SWITCHED ON

Technology Stage 4

Sally Collins, Rachael Cornius-Randall,
Peter Annetts, Su Annetts,
Rick Hampson, Yvette McMurtrie,
Linda Parsons, Judith Simpson

jacaranda
jaconline.com.au

First published 2006 by
John Wiley & Sons Australia, Ltd
42 McDougall Street, Milton, Qld 4064

Typeset in 10.5/13.5 pt Charlotte Book

National Library of Australia
Cataloguing-in-publication data

Switched on: technology stage 4.

Includes index.
Years 7–8 students, N.S.W.
ISBN 978 0 7314 0179 6.

1. Technology — Textbooks. 2. Design — Textbooks. I. Collins, Sally.

607

Illustrated by Steve Hunter, Paul Lennon, Janice McCormack and Wiley Composition Services

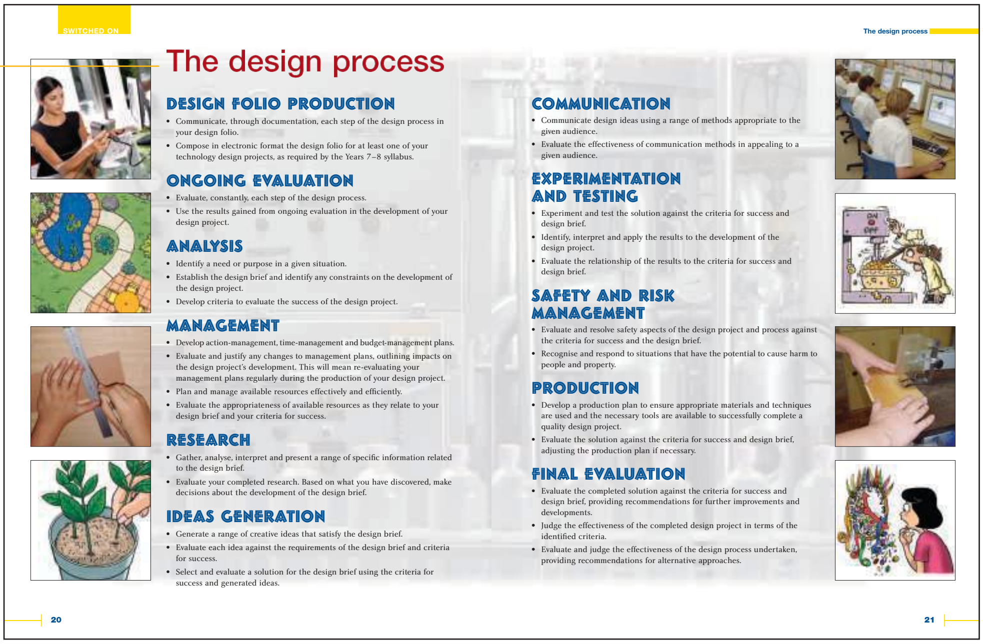
Printed in Singapore by
C.O.S. Printers Pte Ltd

20 19 18 17 16 15 14 13 12 11 10

Contents

How to use this book

- The design process is central to designing, producing and evaluating design projects. The steps should be used in the order that best suits the design project.



SWITCHED ON

The design process

The design process

DESIGN FOLIO PRODUCTION

- Communicate, through documentation, each step of the design process in your design folio.
- Compose in electronic format the design folio for at least one of your technology design projects, as required by the Years 7–8 syllabus.

ONGOING EVALUATION

- Evaluate, constantly, each step of the design process.
- Use the results gained from ongoing evaluation in the development of your design project.

ANALYSIS

- Identify a need or purpose in a given situation.
- Establish the design brief and identify any constraints on the development of the design project.
- Develop criteria to evaluate the success of the design project.

MANAGEMENT

- Develop action-management, time-management and budget-management plans.
- Evaluate and justify any changes to management plans, outlining impacts on the design project's development. This will mean re-evaluating your management plans regularly during the production of your design project.
- Plan and manage available resources effectively and efficiently.
- Evaluate the appropriateness of available resources as they relate to your design brief and your criteria for success.

RESEARCH

- Gather, analyse, interpret and present a range of specific information related to the design brief.
- Evaluate your completed research. Based on what you have discovered, make decisions about the development of the design brief.

IDEAS GENERATION

- Generate a range of creative ideas that satisfy the design brief.
- Evaluate each idea against the requirements of the design brief and criteria for success.
- Select and evaluate a solution for the design brief using the criteria for success and generated ideas.

COMMUNICATION

- Communicate design ideas using a range of methods appropriate to the given audience.
- Evaluate the effectiveness of communication methods in appealing to a given audience.

EXPERIMENTATION AND TESTING

- Experiment and test the solution against the criteria for success and design brief.
- Identify, interpret and apply the results to the development of the design project.
- Evaluate the relationship of the results to the criteria for success and design brief.

SAFETY AND RISK MANAGEMENT

- Evaluate and resolve safety aspects of the design project and process against the criteria for success and the design brief.
- Recognise and respond to situations that have the potential to cause harm to people and property.

PRODUCTION

- Develop a production plan to ensure appropriate materials and techniques are used and the necessary tools are available to successfully complete a quality design project.
- Evaluate the solution against the criteria for success and design brief, adjusting the production plan if necessary.

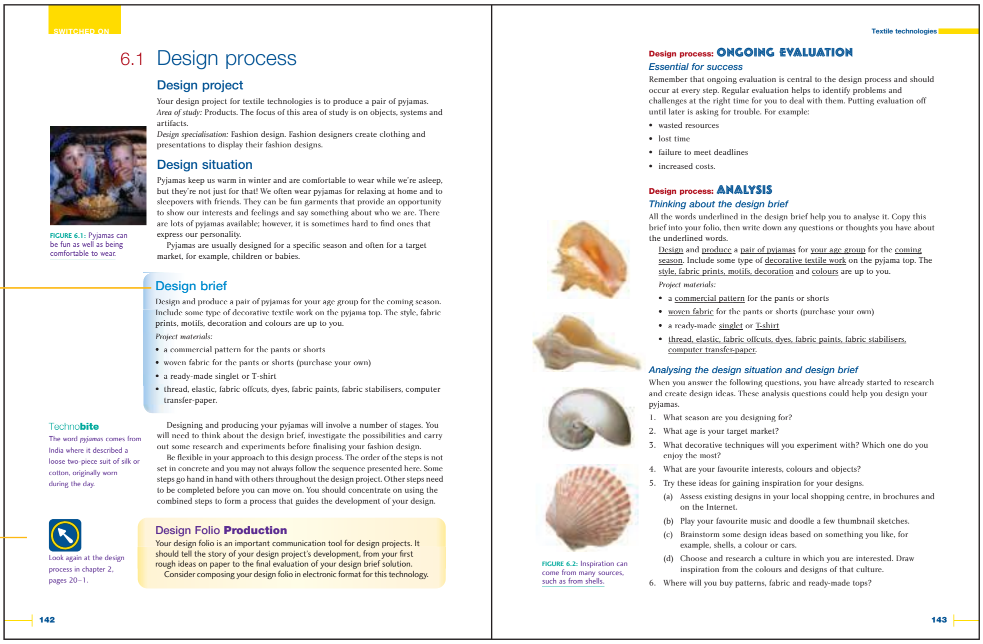
FINAL EVALUATION

- Evaluate the completed solution against the criteria for success and design brief, providing recommendations for further improvements and developments.
- Judge the effectiveness of the completed design project in terms of the identified criteria.
- Evaluate and judge the effectiveness of the design process undertaken, providing recommendations for alternative approaches.

