ICT Applications

Real-world uses of information and communication technology

Communication • Modelling • Control • Banking • Recognition

Chapter 6 • Overview Mind Map



6.1 Communication

- Newsletters & posters
- Websites & multimedia
- Streaming & e-publications
- Mobile communication

6.2 Modelling

- Finance & civil engineering
- Flood & traffic management
- Weather forecasting

6.3 Computer control

- Industrial robots
- Sensors, actuators & production lines

6.4 School management

- Attendance & registration
- Student performance & CAL

6.5 Booking systems

- Online travel and event bookings
- Real-time seat availability

6.6 Banking

- ATM and EFT
- Card payments & online banking

6.7 Medicine

- Patient information systems
- 3D printing in medicine

6.8 Expert systems

- Knowledge base and rules
- Inference engine and user interface

6.9 Retail

- POS and stock control
- Internet shopping

6.10 Recognition

- OMR, OCR, QR, RFID, NFC
- Biometrics and ANPR

6.11 Satellite systems

- GPS and GIS
- Satellite communication

Communication media: choose the right format

Posters & newsletters

Printed or digital; target audiences, layout, proofreading.

Websites

Global reach, hyperlinks, easy updates; security and access issues.

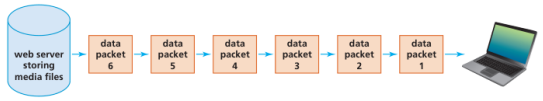
Multimedia

Video, sound, transitions; avoid distracting effects.

E-publications

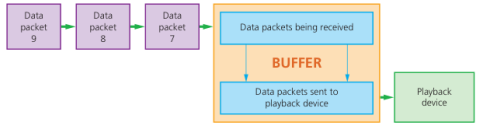
E-books, digital magazines and newspapers; portable and searchable.

Media streaming: buffering



▲ **Figure 6.2** Media streaming data packets

Because the playback of the media files is usually much faster than the rate at which data is received over the internet, data packets are buffered in the computer. **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. In this way, there appears to be no gaps in the received data. Obviously, having a large buffer will considerably reduce the possibility of freezing the play back.



▲ **Figure 6.3** Buffering of media stream

e-publications

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

- e-books
- digital magazines
- digital newspapers
- digital libraries.

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. E-publications also have the advantage that pages can be expanded in size and it is possible to include media, which would be impossible with the more traditional paper-based publications. Specific devices, such as the *Kindle*, have been developed to allow a library of e-books to be stored on the device. These devices use a white background with black text to fully replicate reading a normal book. Because no printing costs are incurred, e-publications are usually cheaper than their paper-based counterparts.

Packets arrive from a server and are buffered to maintain smooth playback. Streaming does not require saving the whole file first.

Figure: supplied Chapter 6 PDF

How mobile communication works

Mobile device

SIM / wireless connectivity

→

Cell tower

Communicates over coverage cells

→

Network

Transfers calls and data

→

Recipient

SMS, VoIP, video or internet

Computer modelling: advantages vs limitations

Safer

Test dangerous situations without real-world risk.

Cheaper

Avoid building multiple physical prototypes.

Faster

Try many what-if scenarios quickly.

Limitations

Results depend on accurate data and programming.

Spreadsheet financial modelling

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).

Examples where computer modelling is used include:

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

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**

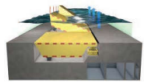
▲ **Figure 6.6** Personal finance modelling using a spreadsheet

Change inputs such as selling price or quantity sold and observe the effect on calculated profit.

Figure: supplied Chapter 6 PDF

Flood and traffic simulations

Figure 6.9 shows the management of the flood protection system in the city of Venice as an example.



