Cambridge

OL- IGCSE

ICT

CODE: (0417)

Chapter 06

ICT application

6.1 Communication

There are several communication systems that make use of ICT technology.

6.1.1 Communication media

Newsletters and posters

Newsletters and posters can be produced very easily using, most commonly, a **word processor**. Often, the newsletter or poster will have photos which have been taken specially or have been downloaded from the internet (with the permission of the copyright holder).

The sequence is not always necessarily in the order shown; it can vary depending on what already exists or what needs to be created):

» First a word-processor application would be opened

» Photos could be obtained by:– using a digital camera and taking photos
– searching for images/photos on the internet, or suitable photos could already be stored on the hard drive or cloud
– using hard copy photos, which could be scanned in.

» If necessary, camera images would then be uploaded (either by connecting the camera or camera memory card) to the computer via a USB port, or by using Bluetooth connectivity).

» Photos from all selected sources would then be saved to a file on the HDD or SSD.

» When the user is finally ready to produce the document, the photos would be imported from the file stored on the HDD/SSD.

» Once imported, photos would need to be cropped, edited and/or resized.

» Text would be typed in using a keyboard.

» Alternatively, any previously saved text would need to be imported.

» Photos need to be placed in their correct position and the text wrapped.

» Finally, the whole document would need to undergo proofreading for errors and then saved, ready for printing.

A **newsletter** is a very useful method for getting important information to a target group.

A few of the common guidelines to produce an attractive newsletter include:

» Do not try and squeeze too much information onto one page.
» Use very clear, easy-to-read fonts
» Decide on whether to use columns (a useful feature if there are diagrams and photos).
» Avoid using capital letters as this appears to be 'shouting'!
» Use bold text in headings rather than underlining text.
» Use real photos rather than clip art to make the newsletter more interesting.

Posters are a good way of publicising. A sporting event poster would need to include at least the following information:

» What the event is and where it will take place
» Date, time and place of event
» Admission fees (if any)
» Contact details
» Other information (such as whether there will be a crèche or facilities for people with disabilities).

The movie poster would need to include:
» An image taken from the movie to give some idea of the type of movie (that is, comedy, horror, science fiction, and so on)
» The date of release
» A list of the main characters.

Websites

Rather than producing newsletters and posters by printing them out, it is possible to use websites for advertising. This method of advertising requires a company to either develop their own website or pay another company to advertise on their website.

It has, however, become much easier and cheaper for individuals or small organisations to create and host their own website, using off-the-shelf content management systems to organise content, and pay hosting fees to rent space on a **web server.**

Table 6.1 Advantages and disadvantages of using websites for communication

Advantages	Disadvantages
» sound/video/animation can be added » links to other pages and websites can be added in hyperlinks and hot spots » buttons to navigate/move around the website, leading to more information » 'hit counters' allow the owner to see detailed information about how many people have visited the website » can be seen by a global audience » cannot be defaced or thrown away » it is much easier to update a website (and there is no need to do a reprint and then distribute the new version)	» websites can be hacked into and modified or viruses introduced » risk of potential pharming » it is necessary for the potential customers to have a computer and internet connection » it is not as portable as a paper-based system (although with modern smartphones and phablets this is fast becoming untrue) » possible for customers to go to undesirable websites (either by accident or as a result of a pharming attack) – this can lead to distrust from customers » there is a need for the company to maintain the website once it is set up – this can be expensive » because it is a global system, it is more difficult to target the correct audience using website advertising » still need to find a way for people to find out about the website

Multimedia presentations

Presentations are produced using one of the many software packages on the market and then used with a **multimedia projector** so that the whole audience is able to see the presentation.

advantages of multimedia presentations

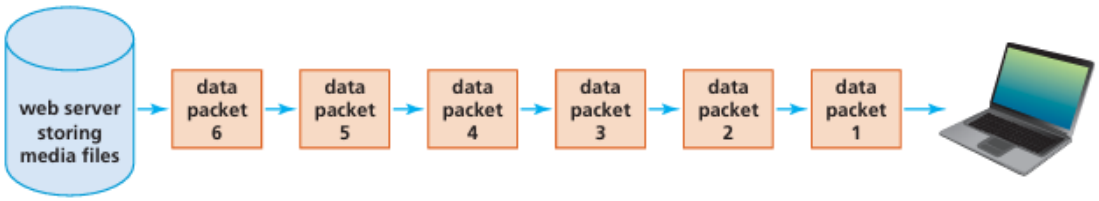
» Use of sound and animation/video effects which are more likely to grab the attention of the audience, and can make the presentation easier to understand
» Possible to have interactive hyperlinks built into the presentation; this means the presentation could access a company's website or even key files stored on the cloud
» Use of transition effects allow a presentation to display facts in a key or chronological order
» Can be interactive
» More flexible; because of the links to websites and other external systems

Disadvantages of multimedia presentations

» A need to have special equipment which can be expensive
» Danger that equipment could fail while giving multimedia presentations
» There may need to be internet access
» Danger when using multimedia in presentations that the focus is on the medium rather than the message or facts
» Very easy to make a bad presentation with too many animation effects and too much text or images.

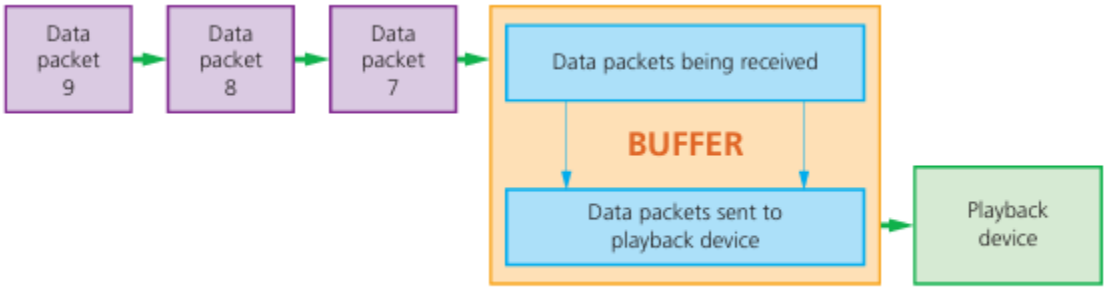
Media streaming

Media streaming is when users watch movies/videos or listen to music on devices connected to the internet. When using media streaming there is no need to actually download and save the video or audio files.



▲ **Figure 6.2** Media streaming data packets

Buffering makes sure the video plays back smoothly without freezing. While the buffer is receiving data packets, it will be sending the data from the previous data packets to the playback device.



▲ **Figure 6.3** Buffering of media stream

e-publications

Most material which is published on paper is also available in an electronic format.

In all cases, the publication can be downloaded to a device connected to the internet where it can be read. Moving between pages is usually done by swiping a finger across the screen.

6.1.2 Mobile communication

Mobile phones communicate by using towers inside many cells networked together to cover large areas. The towers allow the transmission of data throughout the mobile phone network.

▲ **Figure 6.4** Each cell overlaps, giving mobile phone coverage.

Mobile devices either use a **SIM (subscriber identity module) card** to allow it to connect to the mobile phone cellular network, or they use wireless internet connectivity. Together they allow all of the following features:
» SMS (short message service) messaging
» Phone calls
» Voice over Internet Protocol (VoIP) communication
» Video calling
» Internet access.

SMS (text) messaging

SMS or text messaging allows a very quick way of communicating with another person by typing on a keyboard (the keyboard is often virtual on a mobile phone or tablet).

phone calls

Probably the most obvious use of a mobile phone is its ability to make a phone call on the move. Because mobile phones are so small and they have their own power source, they are an ideal way of keeping in touch anywhere, provided there is a network signal.

Voice over Internet protocol (VoIp) and video calling

One of the most common forms of internet telephony (that is, having a telephone conversation via the internet) is **Voice over Internet Protocol (VoIP).**

The main problems are usually sound quality (echo and 'weird sounds' are both common faults). Security is also a main concern with VoIP, as it is with other internet technologies.

Video calling uses software such as FaceTime or Zoom. Both these options require the user to download an app. FaceTime makes use of the built-in smartphone cameras and microphone/speakers.

Video calls permit:
» Live video and audio chat » Screen-sharing during the call » Recording during sessions.

Internet access

Access to the internet from a mobile device is another valuable feature. Any mobile device can connect to the internet either using a wireless broadband connection or via the mobile phone network.

Mobile devices also have a built-in feature which automatically selects wireless broadband connectivity (if possible), instead of the mobile phone network, when connecting to the internet. This has the following advantages:

» Less expensive (mobile phone company 'data plans' often have a cap on how much data can be downloaded, and charge for exceeding this maximum)
» Lower power consumption (Wi-Fi routers are usually much closer than the mobile phone towers; the longer the range, the greater the power consumption)
» Quality of service (Wi-Fi usually offers greater bandwidth than the mobile phone network giving the possibility of downloading more data more quickly).

6.2 Modelling applications

6.2.1 Computer modelling

A **simulation** is the creation of a model of a real system in order to study the behaviour of the system. The model is computer-generated and is based on mathematical representations.

Advantages of using models

» Using computer models is less expensive than having to build the real thing (for example, a bridge!).
» On many occasions it is safer to use a computer model
» Computer modelling allows you to try out various different scenarios in advance.
» It is nearly impossible to try out some tasks in advance in real life because of the high risk involved or the remoteness
» It is often faster to use a computer model than do the real thing.