20

21

- Each technology's sample design project uses the design process. The design brief encourages practical experiences and individual interpretation.



SWITCHED ON

6.1 Design process

Design project

Your design project for textile technologies is to produce a pair of pyjamas.
Area of study: Products. The focus of this area of study is on objects, systems and artifacts.
Design specialisation: Fashion design. Fashion designers create clothing and presentations to display their fashion designs.

FIGURE 6.1: Pyjamas can be fun as well as being comfortable to wear.

Design situation

Pyjamas keep us warm in winter and are comfortable to wear while we're asleep, but they're not just for that! We often wear pyjamas for relaxing at home and to sleepovers with friends. They can be fun garments that provide an opportunity to show our interests and feelings and say something about who we are. There are lots of pyjamas available; however, it is sometimes hard to find ones that express our personality.

Pyjamas are usually designed for a specific season and often for a target market, for example, children or babies.

Design brief

Design and produce a pair of pyjamas for your age group for the coming season. Include some type of decorative textile work on the pyjama top. The style, fabric prints, motifs, decoration and colours are up to you.

Project materials:

- a commercial pattern for the pants or shorts
- woven fabric for the pants or shorts (purchase your own)
- a ready-made singlet or T-shirt
- thread, elastic, fabric offcuts, dyes, fabric paints, fabric stabilisers, computer transfer-paper.

Technobite
The word *pyjamas* comes from India where it described a loose two-piece suit of silk or cotton, originally worn during the day.

Designing and producing your pyjamas will involve a number of stages. You will need to think about the design brief, investigate the possibilities and carry out some research and experiments before finalising your fashion design.

Be flexible in your approach to this design process. The order of the steps is not set in concrete and you may not always follow the sequence presented here. Some steps go hand in hand with others throughout the design project. Other steps need to be completed before you can move on. You should concentrate on using the combined steps to form a process that guides the development of your design.

Look again at the design process in chapter 2, pages 20–1.

Design Folio Production
Your design folio is an important communication tool for design projects. It should tell the story of your design project's development, from your first rough ideas on paper to the final evaluation of your design brief solution.
Consider composing your design folio in electronic format for this technology.

142

Textile technologies

Design process: ONGOING EVALUATION

Essential for success

Remember that ongoing evaluation is central to the design process and should occur at every step. Regular evaluation helps to identify problems and challenges at the right time for you to deal with them. Putting evaluation off until later is asking for trouble. For example:

- wasted resources
- lost time
- failure to meet deadlines
- increased costs.

Design process: ANALYSIS

Thinking about the design brief

All the words underlined in the design brief help you to analyse it. Copy this brief into your folio, then write down any questions or thoughts you have about the underlined words.

Design and produce a pair of pyjamas for your age group for the coming season. Include some type of decorative textile work on the pyjama top. The style, fabric prints, motifs, decoration and colours are up to you.

Project materials:

- a commercial pattern for the pants or shorts
- woven fabric for the pants or shorts (purchase your own)
- a ready-made singlet or T-shirt
- thread, elastic, fabric offcuts, dyes, fabric paints, fabric stabilisers, computer transfer-paper.

Analysing the design situation and design brief

When you answer the following questions, you have already started to research and create design ideas. These analysis questions could help you design your pyjamas.

1. What season are you designing for?
2. What age is your target market?
3. What decorative techniques will you experiment with? Which one do you enjoy the most?
4. What are your favourite interests, colours and objects?
5. Try these ideas for gaining inspiration for your designs.
   (a) Assess existing designs in your local shopping centre, in brochures and on the Internet.
   (b) Play your favourite music and doodle a few thumbnail sketches.
   (c) Brainstorm some design ideas based on something you like, for example, shells, a colour or cars.
   (d) Choose and research a culture in which you are interested. Draw inspiration from the colours and designs of that culture.
6. Where will you buy patterns, fabric and ready-made tops?

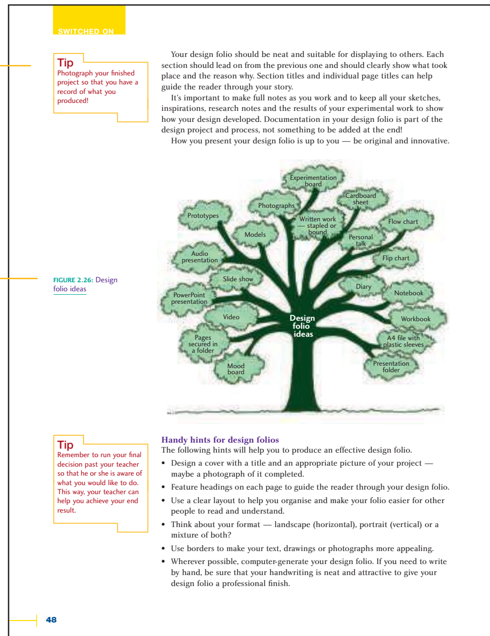
FIGURE 6.2: Inspiration can come from many sources, such as from shells.

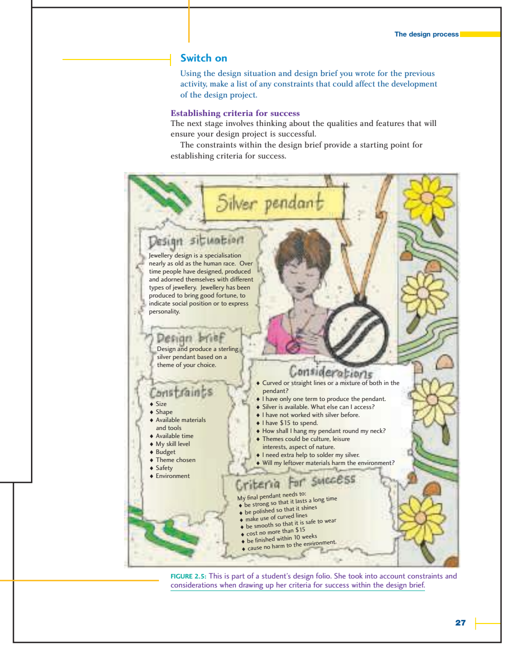
143

- Cross-reference icons point out where additional information can be found in the textbook.

