planned.

For more information, see Chapter 12 (Images) and Chapter 13 (Layout).

Challenge

- 5 Carry out some research into 'Luhn's algorithm', which is a way of checking the validity of the long credit or debit card number.

REFLECTION

Ask yourself the following questions:

- 1 Did my task, when created on computer, match the plan I made?
- 2 If not, why were there differences?
- 3 How could my plan have been improved?
- 4 Did the application I used turn out to be the best software for the job?
- 5 What would I do differently another time?
- 6 Did I manage to find the necessary information for the research task easily? Overall, am I pleased with how I did my work?

batteries, and these are just some of the many millions of products that can be bought from an online store.

Advantages of internet shopping:

- There is often more choice.
- Goods are usually less expensive.
- People choose to shop online because of the convenience as you don't have to travel to the store.
- Disabled or elderly people may find it easier to use online shopping than to go to a town.
- When purchasing an item from a store, each household drives to that store separately, but delivery trucks deliver to many customers on a single route so less fuel emissions are created.
- Some retailers sell a range of goods and so it is easier to get a range of goods delivered in one delivery e.g. books, CDs and food.
- More employment for delivery drivers/ delivery companies.
- No need to stand in a long line at the checkout.

- Online stores don't close.
- There is worldwide access to online goods.
- Comparison sites can be used to find the most appropriate or least expensive option for many items or services.
- Shopping sites online usually provide reviews from previous customers to assist in decision making.

Despite the convenience of online shopping, people do not always choose to use it.

Disadvantages of internet shopping:

- You cannot touch or try the merchandise.
- You cannot choose to buy goods with the longest sell-by date.
- Fear of credit or debit card information being stolen.
- Not everyone has a computer or is ICT literate enough to carry out their shopping online.
- You cannot pay with cash.
- You may have to pay extra for delivery.

Questions

- 10 Internet shopping has many advantages but also has disadvantages. Give **three** advantages and three disadvantages of internet shopping.
- 11 When shopping in a supermarket, you put all your shopping into a shopping cart and pay at the end.
- Define POS.
 - List the steps that occur when the shopper presents the contents of their shopping trolley to the cashier and pays.
 - List the data that is contained in a bar code.

6.10 Recognition systems

Optical mark recognition

Optical mark recognition (OMR) enables data marked by a human, such as surveys, multi-choice examination papers and school registers to be captured during a scanning process. OMR gathers data from marks on a document made by a human by detecting the difference in the reflection of light from marks such as lines or shaded areas. It does this by using a scanner and OMR software. To check OMR sheets, all you would need would be the OMR software on your desktop and an ordinary scanner.

The software will automatically interpret the scanned data and return accurate results very quickly.

Advantages:

- Very fast method of data entry as the machine can read the forms far quicker than a human.
- Much more accurate method of input than a human.

Disadvantages:

- There may be mistakes if the mark isn't dark enough, doesn't fill the required area or has gone beyond it.
- Forms may jam in the machine.
- Only suitable for questions with a definite answer. Could not read continuous text input.

Optical character recognition

Optical character recognition (OCR) scans a typewritten document and translates the images into an electronic format that the computer can understand. If you have a hard-copy of a text document you can scan it into your computer where you can use special software to turn it into text that can be used by a word processor.

OMR and OCR were also discussed in Chapter 2, Section 2 Direct data entry and associated devices.

Advantages:

- Quicker than someone entering the text manually.
- Cheaper than paying someone to do it.

Disadvantages:

- Mistakes often happen, for example, letters are not recognised.
- The documents may be torn and dirty and so difficult to read.

Automated number plate recognition systems

Automated number plate recognition (ANPR) uses infrared lighting to enable it to take images

KEY WORD

automated number plate recognition system (ANPR): a system capable of reading car number plates, with a high degree of accuracy, without human intervention

of car number plates day or night. OCR is used to read the vehicle registration numbers. The purpose of ANPR is to check number plates against databases to identify stolen cars, cars involved in crimes, cars without insurance, cars involved in terrorism and organised crime, and road offences such as speeding, etc. There are privacy issues that arise from the use of ANPR because 99% of the information collected relates to people who are not criminal suspects.

Advantages:

- Number plates can be read all day, every day.
- Vehicles can be checked and located.
- Safety can be improved by helping to catch speeding drivers.

Disadvantages:

- Extreme weather conditions can affect accuracy.
- Privacy concerns: mass surveillance is an infringement of a person's rights.

Bar codes, QR codes and RFID

Bar codes, QR codes (see Figure 6.14) and RFIDs are all ways of identifying items electronically.

Bar codes are read by devices that shine a laser at them and then read the reflection to tell how thick the lines are. Lines are taken in pairs and can represent the digits 0 to 9. They are used in many places to identify items, such as in a shop.

QR codes are used to place information onto your smartphone that will give you more information about something, such as details about a business, an item for sale, a forthcoming concert, etc. QR codes can store a lot more data than a bar code, including url links, geo coordinates and text.

Radio-frequency identification devices (RFID) are used to track stock, passports, automobiles and contactless payments. An RFID reader will take data from an RFID tag attached to an item when it is within range. An RFID device has similar uses to a bar code or the magnetic stripe on the back of a credit card in that once it is scanned it provides a unique identifier for the object it is attached to.



Figure 6.14: A typical QR code

Bar codes, QR codes and RFID were also discussed in Chapter 2, Section 2 Direct data entry and associated devices.

Advantages:

- Product details can be read very quickly.
- Can be used as part of an automatic stock control system.

Disadvantages:

- Labels may be damaged.
- Cost of equipment and staff training.

Biometric recognition

Biometrics provide strong authentication that is based on unique physical traits such as face, fingerprints, hand prints, retina or iris (eye) scans or voice, and behavioural traits such as voice patterns or handwriting and signatures.

The character being measured needs to be universal – it should be something that everyone possesses. It should also be unique, so that an individual can be definitively recognised. It should also be permanent, meaning that it should not change significantly as a person ages.

In order for organisations to make use of biometrics, it would be necessary for them to have:

- A suitable biometric reader or scanner.
- A data bank of the appropriate biometric of its employees or people allowed to enter.
- Software to identify the **match points** from the scanner against the biometrics in the data bank.

KEY WORD

match points: areas on a person that are compared with those on the stored data

Once an item of data is captured, such as a fingerprint, the system will try to match that data with any existing item in the database. A good example of identification biometrics is a database of fingerprints of known criminals.

Advantages of biometric systems:

- Improved security.
- Quicker authentication.
- Improved customer experience.
- Cannot be forgotten or lost like a password or swipe card.
- Reduced operational costs.

Disadvantages of biometric systems:

- Environment and usage can affect measurements.
- Systems are not 100% accurate.
- May not recognise individuals if their characteristics have changed.
- There may be ‘fake positives’, e.g. criminals could take impressions of a person’s fingerprint to make a fake version.
- Hygiene concerns if they are contact based

Biometric authentication is discussed in Chapter 4, Section 4.2 Network issues and communication and biometric data protection is discussed in Chapter 8, Section 8.3 Security of data.

ACTIVITY 6.6

Carry out research on the following methods of biometric identification: fingerprint, face and iris. Create a report explaining how each is carried out and how accurate they are.

ICT IN CONTEXT

Dubai airport has replaced banks of security checks with a virtual aquarium (Figure 6.15).

Visitors walk through admiring the virtual fish while 80 in-built cameras scan each person’s face to verify their identity.



Figure 6.15: The Dubai aquarium

6.11 Satellite systems

Satellite systems provide voice, data and broadcast services with global, coverage to mobile users as well as to fixed sites. They all depend on **satellites** in orbit around the earth and methods to communicate or receive signals from them.

KEY WORDS

satellite systems: provide voice, data and broadcast services with global, coverage to mobile users as well as to fixed sites

satellite: an artificial body placed in orbit round the earth or moon or another planet in order to collect information or for communication

Global positioning systems and satellite navigation

Global positioning systems (GPS) uses satellites to find the precise location of things by communicating with receivers on the ground.

Wherever you are at any time, there are several GPS satellites ‘visible’ out of the 24 in total. They each send a signal to a GPS receiver such as your smartphone or satnav. They transmit information about the satellite position and also the current time; this information is transmitted at regular intervals and travels at the speed of light. When your receiver intercepts the signals it calculates how far away each satellite is, by calculating how long it took for the messages to arrive. Once your receiver knows how far away it is from at least three satellites, it pinpoints your position using a process called **trilateration** (Figure 6.16).

KEY WORDS

global positioning systems (GPS): a navigation system that uses satellites to locate items on the ground

trilateration: a method of determining the relative positions of three points by treating them as the points of a triangle

All GPS devices require three satellites to accurately calculate your position but normally use between four and seven in order to get really accurate data such as altitude.

If, before you begin a journey, you program your satnav with the information of where you want to go, the

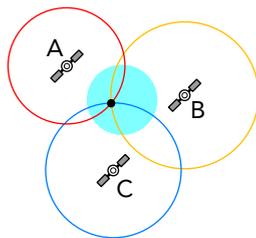


Figure 6.16: Trilateration using three satellites. Using trilateration, your GPS receiver picks up a signal from the yellow satellite, so you must be somewhere on the yellow circle; if it also picks up signals from the blue and red satellites, you must be at the black dot where the signals from the three satellites meet

satnav will calculate the quickest route to get to your destination. However, you can choose another route if you want, by inputting various waypoints that you want the route to take.

Advantages of satellite navigation:

- It helps people find their destinations.
- Helps in tracking parcels and stolen vehicles.
- Gives information on nearby shops, restaurants, petrol stations, etc.
- Can give spoken directions so that drivers do not have to take their eyes off the road.

Disadvantages of satellite navigation:

- It does not work in places where the device cannot receive signals from the satellites, e.g. in some buildings and underground.
- If a driver just follows verbal instructions they will never learn and remember the route.

ICT IN CONTEXT

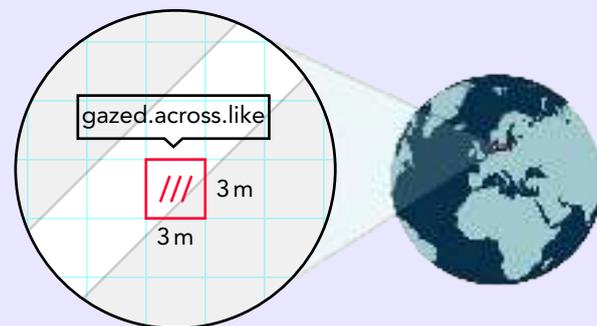


Figure 6.17: What3words

When you enter an address into a satnav it converts it to specific longitude and latitude coordinates which are represented by numbers such as 51.74743863117572 and 0.45043945312500006.

If you don't have an address and want to enter a location, then you have to manually enter these numbers. That is difficult and you are bound to make a mistake.

CONTINUED

To solve this problem a new system called 'what3words' has been devised (see Figure 6.17). It has divided the whole surface of the globe into three-metre squares and given each square a unique address made of three random words.

Any location, anywhere in the world can be found to within an accuracy of three metres if you know the three words. And you can find these or plan a route to them using the app.

Many emergency services around the world are using the system, especially to locate and rescue people in remote regions. Car manufacturers are also allowing the three words to be used in their satnav systems.

The system is free to use if you download the app.

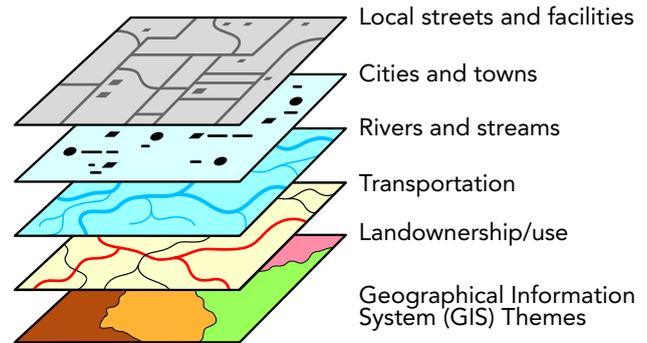


Figure 6.18: Layers of information that can be used to create a map with GIS

Geographic information systems

A **geographic information system (GIS)** lets you produce maps and other graphic displays of geographic information. A GIS is a valuable tool to combine and display spatial data about a particular area.

Different layers of data can be combined or overlaid. For example, data about the population, buildings, roads and boundaries, aerial photographs and GPS coordinates can be stored in relational databases (see Chapter 18) and combined to answer specific questions. For example, a GIS can quickly identify and map all of the locations within a specified area, or all of the roads and streets that run through a territory inside a particular boundary.

Therefore, GIS gives you the power to create maps and integrate information (Figure 6.18). It can be used to visualise scenarios and help to develop effective solutions to many problems, such as pollution, or to assess community needs and resources.

Advantages of GIS:

- Can help organisations make planning decisions, e.g. where to build new offices or factories.
- Can be used to communicate data sets to the public during a pandemic such as COVID-19.

- Can analyse the numbers in different geographical areas and assist with forecasting which can help policy makers prepare for future developments and allocate resources appropriately.

Disadvantages of GIS:

- Expensive software is required.
- The systems require vast amounts of data.

Media communication systems (satellite television and satellite phone)

Satellite television

Satellite television delivers television programs and media streaming services to viewers by relaying it to a communications satellite orbiting the earth (Figure 6.19).

KEY WORDS

geographic information systems (GIS): geographic information systems capture, store, check and display data related to the surface of the Earth as a map

satellite television: a service that delivers television programmes to viewers by relaying them from communications satellites orbiting the earth

Users also need a set-top box to decode the signals and watch the programmes.

They are widely used in areas where there are no cables and transmitters needed for terrestrial television.

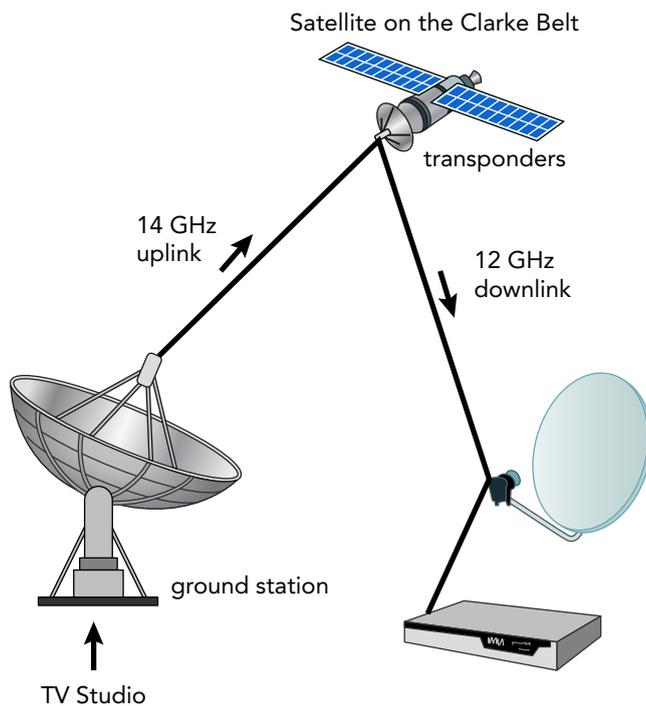


Figure 6.19: The services are transmitted from an Earth station to a satellite and the signals are then returned to Earth and are received by a satellite dish

Advantages of satellite television:

- A large amount of content is available.
- Lots of foreign stations can be viewed.
- Good for rural areas as cables are not required.