Disadvantages of using models

» A model is only as good as the programming, or the data entered; the simulation will depend heavily on these two factors.
» Although building the real thing can be expensive, sometimes computer modelling is also a very costly option, and the two costs need to be compared before deciding which to use.
» People's reactions to the results of a simulation may not be positive; they may not trust the results it produces (there will always be a difference between the results from modelling and reality).

Personal finance

Figure 6.6 uses a spreadsheet to model the sales of a tuck shop in a school.

	A	B	C	D	E	F	G
1	**Item**	**Price**	**Selling**	**Profit**	**Weekly**	**Number**	**Total Profit**
2		**each ($)**	**price ($)**	**per item**	**shop cost**	**sold per**	**item ($)**
3					($)		
4	chew	1.00	1.50	0.50		35	17.50
5	chox	2.00	2.50	0.50		45	22.50
6	gum	3.00	3.50	0.50		30	15.00
7	crisps	1.00	1.50	0.50		45	22.50
8	cake	2.00	2.50	0.50		40	20.00
9							
10					200.00	**profit/Loss: $**	**-102.50**

The formulae behind this spreadsheet are:

	A	B	C	D	E	F	G
1	**Item**	**Price**	**Selling**	**Profit**	**Weekly**	**Number**	**Total Profit**
2		**each ($)**	**price ($)**	**per item**	**shop cost**	**sold per**	**item ($)**
3					($)		
4	chew	1.00	1.50	=(C4-B4)		35	=(C4*F4)
5	chox	2.00	2.50	=(C5-B5)		45	=(C5*F5)
6	gum	3.00	3.50	=(C6-B6)		30	=(C6*F6)
7	crisps	1.00	1.50	=(C7-B7)		45	=(C7*F7)
8	cake	2.00	2.50	=(C8-B8)		40	=(C8*F8)
9							
10					200.00	**profit/Loss: $**	**=sum(G4:G8)-E10**

▲ **Figure 6.6** Personal finance modelling using a spreadsheet

Bridge and building design

When an engineer or architect designs a new building or bridge, it is necessary to test the design long before any construction work is started.

Similar methods are used when designing new buildings, particularly skyscrapers. Again, computer models are used, often in conjunction with wind-tunnel tests on a scale model. When testing the building using a computer model, a number of scenarios need to be considered:

» What is the effect of natural phenomena, such as hurricane winds, flooding, earthquakes and any other potentially damaging phenomena

» The effect of a disaster, such as a fire – how does the structure stand up to such scenarios?

» How is it possible to move people around the building efficiently

▲ **Figure 6.8** Scale models are used to test buildings.

Computer modelling provides the following features:
» It is possible to zoom into images so that fine details can be seen.
» The design can be rotated in a number of different ways to allow different views of the design to be made.
» Building a bridge or building is expensive and dangerous if the final design had a serious flaw; modelling should allow any potential design flaws to be detected before any construction starts.
» Various scenarios can be tried out to see the effect on the design (see earlier list of scenarios).

Flood water management

Computer models are used to predict water levels, water flows and potential flood depths. Input to the system could include:

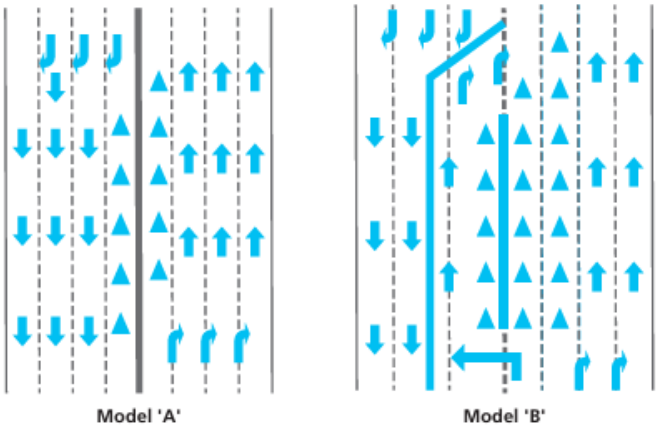
» Cross-section of rivers and sea inlets (for example, bottlenecks)
» Dimensions of any bridges, weirs or sluices in the flood area
» Factors that can affect water flow rates (for example, tides are affected by the time of year and by strong winds)
» Boundary conditions (for example, upstream flows into rivers and downstream water levels)
» The start and finishing date for the simulation
» Calibration data (observation of actual flooding in the past)

Traffic management

Computer modelling can be used in traffic management. We will consider two different situations.

Closure of motorway lanes

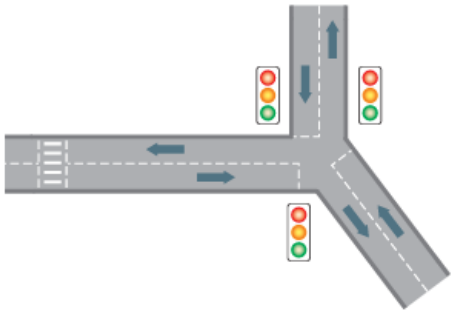
Repairs need to be made to part of the central barriers on an eight-lane motorway. The company given the task of carrying out these repairs needs to model the impact of the roadworks on the traffic flow. They have decided there are two ways of controlling traffic which need to be modelled.



▲ **Figure 6.10** Motorway closures model

Traffic light simulation

Figure 6.11 shows a second use of computer modelling in traffic management – a set of traffic lights are to be modelled at a Y-junction.



▲ **Figure 6.11** Traffic light simulation

In this simulation it is necessary to consider:
1. how and what data needs to be collected
2. how the simulation is carried out
3. how the system would work in real life.

How and what data needs to be collected?

Because the success (or failure) of a model depends on how realistic it is, data needs to be collected by watching traffic for a long period of time at the Y-junction.

The following data is an indication of what would need to be collected:
» The number of vehicles passing the junction in all directions
» The time of day needs to be recorded along with a vehicle count
» How many vehicles build up at the junction at different times of the day
» Data should cover weekends, bank holidays, etc. as this can alter how the data needs be interpreted
» How long it takes a vehicle to clear the junction
» Other data needs to be considered (for example, pedestrian crossings nearby, as shown in Figure 6.11)
» How long it takes the slowest vehicle to pass through the junction
» Consider other factors (for example, left turns, right turns, filtering, etc.).

How is the simulation carried out?

Data from the above list is entered into the computer and the computer model is run. Once the designers are satisfied that the model simulates the real situation accurately (that is, by comparing the model's results with actual traffic flow data) then different scenarios can be tried out.

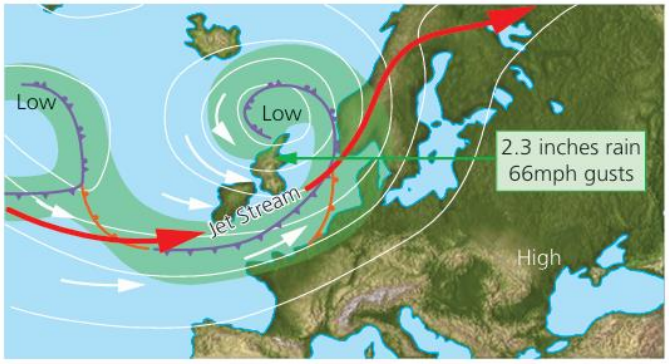
How would the system work in real life?

» Sensors in the road gather data and count the number of vehicles at the junction.
» This data is sent to a control box or to a computer (it will need to be converted first into a form understood by the computer).
» The gathered data is compared to data stored in the system (the stored data is based on model/simulation predictions which were used to optimise the traffic flow).
» The control box or computer 'decides' what action needs to be taken.
» Signals are then sent out to the traffic lights to change their timing if necessary.

Weather forecasting

Weather stations are set up to automatically gather data from the environment. They are usually automatic and use a variety of sensors to measure:
» Rainfall
» Temperature
» Wind speed
» Wind direction
» Barometric pressure (air pressure)
» Humidity.

In a model, the atmosphere is divided up into a three-dimensional grid. The data from the weather stations is input into the appropriate grid and the model is run forward in time to make predictions.



▲ **Figure 6.12** Animated weather forecast

» Data is input into the model and a prediction of the weather for the next few days is made.
» At the end of the weather forecast period, the model compares its weather forecast with the actual weather that occurred.
» The model 'learns' from previous weather situations; improvements to how it predicts weather are constantly made.
» The new data is then input into the model, and a weather forecast for the next few days is made.
» A very powerful computer is needed to run this model, since it has to 'number crunch' vast amounts of data

▲ **Figure 6.13** This robot arm is equipped with a spray gun 'end effector'. Different end effectors allow the robot arm to carry out many different tasks.

6.3 Computer controlled systems

6.3.1 Computer controlled systems

Control of robots is either through embedded (built-in) microprocessors or linked to a computer system. Programming of the robot to do a series of tasks is generally done in two ways:

1. The robot is programmed with a sequence of instructions which allow it to carry out the series of tasks

2. Alternatively, a human operator manually carries out the series of tasks; this can be done in two ways:

i. The robot arm is guided by a worker when spraying the object; each movement of the arm is stored as an instruction in the computer.

OR
ii. The worker straps sensors to his own arm and sprays the object; each movement is stored as a set of instructions in a computer; the sensors send back information such as position relative to the object, arm rotation, and so on – this information forms part of the instructions stored in the computer.

