5 The effects of using IT

In this chapter you will learn about:

- ★ microprocessor-controlled devices:
  - their positive and negative effects on various aspects of everyday life in the home
  - positive and negative effects in monitoring and controlling transport
- ★ health issues from using a computer:
  - such as RSI, back and neck problems, eye problems and headaches
  - causes of health issues and ways of preventing them.

The introduction of microprocessor-controlled devices into our everyday lives has had a profound effect in a number of ways. Some of these are positive and some are negative. This chapter will consider the effects of devices used in the home and elsewhere, and how they have changed how we live. We will also consider the health risks posed by prolonged use of computers at home and at work.

5.1 Microprocessor-controlled devices

5.1.1 Effects of using microprocessor-controlled devices in the home

Using microprocessor-controlled devices in the home can have positive and negative effects on our:

- lifestyle
- leisure time
- physical fitness
- data security
- social interaction.

Many common household devices are now fitted with microprocessors to control a large number of their functions. The devices fall into two main groups:

Labour-saving devices (group 1):

- automatic washing machines
- microwave ovens
- cookers
- automatic dishwashers
- robotic vacuum cleaners
- bread-making machines
- smart fridges and freezers.

Other devices (group 2):

- alarm clocks
- television sets
- central heating and air-conditioning systems
- home entertainment systems
- mobile phones and tablets.

Essentially, a microprocessor-controlled labour-saving device allows people to get on with other things while the device carries out their tasks. Microprocessors within the second group of devices make them easier to use and gives them additional features, such as 'intelligent tuning' in television sets.

Lifestyle, leisure time and physical fitness

Table 5.1 summarises the effects of microprocessor-controlled labour-saving devices on a person's lifestyle, leisure time and physical fitness.

▼ **Table 5.1** Advantages and disadvantages of microprocessor-controlled labour-saving devices

Advantages	Disadvantages
» People no longer have to do manual tasks at home. » They give people more time for leisure activities, hobbies, shopping and socialising. » There is no longer a need to stay home while food is cooking or clothes are being washed. » It is possible to control ovens and automatic washing machines, for example, using smartphones – a web-enabled phone allows devices to be switched on or off while the owner is out. » Automated burglar alarms give people a sense of security and well-being as they give a very sophisticated level of intruder warning at all times. » Smart fridges and freezers can lead to more healthy lifestyles (they can automatically order fresh food from supermarkets using their internet connections) as well as prevent food waste.	» Labour-saving devices can lead to unhealthy lifestyles (because of the lack of exercise) – people can become less fit if they just lie around at home while the devices carry out many of the previous manual tasks. » They tend to make people rather lazy because there is a dependence on the devices. » There is a potential to lose household skills. » As with any device which contains a microprocessor and can communicate using the internet, there is the risk of cybersecurity threats (this is discussed in more depth later).

Table 5.2 shows some of the more general ways in which **all** microprocessor-controlled devices can affect our lives. This table includes devices which are not necessarily labour-saving, and simply use microprocessors to improve their functionality.

▼ **Table 5.2** General advantages and disadvantages of using all microprocessor-controlled devices

Advantages	Disadvantages
» Microprocessor-controlled devices save energy because they are far more efficient and can, for example, switch themselves off after inactivity for a certain time period. » It can be easier 'programming' these devices to perform tasks rather than turning knobs and pressing buttons manually (for example, QR codes on the side of food packaging can simply be scanned and the oven automatically sets the cooking programme).	» The devices lead to a more wasteful society – it is usually not cost effective to repair circuit boards once they fail; the device is then usually just thrown away. » They can be more complex to operate for people who are technophobes or who are not very confident around electronic devices. » Leaving some devices on standby (such as televisions or satellite receivers) is very wasteful of electricity.

Data security issues

As mentioned in Table 5.1, having a microprocessor-controlled device connected to the internet can lead to cybersecurity issues. If you are able to communicate remotely with devices in your home, then so can a hacker. Any household device which can be remotely-controlled could allow a hacker to gain personal data about you. These devices are often set with a default (or no) password, making it easy for cybercriminals to obtain personal details. For example, by hacking into a central-heating controller (or the app used to communicate with the controller) it is possible to find out holiday dates, which then makes a home an easy target for break-ins. If the fridge/freezer automatically orders food from a supermarket, then it is possible for a hacker to gain key data, such as credit card numbers. It is therefore important to manage passwords (and have a different password on each device) and also install software updates, which often contain new security features.