- Tips and Technobites aid learning and understanding.

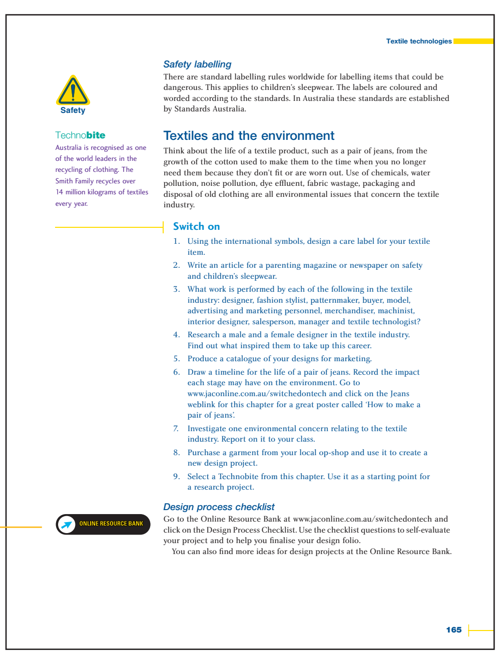
- Switch on sections regularly engage students in active learning and ICT.



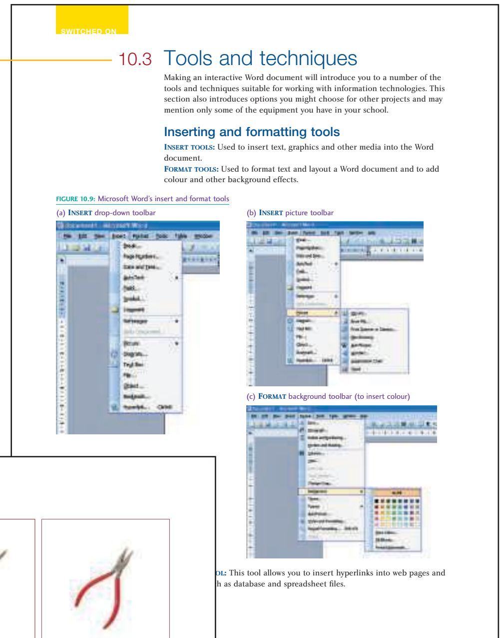


- Design folio production is highlighted throughout and treated in depth in chapter 2.

- The Online Resource Bank at www.jaconline.com.au/switchedontech includes a Design Process Checklist, more ideas for design projects, weblinks and a glossary.



- Chapter opening pages list the essential content for each technology. Design-related content is integrated throughout.


SWITCHED ON

10.3 Tools and techniques

Making an interactive Word document will introduce you to a number of the tools and techniques suitable for working with information technologies. This section also introduces options you might choose for other projects and may mention only some of the equipment you have in your school.

Inserting and formatting tools

INSERT TOOLS: Used to insert text, graphics and other media into the Word document.
FORMAT TOOLS: Used to format text and layout a Word document and to add colour and other background effects.

FIGURE 10.9: Microsoft Word's insert and format tools

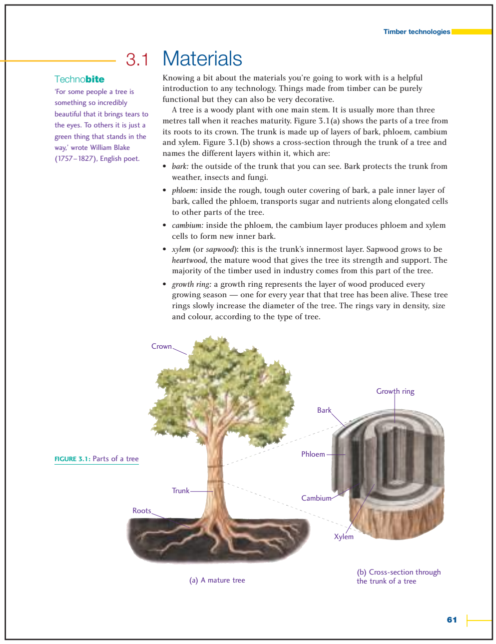
(a) INSERT drop-down toolbar

(b) INSERT picture toolbar

(c) FORMAT background toolbar (to insert colour)

…: This tool allows you to insert hyperlinks into web pages and …h as database and spreadsheet files.

- Tools and techniques are clearly illustrated and explained.


Timber technologies

3.1 Materials

Technobite
'For some people a tree is something so incredibly beautiful that it brings tears to the eyes. To others it is just a green thing that stands in the way,' wrote William Blake (1757–1827), English poet.

Knowing a bit about the materials you're going to work with is a helpful introduction to any technology. Things made from timber can be purely functional but they can also be very decorative.

A tree is a woody plant with one main stem. It is usually more than three metres tall when it reaches maturity. Figure 3.1(a) shows the parts of a tree from its roots to its crown. The trunk is made up of layers of bark, phloem, cambium and xylem. Figure 3.1(b) shows a cross-section through the trunk of a tree and names the different layers within it, which are:

- *bark:* the outside of the trunk that you can see. Bark protects the trunk from weather, insects and fungi.
- *phloem:* inside the rough, tough outer covering of bark, a pale inner layer of bark, called the phloem, transports sugar and nutrients along elongated cells to other parts of the tree.
- *cambium:* inside the phloem, the cambium layer produces phloem and xylem cells to form new inner bark.
- *xylem (or sapwood):* this is the trunk's innermost layer. Sapwood grows to be *heartwood*, the mature wood that gives the tree its strength and support. The majority of the timber used in industry comes from this part of the tree.
- *growth ring:* a growth ring represents the layer of wood produced every growing season — one for every year that that tree has been alive. These tree rings slowly increase the diameter of the tree. The rings vary in density, size and colour, according to the type of tree.

Crown
Growth ring
Bark
Phloem
Trunk
Cambium
Roots
Xylem

FIGURE 3.1: Parts of a tree

(a) A mature tree

(b) Cross-section through the trunk of a tree

61

- Materials are fully described.