Advantages in using robots

» They can work in environments harmful to human operators.
» They can work non-stop (24/7).
» They are less expensive in the long term (although expensive to buy initially, they do not need wages).
» They have higher productivity (do not need holidays, etc.).
» They provide greater consistency (for example, every car coming off a production line is identical).
» They can do boring, repetitive tasks, leaving humans free to do other more skilled work
» They can carry out different tasks by fitting them with different end-effectors (attachments

Disadvantages in using robots

» Robots find it difficult to do 'unusual' tasks (for example, one-off glassware for a chemical company).
» They can cause higher unemployment (replacing skilled labour).
» Because robots do many of the tasks once done by humans, there is a real risk of certain skills (such as welding) being lost.
» Because robots are independent of the skills base, factories can be moved anywhere in the world (again causing unemployment).
» The initial set-up and maintenance of robots can be expensive.

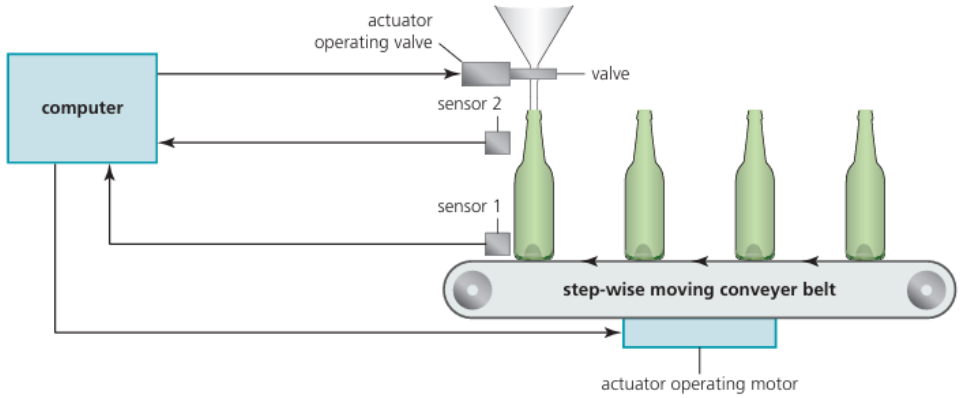
Production line control

Production line control using robots is used extensively in industry. The production line will be continuous, with various robots at each station given a specific task. Using robots in this way leads to:

» Faster operations (the number of cans of baked beans filled is 120 per minute)
» Much greater productivity (the production can run 24 hours a day for every day)
» Greater consistency (every can contains exactly the correct weight of baked beans)
» Built-in quality control (automatic testing for foreign material, such as metal filings, which would result in automatic rejection from the production line)
» Reduced cost to the consumer (although initial robot arms are expensive, there are far fewer staff in the factory who would need wages).

Let us take a closer view of how robots could be used in a bottling plant.

» Sensor 1 (a pressure sensor, light sensor or camera) detects the presence of a bottle; this sensor is constantly sending signals back to the computer.
» When the signal from sensor 1 indicates a bottle is present, the computer sends a signal to an actuator which opens a valve allowing liquid to flow into the bottle.
» Sensor 2 (a level sensor) is used to detect the correct liquid height in the bottle; this sensor sends continuous signals back to the computer.



▲ **Figure 6.14** Bottling plant

6.4 School management systems

6.4.1 School management systems

Schools have to manage a number of different tasks in their day-to-day running. These tasks include:
» Registration and attendance records of students » Student performance » Computer-aided learning.

Registration and attendance records of students

Method 1
Issue each student with an ID card. These contain a magnetic stripe (shown in black) on the rear of the card. The student would have to sign the card and also write their unique student ID on the back of the card. The magnetic stripe would contain the name of the school, the name of the student, the student's data of birth and their unique ID (registration) number

There are further functions that could be used such as:
» The use of a PIN to stop another student swiping in with the wrong card
» The use of GPS tracking (see Section 6.11) so the exact whereabouts of a student would be known; this would require the addition of a chip in the ID card so that the tracking system could identify them (see Section 6.11 for information on RFID) – however, there are privacy concerns surrounding location tracking

Method 2
A second method could make use of biometrics. Each student would have their fingerprints recorded. Their personal details (as in Method 1) plus fingerprints would be stored on a database. When a student entered the school premises, they would be asked to put their hand on a scanner which would read their fingerprints.

Advantages of this method compared to use of magnetic ID cards

» Fingerprints are unique, so it would be impossible for a student to sign in pretending to be someone else (with magnetic cards, a student could give their card to a friend and ask them to sign in for them) – this gives more accurate data and improved security.
» ID cards could easily be lost – fingerprints are 'part of you' so cannot be lost.
» ID cards could be affected by magnetic fields which would stop them working properly.
» It is much easier to 'clone' (make copies of) ID cards than it would be to copy fingerprints (not impossible but very difficult).

Disadvantages of this method compared to use of magnetic ID cards

» It would take a long time to collect the fingerprints for every student in the school.
» The equipment needed to take and read fingerprints is more expensive than magnetic stripe reading equipment.
» If a student cuts a finger, the fingerprint may not be identified by the system (which would prevent entry to the school).
» There are invasion-of-privacy issues and a number of students and parents may object to having fingerprints stored on a database.

Student performance

School management systems are used to record the performance of students. Performance can consist of both academic achievement and behaviour. To produce an end-of-term or end-of-year report, the system would need to have access to the following data:

» Student's exam and test results in all subjects studied over the term/year
» Behavioural data
» CAT scores (these are standardisation test results to enable each student to be measured against a standard).
After processing this data, the system could produce:
» The average grades for all students in a class
» Class and year group reports showing academic and behavioural performance.

Computer-aided learning

Computer-aided learning (CAL) is the use of computer-based systems to assist in the academic teaching of students. They are designed to enhance, and not replace, traditional classroom teaching.

Advantages of using CaL to enhance the learning process

» Students can learn when they want to and at their own pace.
» It allows virtual reality (VR) learning to be used; with VR, the student is fully immersed into the learning environment.
» The student can stop at any point and return later to continue where they left off.
» It is possible to re-take tests until the student reaches the required skills level.
» CAL can make learning more interactive.
» CAL makes use of various multimedia
» The real goal of CAL is to stimulate student learning and not actually replace teacher-based learning; CAL, if used properly, should be an integrated part of the student's learning process.
» CAL can make use of multiple-choice questions (MCQs) which can be marked immediately by the computer system, giving instantaneous feedback to the student; other assessment methods can be used, such as fill in the missing words, crossword puzzles, linking correct terms to descriptions and gaming.
» It can deliver micro-learning; this is where a topic is broken down into small modules which are easy to learn, and is when CAL is most effective

Disadvantages of using CaL to enhance the learning process

» CAL cannot give students the experience of handling laboratory equipment;
» It is expensive and time consuming to integrate CAL properly into the learning environment.
» Students can easily be distracted while online;
» It can lead to the isolation of a student because they are spending their time on their own in front of a computer screen; this needs to be carefully managed.
» CAL cannot answer unusual questions, and the student will need to seek out guidance from a teacher; in other words, CAL is not a self-contained learning system.

6.5 Booking systems

6.5.1 Online booking systems

Online booking systems rely on the ability to update files immediately, thus preventing double-booking, which could happen if the system response time was slow. Online booking systems are used in:

» The travel industry
» For concerts (theatre and music events)
» For cinema tickets
» When booking sporting events.

Advantages

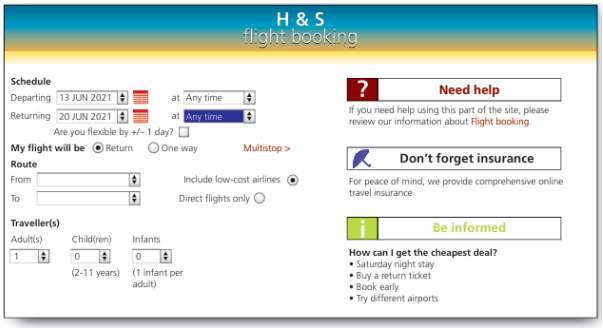
» They prevent double-booking.
» The customer gets immediate feedback on the availability of seats and whether or not their booking has been successful.
» The customer can make bookings at any time of the day.
» The customer's email allows the booking company to connect 'special offers' to their email and inform them of such offers automatically.
» It is usually easier to browse the seating plans (particularly on flights) to choose the best seats available at the price.
» It is possible to 'reserve' a seat for a period of time – this allows a customer to 'make up their mind' before finalising the booking of the seat (this was difficult to do with the older paper-based systems)
» Very often there are no printed tickets, which saves postal costs and also allows 'impulse' bookings only a few hours in advance.
» Online booking allows the use of modern smartphone and tablet Apps technology; the customer is sent a QR code which contains all the booking information necessary

Disadvantages

» The setting up and maintenance of online booking systems is expensive.
» All customers using this service need access to a computer or mobile phone and a reliable internet connection.
» It is often more difficult to cancel the booking and get your money back using online systems.
» If the server is down for maintenance, or if the systems breaks down, it becomes impossible to book seats by any method
» If the websites are not well designed, it can be difficult to make exactly the booking you want or can lead you to make mistakes; this is a particular issue with flight bookings where correcting an error can cost the customer an additional fee.
» Booking online does not allow you to build a personal relationship with a travel agent who might offer free upgrades or special offers which may not be available to online bookings.