Social interactions

There are both positive and negative impacts of microprocessor-controlled devices on social interactions to consider. While some devices leave people with more time to do things outside their home, other devices encourage people to stay at home. Devices, such as smartphones, smart televisions or tablets allow people to communicate from home using VoIP (a type of video conferencing), emails or chat rooms. The positive aspects include:

- easier to make new friends using chat rooms
- easier to find people who share similar interests/hobbies
- less expensive to keep in touch using VoIP technology.

But the negative aspects include:

- people do not meet face-to-face as much (social isolation)
- a lack of social interaction may make people more anxious of meeting people in real life
- people behave differently when interacting online – sometimes they can be ruder or more aggressive, and cyberbullying is a real problem, particularly for young people.

It is a balance that each individual needs to make. Please refer to Chapter 8 for further discussion on electronic communication methods.

5.1.2 Monitoring and controlling transport

The use of microprocessors in transport systems is becoming more and more widespread. Examples of where they are currently used include:

- monitoring of traffic on motorways
- congestion zone monitoring
- automatic number plate recognition (ANPR)
- automatic control of traffic lights
- air traffic control systems
- railway signalling systems.

As with any device containing a microprocessor, security is a big issue.

Control of smart road systems and smart signs

Many modern motorways are now called **smart motorways**. This is because the monitoring and control of the traffic and/or the information displayed on the motorway signs is controlled by a central computer system.

If there has been an accident or there is considerable traffic congestion, then smart motorway signs can control the traffic to keep it moving or redirect it to avoid the accident. Even the traffic lights in cities are now computer-controlled systems.

▲ **Figure 5.1** Smart motorway signs

However, imagine the chaos that would be caused if any of these systems were hacked. Somebody could then have control over a chosen section of the road network. That has huge safety and security implications.

Rail and airline network control systems

Safely coordinating the large number of trains and aeroplanes entering and leaving stations and airports is a complex task, but computerised monitoring systems make this possible. It is possible to run a more efficient timetable under total computer control.

Train and aeroplane journeys are also safer, because human error is removed – many rail accidents are caused by drivers making mistakes.

Advantages and disadvantages of these monitoring and control systems are summarised in Table 5.3.

▼ **Table 5.3** Advantages and disadvantages of transport monitoring and control systems

Advantages	Disadvantages
Smart motorways constantly adapt to traffic conditions, reducing traffic jams and minimising everyone's journey time.	A hacker could gain access to the computerised system and cause disruption.
Transport systems are more efficient – more cars, trains and aeroplanes can use the transport network, allowing for more regular services.	If the computer system fails then the whole transport system could be brought to a standstill.
Traffic offences (for example, driving in the wrong lane) can be automatically penalised using ANPR.	Poorly designed systems could compromise safety.
Stolen cars and criminals can be spotted using ANPR.	ANPR systems mean that innocent people's movements can easily be tracked. Who has access to that data?
Computerised control systems minimise human error, which reduces the rate of accidents.	

Autonomous vehicles in transport

Driverless (autonomous) vehicles are increasing in number every year. These are very complex robots, but the big problem is not really the technology (because problems will be solved over time) – it is human perception. It will take a large

leap of faith for humans to ride in an autonomous car or an aeroplane with no pilot. We are already used to autonomous trains, as these are used in many cities throughout the world. These systems have been generally accepted; but that is probably because trains do not overtake other trains and have a very specific track to follow (see later).

Autonomous cars, buses and vans

In this section, we will consider autonomous cars as our example. Autonomous cars use sensors, cameras, actuators and microprocessors (together with very complex algorithms) to carry out their actions safely. Sensors (radar and ultrasonics) and cameras allow the control systems in cars to perform critical functions by sensing the dynamic conditions on a road. They act as the 'eyes' and 'ears' of the car.