▲ **Figure 6.9** Flood management barriers

Flooding of the city over many years has led to the building of a number of flood barriers. It is useful to use computer models to understand how these flood barriers will react to a range of possible flooding scenarios. It is possible to try out several different solutions, using the model, before actually building any flood defences. Following the computer modelling results, Venice decided to develop a computer-based system rather than build a manual flood defence system. The main advantages of doing this are:

- Sensors could be used out in the bay area to monitor sea height and wave height (and possibly other factors, such as wind speeds); using sensors would give a much faster response to any deteriorating conditions in the bay.
- Using a computer system is safer, since using humans to monitor conditions could potentially put them at risk.
- Data collection is continuous and more accurate than manual measurements (readings can also be taken more frequently).
- Because of the faster response to changing conditions, city dwellers can be warned well in advance of any flooding actually taking place.
- Data from the sensors could also be fed into the simulation modelling the flood area; this could lead to further improvements as more data is gathered, which means the simulation becomes closer to reality.

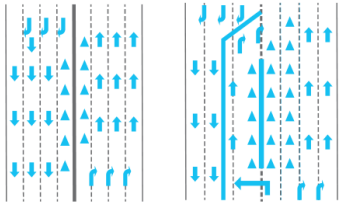
Traffic management

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. The two models shown in Figure 6.10 will appear on the computer screens, representing the motorway lanes.

The company will run model 'A' and model 'B' using different traffic densities at different times of the day to see which one allows for the best traffic flow. The

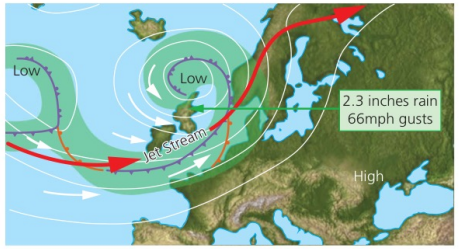


▲ **Figure 6.10** Motorway closures model

Models help compare alternative flood barriers and road layouts before costly implementation.

Figure: supplied Chapter 6 PDF

Weather forecasting



▲ **Figure 6.12** Animated weather forecast

Exercise 6d

Create a spreadsheet to do some personal financial modelling. Include the monthly income in one row and then show all the monthly outgoings. For example:

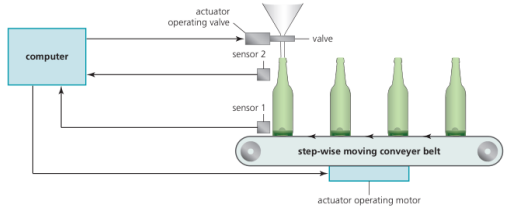
	A	B	C	D	E	F	G
		Month 1	Month 2	Month 3	Month 4	Totals	
Income ($):							
Outgoings:	food						
	cinema						
	clothes						
	other						
	savings						

Extend the list as much as you want or change the outgoings to be more realistic if necessary. Insert some values into the spreadsheet and then change a few values to see the effect on your finances. Add extra columns or extra outgoings to extend the spreadsheet. Finally, try creating a graph of your income against outgoings for each month and for a year (do a prediction for the year after four months, for example).

Sensors supply temperature, pressure, wind and rainfall data to mathematical weather models.

Figure: supplied Chapter 6 PDF

Robotics: bottling plant control



▲ **Figure 6.14** Bottling plant

» When the signal from sensor 2 indicates the bottle is full, the computer sends a signal to an actuator to close the valve.
» The computer then sends another signal to a second actuator which operates a motor to move the conveyer belt to allow the next empty bottle to take its correct position.
» The whole process is continuous until stopped for maintenance, errors occurring or a change in the process.

Exercise 6f

Find out about five industrial processes that use production line control.
In each case, find out the functions of robots at each stage in the process.
In each case, find the advantages and disadvantages of using robots on the production line

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

The traditional way to record the registration and attendance of a student was to complete daily registers. This was very time consuming because it required a ten-minute session at the beginning and end of each day. It was also prone to error if a student's name was missed at some point during the registration process.

There are a number of possible ways of automating the registration process using hardware and software, some of which are included below.

Presence sensor → controller → valve actuator → level sensor → motor moves conveyor.