The travel industry

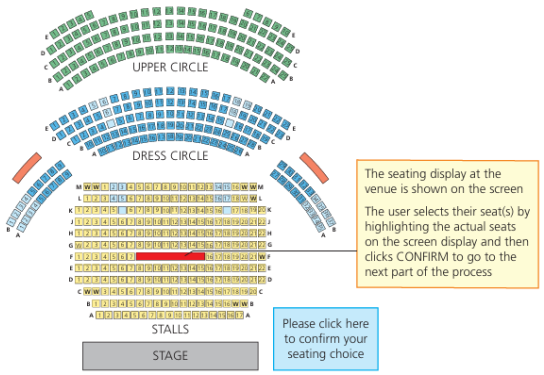
As an example, we will consider booking a flight online. A form similar to the one shown in Figure 6.17 would appear on the screen.



▲ **Figure 6.17** Online flight booking example

Events such as concerts, theatres and cinemas

We will now consider the online booking system when trying to book a concert, theatre or cinema performance.



▲ **Figure 6.18** Event booking screen display

» The customer clicks on the performance they wish to see.

» A date and time is typed in.

» The required number of seats is also entered.

» The seating display at the venue is shown on the screen.

» The user selects their seat(s) by highlighting the actual seats on the screen display and then clicks CONFIRM to go to the next part of the process.

» The database is then searched to check the availability of the selected seats.

» If the seats are available, the total price is shown plus the seat numbers; this shows on another screen on the web page.

» If the customer is happy with this, they select CONFIRM on the screen.

» The seats are now temporarily held and set by the system as NO LONGER AVAILABLE – this stops anyone else from booking them

» The customer then enters their personal details or indicates that they are a returning customer (in which case the website being used will already have their details).

» Payment method is then selected and payment made.

» The theatre seats are then booked in the customer's name.

» The final details are again shown on the screen.

» An email is sent to the customer which may contain a QR code which contains all their booking details (this acts as their e-ticket); the QR code is then scanned at the venue.

» The database is finally updated with the booking transaction and the seats are permanently confirmed as no longer available.

▲ **Figure 6.19** Sports venue booking system seating plan

Booking sporting events

Booking a sporting event is very similar to the example above. Again, depending on the event, the online booking system will show a seating plan. The customer will need to select the event, the required day(s), number of people and preferred seats. Because the seats are often sold in blocks, the database will be searched to see if there are any seats available on the chosen date. The advantages and disadvantages of booking sports events online are the same as for online booking of concert and cinema tickets

6.6 Banking systems

6.6.1 Banking applications

The use of computer technology has revolutionised how we all do our banking transactions. In this section, we will consider:

» The use of automatic teller machines (ATMs)
» Electronic funds transfer (EFT)
» Credit/debit card transactions
» Cheque clearing
» Internet banking.

Automatic teller machines (ATMs)

Automatic teller machines (ATMs) allow the customer to:

» Withdraw cash
» Deposit cash
» Deposit cheques
» Check the balance of their account
» See a mini bank statement
» Pay a bill
» Do a money transfer

▼ **Table 6.2** Withdrawal of money from an ATM

Sequence for withdrawing cash	What goes on behind the scenes
Customer puts card into ATM	Contact is made with bank's computer
PIN is entered using the keypad	PIN is checked to see if it is correct; if not correct, customer is asked to retype PIN The card is checked to see if the card expiration date is exceeded or if the card has been stolen If card is stolen or if number of PIN attempts exceeds three, card is retained and transaction closed
A number of options are given: » change PIN » account balance – on screen – printed out » pay in cheques » get a mini statement » pay a bill » make a money transfer » deposit cash » withdraw cash	
The customer selects to withdraw cash	
A number of cash amounts are shown	

▲ **Figure 6.20** An automatic teller machine (ATM)

Advantages of using ATMs

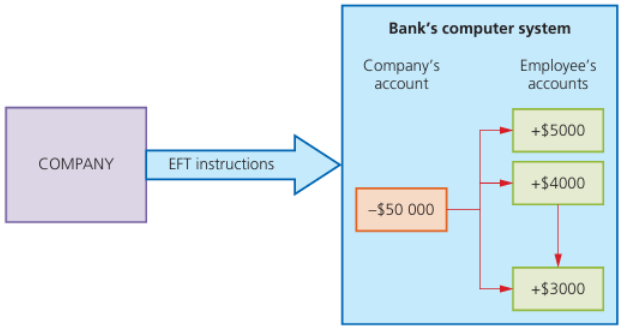
» It is possible to withdraw cash at any time of day.
» They offer many banking services without the need to go into the bank – such as statements, account balance and bill paying – which helps people to manage their money more easily.
» It is possible to access an account from anywhere in the world.
» It usually provides quicker service than waiting in a queue in a bank.

Disadvantages of using ATMs

» They are often in places where theft can take place at night.
» There is potential for shoulder-surfing and card-cloning scams.
» Some banks charge customers for using ATMs.
» Cash withdrawal limits are often imposed on customers.
» If the debit card is faulty then no transaction can take place.
» There is a loss of the personal touch, which some customers will not like.

Electronic funds transfer (EFT)

Electronic funds transfer (EFT) is a system that allows money transfer instructions to be sent directly to a bank's computer system.



▲ **Figure 6.21** EFT example

Another example of EFT in use is when a credit/debit card is used to pay for a purchase in a store, the payment is made using a system called **electronic fund transfer at point-of-sale (EFTPOS).**

Advantages of EFT

» It is a very secure payment method.
» It is a very quick payment method.
» It is less expensive than, for example, using cheques.
» The customer has the right to dispute an EFT payment for up to 60 days.

Disadvantages of EFT

» Once an amount has been transferred the bank cannot reverse a transaction (requires a full dispute investigation).
» The customer needs to have funds available immediately (unlike when using a cheque).
» It cannot guarantee the recipient (someone with a fake ID could collect the money).

Credit/debit card transactions

This system is designed to enhance security because it is better than relying only on a signature. Paying for items using a chip and PIN card is a form of electronic funds transfer (EFT).

▼ **Table 6.3** Advantages and disadvantages of credit cards and debit cards

Type of card	Advantages	Disadvantages
Credit	» there is customer protection if a company stops trading or goods do not arrive » internationally accepted method of payment » interest-free loan if money paid back within agreed time period » can buy items online	» can be charged high interest rate » annual fees often apply » easy to end up with credit damage as sums mount up » security risks when using credit card online (see Chapter 8)
Debit	» money comes from customer's current account, therefore no interest charges » safer than carrying cash » can buy items online	» less customer protection than credit card if goods do not arrive or company goes out of business » no credit allowed; customers must have the funds available » security risks when using debit card online (see Chapter 8)

Cheques

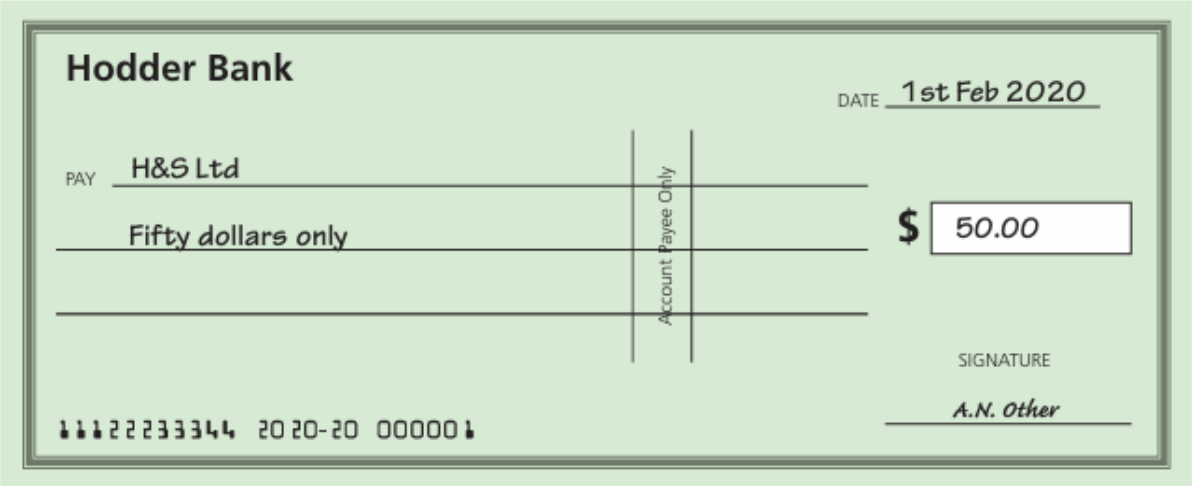
Cheques are one of the oldest ways of paying somebody for services or goods. Because it is a relatively expensive, slow and less secure way of making payments, cheques are slowly being phased out

▼ **Table 6.4** Advantages and disadvantages of using cheques

Advantages	Disadvantages
» more convenient and safer than cash » it is possible to stop payments if necessary » a cheque can be drawn any time (up to six months after it was dated and signed) » cheques can be post-dated » cheques can be traced if they are 'lost'	» cheques are not legal tender and can be refused » it is a slow method of payment » easier for fraudsters than credit card or debit card payment methods » relatively expensive payment method

Centralized clearing of cheques

This method was first introduced around 2017 and has now been adopted by many banks worldwide. It is a much quicker system than the previous method used to clear cheques.