Disadvantages of satellite television:

- Need a **satellite dish**.
- The satellite dish has to be positioned correctly.

Satellite telephone

Satellite phones are mobile devices that beam their data directly to and from satellites orbiting the earth.

They do not depend on cables or the **cellular network** used by smartphones. In remote areas, where there are no cables and no cellular network coverage, people can still communicate using a satellite phone but the phones themselves and the cost of calls are far more expensive than other methods.

KEY WORDS

satellite dish: a bowl shaped aerial through which signals are transmitted to or received from a communications satellite

satellite phones: telephones that have the ability to connect to orbiting satellites

cellular network: a radio network distributed over land through cells where each cell includes a fixed base station

Advantages of satellite phones:

- Easy to get in touch with anyone when travelling.
- Can be used where there is no cellular signal or cables.
- Can connect to cellular and landline phones.

Disadvantages of satellite phones:

- Expensive to buy and to make calls.
- Can only work when in direct line of sight with the satellite – cannot use in covered areas or buildings.

SUMMARY

There are many different types of communication media from newsletters to e-publications.

The use of mobile communication devices can include SMS, VOIP, video calls and accessing the internet.

Computer modelling has applications for personal finance, building design, flood water management, traffic management and weather forecasting among many other ways of using modelling.

Computer-controlled systems such as robotics are in use throughout many applications such as manufacturing and autonomous vehicles.

CONTINUED

Schools use a school management system that includes managing learner registration, attendance and learner performance. Such a system includes the use of CAL (computer aided learning).

Bookings for theatre, cinemas, concerts and sports events, etc. can be made and paid for online.

There are many ICT applications used in banking. Banking can be done online; banking also allows for the use of ATMs, EFT and credit/debit card transactions.

Computers are widely used in medicine to keep patient and pharmacy records and 3D printers can create prosthetics, tissues, artificial blood vessels and customised medicines.

The different uses for expert systems include mineral prospecting, car engine fault diagnosis, medical diagnosis, chess games, financial planning, route scheduling for delivery vehicles, plant and animal identification and a wide range of other uses.

The components of an expert system include a user interface, an inference engine, a knowledge base, rules base and an explanation system that together can produce possible solutions for different scenarios.

Computers in the retail industry can automatically update stock, can allow customers to use different payment methods and can communicate directly with customers' banks to achieve verification of payment using credit or debit cards using POS/EFTPOS systems.

Recognition systems are used in biometrics, smartphone payments (NFC), RFID to track, e.g. stock, passports and automobiles. Other recognition systems include ANPR, OMR, OCR and bar codes.

Satellite systems include GPS, GIS and media communication such as satellite TV and phones.

EXAM-STYLE QUESTIONS

- 1 Some buildings in cold climates use central heating systems controlled by a microprocessor.
- a Give *two* input devices that the system may use. [2]
- b Sort the numbers of the processes into the order in which they take place: [5]

Processes	Order
If the temperature is higher than the pre-set value a signal is sent to turn the heater off.	
If the temperature is lower than the pre-set value the microprocessor sends a signal to the actuator to turn the heater on.	
The temperature is received from the sensor.	
The temperature from the sensor is compared to the pre-set temperature.	
The required temperature is stored as a pre-set value.	

COMMAND WORD

give: produce an answer from a given source or recall / memory

CONTINUED

- 2 You are buying a train ticket online and intend to pay with a credit card. When you enter your card, it will be checked by the credit card company's computer.
State *four* checks that will be made before the payment is authorised. [4]
- 3 The school newsletter is going to be put on the school's website.
Describe the features that can be used on the website version that could not be used in the printed newsletter. The answer should be in the context of the school. [5]
- 4 Different types of software have different uses. State the best software type to use for each task.
- a Model business finances. [1]
 - b Research on the internet. [1]
 - c Create a slide show. [1]
 - d Write a report. [1]
 - e Monitor pollution in the air. [1]
- 5 a State what sort of meeting could be held when the following devices are used together:
keyboard, large screen, pointing device, router, network card, microphone, speakers, web cam. [1]
- b Name devices that could be used at a supermarket checkout to scan the bar codes on products. [3]
- c Give the name of the validity check carried on a product bar code. [1]
- d Describe the steps taken by the computer processor to update the stock file when an item is sold at the checkout. [6]
- 6 a State the name of the system that makes decisions and gives advice such as in health care. [1]
- b Other than health care, give *two* examples of different uses of an expert system. [2]
- c **Demonstrate** the use of the following in an expert system: [6]
- i knowledge base
 - ii user interface
 - iii inference engine.
- d Give *two* advantages and *two* disadvantages of using an expert system. [4]
- [Total: 45]

COMMAND WORDS

state: express in clear terms

describe: state the points of a topic / give characteristics and main features

demonstrate: show how or give an example

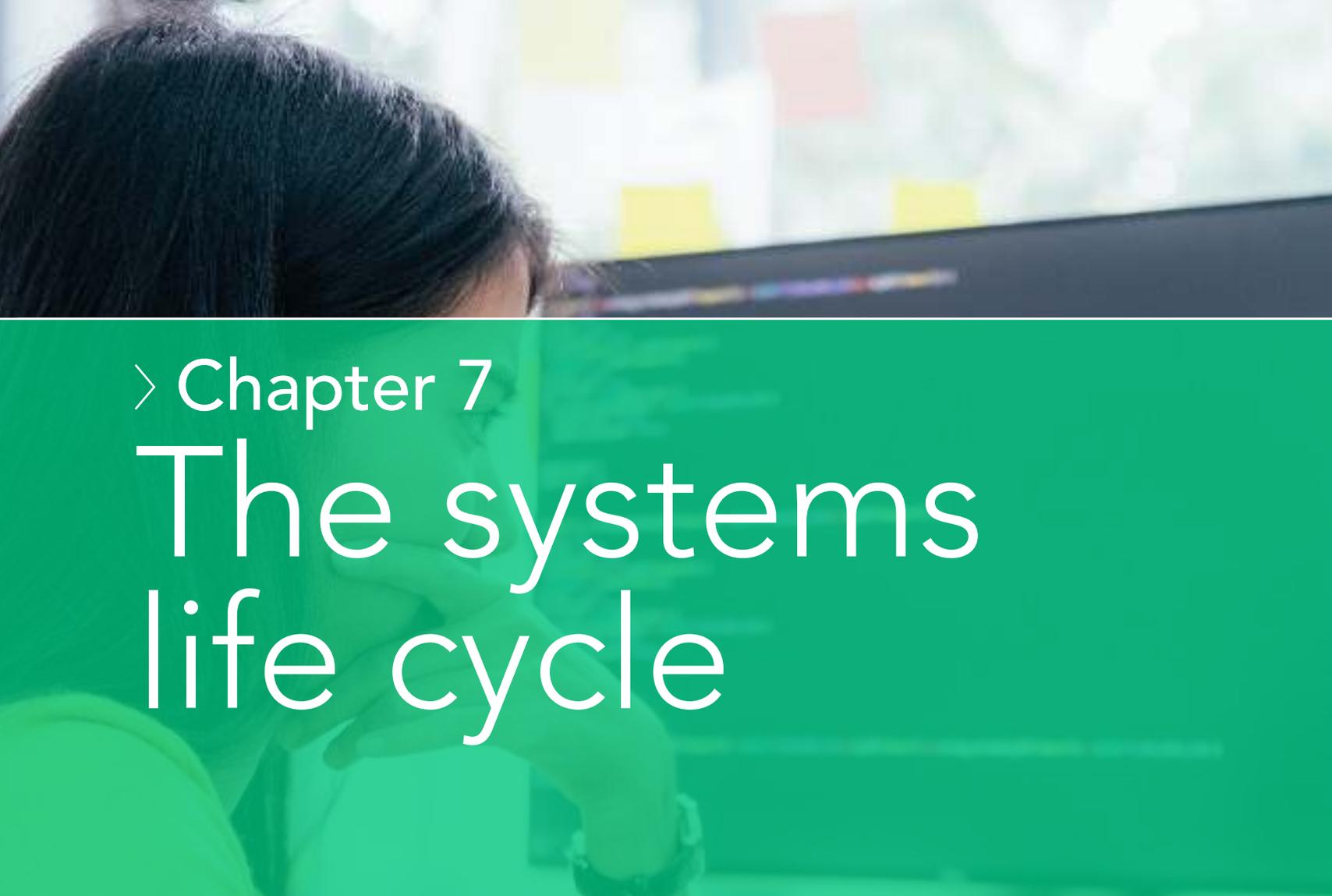
SELF-EVALUATION CHECKLIST

After studying this chapter, think about how confident you are with the different topics.

This will help you to see any gaps in your knowledge and help you to learn more effectively.

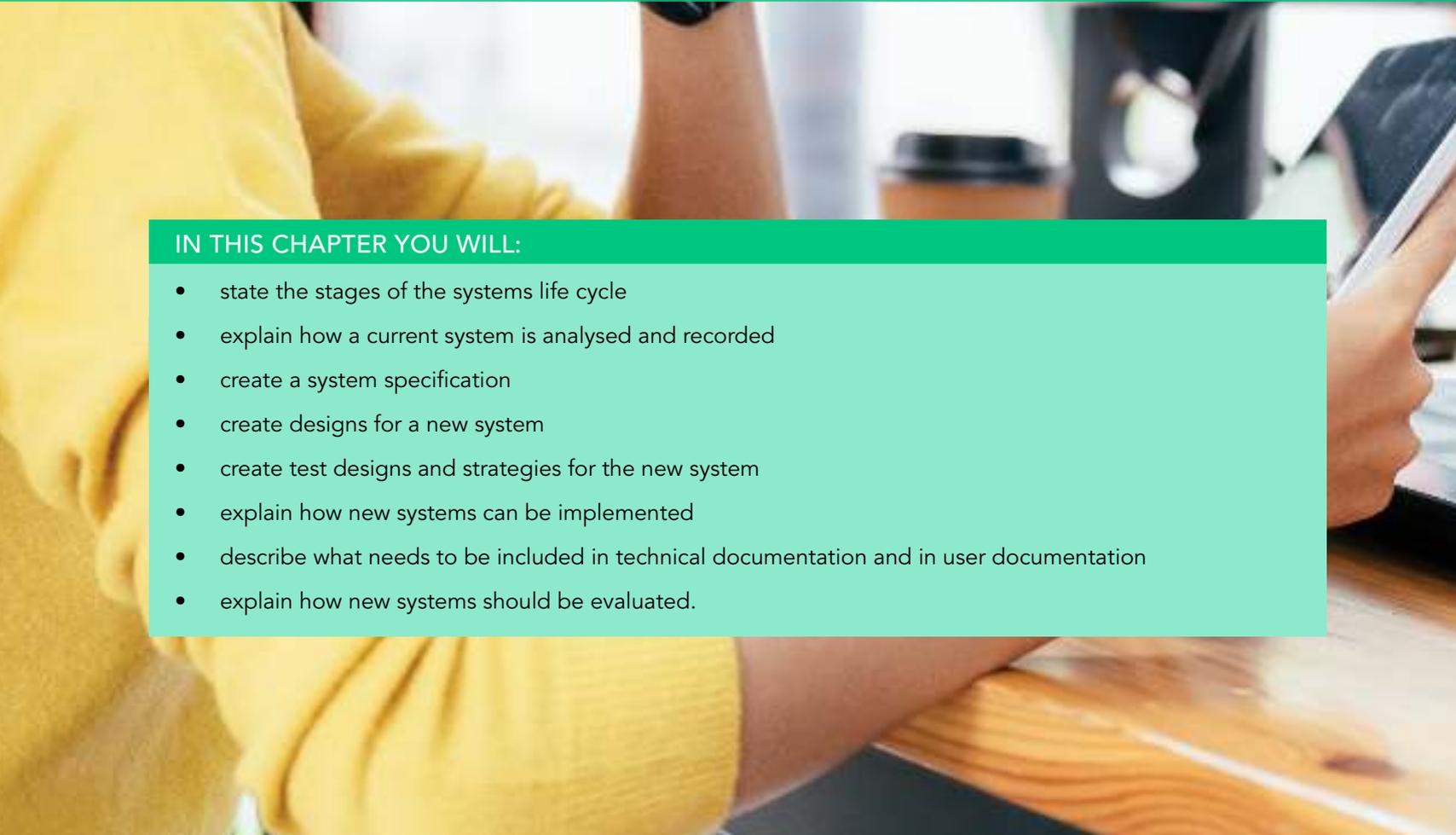
You might find it helpful to rate how confident you are for each of these statements when you are revising. You should revisit any sections that you rated 'Needs more work' or 'Getting there'.

I can ...	See section	Needs more work	Getting there	Confident to move on
identify communication media and mobile communication devices and their uses	6.1			
describe computer modelling and computer-controlled systems such as robotics, and the advantages and disadvantages of their use	6.2 and 6.3			
discuss management systems for school management and computer aided learning	6.4			
describe online systems to make bookings for cinemas and concerts, etc.	6.5			
discuss different banking applications and the advantages and disadvantages of each	6.6			
describe the characteristics and uses of computers in medicine and understand the uses of expert systems for a variety of different applications.	6.7			
explain the uses of expert systems	6.8			
explain how computers work in the retail industry, the uses of different payment methods, and understand the advantages and disadvantages of internet shopping	6.9			
identify the characteristics and uses of recognition systems, including OMR, OCR, RFIDs and biometric recognition	6.10			
understand the uses, and advantages and disadvantages of satellite systems	6.11			



› Chapter 7

The systems life cycle



IN THIS CHAPTER YOU WILL:

- state the stages of the systems life cycle
- explain how a current system is analysed and recorded
- create a system specification
- create designs for a new system
- create test designs and strategies for the new system
- explain how new systems can be implemented
- describe what needs to be included in technical documentation and in user documentation
- explain how new systems should be evaluated.

GETTING STARTED

The systems life cycle is a series of stages that are worked through during the development of a new IT system or the improvement of an existing one.

The stages are shown but they *are not* in the correct sequence.

These stages are:

- a system implementation
- b testing
- c analysis
- d evaluation
- e documentation
- f design.

Shown below are descriptions of the stages, which *are* in the correct order.

Match up the letters of the stages with the numbers of their descriptions.

- 1 Investigating how the existing system works and what the new one will need to do.
- 2 The overall structure of the new system, with details of the software, file system and data structures is specified.
- 3 These specifications are checked using sample data to ensure that they function correctly.
- 4 The new system is set up.
- 5 Instruction booklets and manuals are written to tell the users about the new system.
- 6 The new system is compared to what was wanted and planned for.

THE WORST AND MOST EXPENSIVE CONTRACTING FIASCO IN HISTORY

'If you fail to plan, you are planning to fail' – Benjamin Franklin

All projects to develop new or improve existing computer systems start off with good intentions. Those in favour of the new systems usually proclaim:

- It will help everyone to get their jobs done better and more efficiently.
- It will save money.
- Everyone will find it easy to use.
- People will love to work in this new high-tech way.

But are these statements true? Have the users been asked for their opinions? Without thorough research, meticulous planning and efficient management, projects can easily end in failure.



Figure 7.1: Computerising health data

CONTINUED

In Britain in 2002, the National Program for IT (NPfIT) in the National Health Service (NHS) was the largest public-sector IT program ever attempted in the UK with an original budget of £6 billion.