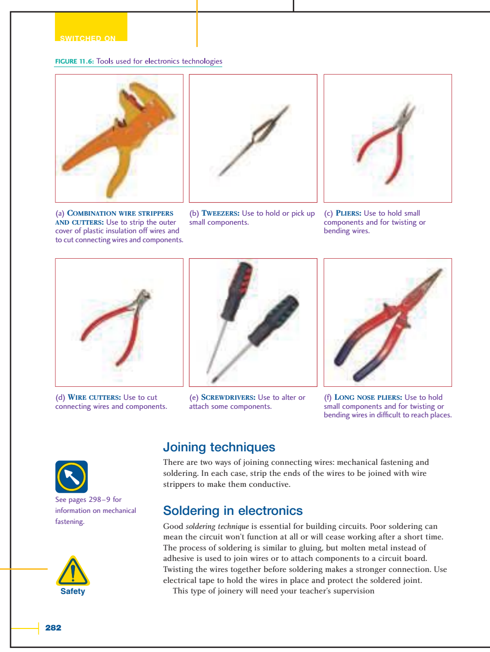

SWITCHED ON

FIGURE 11.6: Tools used for electronics technologies

(a) COMBINATION WIRE STRIPPERS AND CUTTERS: Use to strip the outer cover of plastic insulation off wires and to cut connecting wires and components.

(b) TWEEZERS: Use to hold or pick up small components.

(c) PLIERS: Use to hold small components and for twisting or bending wires.

(d) WIRE CUTTERS: Use to cut connecting wires and components.

(e) SCREWDRIVERS: Use to alter or attach some components.

(f) LONG NOSE PLIERS: Use to hold small components and for twisting or bending wires in difficult to reach places.

Joining techniques

There are two ways of joining connecting wires: mechanical fastening and soldering. In each case, strip the ends of the wires to be joined with wire strippers to make them conductive.

See pages 298–9 for information on mechanical fastening.

Soldering in electronics

Good *soldering technique* is essential for building circuits. Poor soldering can mean the circuit won't function at all or will cease working after a short time. The process of soldering is similar to gluing, but molten metal instead of adhesive is used to join wires or to attach components to a circuit board. Twisting the wires together before soldering makes a stronger connection. Use electrical tape to hold the wires in place and protect the soldered joint.

This type of joinery will need your teacher's supervision

Safety

282

- Safety icons signpost potential dangers or the need for risk management.

- OHS issues are emphasised.


Polymer technologies

Spotlight 1 Polymer banknotes

Polymer banknotes are increasingly replacing cotton rag-based paper banknotes. The new notes, developed in Australia, are already circulating in more than twenty countries. The polymer banknotes, with their protective overcoats, resist moisture, sweat, oil and grime and, therefore, stay cleaner and suit environments where the weather is wet and humid.

Polymer banknotes are durable and difficult to tear and this makes them cost-effective. Plastic currency lasts four to five times longer than paper money, which means that countries adopting polymer technology need to reprint their banknotes far less often.

The plastic banknotes have combined modern and traditional security features to frustrate most would-be forgers. Since 1988, when Australia became the world's first country to circulate polymer banknotes, reports of counterfeiting have dropped significantly.

Polymer is also environmentally friendly. Old Australian paper notes used to be burned or buried, but the polymer ones are shredded, granulated and recycled as plastic wheelbarrows, compost bins and other things — a true cradle-to-grave approach. And the notes are produced on the same equipment that produces paper currency plus one extra machine that overcoats the notes.

See chapter 1, page 12, for more about the cradle-to-grave approach.

Spotlight review

Go to www.jaconline.com.au/switchedontech and click on the Note Printing Australia weblink for this chapter. Read the article, 'Note Printing Australia produced Australia's first polymer banknote in 1988' or search the web for information on polymer banknotes.

(a) What part does the Reserve Bank of Australia play in the production of the polymer banknotes?

(b) Identify four advantages (for example, clean) and four disadvantages (for example, slippery) of polymer banknotes.

FIGURE 5.14: Polymer banknotes

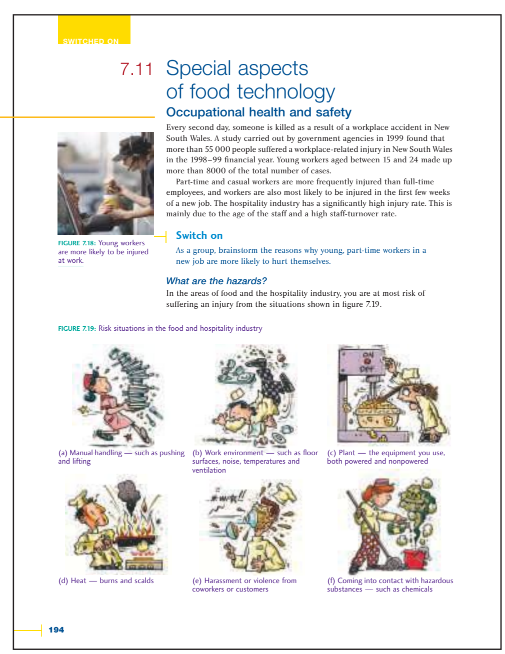
Spotlight 2 Tupperware

Earl S. Tupper (1907–1983) first heard of polyethylene around 1940. This soft plastic, developed in the UK, was being used as a protective coating for electric wire. The Tupper-Dupont team in Massachusetts, United States, produced a finer version of the new material and developed an injection moulding process to shape it. The Tupper Plastics Factory was founded in 1945 and the following year Tupperware parties were launched — a method of selling in homes. Prospective buyers were able to handle the items and watch demonstrations of what they could do. Sales improved almost immediately and eventually Tupperware marketing spread through many countries. Tupperware is still extremely successful — the range expands and updates in response to customers' needs. It is said that every few seconds, somewhere in the world, someone is giving a Tupperware party.

FIGURE 5.15: Tupperware is still sold at Tupperware parties, as well as in shops.

127

- Spotlights feature design and technology at work.


SWITCHED ON

7.11 Special aspects of food technology

Occupational health and safety

Every second day, someone is killed as a result of a workplace accident in New South Wales. A study carried out by government agencies in 1999 found that more than 55 000 people suffered a workplace-related injury in New South Wales in the 1998–99 financial year. Young workers aged between 15 and 24 made up more than 8000 of the total number of cases.

Part-time and casual workers are more frequently injured than full-time employees, and workers are also most likely to be injured in the first few weeks of a new job. The hospitality industry has a significantly high injury rate. This is mainly due to the age of the staff and a high staff-turnover rate.

FIGURE 7.18: Young workers are more likely to be injured at work.

Switch on

As a group, brainstorm the reasons why young, part-time workers in a new job are more likely to hurt themselves.

What are the hazards?

In the areas of food and the hospitality industry, you are at most risk of suffering an injury from the situations shown in figure 7.19.