▲ **Figure 6.23** A typical cheque

Internet banking

Because of the many similarities, internet banking is fully covered in Section 6.9 along with online shopping.

6.7 Computers in medicine

6.7.1 Information systems in medicine

Computers are used in many areas of medicine, such as:
» Keeping patient records and pharmacy records
» Use of 3D printers in many areas of surgery and customised medicines.

Patient and pharmacy records

Doctors and hospitals need to keep accurate records of all their patients. This is essential to ensure correct diagnosis and treatment. An up-to-date medical history is part of the diagnosis process.

The sort of data which would be required on a patient database is as follows:
» A unique identification number
» Name and address » date of birth » gender (male or female)
» Medical history (for example, recent medicine/treatment)
» Blood group
» Any known allergies
» Doctor
» Any current treatment
» Any current diagnosis
» Important additional information such as X-rays, CT scans, and so on.

Use of 3D printers

3D printers were first introduced in Chapter 3. Their use in a number of fields is rapidly progressing. One of the most innovative uses is in the field of medicine.

Surgical and diagnostic aids

It is possible to print out anatomical parts using 3D printers. These are used as an aid towards diagnosis and surgical procedures. The patient is scanned using:

» CT (computed tomography) – which involves producing images of the internal parts of the body in a series of thin slices less than 0.1 mm thick, or
» MRI (magnetic resonance imaging) – this uses strong magnetic fields and radio waves to produce a series of images of the internal organs in the body. 140

Prosthetics

3D printers are now being used to print out prosthetics (false arms, hands and legs). While state-of-the-art myoelectric prosthetics cost tens of thousands of dollars, the price for 3D-printing a prosthetic arm or hand can be as little as $100.

Tissue engineering

3D bio-printing (using **bio-inks**) is a very complex process and requires input from biologists, medical engineers, physicists and other engineers. It has already been used successfully to produce multi-layered skin tissue, bone tissue, heart/artery grafts and tracheal splints.

Artificial blood vessels

One particular type of tissue engineering is the 3D printing of artificial blood vessels using human cells. These bio-printed tissues work in much the same way as natural blood vessels. Biomimetic blood vessels can be fabricated using 3D printing and bio-inks.

Customised medicines

3D printing techniques now allow scientists to customise medicines to suit the individual. This is known as patient-centric medicine. 3D printed medicines are sometimes referred to as printlets (printed tablets).

Some of the advantages of this technology include:
» Tailor-made medicines to suit the individual
» Better control of medicine release into the body
» Saves money (many modern medicines are very expensive) » better targeting of the medicine so its effects can be optimised
» Less chance of an overdose of the medicine, thus reducing harmful side-effects

6.8 Expert systems

6.8.1 Expert systems

Expert systems have been developed to mimic the expertise and knowledge of an expert in a particular field.

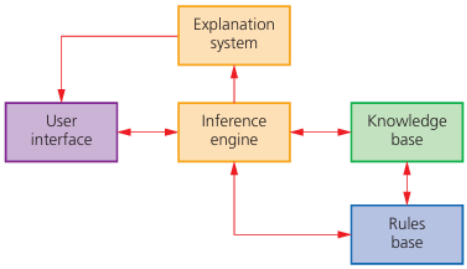
Advantages of expert systems

» They offer a high level of expertise.
» They offer high accuracy.
» The results are consistent.
» They have the ability to store vast amounts of ideas and facts.
» They can make traceable logical solutions and diagnostics.
» It is possible for an expert system to have multiple types of expertise.
» They offer a very fast response time (much quicker than a human expert).
» They provide unbiased reporting and analysis of the facts.
» They indicate the probability of any suggested solution being correct.

Disadvantages of expert systems

» Users of the expert system need considerable training in its use to ensure the system is being used correctly.
» The set-up and maintenance costs are very high.
» They tend to give very 'cold' responses which may not be appropriate in certain medical situations.
» They are only as good as the information/facts entered into the system.
» Users sometimes make the very dangerous assumption that they are infallible.

Figure 6.27 shows the typical make up of an expert system.



▲ **Figure 6.27** Expert system structure

User interface

» This is the method by which the expert system interacts with a user.
» It allows interaction through dialogue boxes, command prompts or other input methods.
» The questions being asked usually only have yes/no answers and are based on the responses to previous questions

Explanation system

» This informs the user of the reasoning behind the expert system's conclusions and recommended actions.
» The expert system will supply a conclusion and any suggested actions to take; the important thing is it will also give the percentage probability of the accuracy of its conclusions.

Inference engine

» This is the main processing element of the expert system.
» The inference engine acts like a search engine examining the knowledge base for information/data that matches the queries.
» It is responsible for gathering information from the user by asking a series of questions and applying responses where necessary; each question being asked is based on the previous responses.
» The inference engine is the problem-solving part of the expert system, which makes use of **inference rules** in the rules base.
» Because the knowledge base is a collection of objects and attributes, the inference engine attempts to use information gathered from the user to find an object that matches (making use of the rules base to find a match).

Knowledge base

» The knowledge base is a repository of facts.
» It stores all the knowledge about an area of expertise obtained from a number of expert resources.
» It is basically a collection of objects and their attributes (see the example in Table 6.5).

Table 6.5 Sample knowledge base showing objects and attributes

Object	Attribute 1	Attribute 2	Attribute 3	Attribute 4	Attribute 5
Dog	mammal	lives on land	makes bark sounds	body is covered in fur	walks on four legs
Whale	mammal	lives in water	makes sonic sound	body covered in skin	swims; no legs
Duck	bird	lives in water	makes quack sounds	body covered in feathers	swims; has two legs

Rules base

» The rules base is a set of inference rules.
» Inference rules are used by the inference engine to draw conclusions (the methods used closely follow human reasoning).
» They follow logical thinking like the example above; usually involving a series of 'IF' statements,

Setting up an expert system

» Information needs to be gathered from human experts or from written sources such as textbooks, research papers or the internet.

» Information gathered is used to populate the knowledge base, which needs to be first created.

» A rules base needs to be created; this is made up of a series of inference rules so that the inference engine can draw conclusions.

» The inference engine itself needs to be set up; it is a complex system since it is the main processing element, making reasoned conclusions from data in the knowledge base.

» The user interface needs to be developed to allow the user and the expert system to communicate.

» Once the system is set up, it needs to be fully tested; this is done by running the system with known outcomes so that results can be compared and any changes to the expert system made.

Example 1: medical diagnosis

Input screen

- First of all an interactive screen is presented to the user
- The system asks a series of questions about the patient's illness
- The user answers the questions asked (either as multiple-choice or yes/no questions)
- A series of questions are asked based on the user's responses to previous questions

Expert system

- The inference engine compares the symptoms entered with those in the knowledge base looking for matches
- The rules base is used in the matching process
- Once a match is found, the system suggests the probability of the patient's illness being identified accurately
- The expert system also suggests possible solutions and remedies to cure the patient or recommendations on what to do next
- The explanation system will give reasons for its diagnosis so that the user can determine the validity of the diagnosis or suggested treatment

Output screen

- The diagnosis can be in the form of text or it may show images of the human anatomy to indicate where the problem may be
- The user can request further information from the expert system to narrow down the possible illness and its treatment

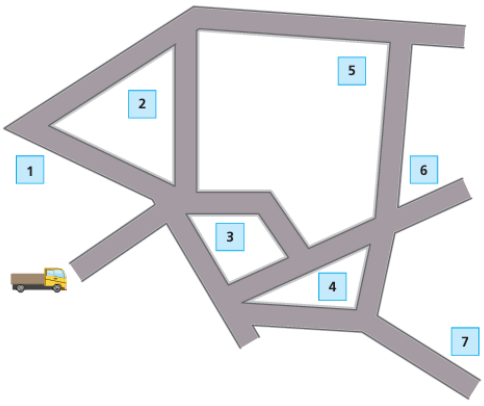
▲ **Figure 6.28** Medical diagnosis (example of use of an expert system)

Example 2: oil prospecting

» An interactive user screen appears (this is often made up of multiple-choice questions or yes/no responses).
» Questions are asked about geological profiles.
» Answers to questions/geological profiles are typed in by the operator.
» The next questions asked are based on the previous response(s) input by the operator.
» The **inference engine** searches the **knowledge base** using the **rules base**.
» The system suggests the probability of finding oil as an output.
» It also indicates the probable depth of deposits (usually as a % probability).
» The explanation system will also explain how the expert system arrived at its conclusions.
» It makes predictions about geological deposits above the soil.
» It produces contour maps showing concentration of minerals, rocks, oil, etc.

Example 3: route scheduling for delivery vehicles

An expert system could be employed to find the most efficient route for a parcel delivery van. The software will determine the fastest and least expensive route, as well as suggest the number of vehicles and drivers that should be used.



▲ **Figure 6.29** Most efficient route map

6.9 Computers in the retail industry

6.9.1 Computers in the retail industry

Computers are used in the retail industry at point-of-sale (POS) terminals, where they are also used in the automatic stock control systems.

Point-of-sale (pos) terminals

Barcodes now appear on most products sold in shops. They allow quick identification of product details once the barcode has been scanned by a **barcode reader**. Supermarkets, in particular, use **point-of-sale (POS) terminals** which incorporate a barcode reader to scan the barcode and retrieve the price of the article.