It was an ambitious project to bring the NHS's use of information technology into the 21st century (see Figure 7.1), through the introduction of integrated electronic patient records systems, online 'choose and book' services, computerised referral and prescription systems, digital scanning and integrated IT systems across hospitals and community care. The project was abandoned in 2011 after numerous failures to meet targets and expectations.

A report by the Public Accounts Committee (PAC) concluded the attempt to upgrade NHS computer systems in England ended up becoming one of the 'worst and most expensive contracting fiascos' in public sector history with a final cost of £12.7 billion.

But what went wrong?

The failure was due to a combination of errors. It was a 'top-down' project – politicians and managers raced headlong into policymaking and implementation processes with little time to consult with the people who would be using the system: the nurses, doctors and health professionals. It should have focused on meeting the specific needs of the users on the ground, a 'bottom-up' approach.

The design was flawed and did not take account of local needs and how it would impact on user satisfaction. There was a lack of project management without leadership in planning and consulting the users and providing training.

Discussion questions

- 1 Can you think of any other examples where IT projects have ended in failure? What caused these failures? Are there common causes for all of the failures?
- 2 Discuss how the stages in planning and implementing an IT project also apply to other situations such as planning a school trip.

7.1 The systems life cycle

The systems life cycle is a series of stages that are worked through during the development of a new IT system or the improvement of an existing one.

These stages are:

- analysis of the current system
- design
- testing
- system implementation
- documentation
- evaluation.

7.2 Analysis of the current system

Analysis involves investigating how the existing system works and what is required for the new system.

KEY WORD

analysis: a detailed examination of something for a specific purpose, e.g. to see how it works or to improve it

When an organisation, or a client thinks that one of its systems has problems or it needs improvement, a **systems analyst** studies the system to find out where the problems are, and how the system can be improved.

ICT IN CONTEXT

A systems analyst's job is not easy. Here is a list of required skills, taken from a job advert:

- Broad knowledge of hardware, software and programming.
- Teamworking skills.
- A logical approach to problem solving.
- Excellent analytical skills.
- Good interpersonal and client-handling skills, with the ability to manage expectations and explain technical detail.
- A methodical, investigative and inquisitive mind and attention to detail.
- Presentation skills.
- Excellent oral and written communication skills.
- Planning and negotiating skills.
- Initiative and self-confidence.
- A flexible approach to work.

Oh, and they should also have a working knowledge of programming using software such as SQL, Oracle or C##.

Is it the job for you?

Methods of researching an existing system

The information can be collected in a number of ways:

- **Observation:** The systems analyst can learn from watching what is going on in an organisation and how tasks are completed. It could involve sitting with users and watching how they carry out their tasks or sitting separately and watching many

users at the same time. The systems analyst will try to understand how things are done and the relationships between different people's work. The advantage of **observation** is that it gathers real-life details and leads to an in-depth understanding of how systems work. The disadvantage is that people tend not to work in a normal way if they know they are being watched (Figure 7.2) as they may become stressed or work more or less efficiently than normal.



Figure 7.2: Sometimes people work differently if they know they are being observed

- **Interviews:** The systems analyst will want to find out how things work and what doesn't work properly in an organisation. The obvious thing to do is to ask the people who operate the system at the moment. The advantage of using **interviews** is that it allows the systems analyst to talk to the people who are actually using the system rather than just receiving information from their managers. They can find out practical issues with the existing system and ideas of how it could be improved. Questions do not have to be fixed in advance, but it is helpful if the

KEY WORDS

systems analyst: an IT specialist responsible for the life cycle of a new/modified IT system, from analysing the problem to implementing an entire system

observation: closely watching something

interview: a meeting in which someone asks questions to another person

analyst has a logical, enquiring mind and knows how to get information from people. Another advantage is that follow-up questions can be asked about areas that were not identified in advance. A disadvantage is that workers may become stressed and feel that they are being interrogated. They may not give honest answers if they think they will be relayed to their managers. Also, it is a time consuming method if each person is interviewed individually.

- **Questionnaires:** With this method, many people's views can be obtained in a short period of time. They are far less time consuming than conducting individual interviews and can be completed online for convenience and it also allows for the answers to be automatically recorded and analysed by the software. Each person also has the chance to consider their answers before filling in the **questionnaire**, and the analyst and worker do not have to be available at the same time, as they would with an interview. Questionnaires can also be anonymous and so get more truthful answers. The disadvantages are that some of the people may not take it seriously and the questions can be phrased to persuade the person being asked to give a particular answer. The users' answers have to be analysed and so the questions may be simple yes/no or multiple choice ones and these may not fully reflect the views of the people answering them. It is very difficult to analyse free text answers where a person can give their honest opinion.
- **Examination of existing documents: Documents** reveal a lot about an organisation. Most processes and procedures require documents for data input and output. The analyst will be looking for answers to questions such as: How is the data collected? What data is collected? What happens to this data after it has been collected? A disadvantage of document examination is that documentation may be difficult to understand for someone who is outside the organisation, so it may be necessary to interview someone to explain it. Documents also do not always reveal all of the processes and procedures about a system and this method is never used on its own.

KEY WORDS

questionnaire: a set of questions with a choice of answers to carry out a survey

documents: written or printed information such as a web page, presentation, spreadsheet, report or database, among others

Table 7.1 summarises the advantages and disadvantages of the different methods of analysis (see the next page).

Record and analyse information about the current system

As the current system is being investigated and analysed, characteristics of the existing system will be identified, such as:

- The data inputs and outputs of the current system. Where data is input manually or automatically.
- How the data is processed by the system. Can different parts of the processing be carried out at the same time or does it have to be sequential so that one stage must be completed before another can begin?
- Problems with the system. Where are there hold-ups and data jams? Areas where data input leads to lots of errors that have to be corrected.

As well as an analysis of the current system, the user and information requirements for the new system will become more obvious, especially if they are intended to solve the problems with the existing one.

Often the information about the current system can be displayed in a diagram that shows the passage of data through the system and the different files that are used (Figure 7.3). It should identify all of the system's inputs and outputs and how data is processed. It would also show details of the storage of files and how the files are related.

Other diagrams could be used to show the hardware involved in the system.

Method	Advantages	Disadvantages
Observation	Allows the systems analyst to gather first-hand, real-life, unbiased information.	Often people won't be working as they normally do if they know they are being watched.
Interviews	A lot of very detailed information can be gathered from people actually using the system. Follow-up questions can be asked.	Interviews take a long time so they are not possible if large groups of people are involved. People may become stressed in a face-to-face meeting and say what they think the management wants them to say.
Questionnaires	A questionnaire is a quick and simple way to gather information. Less time consuming than interviews. Can be done online and automatically marked and analysed.	Information gathered is limited by the questions asked and people may have ideas that the questionnaire doesn't ask about thus limiting usefulness. People don't always take time to fill in a questionnaire well.
Existing documents	Easy way to find comprehensive information on the system. Finds all of the inputs and outputs of the system.	Documentation is often difficult to understand for someone who is outside the organisation, so it may be necessary to interview someone to explain it. Documents do not always reveal all of the processes and procedures about a system. Only shows the data currently input and output and not what additional data is required to improve the system.

Table 7.1: Advantages and disadvantages of the different methods of analysis

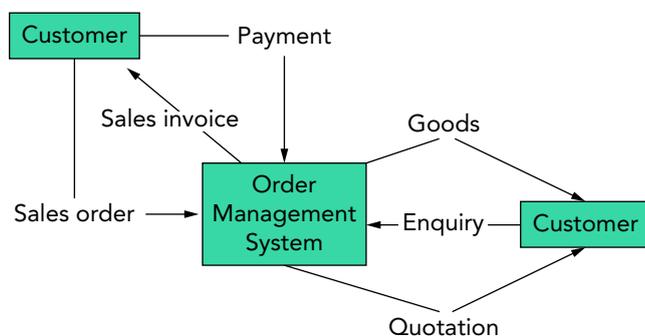


Figure 7.3: A data flow diagram showing data flow in a customer ordering system

System specification

At the end of the analysis stage, various specifications for the new system are written.

The most obvious is a **requirements specification** which identifies such things as:

- The purpose of the system.
- Data that needs to be input and output.
- How the data needs to be processed.
- Performance indicators such as the time it should take for a user to carry out a particular task.

Question

- 1 While investigating an existing system, observation, interviews and questionnaires can be used. Compare and contrast these **three** methods.

KEY WORD

requirements specification: a document listing all of the functions the system is expected to perform and the data flow needed

PRACTICAL TASK 7.1

Getting started

- 1 Here are two scenarios:
 - a A shoe shop wants to install a computerised stock control system. Until now, the owner has done all the ordering of new shoes at the start of each month.
 - b A shop selling musical instruments, servicing and mending them, has used a computerised system for some time for selling items and services and for giving receipts to customers. There are four people who work in the shop. Two concentrate on selling the instruments and the other two service and mend the musical instruments. The stock is ordered by the owner and he is in charge of all the record keeping and paying the wages. The owner now needs a computerised stock control system and a method of ordering so that he doesn't have to spend so much time dealing with the suppliers.

Take part in a class discussion about which would be the best method for the analyst to collect information in each of the two situations given. Also discuss why the methods might differ.

Practice

- 2 Design a questionnaire that could be used by the sales personnel in the music shop (in scenario **b**). You could use database or spreadsheet software to do this. For more information about using databases see Chapter 18 and for using spreadsheets see Chapter 20.

Challenge

- 3 There will be differences in the forms for both the service department and for the owner's stock control system. Plan and create suitable forms for those two departments.

Self-assessment

- Print out your form(s) and pin them to the wall.
- Look at all of the other forms, then compare them with yours looking for ideas for possible improvements to the layouts, the wording, font size and style, any other ideas that you think may be improvements you would consider another time.

In light of the requirements, the **system specification** then identifies and justifies all of the software and hardware required for the new system. For example, it will justify the use of more powerful processors rather than cheaper, less powerful ones. Obviously, the software must be identified first so that the hardware required to run it can be identified. This will include processing power and memory requirements in addition to external hardware devices and networking components.

KEY WORD

system specification: a list of all of the software and hardware required by the new system

7.3 Design

During the **design** stage, the overall structure of the system, with details of the software, are specified without being developed.

Diagrams can be used to show the flow of data through the system.

KEY WORD

design: the process of defining the elements of a system, including software, the different interfaces, the data that goes through that system and the hardware required

The design should be detailed enough to show:

- **file/data structures**
- **input formats** including data capture forms
- **output formats** including onscreen and paper layouts
- **validation rules.**

ACTIVITY 7.1

When analysing and designing new systems, the analyst can take a **top-down** or a **bottom-up** strategy. Carry out research and create a document explaining the differences between these strategies.

File/data structures

A system stores and processes data, and it is vital to design how that will be done.

Data is stored in **data structures** such as files consisting of **records**. The files are stored in memory and on storage devices such as solid-state drives and how the records will be accessed must be designed.

The data stored in the records must be structured so that it can be accessed quickly, and relationships can be found between the different items.

Each record contains information about a particular **entity** – for example, if a system for running a gym is being designed, one of the identified entities would be ‘member’ – and the information needed to be stored about each entity must be clearly identified (e.g. member number, first name, surname, etc.). Once the information needed has been defined, the **fields** in the **table** to store this data would then be designed (see Figure 7.4).

Input formats

Input formats such as on-screen forms can be designed for users to enter and view the data.

The design shows how the fields will be arranged for data input and any sub-forms and command buttons.

KEY WORDS

file/data structures: the way in which the different data items will be stored

input format: how data is to be entered into the system and how it will be interpreted

output format: how the results of processing are to be presented to the users

validation rules: routines to check that the data entered by a user or from a file meets specified requirements

top-down design: an approach that starts with the design of complete system and then breaks it down into designs for the component parts or sub-systems

bottom-up design: the smallest sub-systems are designed first and then combined into progressively larger units

data structure: a way of storing and managing data

record: consists of all the fields about an individual instance of an entity in a database, e.g. all the details about one gym member

entity: a thing that is recognised as being capable of an independent existence, which can be uniquely identified, and about which data can be stored. It is usually a physical object (e.g. a gym member, car, person, book) or it can be a concept (e.g. a customer transaction storing details of the items that were purchased)

field: one item of information about an entity, e.g. Pupil Number, Surname, First Name

table: a collection of rows and columns forming cells that are used to store data in a structured and organised manner in a database

data capture form: a document used for capturing information

The operator may enter the details directly into the on-screen form as the member tells them, and so this is the **data capture form**.

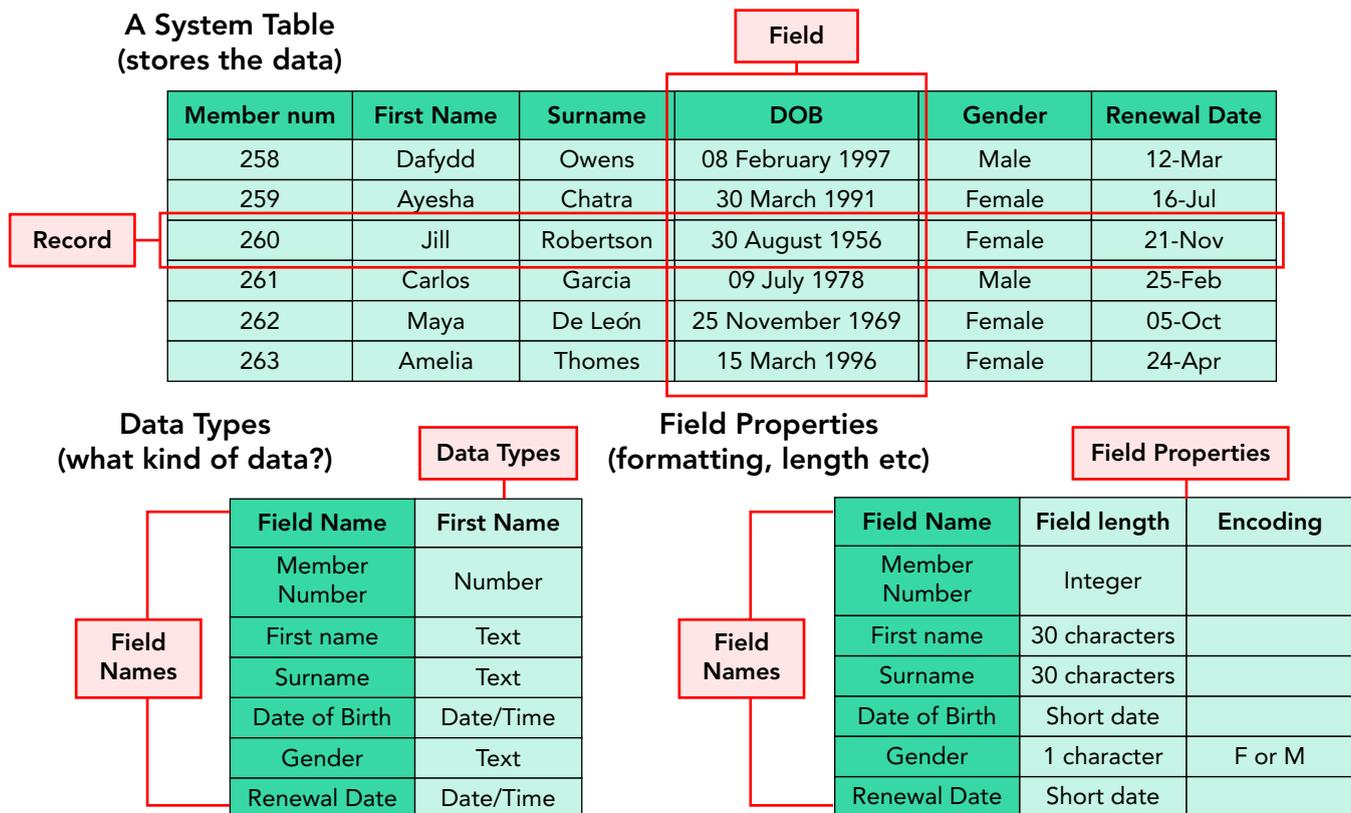


Figure 7.4: Example of file structure. The field names, data types, field lengths and the coding of any data such as using 'F' for female and 'M' for male have been given

In other situations, the data capture form may be a paper form that the members have to fill in, adding their names and details. The operator will then have to read these details from the data capture form and enter them into the on-screen form. This process is called **transcription** and is the source of most data errors.