FIGURE 7.19: Risk situations in the food and hospitality industry

(a) Manual handling — such as pushing and lifting

(b) Work environment — such as floor surfaces, noise, temperatures and ventilation

(c) Plant — the equipment you use, both powered and nonpowered

(d) Heat — burns and scalds

(e) Harassment or violence from coworkers or customers

(f) Coming into contact with hazardous substances — such as chemicals

194

Acknowledgements

The authors and publisher would like to thank the following copyright holders, organisations and individuals for their assistance and for permission to reproduce copyright material in this book.

Images

Adobe product screen shots reprinted with permission from Adobe Systems Incorporated: pages 112 (bottom right), 230, 237 (top & bottom), 238, 240, 244 (top & bottom), 245 (top)/© Sally Collins; 233/© Ben Duffin • © Anthony Browell, reproduced with permission: page 17 • Australian Hardboards Limited/www.australianhardboards.com.au: page 65 (centre left) • Reproduced with the permission of Autodesk, Inc. © 2004. All rights reserved. Autodesk and 3ds Max are registered trademarks of Autodesk, Inc., in the USA and certain other countries: pages 245 (bottom); 241 (top & centre)/Content Sally Collins • AAP Image/David Hancock: page 128 • ANTPhoto.com.au: page 212, figs 8.15(a) & 8.15(d)/Ralph & Daphne Keller; fig. 8.15(c)/Peter McDonald; fig. 8.15(e)/ Cyril Webster • Australian Picture Library: pages 20–1 (background)/Corbis/FK Photo; 104/John & Lorraine Carnemolla; 106 (right)/Corbis/John Lund; 119/Corbis/ Alen MacWeeney; 141 (top)/Corbis/ Penny Tweedie; 198 (bottom left)/John Francesconi; 198 (top left)/Patrick Smith; 205 (bottom)/Corbis/Michael Boys; 206 (top left)/David Morcombe; 272 (bottom)/ Corbis Royalty Free; 283 (top right)/Corbis; 306 (top right)/Corbis/John Madere; 320 (top right)/Retna/Andrew Carruth • Ben Duffin: page 235 (top) • © Biome Living/www.biome.com.au: pages 7 (bottom left), 319 (left & right); 7 (bottom right)/ © Divisible by Zero Pty Ltd; 7 (top)/ © Digital Works Engineering Pty Ltd • Brady Australia Pty Ltd: page 43 (bottom left and safety signs)/Used by permission of Brady Australia • © Brand X Pictures: pages 78 (top left), 129 (centre), 142, 166 (bottom), 204 (bottom) • Bush & Country Furniture/ Andrew Smith: page 83 • Coo-ee Picture Library: pages 214 (bottom centre, bottom left & bottom right), 216 (bottom left), 310 (bottom) • © Corbis Images: pages 76 (bottom left), 145, 200 (bottom), 201 (bottom left), 203 (top left), 204 (top left & centre left), 208 (top left) 209 (bottom), 210 (bottom left), 211 (top left), 213 (top left), 215 (bottom left), 218 (top left), 219 (centre left), 220 (top left), 223 (top), 241 (bottom) • © Corbis Corporation: pages 118 (top left), 129 (left), 132, 217 (bottom left) • © Corel Corporation and Corel Corporation Limited: page 243 (top & bottom) • Dan Hartman www.dansworkshop.com: page 117 (bottom left) • Dept of Primary Industries NSW/Courtesy of Forests NSW/ www.forest.nsw.gov.au: page 62 (permission to redraw diagram) • © Digital Stock/Corbis Corporation: pages 129 (right), 141 (bottom) • © 2002 Digital Vision/Paul Price: page 116 (bottom) • *Chocolate* by Patricia Lousada, Dorling Kindersley Ltd, London, 1997, ISBN 1871854016: page 192/7.16 (a), 7.16(b), 7.16(c), 7.16(d), 7.16(e) • Ford Motor Company of Australia Limited: page 34 (top left) • *Gardens & Outdoor Living*: page 202/ fig. 8.3 • Getty Images: pages 101 (top left)/Robert Harding World Imagery, 217 (top left)/Botanica, 287 (right)/The Image Bank/Steve Dunwell, 289 (bottom)/The Image Bank/Emerich & Webb, 291 (top)/ Stone; • Giovannoni Design: page 15 (right) • © Good Shoot: page 269 (bottom right) • *Yates Garden Guide, 40th Edition*/ Reproduced by permission of HarperCollins Publishers Australia: page 201 (left & right) • Housewares International: pages 2–3 • Hugh Jack: page 242 (left & right) • Image Source: page 283 (top left) • © ImageState Ltd: page 207 (bottom left) • Inflate Design Ltd: page 15 (left) • © John Wiley & Sons Australia: pages 74 (bottom centre), 99 (top right), 160 (top left & top right), 185, 186 (flour & sugar), 239, 262, 269 (bottom left); 20 (2nd bottom), 21 (top right & 2nd bottom), 53, 70, 75 (bottom left & bottom right), 78 (bottom & top right), 79 (bottom, centre & right), 80 (bottom, centre & right), 88 (bottom), 90 (top & bottom), 97 (bottom & centre), 99 (bottom left & bottom right), 101 (right), 102, 114 (left & right), 121, 125, 133, 274 (right), 282 (6 pics), 300 (top)/Photos by Sally Collins; 155 (top)/ Heart by Linda Parsons; 199 (left & right)/ Gabrielle Brady; 268 (top)/Craig Mander • Markitcart Limited: page 57 • Courtesy of Meat & Livestock Australia Ltd www.themainmeal.com.au: page 169 • Micky Ha Ha: page 55 • Microsoft Corporation/Microsoft product screen shots reprinted with permission: pages 256, 264 (left, top right & bottom right), 265 (top, centre & bottom), 267 • Microsoft product screen shots reprinted with permission from Microsoft Corporation/ Compiled by Sally Collins: page 272 (top) • © Moritex USA Inc: page 315 (right) • Mountain Designs/Photograph by Dave Hancock: page 118 (bottom) • © National Heart Foundation/Tick Program National