Figure: supplied Chapter 6 PDF

Feedback control in production lines

Sensor

Detect bottle or liquid level

→

Controller

Process input and decide action

→

Actuator

Open valve or move motor

→

Feedback

Repeat until target reached

School management systems

Attendance

Magnetic ID cards or fingerprint registration.

Performance

Store results and generate student reports.

CAL

Interactive lessons, tests and immediate feedback.

Privacy

Protect student records and biometric information.

Online booking system

Search

Select event, flight or seat

→

Availability

Query booking database

→

Payment

Authorise transaction

→

Confirmation

Update record and issue ticket

Banking applications

ATM

PIN and card verification; cash withdrawal.

EFT

Electronic transfer of funds between accounts.

Cards

Chip and PIN; contactless payment.

Online banking

Account access, payments and transfers.

Computers in medicine

Information systems

Patient records and diagnostic information.

Medical imaging

Digital images support diagnosis and treatment.

3D printing

Models, prosthetics and customised medical applications.

Benefits & risks

Faster access, but accuracy, privacy and security matter.

Expert system: components

User interface

Collect facts from user

→

Knowledge base

Stores domain facts and rules

→

Inference engine

Applies rules to facts

→

Explanation

Justifies conclusion

Retail applications

Point of sale

Barcode reader retrieves product and price.

Stock control

Database updates inventory after sales.

Internet shopping

Orders, payments and delivery tracking.

Benefits

Fast processing and accurate stock records.

Recognition technologies

OMR / OCR

Mark recognition vs printed character recognition.

QR / barcode

Encode information for optical scanning.

RFID / NFC

Wireless tag reading and short-range communication.

Biometrics / ANPR

Identify people or recognise vehicle number plates.

GPS positioning and GIS mapping

Satellites

Transmit timing/location signals

→

GPS receiver

Estimates position

→

GIS software

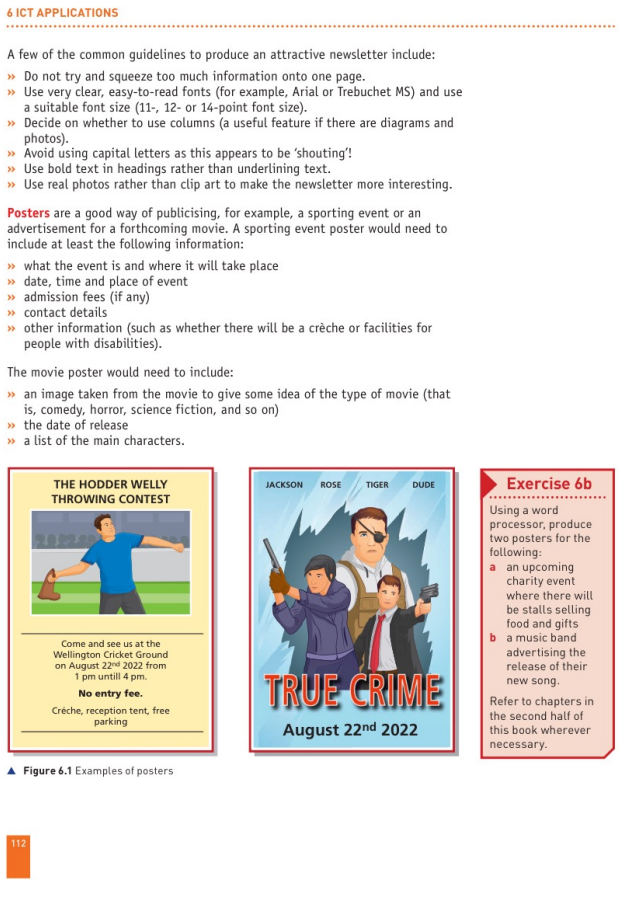
Combines map layers and location data

→

Application

Navigation, mapping and tracking

Posters: communication example



6 ICT APPLICATIONS

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 (for example, Arial or Trebuchet MS) and use a suitable font size (11-, 12- or 14-point font size).
- 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, for example, a sporting event or an advertisement for a forthcoming movie. 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.