KEY WORDS

transcription: the transfer of data from one medium to another, e.g. from written data on a form to digital data in a database

database queries: searches made on the data held in a database to find ones with a particular specification, e.g. to find all of the female members of a gym

Output formats

The design (Figure 7.5) and appearance (Figure 7.6) of output reports should be provided. These designs should also include any **database queries** that will be required to select the information for them.

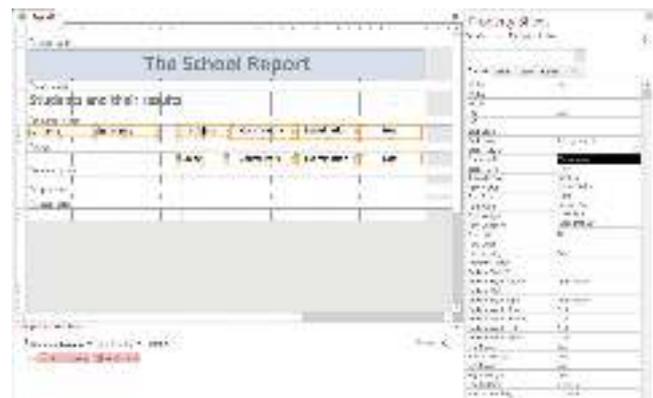


Figure 7.5: The design of the report

The School Report

Students and their results:

Yearly	Name	Subject	Coursework	Examination	Total
		History	88	80	134
		Geography	68	74	142
		Technology	78	78	151
Yearly	Name	Subject	Coursework	Examination	Total
		Swimming	52	58	110
		Art	62	65	121
		Language	58	71	129
Yearly	Name	Subject	Coursework	Examination	Total
		Language	68	62	132
		Maths	64	75	144
		Geography	55	73	132
Yearly	Name	Subject	Coursework	Examination	Total
		Maths	52	57	110
		Swimming	52	58	110
		Language	58	63	123
Yearly	Name	Subject	Coursework	Examination	Total
		Geography	73	77	143
		Technology	78	78	151

Figure 7.6: How the form will appear when printed

They should include data formats such as whether numbers are formatted as currency or how many decimal places should be shown.

Validation routines

It is important to ensure that data entered by the user is **valid**, as invalid data can cause a system to behave unexpectedly or even stop altogether. If the data entered into a system is incorrect, the output it produces will also be wrong. This is sometimes called the Garbage In, Garbage Out (GIGO) principle.

Validation routines check that the data entered by a user or from a file meets specified requirements. The routines should include error messages to help the users when they enter invalid data.

Validation can't guarantee that the data entered is correct. It can only make sure that it is reasonable. For example, if a user enters '9' into a field for the school year of a pupil, it would pass a validation check because it is a number in the correct range, but the pupil may, in fact, be in year 10

and not year 9. The validation check would not find this error.

Range check

A **range check** is used when the data must be between an upper and lower point. For example, in a school system, the range could be between 7 and 13 for a secondary school (see Table 7.2).

This should be designed into the input system.

Character check

A **character check** is used when only certain characters must be input. For example, it could be used on a gender field to ensure that only an 'F' or an 'M' is entered (see Table 7.3).

KEY WORDS

valid: data that has passed a validation test

validation routines: routines to check that the data entered by a user or from a file meets specified requirements

range check: a validation rule to ensure the data is between a minimum and maximum value

character check: a validation rule to ensure that only certain characters are entered

Field Name	School Year	Explanation
Data Type	Number	
Validation Rule	≥ 7 AND ≤ 13	The rule states that the entry must be greater than or equal to 7 and less than or equal to 13.
Error Message	The entered year must be between 7 and 13.	

Table 7.2: A range check for the School Year field

Field Name	Sex	Explanation
Data Type	Text	
Validation Rule	Like 'F' OR 'M'	The rule states that the entry must only be an F or an M character. No other character.
Error Message	You should enter an 'F' or an 'M'.	

Table 7.3: A character check on the Sex field

Length check

A **length check** is used to check the length of the entry. The characters entered could be letter, numbers or symbols.

A length check is used where a fixed length, or a maximum or minimum length is required.

For example, a length check is often used when people are creating passwords, often to ensure that they are at least eight characters in length (see Table 7.4).

Field Name	Password	Explanation
Data Type	Text	
Validation Rule	LEN('Password') >= 8	The rule states that the entry must be greater than or equal to 8 characters long. NB: LEN is short for 'length'.
Error Message	There should be a minimum of 8 characters.	

Table 7.4: A length check on the Password field

Type check

A **type check** is a simpler validation rule and will automatically be applied to database programs as the data type must be given when a table is being designed.

If the field type is number (or numeric), then text would not be accepted. An error message would

inform the user and ask if they wanted to change the data type.

If the user enters a number in a text field then that would be accepted but it would be treated as text and would not be able to be used in a calculation.

Format check

The **format check** will ensure that the data is entered in a particular sequence or pattern. An **input mask** can be applied to fields to show the pattern required.

For example, the required format for entering a data could be set to:

__ / __ / __. The user would have to enter two numbers, a forward slash, two numbers, a forward slash and another two numbers to represent the date, e.g. 13/09/22.

Dates entered in other ways will be rejected.

Presence check

This is the most basic and obvious check. A **presence check** ensures that some data has been entered into a particular field.

When a field is being designed, you can specify that it is a 'required' field and must have some data entered. If a user leaves it blank, they will be shown an error message and not allowed to continue until data has been entered.

KEY WORDS

length check: a validation rule to ensure the number of characters entered are a certain number, greater than a minimum number or less than a maximum number

type check: a validation rule to ensure that the correct data type has been entered

format check: a validation rule to ensure the characters entered are in a particular order or pattern

input mask: a string of characters that indicates the format of valid input values

presence check: a validation rule to ensure that data is entered and that the field is not empty

Check digit

When data is being read, entered and transmitted errors may occur, especially with long lists of numbers.

To tell if an error has been made, an extra value that is calculated from the entries is sometimes added. This is known as a **check digit**.

One example is the ‘modulus 11’ check digit. This does a calculation on the numbers (including the check digit) and the total it finds must be divisible by 11.

KEY WORD

check digit: an extra value that is calculated from the entry made and is sometimes added to it

To create the check digit for a bank account, the system shown in Table 7.5 is used.

Whenever the account number is automatically read or entered by a human, this calculation is performed to and if the result is not divisible by 11, then it is rejected.

ACTIVITY 7.2

Carry out research and find different methods of validation using check digits.

1	The system creates the first seven digits.	1468970. The last digit – the check digit – hasn’t been created yet.																											
2	Starting from the right, each number is given a weighting from 2 upwards (e.g. 2, 3, 4, 5, 6, 7, 8 in this example).	<table border="1"> <tbody> <tr> <td>Number</td> <td>1</td> <td>4</td> <td>6</td> <td>8</td> <td>9</td> <td>7</td> <td>0</td> </tr> <tr> <td>Weighting</td> <td>8</td> <td>7</td> <td>6</td> <td>5</td> <td>4</td> <td>3</td> <td>2</td> </tr> </tbody> </table> <p>There is no 1 weighting as the check digit still hasn’t been created yet.</p>	Number	1	4	6	8	9	7	0	Weighting	8	7	6	5	4	3	2											
Number	1	4	6	8	9	7	0																						
Weighting	8	7	6	5	4	3	2																						
3	Each digit is now multiplied by its weighting...	<table border="1"> <tbody> <tr> <td>Number</td> <td>1</td> <td>4</td> <td>6</td> <td>8</td> <td>9</td> <td>7</td> <td>0</td> </tr> <tr> <td>Weighting</td> <td>8</td> <td>7</td> <td>6</td> <td>5</td> <td>4</td> <td>3</td> <td>2</td> </tr> <tr> <td>Multiplication</td> <td>8</td> <td>28</td> <td>36</td> <td>40</td> <td>36</td> <td>21</td> <td>0</td> </tr> </tbody> </table>	Number	1	4	6	8	9	7	0	Weighting	8	7	6	5	4	3	2	Multiplication	8	28	36	40	36	21	0			
Number	1	4	6	8	9	7	0																						
Weighting	8	7	6	5	4	3	2																						
Multiplication	8	28	36	40	36	21	0																						
4	...and the total is found.	$8 + 28 + 36 + 40 + 36 + 21 + 0 = 169$																											
5	This number is divided by 11.	$169 \div 11 = 15$ remainder 4																											
6	The remainder is subtracted from 11.	$11 - 4 = 7$																											
7	The result becomes the check digit.	Account number = 1468970 <u>7</u> If the remainder is 10 then an X is used as the check digit and a 0 is used if there is no remainder.																											
8	We can do a quick check by weighting and multiplying as before...	<table border="1"> <tbody> <tr> <td>Number</td> <td>1</td> <td>4</td> <td>6</td> <td>8</td> <td>9</td> <td>7</td> <td>0</td> <td>7</td> </tr> <tr> <td>Weighting</td> <td>8</td> <td>7</td> <td>6</td> <td>5</td> <td>4</td> <td>3</td> <td>2</td> <td>1</td> </tr> <tr> <td>Multiplication</td> <td>8</td> <td>28</td> <td>36</td> <td>40</td> <td>36</td> <td>21</td> <td>0</td> <td>7</td> </tr> </tbody> </table>	Number	1	4	6	8	9	7	0	7	Weighting	8	7	6	5	4	3	2	1	Multiplication	8	28	36	40	36	21	0	7
Number	1	4	6	8	9	7	0	7																					
Weighting	8	7	6	5	4	3	2	1																					
Multiplication	8	28	36	40	36	21	0	7																					
9	And dividing the total by 11 to check that there is no remainder.	$8 + 28 + 36 + 40 + 36 + 21 + 0 + 7 = 176$ $176 \div 11 = 16$																											
10	Therefore, the number is accepted as an account number.																												

Table 7.5: Calculating check digits

PRACTICAL TASK 7.2

Getting started

- 1 Look back at Practical task 7.1 and then work with another student.
- 2 For scenario **a**, the shoe shop, discuss:
 - What will the inputs to the system and outputs from the system need to be?
 - What validation routines will be necessary for the data that is going to be input?

Practice

- 3 Using database software:
 - Create an example table for your inputs.
 - Enter the necessary validation rules decided upon in the discussion in Getting started.
 - Enter six rows of sample data, then save your database table.

For information about using databases, see Chapter 18.

Challenge

- 4 Design a report for one of the necessary outputs discussed in Getting started.

7.4 Testing

Before a system is released to the users, it should be thoroughly tested to ensure that it functions as expected.

Testing is necessary because no team of programmers and developers are perfect, and errors are to be expected.

Test strategy

A **test strategy** is a set of guidelines explaining how the testing will be carried out. It describes the approach that the team will take during the testing that can be done during the development of the software as well as when it is completed. Test strategies include testing each module, each function and the whole system.

The solution produced will consist of separate sections such as the different tables in a database file or a discrete block of code in a program called **modules**.

As these are developed, they can be tested individually before waiting until they are all complete and any problems should be easier to fix.

Within these modules there will be individual **functions** that carry out one specific function and these too can be tested as they are written.

Final testing (or terminal testing) is carried out on the whole system once the software has been completely developed. It will ensure that all of the functions and modules work correctly together and that data flows between them without errors.

KEY WORDS

testing: checking, using sample data, that all parts of the system function as expected

test strategy: a set of guidelines explaining how the testing will be carried out

modules: part of a computer program that carries out a particular function of the program

functions: a self-contained section of code, within a module, which is called by the main program to perform a particular task

final testing (or terminal testing): tests carried out on the whole system once it has been completely developed

Test plan and test design

A **test plan** is a document that lists and describes all of the tests that will be carried out to thoroughly test the new system. It should contain tests for:

- data and file structures such as tables and fields
- input formats – so that data input forms access data in the correct tables
- output formats – so that reports submit the expected data
- validation routines.

The **test design** for each test should show details such as:

- what is being tested
- the test data that will be used
- the expected outcomes
- the actual outcomes
- space so that any **remedial actions** taken to correct errors can be described.

Normal data	Data that could be expected to be input and used in the normal working conditions of the program.
Extreme data (or boundary data)	This is data at the upper and lower limits of what should be acceptable to the system.
Abnormal data	Data that falls outside of what is acceptable. The software deals with incorrect inputs that may be entered deliberately or by mistake. It tests whether the program has suitable routines to deal with erroneous data that could cause the program to fail. For example, it could check and inform the user that inputs are outside the requested range or numbers have been entered instead of text.

Table 7.6: Some different types of test data

Test data

Test data is the data that is going to be used in each specific test. So that the system can be thoroughly tested, the types shown in Table 7.6 should be used.

KEY WORDS

test plan: a detailed and structured plan of how testing should be carried out

test design: a detailed description of a particular task listing test data, expected results and actual results

remedial action: steps taken to correct an error

test data: data that will be used for testing a system

normal data: data that would normally be expected to be entered

extreme data: (also called boundary data) values at the minimum and maximum range of what should be accepted by the system

abnormal data: data that should not normally be accepted by the system being tested because the values are invalid and should therefore be rejected

Example of a test plan

Table 7.8 is part of a test plan testing the input of data into a database table with the fields shown in Table 7.7.

Field	Data type	Validation rule
Student Number	Number	
First name	Text	
Surname	Text	
Gender	Text	Like 'M' or 'F'
School Year	Number	>=7 AND <=13

Table 7.7: Database table

Test Number	Test data	Expected result	Actual result	Remedial action	Notes
1	Enter 'Any number' into Student Number field.	Error message saying incorrect data.	Error message saying incorrect data.	None required.	Abnormal data.
2	Enter 1369 into Student Number field.	Should be accepted.	Was accepted.	None required.	Normal data.
3	Enter 'P' into Gender field.	Entry was accepted.	Error message saying only 'F' and 'M' are acceptable.	The validation rule for the gender field was checked and corrected.	Abnormal data.
4	Enter 7 into School Year field.	Should be accepted.	Was accepted.	None required.	Extreme data.
5	Enter 13 into School Year field.	Should be accepted.	Was accepted.	None required.	Extreme data.

Table 7.8: Test plan for the database table shown in Table 7.7

Live data

Finally, testing should be carried out using **live data**. This is actual, real-life data that has been used while the old system was running, instead of test data.

It may be done while the system is actually 'live' (a **live system**) and is being used with actual users.