Microprocessors process the data received from cameras and sensors and send signals to actuators to perform physical actions, such as:

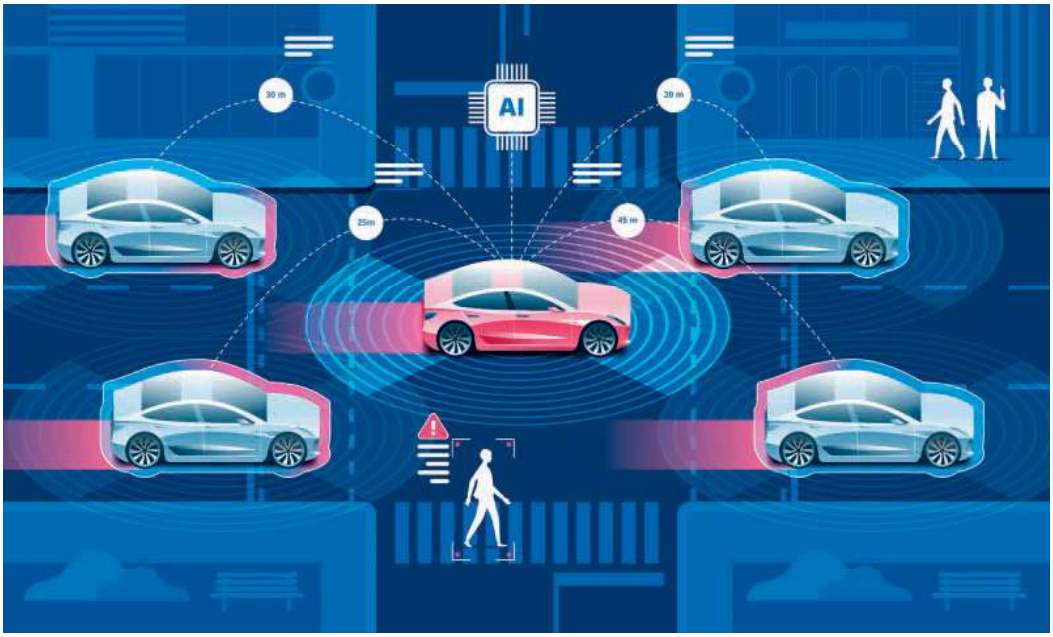
- change gear
- apply the brakes
- turn the steering wheel.

Cameras catch visual data from the surroundings, while radar and ultrasonics allow the vehicle to build up a 3D image of its surroundings (very important when visibility is poor, such as in heavy rain, fog or at night).

Suppose an autonomous car is approaching a set of traffic lights which are showing red. The first thing the control system in the car needs to recognise is the road sign, and then check its database as to what action to take. Because the traffic light shows red, the microprocessor must send signals to actuators to apply brakes and put the gear into 'park'. Constant monitoring must take place until the light changes to green. When this happens, the microprocessor will again instruct actuators to put the car into first gear, release the brakes and operate the throttle (accelerator). This is a very complex set of operations because the microprocessor must constantly check all sensors and cameras to ensure moving off is safe (for example, has the car in front of it broken down or has a pedestrian started to cross the road, and so on). To go any further is outside the scope of this book.

Security and safety when using autonomous vehicles

Autonomous vehicles use sensors, cameras and microprocessors to 'understand' their immediate environment. These vehicles run using complex software systems and a large number of external sensors. This makes such vehicles rather vulnerable to cybercriminals. A hacker may not even have to break into the vehicle's control system; they may be able to cause many problems by blocking sensor information or sending false information back to the vehicle. There are many reasons why this would be of benefit to a hacker, but it is outside of the scope of this textbook. However, the hacker probably is not really interested in gaining control of the vehicle; they may be more interested in knowing where the car is, where it is going and finding personal information about the owner of the vehicle. Remember, these vehicles could be a car, a train or even an aeroplane – so the potential security and safety risks are vast.



▲ **Figure 5.2** Autonomous car sensors

However, there are many positive sides to autonomous transport. If the security issues can be resolved, all forms of transport will become safer by removing the human element. Vehicles will be able to drive in cities or on the open road, for example, and be totally aware of their environment, thus removing many of the current safety issues (both to vehicle occupants and to pedestrians).

Table 5.4 considers some of the advantages and disadvantages specific to autonomous vehicles.