Exercise 6b

Using a word processor, produce two posters for the following:

a an upcoming charity event where there will be stalls selling food and gifts
b a music band advertising the release of their new song.

Refer to chapters in the second half of this book wherever necessary.

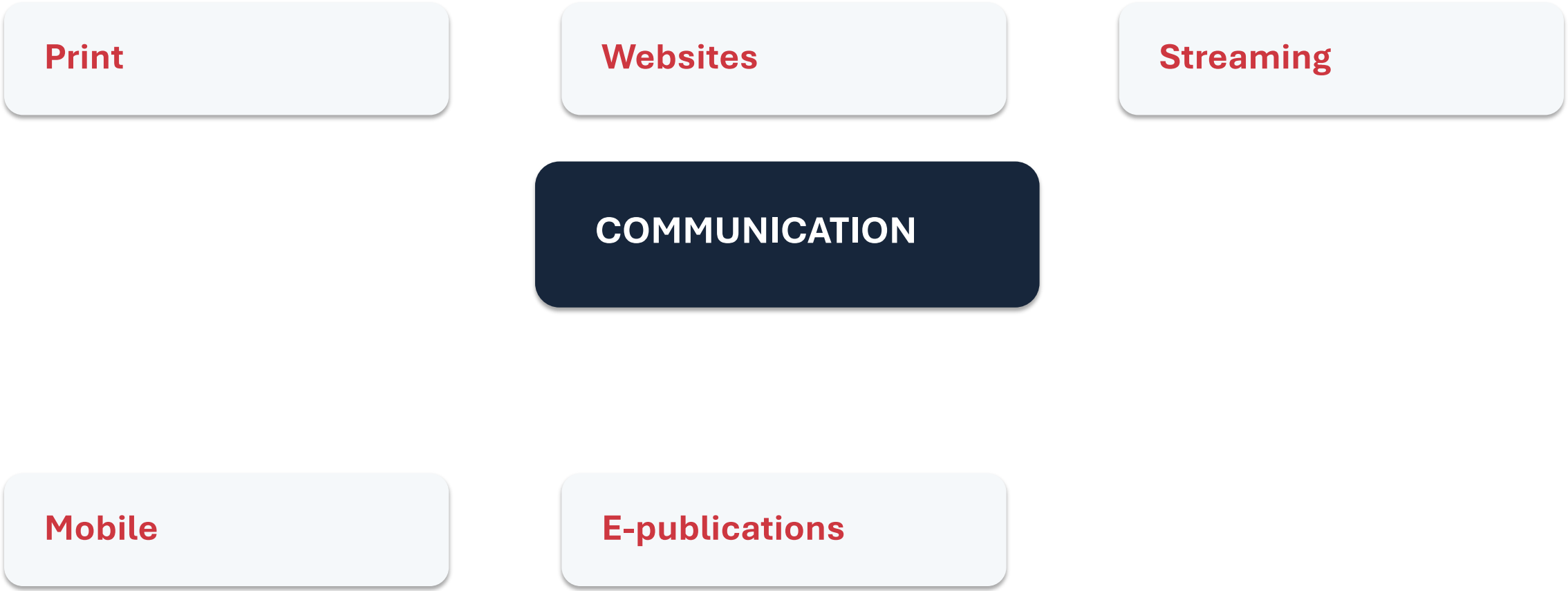
▲ **Figure 6.1** Examples of posters

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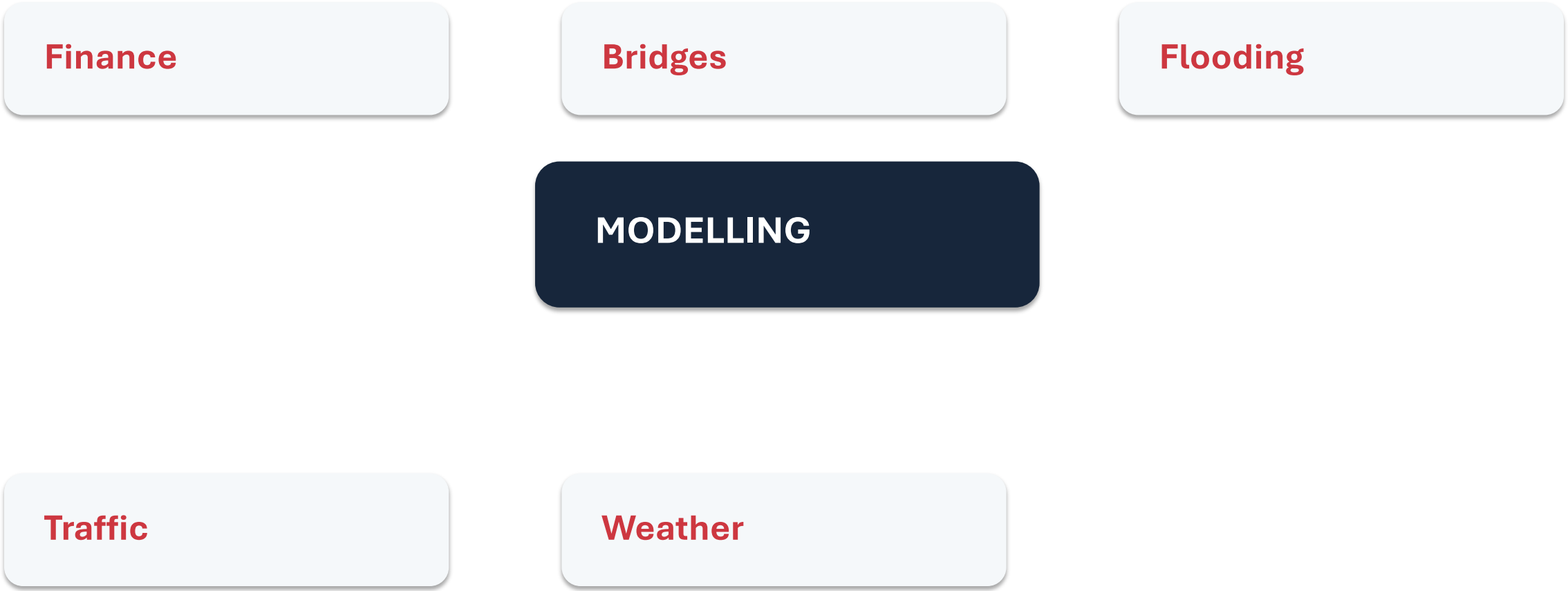
Compare printed poster designs. Evaluate audience, readability, visual hierarchy and required information.