KEY WORDS

live data: actual, real-life data that has been used while the old system was running

live system: a system that is being used in real life, not being tested

Questions

- 2 Define the term 'validation'.
- 3 There are different ways to ensure that the data entered into a field is valid. Describe the following types of validation routine:
 - a type check
 - b format check.
- 4 Describe the purpose of using extreme test data.

ACTIVITY 7.3

Suggest normal, extreme and abnormal data to test the validation rules for data entered into the following fields:

- a Mark out of ten for a piece of homework.
- b Exam results given in percent.

7.5 System implementation

When the system has been produced and thoroughly tested, it then has to be **implemented** into the client organisation.

If a completely new system has to be designed, doing something that was not done before, then there is no choice; the system has to be put in place and switched on.

KEY WORD

implementation: the act of starting to use a new system

However, most systems are designed to take over from an older system, so a changeover plan between the new and the old is necessary to manage the change from one system to the other. The following steps should be considered as part of this process:

- **Hardware:** The first thing to be done is to buy and install any new hardware that will be necessary for the new system. It is possible that all the old hardware will be good enough, but this is unlikely. The business may need to shut down, although it could be possible to install the new hardware while the business is normally shut (overnight or at the weekend).
- **Data files:** After the hardware has been installed, the files of data have to be loaded onto the new system from a storage device. It may be necessary to employ data entry staff temporarily in order to ensure that the data is entered properly. Note that it is important that these data files are as accurate as possible when the new system starts to work. Decisions will have to be made about how the data entry should be checked for accuracy.
- **Training:** The staff who are going to be using the new system will need to be trained in how to use it. If they are familiar with a computerised system already, then the training may not need to be very long or detailed. However, if they are not used to a computerised system, the training has to be planned. Staff could be trained by having training days where a tutor is brought in to the firm. This has big advantages: there is someone who can answer specific questions that the staff may have and the management can be sure that everyone has actually done the training. A disadvantage is that the staff are not working while the training sessions are held. Another method is to put all the lessons on the company intranet and ask each member of staff to do the training when it suits them. Advantages of this are: the firm can run normally while the staff are learning; staff can learn at their own speed; staff can skip sections they already know or can redo sections that they find difficult. A disadvantage is that the staff may have to use their own time to do the training and management could have to remind other staff to do it.

Direct changeover

Direct changeover is when the old system is shut down and the new system is started up. The old system is no longer available, so if something goes wrong it is

not possible or very difficult to go back to the old system. Although this sounds like a simple method of implementation, it requires careful planning. All the files must be loaded up and ready to use; all the workers must have been properly trained and the system must have been fully tested.

An advantage of a direct changeover is that it is simple and cheap to do, but a disadvantage is that if it is not properly planned and tested, the organisation might have to shut down until all issues have been resolved.

Phased implementation

Phased implementation is a method usually used by large organisations when adopting a new system and is also referred to as 'phased adoption' or 'phased rollout'.

It can mean either implementing different parts or units of the new system gradually until it has all been replaced, or implementing it totally in different parts or sections of the organisation so that some workers will be using the old system and some the new one until eventually everyone is using it.

Advantages of a phased rollout:

- The organisation does not have to deal with all the implementation problems, for example, training and bugs in the new system, at the same time.
- Lessons learnt from early implementation make it easier to implement later stages.
- It also allows users to adjust to the new system gradually.

Disadvantages are of a phased rollout:

- It can be confusing for the users to use some parts of the old system and some of the new.
- Data produced by the old system might not be compatible with that from the new.

KEY WORDS

direct changeover: implementation where the old system is shut down and the new system is started up

phased implementation: implementation where one part of the system is changed but the rest of the system continues to use the old methods

Pilot running

Pilot running means that the new system is trialled in just one part of the organisation and, when successful, it is rolled out to other areas. This means that the full system can be trialled in just one area and problems identified. It also means that the users involved in the pilot can train other users. It can, however, be expensive as two systems have to be running at the same time and the two systems have to be kept synchronised.

Parallel running

Parallel running means running the old system alongside the new system until it has proved to be effective and all the users are confident and have been trained in using it.

Advantages of parallel running:

- If anything goes wrong with the new system, the old system can still be used.
- The outputs from the old and new systems can be compared to check that the new system is running correctly.

Disadvantage of parallel running:

- It can be expensive as two systems have to be running at the same time and the two systems have to be kept synchronised.

KEY WORDS

pilot running: the new system is trialled in just one part of the organisation

parallel running: implementation that involves both the old and new systems running at the same time

Table 7.9 summarises the advantages and disadvantages of the various implementation methods.

Questions

- 5 Name the stage of the system life cycle that applies to each action (analysis, design, testing or implementation). The first one has been done for you.
 - a Parallel running – *Implementation*.
 - b Document collection.
- 6 If the data required to be input to a numerical field must be a minimum of 10 and a maximum of 35, give an example of data that is 'Normal', 'Abnormal' and 'Extreme'.
- 7 List the actions that are carried out during the design stage of the systems life cycle.

ICT IN CONTEXT

Serious problems can occur when the analysts get it wrong. In April 2018, the TSB bank (Figure 7.7) shut down its online and internet banking for one weekend to upgrade the system.

Unfortunately, when the new system was switched on many people couldn't log in and were shown inaccurate information about their deposits and withdrawals or were shown details of other peoples' accounts. Customers were locked out of their accounts for over two weeks. In July, TSB were still working on some accounts when it happened again, locking users out of their accounts once again.



Figure 7.7: TSB experienced problems after an IT upgrade

- c Programmers write the software.
- d Decide what outputs will look like.
- e Interviews.
- f Install new hardware.
- g Decide what inputs will look like.
- h Users are asked how well the new system works.
- i Validation routines are decided on.

Implementation method	Advantages	Disadvantages
Direct changeover: the old system is stopped and the new system started.	Very quick to changeover. Little time or effort.	If the new system fails, normal work will not be possible and the old system will have to be restarted.
Phased implementation: the new system will be introduced in gradual stages, slowly replacing the old system until it takes over.	Allows users to become familiar with new system in stages. Staff training can be done at each different stage.	It may be difficult to ensure that data flows correctly between the old and the new parts of the system.
Pilot running: the new system is trialled or piloted in one department of the organisation. Once the pilot system is running successfully, the new system will be implemented throughout the organisation.	Every feature in the new system can be fully trialled so if there is a problem with the new system, only one department of the organisation is affected. Staff from the trial can train other staff.	Expensive as two systems have to be running at the same time and the two systems have to be kept synchronised.
Parallel running: the new system is started and the old system runs side-by-side until there is confidence in the new one.	If there is a problem with the new system, the old system will carry on running as a backup. Outputs from both systems can be compared to ensure the new system is running correctly.	Expensive as two systems have to be running at the same time and the two systems have to be kept synchronised.

Table 7.9: Advantages and disadvantages of different implementation methods

7.6 Documentation

To use and maintain an information system, the organisation will need technical documentation to cover how every part of the system works and how to use it.

Documentation should be produced while the system is being developed. This is especially important for the technical documentation because there will almost certainly be more than one person producing the solution and each person involved needs to know what everyone else is doing.

Technical documentation

The **technical documentation** is the information about the system that a technician or future developer needs in order to understand how the system works. It is required when updating or fixing problems with the system. It will include:

- **Purpose of the system:** this is the description of the problem that the system solves.

- **Limitations of the system:** what the system will not do. It could include items from the requirements specification that have not been implemented.
- **How to install/run the system:** **system managers** will need to know how the system should be installed and run if it fails and has to be restarted.
- **Program flowcharts/algorithms:** these show the logical structure of the software and how they function.

KEY WORDS

documentation: official information about a system

technical documentation: documentation that includes details about the structure of the system and details of software and hardware needed by programmers and technicians

system manager: the person who oversees the system and is responsible for ensuring that it works correctly

- **Program language and listing:** these show the **programming languages** used – e.g. Python, C# – and give all of the **program code**. The code should have comments to explain what each function is intended to do.
- **System flowcharts:** **system flowcharts** show how data flows through the system and how decisions are made or functions are repeated until a condition is met.
- **List of variables used:** this will include the names of all the **variables** – e.g. StudentNumber, StudentName – the reason they are being used and the data type. There are two reasons for this list: to help the technician follow the program if some maintenance needs to be done, and to ensure that variables are not duplicated.
- **Input format/output formats:** these describe the types of data that will be accepted by the variables and fields, e.g. numeric, text. Output formats specify how data will be output, e.g. should a number be displayed as currency and the symbol to be used in a ‘price of item’ field.
- **Sample/test runs:** there will be details of test and sample runs that have been made with the system and the results obtained.
- **Validation routines:** reasons for using validation were given earlier in this chapter, as were the different validation routines that can be used. Details of the different validation routines that are used to check the input data are given in this section of the technical documentation.

KEY WORDS

programming languages: sets of commands, instructions and the rules of how to use them, that are used to create software

program code: the statements and commands written in a particular programming language

system flowcharts: diagrams using symbols to display how data flows in a computer system

variable: a section of computer memory used to store data about a particular element in a program. When writing a program, variables are given names, e.g. StudentNumber, FirstName. While a program is running the data stored in a variable can change

- **File structures:** these define the data types of all the fields in the files used by the system. They also shows the links between the files. If the system uses databases, then the database management system will have a view that shows the relationship between the tables. This information is needed in case the file structures need to be modified in the future.
- **Hardware and software requirements:** the hardware needed to run the system is listed, including estimated file sizes so that storage choices can be justified. There may be diagrams to show how the servers, peripherals, storage devices, network and user terminals are interconnected. Minimum system requirements for running the software will also be included.
- **User documentation**
 - The purpose of the system.
 - Limitations of the system.
 - Hardware and software requirements.
 - How to install/run the system.
 - Error handling – what to do if a particular error occurs and an error message is or isn’t given. Lists of error messages and the relevant remedial action are often given.
 - Troubleshooting guide/helpline. There should be some assistance given for minor problems that can happen with the system, otherwise every time things go wrong it will be necessary to call a technician. The trouble-shooting guide tells the user how to identify that certain things have gone wrong and what can be done about them. A helpline may also be provided that users can call. This could be by telephone or using text messages over a network.
 - How to save a file.
 - How to print data.
 - How to add records, and edit and delete them.
 - Input and output formats.

- Sample/test runs.
- Frequently asked questions (FAQs) – these list solutions to common user queries.
- Glossary of terms. A list of technical terms and their meanings.

The purpose of the system will be in terms that the user can understand and will simply state what they can use the system for. Similarly, the limitations and the hardware and software requirements will be explained in terms a layman can understand and not give all of the hardware specifications that are required by a technician. This section is about what to use the system for and how to use it. The glossary of terms is necessary for users who are not familiar with all the technical terms that the documentation may include.

ACTIVITY 7.4

Create some user documentation for a student using word processing software. It should include how to open the software, create a new document and how to save a document. You can add screen prints if they help.

Questions

- 8 Name **two** implementation methods.
- 9 Describe how each of these methods is used.
- 10 Technical and user documentation each hold different information. Make **two** lists (one titled *Technical documentation* and one titled *User documentation*) to show which type of documentation would contain the following items:
 - hardware and software requirements
 - glossary of terms
 - purpose of the system
 - system flow charts
 - details of different validation routines
 - FAQs.

7.7 Evaluation

At some point after the new information system has been operating as a normal business application, it is time to review the project.

Evaluation against the original task requirements

Before the solution was produced, the systems analyst and the client organisation will have agreed a set of functions that the finished solution should do. These were listed in the requirements specification and the required software and hardware were identified in the system specification.

If the system does not satisfy these requirements, the problem may not have been solved. The solution will be considered a success if all the requirements are met and may even be considered a success if most of the requirements are met.

Limitations and improvements

As a result of the evaluation, a list of required changes will probably be built up.

Some of the changes are needed to address the **limitations** as necessary improvements to the system – a gap between the requirements specification and what has been delivered. These should be rectified in the next version of the software.

KEY WORD

limitations: restrictions that prevent something working correctly

Other changes will address improvements identified when the users were testing the system. It may include things that the developers did not think of, but which make using the system far easier such as the sequence of the fields where data has to be entered. They may not be in the order that the users would prefer. When the users' responses are analysed, these should become apparent and appropriate changes can be made.

Efficiency

The system should be evaluated on its **efficiency** – the amount of work that the users have to do to carry out their tasks successfully.

It should be the aim of new systems to improve efficiency, save time and so save money for a company. The new system would be considered a failure if more workers were required or it took them longer to complete their tasks.

Ease of use

A system should be intuitive so that data has to be entered where the users expect it to be or that clicking on a menu item will print out the expected document.

Ease of use will affect the efficiency of the system.

Appropriateness of the solution

The **appropriateness** of the solution means whether it is suitable and appropriate for solving the problem. Does it do enough to meet the specification or does it do too much?

It could also assess whether all of the views and beliefs of the organisation are met. Does it preserve all data protection rules or could users data be vulnerable to hackers?

KEY WORDS

efficiency: the amount of work that has to be done to carry out a particular task

ease of use: how easy it is to use something to perform a task

appropriateness: how suitable or fitting something is

REFLECTION

What most helped you to understand the different methods used to analyse an existing system and test a new one?

SUMMARY

Before a new system can be designed, the current system needs to be analysed.

Observation, interviews, questionnaires and the examination of documents are used to analyse existing systems.

Input designs uses validation routines to check that the input is acceptable.

Output formats describe how screen and printed reports will appear.

File and data structures must identify the items of data that will be input, processed and stored.

Test strategies specify how and when testing will take place.

Test plans list all of the tests that will be carried out.

Test designs list test data, expected and actual results for each test.

Implementation is the changeover from the old to the new system; there are different methods of implementation such as: direct changeover, phased implementation, pilot running, parallel running.

Documentation consists of technical and user guides.

Evaluation discusses how successful the new system meets the identified requirements.

EXAM-STYLE QUESTIONS

- 1 Give the stages of the system life cycle in the order they should be carried out. [3]
- 2 The analysis stage investigates the current system.
 - a Give *three* activities that need to be investigated. [3]
 - b Observation is one of the ways to find out about the current system. Give *one* advantage and *one* disadvantage of the observation method. [2]
 - c Other than observation, give two other methods of finding out about the current system. [2]
- 3 There are many different items that will need to be designed during the design stage.
 - a Define validation. [1]
 - b Describe *two* methods of verification. [4]
 - c Copy and complete the table to show *four* items that will need to be designed and give *one* example of each.

What is being designed?	Example

- 4 An organisation is introducing a new computer system. Compare and contrast pilot implementation with phased implementation of the new system. [6]
- 5 Explain the difference between technical documentation and a user manual. You should give examples of what is contained in each. [8]
- 6 Describe *three* properties of a new system that would be considered when evaluating the system. [6]

[Total: 39]

COMMAND WORDS

give: produce an answer from a given source or recall / memory

define: give precise meaning

describe: state the points of a topic / give characteristics and main features

compare: identify / comment on similarities and / or differences

contrast: identify / comment on differences

explain: set out purposes or reasons / make the relationships between things evident / provide why and / or how and support with relevant evidence

SELF-EVALUATION CHECKLIST

After studying this chapter, think about how confident you are with the different topics.

This will help you to see any gaps in your knowledge and help you to learn more effectively.

You might find it helpful to rate how confident you are for each of these statements when you are revising. You should revisit any sections that you rated 'Needs more work' or 'Getting there'.