▼ **Table 5.4** Advantages and disadvantages of autonomous vehicles

Advantages	Disadvantages
Safer because human error is removed, leading to fewer accidents	Very expensive system to set up in the first place (high technology requirements)
Better for the environment because vehicles will operate more efficiently	The ever-present fear of hacking into the vehicle's control system
Reduced traffic congestion (humans cause 'stop-and-go' traffic known as 'the phantom traffic jam' – autonomous vehicles will be better at smoothing out traffic flow, reducing congestion in cities)	Security and safety issues (software glitches could be catastrophic; software updates would need to be carefully controlled to avoid potential disasters)
Increased lane capacity (research shows autonomous vehicles will increase lane capacity by 100% and increase average speeds by 20%, due to better braking and acceleration responses together with optimised distance between vehicles)	The need to make sure the system is well-maintained at all times; cameras need to be kept clean so that they do not give false results; sensors could fail to function in heavy snowfall or blizzard conditions (radar or ultrasonic signals could be deflected by heavy snow particles)
Reduced travel times (for the reasons above) therefore less commuting time	Driver and passenger reluctance of the new technology
Stress-free parking for motorists (the car will find car parking on its own and then self-park)	Reduction in the need for taxis could lead to unemployment (imagine New York without its famous yellow cabs!)

Autonomous trains

As mentioned earlier, autonomous (driverless) trains have been around for a number of years in a number of large cities. As with other autonomous vehicles, driverless trains make considerable use of sensors, cameras, actuators and on-board computers/microprocessors. Autonomous trains make use of a system called **LiDaR** (Light Detection and Ranging); LiDaR uses lasers which build up a 3D image of the surroundings. Other sensors (such as proximity sensors on train doors) and cameras (including infrared cameras) are all used for various purposes to help control the train and maintain safety. The control system in the train also makes use of global positioning satellite technology, which allows accurate changes in speed and direction to be calculated. Again, actuators pay a huge role here in controlling the train's speed, braking and the opening and closing of the train doors. The safety improvements made by these autonomous systems are fairly obvious.

▲ **Figure 5.3** Autonomous train (London Transport)

Table 5.5 considers some of the advantages and disadvantages specific to autonomous trains.

▼ **Table 5.5** Advantages and disadvantages of autonomous trains

Advantages	Disadvantages
Improves the punctuality of the trains	The ever-present fear of hacking into the vehicle's control system
Reduced running costs (fewer staff are required)	System does not work well with very busy services (at the moment)
Improved safety because human error is removed	High capital costs and operational costs initially (that is, buying the trains, expensive signalling and control equipment and the need to train staff)
Minimises energy consumption because there is better control of speed and minimal delays (trains stuck in stations still use energy)	Ensuring passenger behaviour is acceptable, particularly during busy times (for example, jamming doors open on trains, standing too near the edge of platforms, and so on)
It is possible to increase the frequency of trains (automated systems allow for shorter times between trains)	Passenger reluctance of the new technology
It is easier to change train scheduling (for example, more trains during busier times)	No drivers mean there will be a need for CCTV to monitor railway stations

Autonomous (pilotless) aeroplanes

Aeroplanes have used auto-pilots for many years to control flights. Human pilots only take over during take-off and landing. Autonomous (pilotless) aeroplanes would make even more extensive use of sensors, actuators and microprocessors to control **all** stages of the flight. Some of the main features of a control system on a pilotless aeroplane would include:

- sensors to detect turbulence to ensure smooth flights
- an increase in self-testing of all circuits and systems
- sensors that would automatically detect depressurisation in the cabin, therefore allowing for quick stabilisation of the aeroplane
- use of GPS for navigation and speed calculations
- use of actuators to control, for example, throttle, flaps (on the wings) and the rudder.

Table 5.6 considers some of the advantages and disadvantages specific to pilotless aeroplanes.