▲ **Figure 6.30** Barcode sample

A number underneath the barcode usually consists of four parts: a country code, manufacturer's code, product code and a **check digit**. The check digit is a form of **validation** which is used to make sure no errors occurred during the reading of the barcode.

When all the items have been scanned, the customer is given an **itemized bill** showing a list (with prices) of everything they have bought.

Electronic funds transfer at point-of-sale (EFTPOS)

When payment is made by card or electronic device (such as a mobile phone) at the POS terminal, it is known as electronic funds transfer at the point-of-sale (EFTPOS)

Chip and PIN

The use of chip and PIN was discussed in Section 6.6. In the case of payment at a supermarket, this is usually done by inserting the card into a reader and then the procedure is identical to that described in Section 6.6. The reader makes a connection with the chip embedded in the card.

Advantages of chip and PIN cards

» They are more secure system than magnetic stripe cards (PIN typed in must match up with PIN stored on chip).
» It is a quicker system than magnetic stripe cards and allows for contactless payments to be made

Disadvantages of chip and PIN cards

» The risk of fraud when typing in the PIN – the customer needs to be careful to ensure the PIN is not being read by somebody else while typing it in.
» Some countries do not accept chip and PIN cards.

Contactless cards

The use of contactless card payments was discussed in Section 2.2, together with their advantages and disadvantages.

Near field communication (NFC) devices

Near field communication (NFC) technology is discussed in more detail in Section 6.10. When using NFC payment at a POS terminal the sequence of events taking place is:

» The electronic device (for example, mobile phone) is held close to the NFC reader (the terminal); this only works up to a distance of 5 cm, so the devices need to be very close together.
» When the NFC (contactless) payment is initiated, the NFC terminal and electronic device (smartphone) pass encrypted data back and forth to each other to enable the payment to be made.
» This is very secure because NFC communications are encrypted and are dynamic (which means encrypted data being shared changes every time a transaction takes place).
» Mobile phone manufacturers use **tokenisation** to improve security.

Use of tokenisation with mobile phones

Tokenisation is used when setting up a mobile wallet. The user takes a photograph of their credit card using the smartphone's camera.

The bank replaces the details on the card with a series of randomly generated numbers (called **tokens**), which they send back to the mobile phone manufacturer, who then programs this random number into the user's smartphone.

6.9.2 Internet shopping

Internet banking and internet shopping

Using **internet banking** requires good online security. As the amount of **online shopping** and banking increases, the positive and negative impacts on society become clearer.

Advantages of online shopping and banking

» There is no longer a need to travel into town centres, thus reducing costs (money for fuel, bus fares, etc.) and time; it also helps to reduce town centre congestion and pollution.

» Users now have access to a worldwide market and can thus look for products that are cheaper; this is obviously less expensive and less time consuming than having to shop around for goods or services in person and they will also have access to a much wider choice of goods.

» Being able to access any shop or bank without the need to leave home may be of benefit to some people with disabilities and elderly people.

» Because it is online, shopping and banking can be done at any time on any day of the week (i.e. 24/7) – this is particularly helpful to people who work during the day as the shops and banks can often be closed when they finish work.

» People can spend more time doing other things, for example, going shopping to the supermarket probably took up a lot of time; by doing this online (and being able to set up repeat items) people are now free to do more leisure activities.

» Similarly, paying bills in person or by posting cheques was time consuming – now this can be done simply and easily using online banking.

» Many people find it less embarrassing to ask for a bank loan using the internet rather than enduring a face-to-face discussion with bank staff.

» There are often long queues at the banks so internet banking saves time.

» The shops and banks save money by not having as many staff working for them (reduced wage bill) or needing as many high-street premises (reduction in rental costs) – these savings may be passed on to the customer in the form of lower interest rates, cheaper goods or higher rates of interest for savers.

Disadvantages of online shopping and banking

» There is the possibility of isolation and lack of socialisation if people stay at home to do all their shopping and banking.

» There are possible health risks associated with online shopping or banking because of lack of exercise; if people physically go shopping then they are getting some exercise.

» Security issues are a major concern as are viruses and other malware

» Accidentally using fraudulent bank or shopping websites is always a risk and this is linked to security issues.

» It is necessary to have a computer and to pay for the internet to take part in online shopping and banking.

» Unlike high-street shopping, it is only possible to see a picture of the goods, and nor can you try something on to see if it fits before buying them; you also have to wait several days for the goods to arrive and returning goods may be expensive and time consuming.

» Next-day delivery of individual items leads to more delivery traffic and pollution.

» High-street shops and banks are closing because of the increase in online shopping and banking and this is leading to deserted high streets.

» Local independent retailers may lose out to huge multinational retail companies.

» It is easier to make errors with online banking and transfer money incorrectly to different accounts.

Effects on companies due to the spread of online shopping and banking

Companies and other organisations have also been affected by the growth of ICT and online shopping and banking. Some of the effects are listed below:

» Companies can save costs because fewer staff need to be paid and it is not necessary to have as many shops and banks in high streets to deal with potential customers.

» Because the internet is global, the potential customer base is increased.

» There will be some increased costs, however, because of the need to retrain staff and the need to employ more staff in despatch departments.

» There are also costs due to the setting up and maintaining of websites to enable online shopping and banking.

» Because there is very little or no customer–employee interaction, this could lead to a drop in customer loyalty, which could lead to loss of customers

» Robberies are less likely due to the decrease in the number of high-street banks.

» Banks also need to employ fewer security staff, which has a cost benefit.

6.10 Recognition systems

6.10.1 Recognition systems

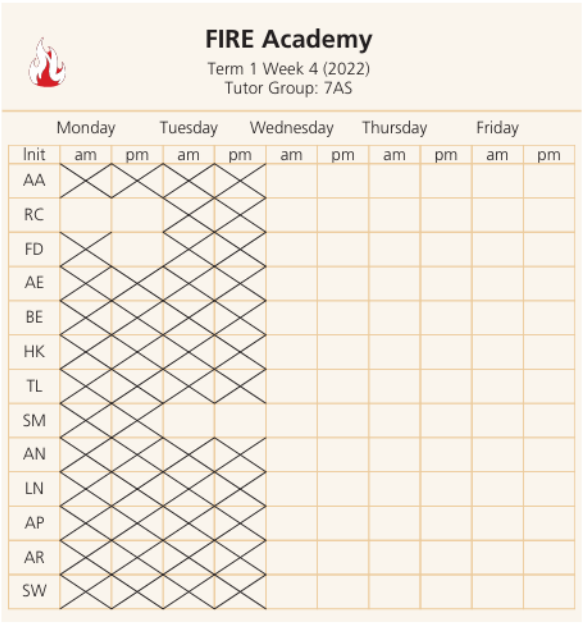
Recognition systems include OMR, barcode readers, QR code readers, OCR, RFID and biometric recognition systems.

optical mark recognition (OMR)

Use of OMR to read school registers Other digital methods of registering students were mentioned earlier on in this chapter (i.e. use of magnetic stripe cards and biometrics). However, paper-based systems are still used in many schools.

Use of OMR to read multiple-choice question (MCQ)

papers Completed multiple-choice forms can be scanned in using OMR. The forms have timing marks down one side – these timing marks pass under the first column sensor of the scanner



FIRE Academy
Term 1 Week 4 (2022)
Tutor Group: 7AS

Init	Monday am	Monday pm	Tuesday am	Tuesday pm	Wednesday am	Wednesday pm	Thursday am	Thursday pm	Friday am	Friday pm
AA										
RC										
FD										
AE										
BE										
HK										
TL										
SM										
AN										
LN										
AP										
AR										
SW										

▲ **Figure 6.31** Sample register which can be read by OMR

Advantages of OMR devices

» It is a very fast way of inputting the results of a survey, etc. – the documents are fed in automatically and there is no user input.
» Because there is no typing, they are more accurate than keying in the data.
» They are more accurate than OCR methods.

Disadvantages of OMR devices

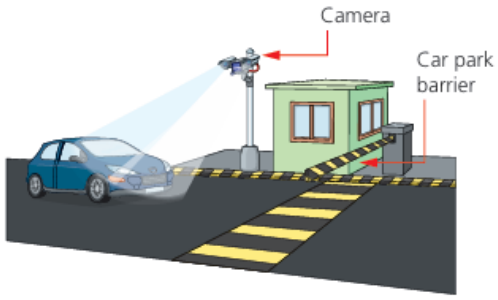
» The forms need to be carefully designed to make sure the marks/shading are correctly positioned to gather accurate information.
» There can be problems if they have not been filled in correctly, and sometimes have to be manually checked before being read – this is both time consuming and expensive.
» They often only work with black pen or pencil.
» They are limited to the questions on the paper; it is not possible to get expansion to answers in a questionnaire, for example.

Automated number plate recognition (ANPR) systems

Automatic number plate recognition (ANPR) systems are used to read the number plates on cars in a number of applications.

Step 1

A sensor detects a vehicle and sends a signal to instruct a camera to capture an image of the front of the vehicle (often an infrared camera is used to give a clearer image and for use at night)



▲ **Figure 6.33** ANPR system

Step 2

i An algorithm is used to locate and isolate the number plate from the image taken by the camera. This algorithm also takes into account the size of the number plate and any damage or orientation. → 1ABC234

ii The brightness and contrast of the number plate is first adjusted (this ensures that the characters can be clearly read). → 1ABC234

Each character on the number plate is then segmented. → 1ABC234

iii Each character is then recognised using OCR software. The characters are converted into a string of editable text by the software.

iv This text string is then stored on a database.