I can ...	See section	Needs more work	Getting there	Confident to move on
state the stages of the systems life cycle	7.1			
explain how a current system is analysed and recorded	7.2			
create a system specification	7.2			
create designs for a new system	7.3			
create test designs and strategies for the new system	7.4			
explain how new systems can be implemented	7.5			
describe what needs to be included in technical documentation and in user documentation	7.6			
explain how new systems should be evaluated	7.7			

> Chapter 8

Safety and security



IN THIS CHAPTER YOU WILL:

- describe common physical safety issues, what causes them and the strategies that can be used to prevent them
- evaluate how you use IT equipment and develop ways to minimise any safety risks that you find during your evaluation
- discuss the principles of a typical data protection act
- explain what is meant by personal data, why it should be kept confidential and protected and how to avoid inappropriate disclosure of personal data
- discuss eSafety strategies to minimise danger when using the internet, sending emails, using social media and playing online games
- discuss the threats to data and understand what measures should be taken to protect your data.

CONTINUED

Discussion questions

Despite the problems, we all use the internet and the world wide web. Do the benefits outweigh the problems? How would your day-to-day life be different without them?

- 1 How would it affect how you learn at school, do your homework and submit it to the teacher?
- 2 How would it affect your relationships with your friends and how you use your leisure time?

8.1 Physical safety issues

The use of computers comes with a number of physical safety concerns. There are hazards to the physical safety of users such as the cabling, the siting of a new printer, electrical overload or having a drink next to a computer. Most of these safety concerns are temporary and can be easily avoided.

Computers and their peripherals are electrical devices that need to be connected to each other, and this will involve some cables and an electricity supply. Add to that the possibility that several computers may be connected by cables in order to create a network, and suddenly there are a lot of wires around. Simple precautions can be taken to overcome the safety problems that this can cause.

Trailing cables

You will probably have noticed that there are usually a lot of cables attached to computers, such as power cables, network cables and ones connecting mice, keyboards and printers. When these cables need to go across the floor, there is a risk that people might trip over them.

What could happen if someone trips on a cable? There might be injury such as a broken bone or an electric shock to the person if they grab a live wire or cable. If the plug has been pulled out during the trip, there could be damage to the lead or plug, and the equipment attached to the cable may be damaged if it was pulled off a desk.

Ideally, the installation of the computers will have been well planned and the cables will all be hidden and out of the way (see Figure 8.2). In many cases this does not happen, so because of these potential risks of tripping, or of electric shocks or fires if the cable or plug is damaged, it is good safety practice to make sure that

when cables need to cross a floor, they are all inside cable ducts, or under the carpet or flooring.

ACTIVITY 8.1

Look around your computer room to check if there are any trailing cables, or cables looped under desks where your feet may catch in them. Also look for cables that may be crossing the floor but are not protected.

Draw a map of the room and mark the place if you find any and alert your teacher.

Spilling drinks

Most of the time computers and devices need to be plugged in to an electrical power source. This is why care has to be taken to avoid any risk of electrocution. If a drink spills into your computer or device you could risk it being damaged and you may be in danger of injury! You will probably have been told not to have drinks near to your computer so that you will avoid accidental damage to the device or injury to yourself (see Figure 8.3).

Liquids and electricity do not mix. A spillage could cause permanent damage to your devices and, more importantly, to yourself. As water conducts electricity, you can easily be electrocuted by spilled drinks.



Figure 8.2: Trailing cables can be tidied up to prevent them becoming a hazard

If a drink is spilled into your keyboard:

Don't panic.

- Unplug your computer immediately. (Do not wait to shut down your computer using the software.) If you unplug it quickly, you may prevent the electronics inside the computer from being damaged.
- Using a soft cloth, dry up as much of the liquid as you can.
- Pull out any other cables connected to your computer, such as USB components, cards and any other external devices.
- Hold the laptop or keyboard upside down and very gently move it from side to side to drain it. Don't shake it. A lot of the liquid should drain out.
- Leave it upside down on the desk so that the rest of the liquid can drain out.
- Wait about 24 hours then use a soft, damp cloth to clean the outside.

The best advice is the most boring: don't drink while you work at a computer or near to any devices!



Figure 8.3: Don't risk spilling a drink on your PC!

What is electrical overload?

When an extension lead has several sockets for you to plug more than one appliance into, you may find that once you have everything plugged in, together their individual currents will add up to more than the maximum current rating stated for the extension lead. This is **electrical overload**, which could cause the plug in the wall socket to overheat and cause a fire. Similarly, if electrical equipment overheats it can cause fires.

KEY WORD

electrical overload: electrical circuit overloads are when too many electrical items are plugged into one socket causing more current to be put across an electrical wire or circuit than it can handle

The danger signs are if the plugs or sockets become hot, or fuses blow unexpectedly; there may be flickering lights or burn marks on sockets or plugs.

If this happens, you should check that there isn't any loose wiring, that only one extension lead per wall socket is being used and that there isn't one extension lead plugged into another.

To avoid electrical overload and equipment overheating, you can calculate the amps being used by dividing the amount of wattage by the voltage. For example, if you have an electrical item that is rated at 1000 watts and it runs on 120 volts, when you divide it you will see that almost half of a 20 amp circuit is already being used. You can usually find the information on the bottom of the device or on a sticky label attached to its cable.

$$\frac{1000 \text{ watts}}{120 \text{ volts}} = 8.33 \text{ amps}$$

Remember that when more than one device is plugged into an extension socket, you will need to add the amps that you have calculated together (see Figure 8.4).

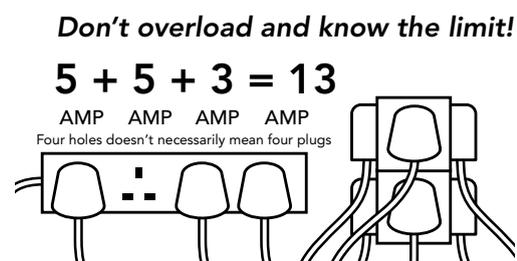


Figure 8.4: Think about overload

Other risks associated with computer equipment

Because computer equipment is often heavy, there is a risk of injury if you move it, or if an item of hardware falls on someone. If you get a new printer, and it

PRACTICAL TASK 8.1

Getting started

- 1 Discuss with two students sitting near to you what steps you can take to prevent physical danger to yourself and others when using a computer, whether at home or at school.

Practice

- 2 Collaborate with others in your group to plan what guidelines need to be followed in order to keep safe when using a computer.
- 3 Plan together what guidelines should be included in a notice for the school computer rooms.
- 4 Work individually using a word processor to produce a one-page notice to pin on the computer wall, listing the guidelines. You should format your notice to look interesting so that people will read it. You may want to use a page border, consider the size of the font so it can be easily read when it is on the wall and use an eye-catching heading.
- 5 Save and print your work.

Challenge

- 6 Using suitable software, create a multiple choice quiz on hazards in computer rooms. There should be at least five questions.

Peer assessment

Within the group discuss everyone's notice and make suggestions and decide which parts of each notice work well and why they work well.

needs to be connected to a computer as well as to the electricity power point, you will need to decide where to put it. Even if your new printer is Wi-Fi enabled, it will still need to plug into the electricity power point. Whichever type of printer you have, you will probably put it on a shelf near the computer, but before you put it there, ask yourself two questions:

- Is the shelf designed to carry that much weight?
- Will the printer fit properly on the shelf without it being dangerously balanced?

Devices must be placed in suitable positions. Make sure equipment is placed on tables or shelves that are strong enough for them; the position must be able to support the weight of the device and a check should be made to see if it will be large enough to support the device under each of its corners. Also, devices need to be placed where users can get at them easily. If it is a printer, you will need to add more paper regularly and to change the ink when necessary.

Question

- 1
 - a What is meant by electrical overload?
 - b Give the signs to look for if you think there may be an electrical overload on a socket.

8.2 eSafety

Data protection

The huge demand for personal information to be securely gathered, processed and stored electronically has resulted in the need for **international data protection legislation**. There are many laws globally to control how

KEY WORD

international data protection legislation: laws to govern the collection and storage of personal data

personal information is handled and the rights of the **data subjects** – the people whose data is being stored. This global requirement has resulted in laws varying greatly from country to country.

The essential principles of a typical data protection act are shown in Table 8.1.

Legal responsibilities of data holders	Rights of data subjects
to process data in a fair, lawful and transparent manner	to be informed about the collection and use of their data
to ensure that data subjects give their consent – they must be asked to ‘opt in’ rather than ‘opt out’	to access their personal data free of charge
to collect data for a specified purpose and not use it for any other purpose	to have inaccurate data corrected
to only hold as much data as is necessary	to have data deleted when it is no longer needed for the purpose for which it was collected
to ensure data is accurate and kept up-to-date	to obtain and reuse the data for their own purposes
not to keep the data longer than is necessary	to object to the processing of their data
to keep the data secure	

Table 8.1: General data protection laws – responsibilities and rights

Question

- 2 a Describe **three** responsibilities of the data holder that should be in a data protection act.
- b Describe **three** rights that should be given to the data subjects.

ACTIVITY 8.2

Carry out research to find maps showing which countries have adequate data protection laws, partial ones or no laws at all.

Personal data

Personal data is information used to identify an individual and includes identification markers such as name, address, date of birth, location, race, ethnic origin or medical data such as genetic and health data. Even personal images such as a photo of you in your school uniform or when you are caught on a CCTV camera counts as personal data.

Personal data such as this is collected every time you post an update on social media, sign up for an online account, or use a web-based email service or a search engine. These data items will probably be held by lots of different official organisations such as schools, health services and government departments, and also online shops.

KEY WORDS

data subject: the person whose personal data is being stored

personal data: data relating to a living individual; it covers any information that relates to an identifiable, living individual

ACTIVITY 8.3

In a small group, brainstorm a list of any personal data that you may have entered into a computer, including if you have used social media, games sites, shopping sites, email providers and any other web pages you have used. Then compare your list with other groups.

People should be concerned about the privacy implications of the storage and processing of their personal information and about the security of the data as weak security could result in personal information falling into the wrong hands. This makes people vulnerable to fraud and identity theft and also burglary

of their homes if the address is included in the data. It can also lead to harm from predators if they know how old you are and where you live. This is discussed later in this chapter (see Section 8.3).

eSafety

eSafety basically means being safe on the internet but it can also include the safe use of technology in general. eSafety is intended to prevent online threats which include:

- bullying/cyberbullying
- inappropriate behaviour or content
- emotional abuse
- data theft.

eSafety when using the internet

When finding information using the internet, everyone uses a search engine. There are lots of different search engines and some are especially designed for children and young people so that they will not be exposed to inappropriate content. Young people should be encouraged to use age-appropriate search engines to stay safe.

ACTIVITY 8.4

Carry out research and list the names of five search engines designed especially for children and young people.

Young people should also be encouraged to only visit websites recommended by their teachers and parents to minimise the potential danger.

In addition to using safe search engines, software can be used to limit and screen web access.

If a young person comes across inappropriate content, they should simply shut down the computer without clicking on anything else and inform an adult.

eSafety using email

The following points outline the ways to be careful when using email.

- Always be careful when opening emails from senders you do not know. Never click on a link in an email if possible, unless you are expecting

the email (such as resetting a password) or you know both the sender and that the link is safe (sometimes our friends can send on **malware** without knowing they have done so, so make sure you know that your friend did send that link). Never open attachments from senders who you do not know as they may install malware onto your computer.

- If you receive an email from a company that you do know, always go to the website by typing the address directly into your web browser, rather than clicking on a link in an email. This is because sometimes criminals will make a copy of a website to trick you into entering your login details so that they can steal them.
- If you receive an email, always check the actual address of the sender by viewing the details of the email header. Sometimes criminals will try to trick you by setting the visible name of the sender to be something familiar.
- Never send any payment information, such as your credit card number, in an email. Email isn't always secure for its entire journey from the sender to the receiver and your details may be intercepted.
- Always be careful when sending identifiable personal data or images in an email. Treat this as publishing that data or image. If you wouldn't be happy to put it in a newspaper, then don't send it in an email. Data that could be used to identify you could be used by people to locate you.

KEY WORDS

eSafety: being safe on the internet but it can also include the safe use of technology in general

malware: software designed to gain unauthorised access to a computer system in order to disrupt its functioning or collect information without the user's knowledge

REFLECTION

Think about your approach to using the internet and email. Reflect upon how you use the internet and how you use email.

PRACTICAL TASK 8.2

Getting started

- 1 Using word processing software, enter the following headings in a document and save the file.
 - Do I regularly change my password?
 - Have I shared my password with anyone?
 - Do I always log out or sign off from my account when I have finished using email?
 - Have I ever forwarded chain emails?
 - Do I regularly make sure my antivirus software up to date?
- 2 Consider each of the points above and note your answers.

Practice

- 3 Use the document as a questionnaire and find and record the yes/no responses of the other members of your class.
- 4 Using spreadsheet software create charts to illustrate the results of your survey.
Help with creating charts can be found in Chapter 16.

Challenge

- 5 Go to your email software's security and privacy settings and alter them appropriately.

eSafety using social media

There are many different **social networking sites** where you can share information with others and make comments, including sites specifically for sharing photographs. There is nothing wrong with social networks themselves, but if they are not used carefully, some very serious problems may occur.

KEY WORD

social networking sites: types of websites or services that allow you to interact with friends and family online and to find other people online who have similar interests or hobbies

Problems that may arise include:

- Cyberbullying could occur when people have access to an individual on a social networking site.
- Because it is easy to contact others using social network sites, some people may try to exploit or abuse others, in particular young people, especially where it is difficult for a young person to know with whom they are interacting.
- Catfishing is a kind of online deception where a person creates a fake persona on social networks called a 'sock puppet' for the purpose of luring someone into a relationship in order to get money, gifts, or attention.
- Some people use social networking sites to slander (make a false statement about) other people that could damage their reputation. If someone makes an abusive comment about another person, and it is shared by others, it will not be possible to remove that comment from everywhere that it might be seen.
- When people start using a social networking site, it is usual to create a personal profile. If this can be accessed by the public, rather than being restricted to your friends, their personal details could be stolen.
- People using social networks may not be aware that the sites can be searched. Nowadays employers may look on these sites to assess people applying for a

job with them. Sometimes, inappropriate discussions or behaviour can influence employers against employing you, even if they are not recent. The data trail you leave is called your digital footprint and is a public record of:

- What you said.
- What was said about you.
- What you liked, retweeted or shared.
- Where you are or have been.

You can manage your privacy settings on social network sites; most of them also have an option to report abusive users.

Before disclosing your personal data (such as name, address, the name of your school or an image of yourself in school uniform) ask yourself these questions:

- Who is collecting this information?
- Why is it necessary?
- What will be done with it?
- What will the outcome be for me?

ICT IN CONTEXT

When you apply to go to a university or for a job at a large company, the recruiter may look at your social media presence to get more information about you.

It is important therefore to take care of what you say, how you say it and what pictures you post. Just deleting a post will not be enough because your friends may still have it on their page! Ask your friends to be careful what they post about themselves and about you, and to never post a picture of you without checking with you first.

To minimise possible dangers that you might encounter when using social media or networking sites, blogging sites, instant messaging or game sites, you should take precautions and follow rules:

- All social media sites allow users to block and report unwanted users. All users should read the security details published by social media sites before they start using them.
- Users should always be aware of the potential dangers of meeting an online contact face to face.

Users never know the true identity, age and gender of the user who has contacted them, they only know what they claim to be online. Meetings have led to some dangerous situations. If a user receives a request, they should decline it and tell their parents or carers that they have been approached.