Heart Foundation of Australia. Reproduced with permission: page 234 • National Library of Australia/Loui Seselja, 1948/Ref: nla pic-an12942: page 16 • New Generation/ www.newgen.com.au: page 51 • Newspix: pages 10/Erica Harrison, 18 (top left)/ John Fotiadis, 127 (bottom)/Gary Graham, 164, 212 (bottom)/Bob Finlayson, 274 (top left)/Brett Hartwig, 288 (top & bottom)/ AFP/Toshikazu Tsuno, 301 (bottom)/AFP/ Yoshikazu Tsuno, 320 (top left)/AFP/ Emmanuel Dunand • Nic Wood Designs: page 15 (centre) • © The Australian Nutrition Foundation, Inc: page 182 • Paul Heald Mosaic Studio/www.mosaic-tabletops.com: page 225 • © Peter Ware: page 268 (bottom) • © PhotoDisc, Inc.: pages 20 (top left), 42, 60 (top & bottom), 71 (bottom), 74 (bottom left), 95 (top), 99 (top left), 100 (top), 101 (bottom left), 108 (aesthetics pic), 116 (top), 127 (top left), 143 (top, 2nd from top, 3rd from top & bottom), 151 (top), 152 (top, top left, bottom & bottom left), 160 (bottom), 166 (top), 170 (top left), 174, 186 (eggs & oil bottles), 187, 191 (bottom left), 207 (top), 210 (top right), 216 (top left & top right), 222 (top left), 224 (top), 228 (top right), 229 (left), 247, 250 (top & bottom), 259, 269 (top left), 273 (top & bottom), 274 (bottom left), 276 (bottom), 278 (top), 285 (bottom), 302 (left & right) • © The Picture Source: pages 277 (bottom), 285 (top), 305 (centre right), 306 (bottom left), 308 (bottom left), 312 (top), 315 (centre)/Terry Oakley; 315 (left)/ MEA • photolibrary.com: pages 8/SPL/ Dr Jeremy Burgess, 19 (bottom left), 72 (bottom & centre), 74 (top & bottom right), 75 (top left & top right), 76 (top left, top centre, top right, bottom centre, bottom right), 82/Eric Millette, 93 (bottom), 94/ Catherine Secula, 95 (bottom)/ Charles D. Winters, 98 (left & right), 105, 106 (left), 209 (top)/Rob Blackburn, 210 (top left), 216 (bottom right), 212/ fig. 8.15b/SPL/Geoff Kidd, 213 (bottom left)/ Everton Macduff, 269 (top right)/Sydney/ SPL/Martyn F. Chillmaid, 276 (top)/SPL/ T358/148, 278 (bottom)/SPL/Andrew Lambert Photography, 286 (left)/SPL/ Chris Knapton, page 287 (left)/SPL/ Seagate Microelectronics Ltd/David Parker, 301 (top)/SPL/D. Roberts, 302 (centre)/ SPL/Martin Dohrn, 305 (top left & bottom left) (top left)/Photonica Inc., 308 (bottom right)/SPL/Martyn F. Chillmaid, 310 (top left)/SPL/Alfred Pasieka, page 320 (bottom left)/Science Photo Library • Rexite SpA: page 39 • © Robert Thomson, Department of Electrical & Computer Engineering, University of Calgary: page 284 (bottom left) • Roman Camping Equipment Pty Ltd: page 49 • © Rubberball Productions: page 194 (top) • © Sally Collins: pages 109 (right), 111, 112 (bottom left), 232 (left & right) • © Sanbrook Holdings Pty Ltd: page 28 • schamburg + alvisse design: page 22 • © Stockbyte Images: pages 144, 167, 186 (butter), 191 (top), 270 • © Stockdisc: page 72 (top) • Victa Lawncare Pty Ltd: page 222 (bottom left) • © Viewfinder Australia Photo: page 18 (bottom left) • Photograph courtesy Wm C Jackson Pty Ltd: page 153 (bottom) • Write Away/Image courtesy of Sunbeam: page 155 (bottom) • Yates, a division of Orica Australia Pty Limited: page 218 (right) • Zip Heaters (Aust) Pty Ltd: page 23.

Text

• Technology (Mandatory) 7–8 Syllabus © Board of Studies NSW for and on behalf of the Crown in right of the State of New South Wales, 2003: pages 19, 60, 93, 116, 141, 166, 198, 224, 250, 276, 301 • Bush & Country Furniture: pages 82–3 • © Dorling Kindersley 1997, from *Ultimate Chocolate* by Patricia Lousada, Dorling Kindersley, 1997: page 192 • News Limited, *The Australian*, 12 August 2004: pages 222–3 • Adapted from Prof. Emanuel Peled, 'New TAU Battery Gives Cars a Boost', Tel Aviv University: page 288 • *Science Daily*/www.sciencedaily.com: pages 287–8 • David Stauth, Oregon State University News & Communications Service: pages 314–15

Every effort has been made to trace the ownership of copyright material. Information that will enable the publisher to rectify any error or omission in subsequent reprints will be welcome. In such cases, please contact the Permissions Section at John Wiley and Sons Australia, who will arrange for the payment of the usual fee.

‘Everything

‘Everything is design. Everything!’

is design.

said Paul Rand, American graphic designer.

Everything!’

Techno*bite*

'Everything is design.
Everything!' said Paul Rand,
American graphic designer.

CHAPTER One

Introducing design

Most of the objects that we use every day have been designed by someone. In this chapter, you will explore the exciting world of design and the work of designers. You will also investigate innovation and emerging technologies and their impact on society and the environment.

Design is all around us. It's what drew you to the last piece of clothing you purchased and it's what attracts you to different food at the local café. Design has made mobile phones smaller and faster, and Kylie Minogue a household name. Design decisions impact on nearly every part of our lives, be it the house that we live in, the way we get to the beach or how we go about taking the lid off the Vegemite jar.

Focus

By the end of this chapter you will be able to:

- list and analyse the factors influencing design
- describe the working methods and responsibilities of designers
- consider the impact of design on the environment
- research innovation and emerging technologies
- understand a range of design specialisations.

Switch on

1. **Find out the name of one Australian designer. Search for information about this person on the Web. Draw up a profile of your chosen designer for your design folio.**
2. **In your home or classroom, test some articles that have the same use, for example, chairs, flower vases or jugs. For each group of articles, define the function. Then compare each article and rate it according to how well it fulfils that function. Report your findings to the class.**

1.1 Factors influencing design

Design activities range from designing to satisfy our personal needs and wants to designing for a larger commercial market. *Needs* are life's basic essentials that enable us to survive: food, water, clothing and shelter. *Wants* are things that make our lives easier and more enjoyable, and might include a surfboard, jewellery, movie tickets or a DVD player.

Switch on

1. How do the designs in figure 1.1 meet people's needs?

FIGURE 1.1: Some of the things people need for survival

2. On your own or in a group, make a list of your needs and wants. Compare your notes with others. Can you think of more?

Design is not only about meeting needs and wants. The end result of design can be classified as a product, a system or an environment:

- *product:* object or thing, such as a school diary or a tennis ball
- *system:* a combination of products linked together to perform a task, such as a stereo or the engine in a car
- *environment:* what is all around us — our surroundings, such as the room you are in now, your school or your bedroom.

Sometimes a design can belong to two or even three groups. For example, the motor car is a product, but it is also a collection of systems: a steering system, braking system and electrical system. Also, the car's interior creates an environment for both the driver and passengers.