Step 3

Once all of this has happened, the car park barrier is raised and the motorist is issued with a ticket. The ticket shows the date and time of entering the car park.

Step 4

When the motorist returns to the car park, they insert their ticket into a machine which calculates the car park charges. The payment is registered on the database.

Advantages of ANPR

» It can be used to automatically monitor average speed of vehicles over a stretch of road; this can be used in smart traffic management systems (see also Section 6.2).

» There is no need to employ car park security guards, which saves money.

» It is a much faster system than having to check a ticket at the exit; car parks can issue tickets on entry, but this ticket is simply used for payment purposes by the motorist before leaving the car park and is not used at the exit since payment will now be linked to the number plate on the car.

» It can be used to automatically control the entry and exit to a car park or private roads.

Disadvantages of ANPR

» There is a lack of manned security car park surveillance which could lead to vandalism (and other crimes) because nobody is checking on a regular basis; CCTV is often used, but this is often just used 'after the event'.

» There could be invasion of privacy issues due to the recording of drivers' number plates.

» Damaged or very dirty number plates will not be recognised by the system.

» Number plate cloning; the ANPR system only recognises the number plate and not the car, so it is possible for a car to be fitted with a cloned number plate thus by-passing car park security, for example.

Radio frequency identification devices (RFID)

Radio frequency identification devices (RFID) were covered in Chapter 2 (Section 2.2). This section will look specifically at four uses of RFIDs:

» Tracking of stock
» Passports
» Automobiles
» Contactless payments.

Advantages of RFID

» No line-of-sight contact is necessary; the tags can be read from a distance.
» It is a very robust and reliable technology.
» Tags are much more difficult to forge than barcodes; barcodes can be altered or even damaged, but RFID tags are more robust and difficult to alter.
» RFID tags can reduce the number of staff needed in
» It provides a very fast read rate (typically < 100 milliseconds to respond).
» It allows bi-directional data transfer (that is, it allows read and write operations to take place).
» Bulk detection is possible (that is, detect several RFID tags at the same time).

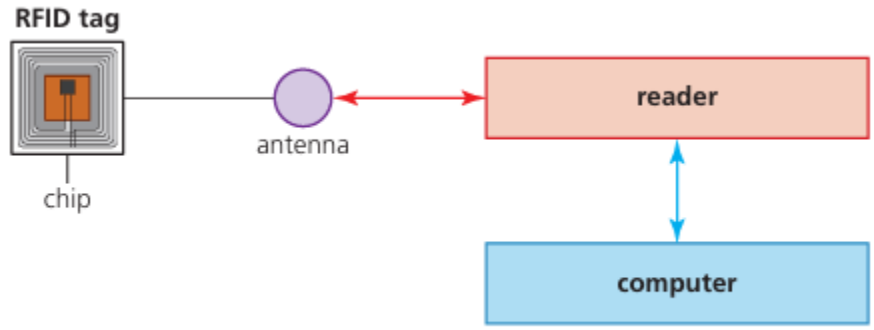
Disadvantages of RFID

» Tag collision – this is when the signals from two or more tags overlap, interfering with each other.
» Because RFID uses radio waves, they are relatively easy to jam or interrupt.
» It is relatively easy to hack into the data/signal transmitted by the tag.
» Although there is a potential saving in staff wages, the initial cost of an RFID system is more expensive than a comparable barcode system

Tracking of stock

As mentioned in Chapter 2, RFID readers use radio waves to read and capture information stored on a tag.

The RFID tag is made up of two components:
» A microchip that stores and processes information
» An antenna which is used to receive and transmit data/information.



▲ **Figure 6.34** RFID tag showing antenna and chip

» Livestock tracking is used to:
– keep track of the whereabouts of every animal on a farm using active tags
– allow farmers to identify who owns an animal; particularly important where animals graze freely on farms where it is possible for animals to stray into neighbouring fields
– keep data about the animals on the tag (for example, medical history, date of birth, identification (passport) number, and so on).

» Retail make use of RFID tags in the following ways:
– similar to barcodes, but can contain much more information and do not require any manual scanning; details, such as price, description, and so on, can all be stored on the tag and then automatically read at a checkout
– a big advantage is that several tags can be read at the same time, thus speeding up the checkout process
– can be used in distribution centres; an item can easily be located because the tag can store its exact location in the warehouse
– allow automatic tracking of an item from warehouse to customer; the customer can be informed at all stages where the item is.

Passports

Tiny RFID chips and antenna (i.e. tags) are now embedded into passports. The RFID tags in passports have no power supply, so they are examples of passive tags. When the passport is presented to an RFID scanner, the scanning device provides enough energy so that the chip can broadcast its stored information. This information is then sent to a computer.

Use of RFID in vehicles RFID tags can be used in vehicles. The main reasons for doing this include:
» The tags allow or deny access to parking in a secure, private car park.
» RFID tags in lorries and delivery vans can be used at weigh-stations to ensure the vehicle is not carrying too much weight.
» Tags can be used on toll roads; the driver registers their vehicle and attaches a tag to the windscreen; as the vehicle approaches the barrier, a device near the barrier (a transponder) reads the tag and checks the stored reference number, and if it is valid the barrier will open without them having to stop.
» RFID tags can be used on a car production line to track its progress through the assembly process.

Contactless credit/debit cards

Contactless credit/debit cards were discussed in Sections 6.6 and 2.1. This type of card uses an embedded passive RFID tag:

» The chip in the RFID tag is passive and emits a low-powered radio wave when it comes into contact with an RFID reader.
» An antenna is built into the card to allow a connection with the contactless reader.
» The RFID reader picks up a signal from the chip and this initiates the payment process

Near field communication (NFC)

As mentioned in Section 6.9, near field communication (NFC) can be used by smartphones when making payments. NFC is a subset of RFID technology, operating at a particular frequency, and is another standard for wireless data transmissions. In contrast to general RFID, the frequency at which NFC operates requires the sender and receiver to be in very close proximity, which makes communication more secure.

Biometric recognition systems

Biometric recognitions systems include:
» Face recognition
» Iris and retina recognition
» Finger and thumb recognition
» Hand recognition
» Voice recognition.

Retina recognition

» The retina is the light-sensitive area at the back of the eye that has a unique pattern of blood vessels.
» The retina cannot be seen without specialised equipment – this means it is a secure technology, but more expensive to implement.
» The special equipment is used to take an infrared photograph of the retina.
» It is quite invasive – the subject has to sit very still and stare directly into the light source.
» It is slower to scan and verify.
» It is only used in very specialised high-security settings.

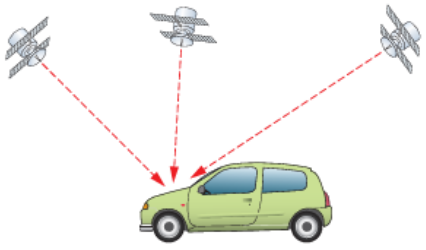
Iris recognition

» The iris is the coloured part of the eye, surrounding the pupil.
» A digital camera is utilised which uses both visible and near infrared light to take a sharp photograph of a person's iris.
» The method produces a unique pattern of a person's iris by locating and taking an image of:
– the centre of the pupil
– the edge of the pupil
– the edge of the iris
– the eyelids and eye lashes.

6.11 Satellite systems

6.11.1 Satellites

In this final section, we will be considering:
» Global positioning systems and satellite navigation
» Geographic information systems (GIS)
» Media communication systems (satellite television and satellite phones).

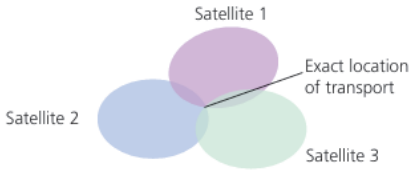


▲ **Figure 6.36** GPS and satellite navigation systems

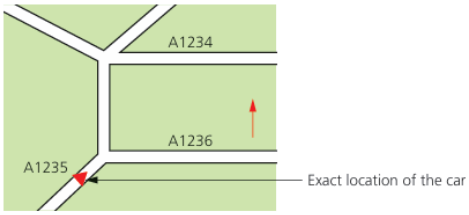
Global positioning systems and satellite navigation

Global positioning systems (GPS) are used to determine the exact location of a number of modes of transport (for example, aeroplanes, cars, ships, etc.). Cars usually refer to GPS as satellite navigation systems (i.e. 'satnav')

In cars, the onboard satellite navigation system contains stored road maps. When combined with satellite positioning data, the car's exact location can be shown on the map and the driver can also be given verbal instructions such as: 'After 100 metres, take the next left turn onto the A1234'. A screen on the satnav device will also show the car's position in relation to the road network.



▲ **Figure 6.37** Three satellite system



▲ **Figure 6.38** Satellite navigation system

Advantages of GPS and satnav

» The driver does not have to consult paper maps, so it is far safer.
» It removes errors (can warn drivers about one-way streets, street closures, etc.).
» The system can estimate the time of arrival.
» It is also possible to program in the fastest route, route to avoid towns, etc.
» The system can also give useful information such as location of petrol stations.