- Users should avoid distributing inappropriate images. These could be ones of other people or images they have been asked to take of themselves and send to an online contact. The images could be sent to other people and will remain part of your digital footprint for others to see and maybe misuse.
- Users should be careful of the language they use. It should always be appropriate and respectful of other people. They should never send hateful messages or criticise others even if they think they are anonymous or use social media to make complaints or vent their frustrations in strong language containing inappropriate words. Again, this could have consequences in the future.
- Users should respect the confidentiality of other users. If another user has told them a piece of information or sent an image just for them personally, they should never disclose it to other users.

ACTIVITY 8.5

Carry out research to find how to block and report unwanted users on social media sites such as Facebook, Twitter and any others that you may use.

Playing games on the internet

Current technologies and high-speed internet connections have made it possible for online gaming to become very popular. Because of this, large amounts of time and money are being invested in very complex games. This has resulted in some people seeing an opportunity to cause trouble, and to make illegal profit.

It is therefore important to understand the technological and social risks of online games.

You can play online games with people from all over the world. When you play these games, you may be playing with people you know and also with people you don't know. Online gaming is a good way to make new friends with the same interests as you, but you need to know how to keep yourself safe.

Tips for playing online games safely

- Some people can become nasty when they are playing online games because they want to win. Make sure that when you play online games, you treat the other players with respect, and don't do anything that you know is wrong to get cheats or tips.
- Because some people you could meet online may not be who they say they are, it is always a good idea not to use your real name when you are gaming. Use a screenname instead.
- Just as when you are using social media sites, never give out personal information or agree to meet another player face to face. Users are charged by the providers for buying materials, weapons or even extra lives but other players often develop successful characters in the games and offer to sell them to other people. As these are not officials of the company, you should never disclose any financial data such as bank or credit card information.

Question

- 3 Describe what steps you could take to keep safe when playing online games.

8.3 Security of data

Security of data is about keeping data safe and unchanged by restricting access to it – this reduces the chances of it being damaged maliciously. Security of data is also concerned with the recovery of data if it has been damaged. In this section, we will consider the different ways in which data could be compromised (it's no longer private) and ways of keeping it as safe as possible (see Figure 8.5).

You should be aware of what information you have online that needs protection: your **information assets**.



Figure 8.5: Keep your personal data safe from threats

KEY WORD

information assets: valuable data that you wouldn't want to be stolen or corrupted

ACTIVITY 8.6

Create a list, either in a spreadsheet or on paper, of the different types of information you store on your computer or online. For example, you may have personal correspondence, photographs, work documents, study materials, images, banking details, music, personal details and all of your passwords for online services.

For each type of information, think of its value to you in terms of the cost of replacing it in time and effort or your reputation if it was disclosed to others. Label the most valuable types of information as 'High', the least valuable as 'Low' and those that are in between as 'Medium'.

ICT IN CONTEXT

A Cybersecurity poll in 2018 found that 59% of people use the same password for everything on the internet. It is like having one key to unlock everything. If someone found or stole the key, they would have access to a person's house, car, office, safe, cabinets, etc. Having the same password poses the same risks and is an ongoing cause of hacking and data breaches.

Threats to data

Identity theft is a type of fraud (criminal trick) where personal information is stolen and used to impersonate that person. This isn't a new problem because in the past, postal deliveries were intercepted to find out names, addresses and bank account details. The person committing the fraud could then open a credit card account, for instance, or apply for a loan in the victim's name. Pretending to be someone you're not based on another person's details is identity theft.

Now, in the online world, we have malware, which is software that has been designed to find personal information on a computer and botnets are created using malware for sending **spam** emails (discussed in Chapter 10, Section 10.1 Communication with other ICT users using email) or flooding a website with so many requests for content that the server cannot cope. **Hacking** is also a way of obtaining personal information: large retailers have been hacked and millions of personal records have been stolen. Online identity theft is a growing threat.

KEY WORDS

identity theft: a type of fraud where personal information is stolen and used to impersonate that person

spam: junk email that involves nearly identical email messages being sent to lots of people. Usually sent to try and persuade you to buy something

hacking: the gaining of unauthorised access to data in a system or computer

ACTIVITY 8.7

Investigate how to recognise a spam email, and find out how to report them in your country. Use the word processor to record your findings.

What is hacking?

Hacking is malicious (intending to do harm) damage caused by people who get unauthorised access to computer systems. People who do this are called hackers.

Hackers have different reasons for doing what they do: some of them gain access just to prove that a system is

vulnerable; other hackers may alter or destroy the data for malicious reasons. It is most likely that they are breaking in to steal some of the data so they can make money. For example, if a hacker gets into your computer and steals any financial information you have there, such as your credit card number, or the password to your bank account, they could use that to spend your money.

What effects does hacking have?

You could lose all your data as a result of hacking because hackers often delete or change files; for businesses, they may steal or delete customer or order information, or leak top secret information that could cause huge real-world security problems.

Another effect is reduced privacy. When hackers gain access to a computer, they can see everything. Since much of the personal, professional and financial areas of people's lives are now kept online, the risk is in losing more than money or information. A hacker with access to your email or your social networking account and personal photos can very quickly destroy your privacy.

If a lot of information about you is stolen, a hacker could use this to impersonate you online.

They might apply for credit cards, buy a car or apply for a loan in your name!

If they did, this would be called 'identity theft' (see earlier in this section).

Protection against hacking

Hackers have to gain access to your computer. If it isn't connected to a network, then it must never be left logged in and unattended for anyone walking past to access.

If it is connected to a network, e.g. the internet, then the hackers will need login and password details. They can obtain them in a variety of ways such as phishing, pharming, smishing, vishing and using malware that are explained below, with methods to safeguard against them.

In addition, users should ensure that they have firewall protection and can encrypt sensitive data. Both of these are explained later in the chapter.

Phishing

This is when fraudsters send emails claiming to be from a bank or building society e-commerce site in order to find out your personal and financial details.

Phishing emails can be prevented by recognising them:

- Urgency: they want you to respond quickly, without thinking.
- Careless use of language: they sometimes contain spelling errors and a careless writing style.
- Impersonal: you may not be addressed personally but only as ‘Dear customer’, although as the criminals become more sophisticated they are able to find your personal details from various sources such as social networking sites.
- False links: you are asked to click on a link that leads to a website controlled by the criminals.
- Attachments: sometimes you are asked to open programs or documents sent with the email; these attachments may contain **spyware**.
- If there are any attachments in an email from an unknown sender, do not open them as they may contain malware.
- Does the email ask you for personal information? If it does, do not reply.

Pharming

Pharming is similar to phishing, but a phishing attack tries to redirect you to a bogus (fake) site even when you have typed the correct web address. This is often applied to the websites of banks or e-commerce sites. Phishing needs you to click on a link to take you to a fake site.

In a pharming attack, a hacker can install some malicious code on a computer or server that will redirect you to a different, fake site, where you may be tricked into providing personal information such as a bank account number or a password. This information is then accessed by the hacker.

Pharming is caused by malware and the precautions to take against malware should be followed (see the Chapter 4, Section 4.2 Network issues and communication for more information on how to do this).

Vishing and smishing

Vishing is a combination of ‘voice’ and ‘phishing’. It is when fraudsters obtain personal details of a victim through making phone calls or leaving messages supposedly from a reputable company, even their own bank. They persuade people to reveal personal information such as bank details and credit card numbers.

When receiving telephone calls or messages, you should be highly suspicious if they ask you to provide credit card or bank numbers or any PINs. Never disclose any as banks will never ask for them over the phone. If you are worried about any phone calls, hang up and call that company back using a number that you know to be real.

Smishing is a bit like phishing, but it uses text messages to hoax consumers. The text message will probably have a URL or a telephone number. They may, for instance, tell you that there is a problem with your bank account and that they need to check the information with you.

Do not respond to text messages from unknown senders, especially if they are asking for personal information. Delete any text messages you are suspicious of.

KEY WORDS

phishing: a criminal activity trying to find sensitive information, such as passwords or banking details, by fraudulent means

spyware: malware that is designed to be installed secretly on a computer. It records private information as the user enters it and transmits it to the installer

pharming: when a hacker installs a malicious program on a computer or a server. This program code causes any clicks that you make on a website to be redirected to another website without you knowing

vishing: a combination of ‘voice’ and phishing, it is when fraudsters obtain personal details of a victim through their landline telephone

smishing: uses mobile phone text messages to lure people into returning their call or to click on a link in the text message

Computer viruses and malware

Computer viruses and other malware (see Figure 8.6) pose severe threats to data security and preventative action should be taken. Types of malware include viruses, worms, Trojan (or Trojan horse), spyware and adware. To avoid infecting your computer, take the precautions discussed earlier in the chapter when opening your email and make sure you’re certain of

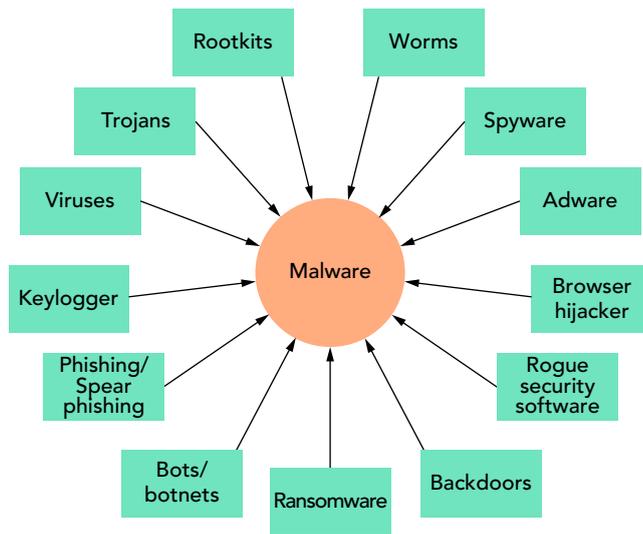


Figure 8.6: Malware

any links you click on. It is also recommended that you have some form of anti-malware software installed on your system. Full details of both the malware and anti-malware software are given in Chapter 4, Section 4.2 Network issues and communication.

ACTIVITY 8.8

Find out how many new viruses are created each year and compare this with how often your antivirus software is updated. Discuss your conclusions in small groups.

Card fraud

Credit card fraud is a broad term used to describe theft or fraud that is committed using a payment card, such as a credit card or a debit card. The purpose of credit card fraud will probably be to obtain goods without paying, or to steal funds from an account.

As well as hacking using methods already mentioned to obtain card details, the following are also used: shoulder surfing (or ‘shouldering’), card cloning and key logging.

Shoulder surfing

This involves finding login names, passwords, credit card and PIN numbers by direct observation.

- Someone in an office could watch others entering passwords.

- Someone in the queue behind could watch a person enter their PIN number at a cash machine (ATM).
- An employee at a shop or petrol station could watch PIN numbers being entered.

Criminals often use binoculars or closed-circuit television to watch from a distance or record users entering sensitive information.

To prevent **shoulder surfing**, users should shield the keypad from view by using their body or cupping their hand over it. When working on a laptop, their back should be to a wall with no open sides. Extra care should be taken when entering a password.

Card cloning

Cloning or ‘skimming’ is the copying of stolen credit or debit card information to a new card. An electronic device or software can be used to capture the information at a terminal, then transfer it to a new card.

An employee in a shop or petrol station could use a portable reader to scan the card prior to inserting it into a credit card terminal and then record it onto new cards.

Customers should carefully observe shop employees when they have access to their cards, or never hand them over and enter them into the terminals themselves.

Key logging

Key logger is short for ‘keystroke logger’. They belong to a class of malware known as spyware as they can discover a user’s passwords and credit card PINs as they type them in. They are a type of monitoring software as

KEY WORDS

credit card fraud: theft or fraud that is committed using a payment card, such as a credit card or a debit card

shoulder surfing: finding login names, passwords, credit card and PIN numbers by standing next to someone and watching as they enter them

cloning: making an exact copy of something

key logger: short for ‘keystroke logger’; type of malware that records individual key strokes that are pressed on a computer’s keyboard

they record the individual keys pressed on a computer's keyboard. This is done without the user's knowledge. A record of all the keys is kept in a log. The logs can be saved to a local file or sent over the network to another computer or person. They may be transmitted in Trojans, infected files, instant messages or by visiting an infected website. Hackers review these logs for repeated patterns, which could be your passwords.

As they are malware, the precautions mentioned in Chapter 4, Section 4.2 Network issues and communication should be followed.

Protection of data

Biometrics

Biometrics can be used in the protection of data. It uses technologies that analyse unique personal characteristics as a form of identification so that data can be protected by preventing unauthorised people from accessing it. Biometrics and details of this are given in Chapters 4, Section 4.2 Network issues and communication and 6, Section 6.10 Recognition systems.

It includes:

- Physiological biometric data such as fingerprints, eye retinas and irises, voice and facial patterns, and hand measurements.
- Behavioural biometrics, which include signatures, handwriting analysis and voice pattern recognition.

Encryption

When data is saved to a storage device attached to a computer or transmitted to the cloud, in an email or to a website, it is vulnerable to being stolen or intercepted by a third party. To prevent them from being able to read this information, it should be **encrypted**. **Encryption** means that the data will be scrambled into a form that cannot be understood by unauthorised recipients

In order to encrypt the data it must be changed in some way. There are lots of algorithms or methods of encrypting data and these different methods are called **ciphers**.

If you wanted to pass a message to a friend at the other end of the row, and not let anyone else read it, you could use a very simple cipher, first used by Julius Caesar. This method replaces each **plaintext** letter with another plaintext letter. But which ones?

The way in which they are replaced is called the **key**. This is the piece of information that is needed to use the cipher. The key does not have to be fixed. It could be changed each time the cipher is used.

For example, the key could be 'right three'. Each letter would be replaced with a letter three places to the right, e.g. A would become D; D would become G; X would become A, Y would become B and Z would be C.

KEY WORDS

encrypted: data that has been scrambled into a form that cannot be understood

encryption: the process of turning information (e.g. a message) into a form that only the intended recipient can decrypt and read

cipher: a method of encrypting data

plaintext: the text that is to be encrypted

key: a piece of information that is used for encrypting and decrypting data

ciphertext: the encrypted plaintext

decrypt: changing the ciphertext back into plaintext

symmetric encryption: the same key is used for encryption and decryption

Therefore 'HELLO' would be encrypted to 'KHOOR'.

'Hello' is the plaintext and 'KHOOR' is the **ciphertext**.

Your friend could then **decrypt** the message back into plain text (see Figure 8.7 on the next page). No one else in the row would be able to read it.

As the message is encrypted and decrypted with the same key, it is called **symmetric encryption**.

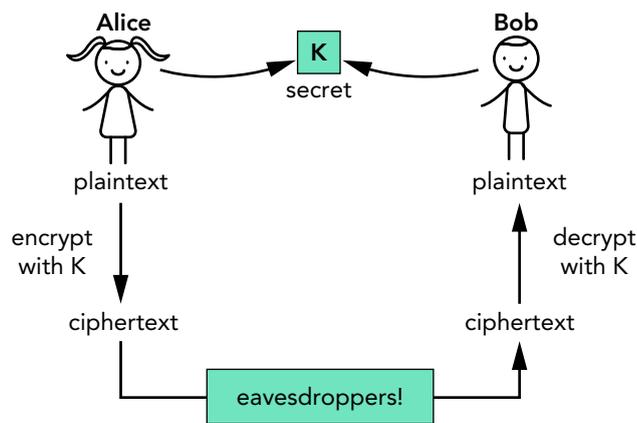


Figure 8.7: Symmetric encryption

In a similar way, data can be encrypted when it is being saved on storage device, e.g. disk drive or USB device. This method encrypts and decrypts a message using the same key. Both ends of the transmission must know the exact same shared key.