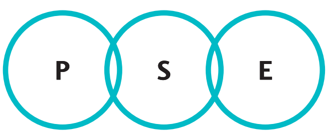


FIGURE 1.2: The motor car is a product, a collection of systems and an environment.

Switch on

Locate pictures of design in magazines and newspapers. Classify them into products, systems or environments. Remember they may belong to more than one group.

Technobite

'The difference between good design and bad design is like the difference between a good story and a bad joke: one is worth hearing again and again; the other preferably not!' said Julian Brown, British designer.

Analysing design factors

People often think that good design is about style and fashion or the way something looks, but good design isn't simply about the surface. There are many factors that can influence design.

FIGURE 1.3: Factors influencing design

Function

Before you begin to design, you must be clear about what your design needs to do or what its function will be.

Switch on

Functional analysis. To learn more about function, complete this functional analysis.

(a) Select a product with which you are familiar.

(b) Describe the purpose of this product and outline its main function.

(c) Does the product function well? Why or why not?

(d) List the materials from which it is produced.

(e) Are the materials appropriate? If not, why?

(f) Outline ways in which the product's function could be improved.

(g) Identify the users of the product. Do you think the product meets their needs?

Undertake a functional analysis each time you start to design. It will clarify the purpose of your design and help you to refine and develop your ideas.

Aesthetics

Aesthetic factors relate to the way something looks — its appearance. Aesthetic criteria can include the colour or shape of a product and/or the decoration and finish that is applied to it.

Switch on

Provide an example of a product you bought because of its aesthetics. Explain why this design factor was important to you.

Techno**bite**

'Beauty without depth is just decoration,' said MetaDesign, international information design firm.

Human form

We all know our shirt, shoe and hat size, but not all clothing in our size is comfortable or allows us to move easily. This is because designers often create for an 'average' person; but we are not all 'average' and our size and shape vary throughout our life.

When designing a product, system or environment, it is vital that you think about the human form that is going to wear or use your design.

Switch on

1. Seats in many cinemas are designed for the average person. List three kinds of people who might find these seats uncomfortable.
2. Prepare a list of ten other items that are designed for average people and may cause discomfort to some.

Techno**bite**

Sebastian Bergne, British designer, is 'happy with a design when it makes people smile.' He says, 'There are many ways an object can make you smile. Familiarity, surprise, beauty, satisfaction, pride, simplicity, humour or wonder. If an object can stimulate a smile whilst or even because of performing its function, it is well designed.'

Scale

Scale refers to size and the relationship of sizes to each other. When you draw your initial design ideas, they will not necessarily be life-size.

You might have to reduce or enlarge your drawings. If you do this, you will need to indicate the scale of the drawing. To do this we use a ratio, so that anyone looking at the drawing can get an idea of what the object's size would be in real life. For example, an object that is drawn at half its actual size would have a ratio of 1:2 and a measurement of 10 cm would be shown on paper as 5 cm.

FIGURE 1.4: This dollar coin is drawn to a ratio of 2:1 and has a diameter of 5 cm. The diameter of a real dollar coin is 2.5 cm.

Ergonomics

Ergonomics is about ensuring people's individual characteristics are considered when designing products, systems or environments. Failure to do so may lead to designs that do not meet the users' needs and are unsuccessful or unsafe.

Switch on

Go to www.jaconline.com.au/switchedontech and click on the Bad Design weblink for this chapter. Read the Ergonomic Toothbrush case study.

(a) Redesign the toothbrush on a blank piece of paper.

(b) Present the design to your class, outlining the ways in which you incorporated ergonomics.

Ethics

Ethics are moral principles that help us to set our values, and judge right from wrong and good from bad. Ethics influence the decisions that we make and, for designers, can influence the appropriateness of their final product, system or environment.

Environment

Designers are becoming more aware that they must consider the environmental effect of their designs. Today, we are seeing more and more environmentally friendly products on the market. Environmentally aware designers are helping to conserve our natural resources and reduce excessive pollution during production of their designs.

(a) The ReZap battery recharger will recharge ordinary household batteries up to 15 times and rechargeable batteries hundreds of times.

(b) This hand-crafted bath mat is made from recycled denim jeans.

(c) This swing has been hand-crafted in the shape of a horse from recycled tyres.

FIGURE 1.5: Environmentally friendly products

Technobite

Biomimetics is the science of studying nature to develop practical technology for humankind. Looking for solutions designed by nature is a promising area of research. In 1948, George de Maestral went for a walk in a field in Switzerland. He returned home bothered by burrs — the small hooks clinging to the loops in the fabric of his trousers. De Maestral examined a burr under his microscope and came up with the idea of Velcro fastening.

Safety and safety legislation

Safety is an essential consideration for designers and manufacturers as they must take responsibility for the safety of the products, systems and environments they design and produce.

Designers often use a variety of dangerous equipment, hazardous materials, tools and substances. Designers and producers should consider:

1. their own safety and the safety of others around them
2. the safety of the design for those who will use it
3. what to do if an accident happens.

Safety issues are very important. You should investigate *legislative requirements* relating to the products, systems and environments you are designing and producing. Investigate the potential hazards of each material you select. Consider and constantly evaluate any potentially hazardous aspects of the design for yourself in production and for the user when completed.

Designers must ensure that their designs conform to all the relevant safety standards, including those of other countries in which the designs may be sold. Careful consideration must be given to ways in which people might misuse the product, and any necessary safety devices and warning labels. Designers can be held responsible for any accidents that occur as a result of poor design.

Cost

Most products are available in a range of prices to suit a range of consumers. Designers must think about their budget and know exactly how much money they require for a quality end result.

Sociocultural factors

It is important to consider the effects of a new design on different cultural groups. Sometimes, not everyone will benefit. Both the positive and negative aspects of a design must be considered.

Switch on

Use the Internet to locate a design that interests you. Evaluate the appropriateness of this design for different cultural groups, including Aboriginal and Torres Strait Islander peoples and indigenous peoples in other countries.

Resource availability

A resource is anything that is used to complete your design project: time and money; materials, tools and techniques; information gained through research; people who provided you with assistance; or even your own expertise. Designers should investigate the availability of the resources needed for their designs. If a particular resource is unavailable at the specific time it is needed, the production process could be delayed indefinitely.

Physical and material properties

Physical and material properties refer to the distinguishing features of resources, for example, the texture, colour, durability, strength or weight of a material. Designers should investigate, experiment and evaluate a range of resources when developing their designs.

Switch on

1. Draw a table similar to table 1.1. List six materials you could use to develop a design project. Fill in the type and use of each material and the properties that make it suitable for this project.