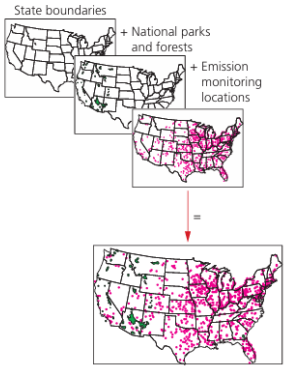
Disadvantages of GPS and satnav

» If the maps are not kept up to date, they can give incorrect instructions.
» Unless the system is sophisticated, road closures due to accidents or roadworks, can cause problems.
» Loss of satellite signals can cause problems.
» If an incorrect start-point or endpoint is keyed in the system will give incorrect information.

Geographic information systems (GIs)

Geographic information system (GIS) is a computer system that allows us to map, model, query and analyse large amounts of data according to their location.

Essentially GIS enables the following:
» Amalgamation of information into easily understood maps
» Performance of complex analytical calculations and then presentation of the results in the form of maps, tables or graphics (or a combination of all three)
» Geographers, scientists and engineers are able to see the data in several different ways in order to see patterns and relationships
» Anything that can be placed on a map is a candidate for GIS



▲ **Figure 6.39** Layering of state boundaries using GIS

Advantages of GIs

» It allows geographical and thematic data of any kind to be combined in a way which shows how they are connected to each other.
» It allows the handling and exploration of huge amounts of data (massive number crunching).
» It allows data to be integrated from a wide range of very different sources (which appear at first to be totally unconnected).

Disadvantages of GIs

» The learning curve on GIS software can be very long.
» GIS software is very expensive.
» GIS requires enormous amounts of data to be input (thus increasing the chances of errors).
» It is difficult to make GIS programs which are both fast and user-friendly; GIS requires very complex command language interfaces to work properly.

Media communication systems

Communication media refers to a method of delivering and receiving data/ information using telecommunications. There are many types of media used to send and receive information (for example, fibre optics, copper cable and Wi-Fi); we will concentrate on the global communication method which makes use of satellites

Advantages of media communication systems

» They have good global coverage (covers the majority of the Earth's surface).
» They are cheaper, faster and safer than laying cables in difficult or treacherous terrain.
» They have a very high bandwidth.
» It is relatively easy to expand the network (there are numerous companies now manufacturing satellites for various uses).
» Security in satellite transmission is very good due to the fact that data is coded and the receiver requires decoding equipment to read the data.
» During emergency situations it is relatively easy to move stations on the ground from one place to another; satellites can also change their orbits if necessary, using built-in boosters.
» They are well-suited for broadcasting, that is, one satellite signal being picked up by many different receivers on the ground.
» Satellite receivers on the ground can be portable, enabling mobile communication in very remote locations.

Disadvantages of media communication systems
» There is a time delay in receipt of the signals (this can be a problem in voice communications, where even 0.5 seconds delay can be noticeable as the sound and video appear out of synchronisation) or there may appear to be an 'echo' on the sound
» The signals received can be affected by bad weather (for example, heavy rain or hailstones), obstructions (such as tree branches) and whether the satellite dish has been correctly orientated.
» Sunspot activity can affect the performance of a satellite.
» If they are not in a fixed position relative to the Earth then they need to be monitored and controlled on a regular basis to ensure they remain in the correct orbit.

Revision questions

1. March/2023/Paper_0417/12/No.5
   The number of people using online shopping has increased. This has led to an increase in the number of journeys for the delivery drivers.

   Describe how an expert system can be used to produce the best route for the delivery of items.

2. March/2023/Paper_0417/12/No.13
   People can watch a movie either by streaming or from a Blu-ray disc.

   Give **two** advantages of watching the movie by streaming rather than from a Blu-ray disc.

3. March/2023/Paper_0417/12/No.16(b)
A school car park is controlled by a barrier. When teachers enter the car park their number plate is read and the barrier is raised automatically.

(b) Automated Number Plate Recognition (ANPR) is used to read and check the number plate of the vehicle.
Discuss the benefits and drawbacks of using an ANPR system.

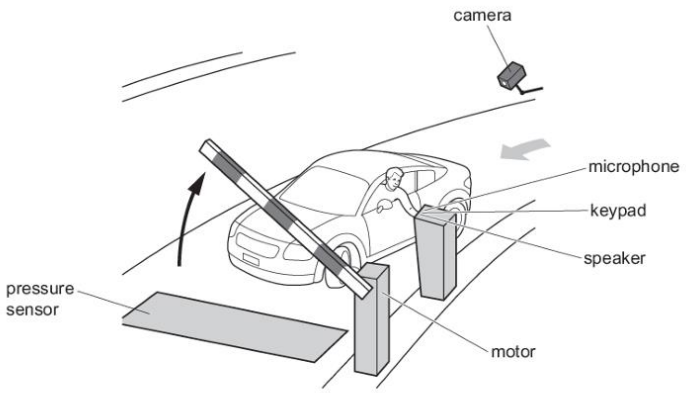


Fig. 16.1

4. June/2023/Paper_0417/11/No.12
Many media companies now provide media streaming for users to watch their television programmes.
(a) Explain what is meant by the term media streaming.
(b) Describe the benefits and drawbacks of media streaming.

5. June/2023/Paper_0417/12/No.13(a)
   Weather forecasters use computer modelling.

   (a) Explain why computer modelling is used to forecast the weather.

6. June/2023/Paper_0417/12/No.14(a)
   ePublishing software is used to create an ePublication to display a school's yearly magazine.

   (a) Describe the characteristics of an ePublication.

7. June/2023/Paper_0417/13/No.7
   The retail industry uses point of sale (POS) systems.

   (a) Discuss the benefits of using POS in the retail industry.

8. Nov/2023/Paper_0417/11/No.6
A cricket club secretary saves a list of players as a PDF file.
(a) Describe two disadvantages of saving the list of players as a PDF file.

The cricket club has a junior team for 6-8-year-old players. The secretary has produced an ePublication to attract new members to the junior team.
(b) State two features of an ePublication that could not appear on a paper poster.
(c) Describe the features that could be used to make the ePublication attractive to a younger audience.

9. Nov/2023/Paper_0417/11/No.11
Many Automatic Teller Machines (ATM) allow customers to print out mini statements of their bank accounts.
Describe the inputs and processing involved in printing out a mini statement.

10. Nov/2023/Paper_0417/12/No.7
A video of a race can be recorded using a camera either on an autonomous flying vehicle (drone) or in a helicopter. A person would be needed in the helicopter to operate the camera.
Describe two advantages and two disadvantages of using an autonomous flying vehicle (drone) to record the video of the race.

11. Nov/2023/Paper_0417/12/No.11
A clothing retailer only sells its clothes on the internet.
(a) Discuss the benefits and drawbacks to the clothing retailer of using internet shopping.

12. Nov/2023/Paper_0417/13/No.13
A computer model can be used to design and test a bridge before it is built.
Discuss the benefits and drawbacks of using a computer model before building a bridge.

13. Nov/2023/Paper_0417/13/No.8(c, d)
Many devices in the home can be connected to the internet so they can be controlled remotely. These devices are called smart devices. A house contains a smart security system.
(a) Part of the smart security system involves an automatic gate for vehicles approaching the house. There is a CCTV camera at the gate and the smart security system has software for recognising each vehicle's number plate.
Explain how automatic number plate recognition (ANPR) systems work.
(b) Describe three problems that could occur when the ANPR system reads a vehicle number plate.

14. March/2024/Paper_0417/12/No.7
An expert system is used to help to locate an underground water source.
(a) Describe the following components of an expert system.
(i) User interface
(ii) Knowledge base
(b) Explain how an expert system is used to discover locations to drill for water.

15. March/2024/Paper_0417/12/No.13
Smart devices and microprocessors can monitor and control devices in the home.
Describe, giving examples, the negative effects of using these smart devices.

1. March/2022/Paper_12/No.4

Tick (✓) whether the following statements refer to control, measurement or modelling systems.

Only tick (✓) **one** answer for each statement.

	control (✓)	measurement (✓)	modelling (✓)
Maintaining the growing conditions in a glasshouse			
Aircraft flight simulation			
Monitoring the pollution in a river			
Using what-ifs			

2. March/2022/Paper_12/No.6

Global Positioning Systems (GPS) are used for many different applications.

(a) Describe how GPS is used by a smartphone to pinpoint its location.

(b) Give three other examples of the use of GPS.

3. March/2022/Paper_12/No.7(a)

Tawara School is presenting a concert. For previous concerts the booking of tickets was carried out manually using pen and paper.

For this concert they are going to use an online booking system.

(a) Discuss the advantages and disadvantages of Tawara School using an online booking system rather than the manual system.

4. June/2022/Paper_11/No.10

A river authority is concerned about levels of pollution in a major river. The quality of the water in the river needs to be monitored using sensors.

(a) Name three sensors that could be used to measure the pollution in the river.

(b) Discuss the advantages and disadvantages of using computers to measure the pollution in the river rather than humans measuring the pollution.

5. June/2022/Paper_12/No.2

A computer-controlled glasshouse is used to grow plants.

Identify two output devices used in this glasshouse.

7. June/2022/Paper_12/No.11

A car manufacturing company uses computer-controlled robots to manufacture its cars.

Discuss the advantages and disadvantages to the company of using computer-controlled robots rather than using humans to manufacture the cars.

8. June/2022/Paper_13/No.5(c)

(a) Discuss the advantages and disadvantages of using manual booking systems rather than online booking systems.