▼ **Table 5.6** Advantages and disadvantages of pilotless aeroplanes

Advantages	Disadvantages
Improvement in passenger comfort (reasons given earlier)	Security aspects if no pilots on-board (for example, handling terrorist attacks)
Reduced running costs (fewer staff are required)	Emergency situations during the flight may be difficult to deal with
Improved safety (most crashes of aeroplanes have been attributed to pilot-induced errors)	Hacking into the system (it could be possible to access flight control via the aeroplane's entertainment system)
Improved aerodynamics at the front of the aeroplane because there would no longer be the need to include a cockpit for the pilots	Passenger reluctance to accept the new technology
	Software glitches (recent software issues with modern aeroplanes have highlighted that software glitches sometimes only surface a few years later, causing devastating results)

5.2 Potential health problems related to the prolonged use of IT equipment

Using IT equipment for long periods of time can impact on a user's health. Table 5.7 considers the most common health risks and shows ways to eliminate or reduce the risk.

▼ **Table 5.7** Health risks of using IT equipment

Health risk	Causes of health risk	Elimination or reduction of health risk
Back and neck strain	Caused by sitting in front of a computer screen for long periods of time	» Use fully adjustable chairs to give the correct posture » Use foot rests to reduce posture problems » Use tiltable screens, raised to the correct height, to ensure the neck is at the right angle
Repetitive strain injury (RSI)	Damage to fingers and wrists caused by continuous use of a keyboard or repetitive clicking of mouse buttons, for example	» Ensure correct posture is maintained (for example correct angle of arms to the keyboard and mouse) » Make proper use of a wrist rest when using a mouse or keyboard » Take regular breaks (+ exercise) » Make use of ergonomic keyboards » Use voice-activated software if the user is prone to problems using a mouse or keyboard
Eyestrain	Caused by staring at a computer screen for too long or by having incorrect lighting in the room (causing screen reflections)	» If necessary, change screens to LCD if older CRT screens are still used » Take regular breaks (+ exercise) » Make use of anti-glare screens if the room lighting is incorrect (or use window blinds to cut out direct sunlight) » Users should have their eyes tested on a regular basis (middle vision glasses should be prescribed if the user has a persistent problem with eye strain, dry eyes, headaches, etc.)
Headaches	Caused by incorrect lighting, screen reflections, flickering screens, and so on	» Make use of anti-glare screens if the room lighting is incorrect (or use window blinds to cut out reflections which cause squinting, leading to headaches) » Take regular breaks (+ exercise) » Users should have their eyes tested on a regular basis (middle vision glasses should be prescribed if the user has a persistent problem with headaches)
Ozone irritation	Caused by laser printers in an office (symptoms are dry skin and respiratory problems)	» Proper ventilation should exist to lower the ozone gas levels to acceptable values » Laser printers should be housed in a designated printer room » Change to using inkjet printers where possible

Exam-style questions

1 The use of microprocessor-controlled devices in the home affects an individual's leisure time, social interaction and the need to leave the home.

a Give **three** advantages to the individual when microprocessor-controlled devices are used in the home. [3]

b Give **three** disadvantages to the individual when microprocessor-controlled devices are used in the home. [3]

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2 You use a computer to do your homework. You are concerned about the health issues of using a computer.
Discuss the advantages and disadvantages of different methods you could use to help minimise the health problems of using the computer. [6]

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3 **a** There are potential security issues when using microprocessor-controlled devices in the home.
Describe these issues and explain how they can be mitigated. [4]

b Indicate which of the following statements are True or False by ticking (✓) the appropriate box. [5]

	True (✓)	False (✓)
Using microprocessors has increased the longevity of devices in the home, therefore reducing waste		
Microprocessor-controlled devices are far more energy efficient		
Smart televisions are an example of a labour-saving device		
Microprocessor-controlled devices in the home are not vulnerable to attack by viruses or hackers		
Microprocessor-controlled devices, such as smartphones, have no impact on social interactions		

4 Five statements are shown on the left and eleven ICT terms on the right.
Draw arrows to connect each statement to its correct term. [5]

	Monitor
Name given to driverless vehicles, such as cars, vans and buses	Cybercriminal
	Autonomous
A type of 'intelligent' road sign used to monitor and control road traffic	Regular
	Smart
Name given to hackers and other people who try to break into ICT systems	Restorative
	Automatic
Name of the type of risk associated with ozone gas reaching high levels	Repetitive
	Clever
Meaning of the letter 'R' in RSI	Health
	Control

5 **a** Describe the advantages of having major roads controlled and monitored by smart road signs. [3]
b Describe the risks of having smart road signs under computer control. [3]