But there is a problem. How do you let your friend know what the key is? You could shout it to them, but others would hear. You could write it down and pass it along the row, but then others could read it.

So symmetric encryption has a problem if you want to use it to encrypt messages sent to other people. It's fine if you are only using it yourself to encrypt and decrypt stored data.

Sending encrypted data from computers through the internet faces the same problem. How can you keep the key secret?

The answer is to use **asymmetric encryption**. Obviously asymmetric encryption uses two keys – one to encrypt the message and one to decrypt it.

These are called the **public key** and the **private key**.

Now if you want to send a message to your friend you would have to ask her for her public key, and it doesn't matter who hears it. It is meant to be public. So, you now encrypt the message using her public key, pass the note along the row and then your friend can decrypt it with her private key that only she knows (see Figure 8.8 on the next page).

- This method encrypts and decrypts data using two different keys. Every user has two keys: a public

key, known to everyone; and a private key, known only to themselves. A message sent to someone is encrypted with their particular public key. This can only be decrypted by the corresponding private key.

- This type is also used when you want to send encrypted messages across the internet in emails and also when you want to send your credit card and other details to a secure website using HTTPS which stands for HyperText Transfer Protocol Secure and encrypts all transmissions between the website and your computer.

A client computer is one that connects to and accesses a server. When it wants to communicate with a server using the HTTPS protocol, its browser sends a request to the web server and the web server replies, sending its public key.

- The client computer then generates and sends an encryption key to the server using the server's public key and it decodes it using its private key (asymmetric encryption).
- The client and server then use the same key (symmetric encryption) for sending data such as financial and personal details.
- But there is still a security problem. How does the client know that the public key that has been sent is from the correct server? A hacker could have hijacked the request and sent their public key instead and you will be sending them your details.
- The answer to that is the use of digital certificates.

KEY WORDS

asymmetric encryption: a method of encryption that uses two different keys

public key: a key that is freely available and is used to encrypt a message

private key: a key that is known only to the person to decrypt messages encrypted by their public key

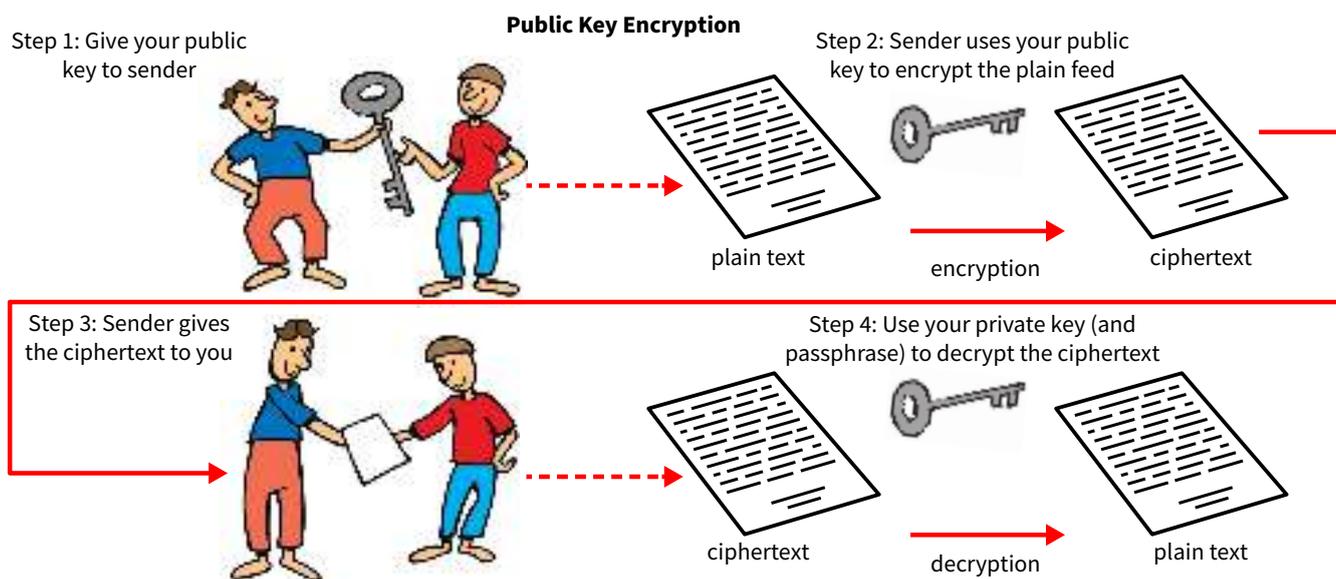


Figure 8.8: Asymmetric encryption

Digital certificates

A **digital certificate** is a digital form of identification, like a passport, used to authenticate the web credentials of the sender and lets the recipient of an encrypted message know that the public key is from a trusted source (or a sender who claims to be one). Most browsers display an icon to show that they are secure; it is usually a small locked padlock (Figure 8.9). For Mozilla Firefox, Internet Explorer and Google Chrome, the icon appears in the address bar. When using or sending information to a website using HTTPS, check that this icon appears just before its site name.

Digital certificates are issued by **certificate authorities** (or **CAs**). There are about 50 CAs around the world, including Verisign, Comodo and Symantec.

KEY WORDS

digital certificate: a digital certificate is a method of guaranteeing that a website is genuine and that communication between you (the client computer) and the server is secure. A website with a digital certificate has a small padlock icon you see in the bottom right of your web browser

certificate authorities (CA): a trusted entity that issues digital certificates

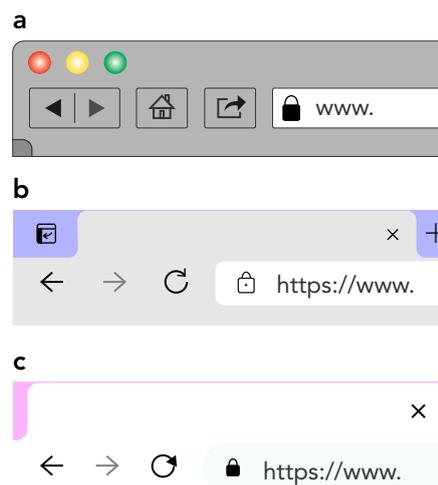


Figure 8.9: The padlock icon to show that the website is secure

What makes up a digital certificate?

The digital certificate guarantees the authenticity of the public key that the site will provide for secure transmission. A certificate consists of:

- the person's name
- an email address
- a serial number

- a public key
- an expiration date (certificates are only valid for a limited time)
- a digital signature.

The SSL (Secure Sockets Layer) and its successor, TLS (Transport Layer Security), are protocols on the client and server computers for establishing these encrypted links. SSL uses encrypted links to provide a secure channel for communication between the two devices when they are using HTTPS (see Figure 8.10). For web browsing, for example, it allows you to use the secure HTTPS protocol (rule) rather than the normal HTTP (see Chapter 10, Section 10.2 Effective use of the internet).

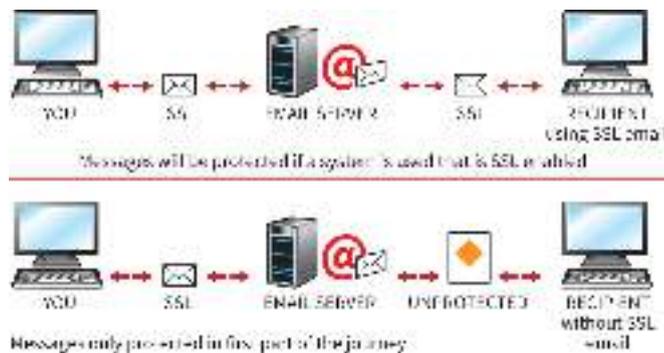


Figure 8.10: Secure Sockets Layer

Questions

- 4 Security of data when it is being transmitted is very important.
 - a Define SSL.
 - b Describe what SSL does.
 - c State the difference between SSL and a digital certificate.
- 5 Yolande works in a software development company. She needs to use biometric data to enter her office every morning.
 - a Give four types of biometric data that the company could ask Yolande to provide.
 - b Explain how biometric data works when Yolande has to give a fingerprint scan as a means of entry to her place of work.

Data security in the cloud

Cloud computing is when data and programs are stored in a centralised place on the internet and not on the hard drive of your computer. Cloud computing was discussed in Chapter 4.1.

The issues relating to security in the cloud are worldwide. These are the main problems for the people who make the laws all over the world:

- Data flows across country borders.
- A lot of data storage servers are in the USA but they are used by people in different countries so it is not clear which laws of which country should be regulating the privacy of the data when it is travelling from the sender to the server.
- People using the cloud for data storage think that their information is confidential to them because it is their property. However, the place where their data is stored (the internet) is not theirs.

With so much legal uncertainty, your only option is to be responsible for your own data. Here are some ideas to help you:

- Don't store sensitive data in the cloud.
- Make sure you read the small print of your cloud provider to find out how their storage works.
- Be very serious about all of your passwords. Don't use your email login and password for any other purpose because all of your login details and forgotten password details come to you via email.
- Use encryption as it is an excellent way for you to protect your data.
- Some cloud services provide local encryption and decryption of your files, so find out about which they are and use that service. It means that the service will encrypt your files on your own computer and store them safely on the cloud.

What is a firewall and why is it used?

A **firewall** is protective barrier between you and any other computers that you are connected to. A firewall can be either a software program or a hardware device that intercepts communications between your computer and the outside in order to help block malicious connections. Firewalls are discussed in detail in Chapter 4, Section 4.2 Network issues and communication.

KEY WORD

firewall: software or hardware devices that protect against unauthorised access to a network

Two-factor authentication

Multi-factor authentication (MFA) is a **challenge-response check** that combines two or more independent **credentials** (verification of identity for authentication) or factors.

The authentication factors are:

- **Knowledge factors:** consisting of information that the user possesses, such as a personal identification number (PIN), a user name, a password or the answer to a secret question.
- **Possession factors:** items that the user has with them, typically a hardware device such as a security token or a mobile phone used in conjunction with a software token (e.g. login details).
- **Inheritance factors:** such as fingerprints or iris which are examples of biometric authentication.

The most common methods use **two-factor authentication**. Examples include:

- Withdrawing money from a cash machine. Authentication requires a possession factor (a debit or credit card) and a knowledge factor (a PIN).
- USB devices with authentication codes. The user inserts the USB device, a token, which contains a password which the user is asked to enter when they are asked for authentication. The password they enter must match that on the token.
- As USB devices may be lost, forgotten or stolen, some two-factor authentication methods use mobile phones as the possession factor. This happens on a lot of websites. The user enters their knowledge factor, for example, their password, and the server sends a text message containing an access code to their registered mobile phone. The code can be used once within a certain time limit.

KEY WORDS

multi-factor authentication: a user has to produce several pieces of evidence in a challenge test

challenge-response check: an authentication method used to identify a user who has to produce a piece of evidence, e.g. a password

credentials: pieces of information

knowledge factor: something that a person knows that can be used for authentication

possession factor: something that a person owns that can be used for authentication

inheritance factor: a physical characteristic that someone can use for authentication, e.g. their fingerprint

two-factor authentication: a user has to produce two pieces of evidence in a challenge test

User ID and password

Passwords are the most common method of authentication. Each user registers initially, using an assigned or self-declared password, and on each subsequent use the user must know and use the previously declared password. The security of the data is increased as only authenticated users can access it. Passwords are discussed in Chapter 4, Section 4.2 Network issues and communication.

ICT IN CONTEXT

If you use the same password for more than one internet site, and someone hacks one of those accounts, they will also have the password for all your other accounts with the same password.

It is therefore important not to use the same username and password more than once to make sure you are not an easy target for identity theft.

SUMMARY

Physical safety issues can be solved by using simple strategies to prevent problems occurring.

Evaluate how you use IT equipment and develop ways to minimise any safety risks that you find.

Most countries have data protection legislation for the protection of users' personal data.

Explain what is meant by personal data, why it should be kept confidential and protected and how to avoid inappropriate disclosure of personal data.

Evaluate your own use of the internet, email, online gaming and social media sites and discuss why eSafety is needed.

Understand what effective security of data is, as well as what security of data online is, then discuss the effectiveness of different methods of increasing security.

Understand the threats to data, such as hacking, phishing, pharming, smishing and vishing and how to prevent them.

Understand and know how to take action against viruses and malware.

Know about credit card fraud, including shoulder surfing, card cloning and key logging.

Know what encryption and SSL are and how to protect data, including using biometric data, digital certificates, firewalls and user IDs and passwords.

EXAM-STYLE QUESTIONS

- 1 **Define** the term 'electrical overload'. [1]
- 2 **State** *three* things you should do immediately if you spill a drink into your keyboard or laptop. [3]
- 3 List *three* hazards associated with trailing wires in a computer room. [3]
- 4 Chunhua is about to give personal information on an internet site. State *three* things she should consider before doing this. [3]
- 5 Which of the following could you do to get less spam? You may choose more than one if you think that is correct: [1]
 - a Change your password regularly.
 - b Change your email address.
 - c Do not tell anyone your password.
- 6 Which of the following is *not* personal information? [1]
 - a Photograph of me in school uniform.
 - b Online nickname.
 - c Date of birth.
- 7 **Explain** what you should do if you want to meet someone you only know online. [1]
- 8 You have received some junk mail and you reply to the message asking them not to send you anymore. Explain why this is the wrong thing to do. [4]

COMMAND WORDS

define: give precise meaning

state: express in clear terms

explain: set out purposes or reasons / make the relationships between things evident / provide why and / or how and support with relevant evidence

CONTINUED

- 9 **Discuss** the possible dangers of communicating over the internet.
Give specific types of problems. [10]
- 10 It is possible to be robbed as a result of a Facebook post.
Discuss ways that help thieves to rob your house. [4]
- 11 Mahesh is a student who has been advised to make sure that a firewall has been installed before he starts to use social media.
Describe *three* ways that a firewall would protect data on Mahesh's computer. [3]
- 12 Describe different ways to help you to decide if a website is fake or not. [5]
- [Total: 40]

COMMAND WORDS

discuss: write about issue(s) or topic(s) in depth in a structured way

describe: state the points of a topic / give characteristics and main features

SELF-EVALUATION CHECKLIST

After studying this chapter, think about how confident you are with the different topics.

This will help you to see any gaps in your knowledge and help you to learn more effectively.

You might find it helpful to rate how confident you are for each of these statements when you are revising.

You should revisit any sections that you rated 'Needs more work' or 'Getting there'.

I can ...	See section	Needs more work	Getting there	Confident to move on
describe common physical safety issues, what causes them and the strategies that can be used to prevent them	8.1			
evaluate how I use IT equipment and develop ways to minimise any safety risks that I find during my evaluation	8.1			
discuss the principles of a typical data protection act	8.2			
explain what is meant by personal data, why it should be kept confidential and protected and how to avoid inappropriate disclosure of personal data.	8.2			
discuss eSafety strategies to minimise danger when using the internet, sending emails, using social media and playing online games	8.2			
discuss the threats to data and understand what measures should be taken to protect your data	8.3 and 4.2			