Figure: supplied Chapter 6 PDF

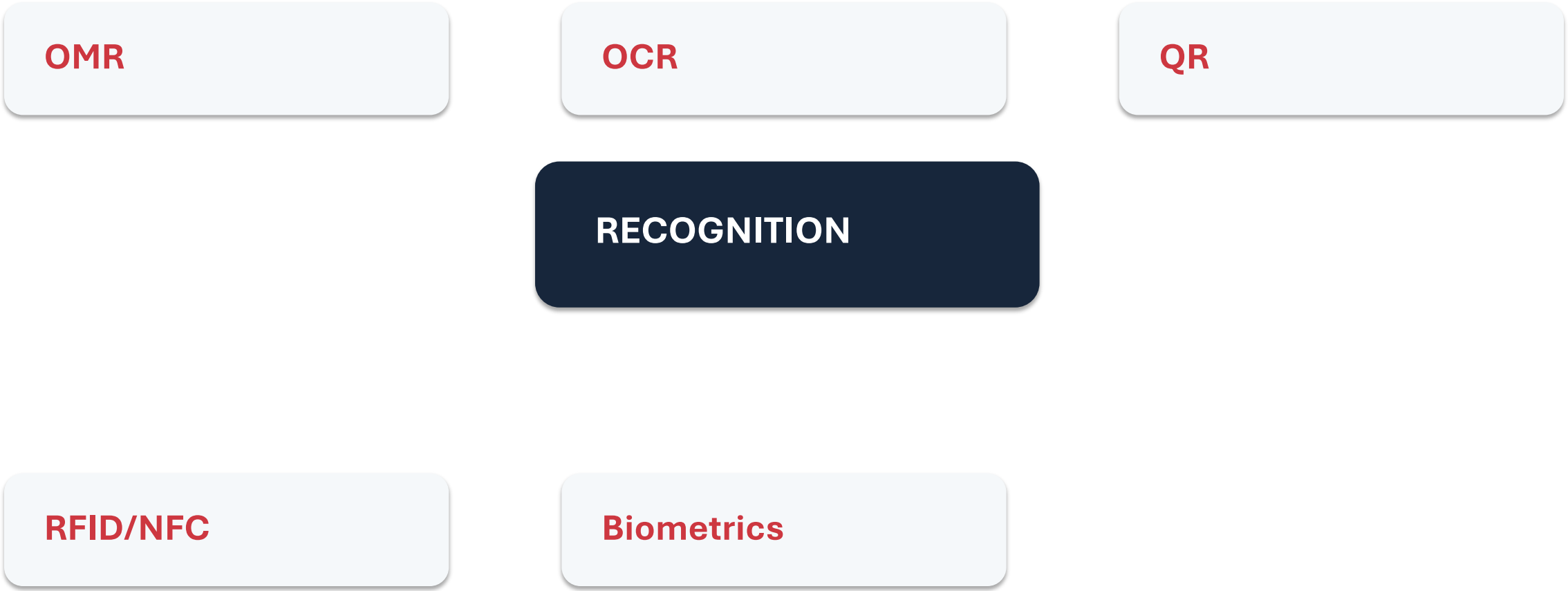
Communication mind map



Modelling mind map



Recognition mind map



Exam Practice 1

- Explain two advantages of computer modelling.

- Think: use precise technical terms and explain cause → effect.

Exam Practice 1 • Model Answer

Suggested answers • not an official mark scheme

- Safer: hazardous situations can be simulated without putting people at risk.
- Cheaper/faster: multiple designs can be tested without building each real prototype.

Exam Practice 2

- Describe how sensors and actuators control bottle filling.
- Think: use precise technical terms and explain cause → effect.

Exam Practice 2 • Model Answer

Suggested answers • not an official mark scheme

- A sensor detects the bottle and sends data to the controller.
- The controller opens the valve via an actuator; a level sensor triggers closure when full.

Exam Practice 3

- Compare OCR and OMR.
- Think: use precise technical terms and explain cause → effect.

Exam Practice 3 • Model Answer

Suggested answers • not an official mark scheme

- OCR converts printed characters into editable or machine-readable text.
- OMR detects filled-in marks in predetermined positions, e.g. multiple-choice answer sheets.

Exam Practice 4

- State two benefits and two risks of online banking.

- Think: use precise technical terms and explain cause → effect.

Exam Practice 4 • Model Answer

Suggested answers • not an official mark scheme

- Benefits: 24-hour access and rapid transfers without visiting a branch.
- Risks: phishing or unauthorised access, and dependence on internet availability.

Exam Practice 5

- Describe the main components of an expert system.
- Think: use precise technical terms and explain cause → effect.

Exam Practice 5 • Model Answer

Suggested answers • not an official mark scheme

- Knowledge base stores facts and rules; inference engine reasons using them.
- User interface accepts inputs; explanation system describes how advice was reached.

Exam Practice 6

- Explain the difference between GPS and GIS.
- Think: use precise technical terms and explain cause → effect.

Exam Practice 6 • Model Answer

Suggested answers • not an official mark scheme

- GPS uses satellite signals to calculate receiver position.
- GIS stores, combines and analyses geographically referenced map information.

Chapter 6 • Final revision checklist

- Know uses, benefits and drawbacks of each ICT application.
- Explain sensor → processor → actuator feedback loops.
- Distinguish OCR / OMR / RFID / NFC / GPS / GIS.
- Use specific examples and justified comparisons in exam answers.