TABLE 1.1: Type, use and properties of material

Type of material	Use of material	Properties of material
Cotton	Clothing	Strong, absorbent, heat conductor, easily dyed

2. Design a locker system for high school students.
   (a) List the factors that you need to consider before you start designing.
   (b) Sketch a design of your locker system and label five of its best features.
   (c) Outline how you incorporated the factors you listed in (a) into your design.
   (d) Is there any connection between the factors you listed in (a) and the features you labelled in (b)? Discuss.

1.2 Designers at work

The professional designer earns a living by creating designs and resolving challenges to meet the needs of clients, or the needs and concerns of society.

Note
The design process works best as a collaboration between the design team and the people the team works with and for, whether in-house colleagues or external clients.

Teamwork

There are a small number of solo fashion and graphic designers but the vast majority of professional designers are part of a design team. In a design team, knowledge, skills and the different steps of the design process can be shared among many people, each with their own expertise.

Working collaboratively lets you explore ideas and experiences with others in your group. You have the chance to hear, talk about, and consider alternative views and thoughts with your classmates. By working collaboratively, you can usually learn and achieve far more than by working individually.

To be an effective design team member you should:

- cooperate with other team members
- share leadership roles so that each team member can have a go
- communicate effectively and listen to others' points of view
- be willing to support the view or idea that carries the best hope of providing a solution — even if it is not your own
- persevere — negotiate and resolve conflicts before they get out of hand
- complete your assigned tasks on schedule and coordinate your task with others — team success relies on this
- assign tasks fairly to members of the team — make sure that one or two team members are not carrying the load for the rest of the team.

FIGURE 1.6: Marc Newson tries out his cocoon-like 'skybed', which provides comfort for passengers on long-haul flights — by Marc Newson Ltd, manufactured by B/E Aerospace Inc, Seating Products Group for Qantas Airways Business Class.

Switch on

Working in groups, think of as many real-life groups as you can.

(a) Why is it useful for these people to be in a group?

(b) Does each group need a leader?

(c) How is each group run — what does it do?

(d) Discuss the value of working with others.

Designers' processes

It's important for designers to work with their clients to understand the design situation and establish a design brief. The design brief outlines the aims and objectives of the project and clearly states the client's needs. The design brief also includes the project's limitations.

Once the design situation and brief are established, the designer starts to research. Market research helps a designer to understand existing designs, competitors' products, legislation, and economic and social changes.

Designers need to plan every detail of the design process in order to produce a quality solution to the design brief. They must consider all the factors that could influence their design and the constraints within the design brief.

Designers must be good communicators, especially when they are working in teams. Communication needs to be maintained throughout the design process so that the project doesn't progress in the wrong direction.

The designer doesn't leave the design process when the design goes into production. It's important to allow for evaluation and redesign. The designer also has an important role to play in communicating ideas to the client and the

Technobite

'With Samsonite, we have dreamed up a line of luggage that combines the ultimate in elegance with the expertise of a great brand, yet one that is affordable to as many people as possible,' said Philippe Starck, French designer.

rest of the design team: the manufacturers, engineers, graphic designers, managers and even board managers (in very large companies).

Finally, the designer evaluates the design project and the design process to assess how the project was handled and how the process can be improved in future.

This process may not sound too familiar now, but it will do when you begin your first design project. It's the same process that you will be involved in — just on a larger scale!

Responsibilities of designers

See page 7.

For modern designs to be effective and successful, designers need to be ethical and make responsible decisions. Most professional design groups in Australia have well-developed *codes of ethics* that provide guidelines to assist designers in acting responsibly.

Switch on

1. Using an appropriate Internet search engine, locate a code of ethics relevant to a design specialisation (see table 1.2, page 18) you are currently working with or are interested in working with.
2. Outline why you think there is a need for organisations to develop codes of ethics for different design specialisations.

Techno**bite**

'Design is not just about how something looks, but how it works. I don't see a difference between a designer and an engineer. And I don't want to see a difference. A designer should be both,' said James Dyson, artist, designer and inventor, pioneer of the bagless vacuum cleaner.

There are many other ethical considerations that influence designers, including:

- community and society needs
- cultural beliefs
- environmental impact
- invasion of privacy
- protection of intellectual property
- rights of the consumer
- safety and health
- animal and human welfare
- sustainability.

Switch on

1. Develop a code of ethics in your classroom that will ensure appropriate behaviour and decisions.
2. Design a poster for your classroom that informs others of the importance of making ethical decisions.

Designers today need to consider the lifelong impact of their designs and whether they are sustainable. Sustainable design is about ensuring a better quality of life for everyone, now and for generations to come. Designers are responsible for the entire life cycle of a design — from initial resource selection to the production process, completion, end use and disposal of their design.

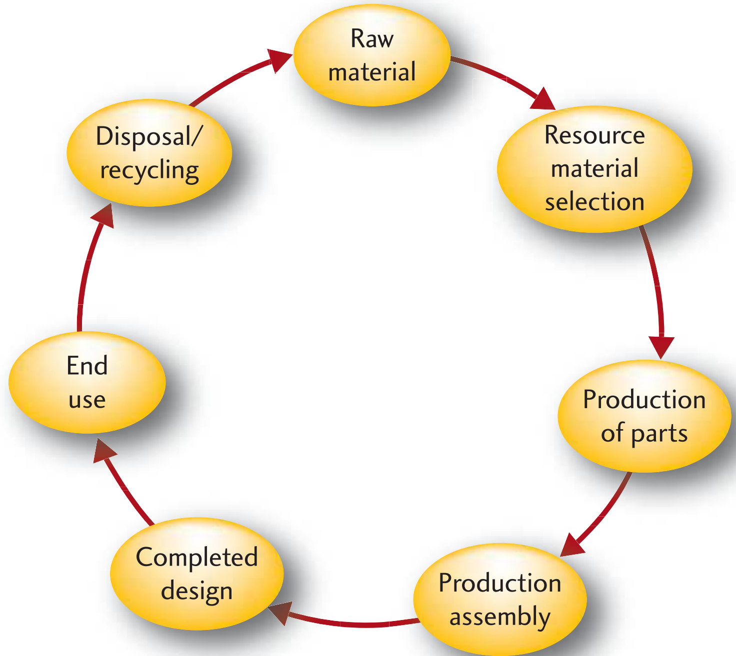


FIGURE 1.7: Stages in the life cycle of a design

Within the design profession, this life cycle is usually identified as the cradle-to-grave approach (see figure 1.8). The cradle-to-grave model of manufacturing examines each stage of a product's life cycle and tries to lessen its impact on the environment. For example, 'downsize products' refers to producing goods that are not necessarily just smaller, but may also:

- last longer, or
- biodegrade when thrown away, or
- need less fancy packaging.

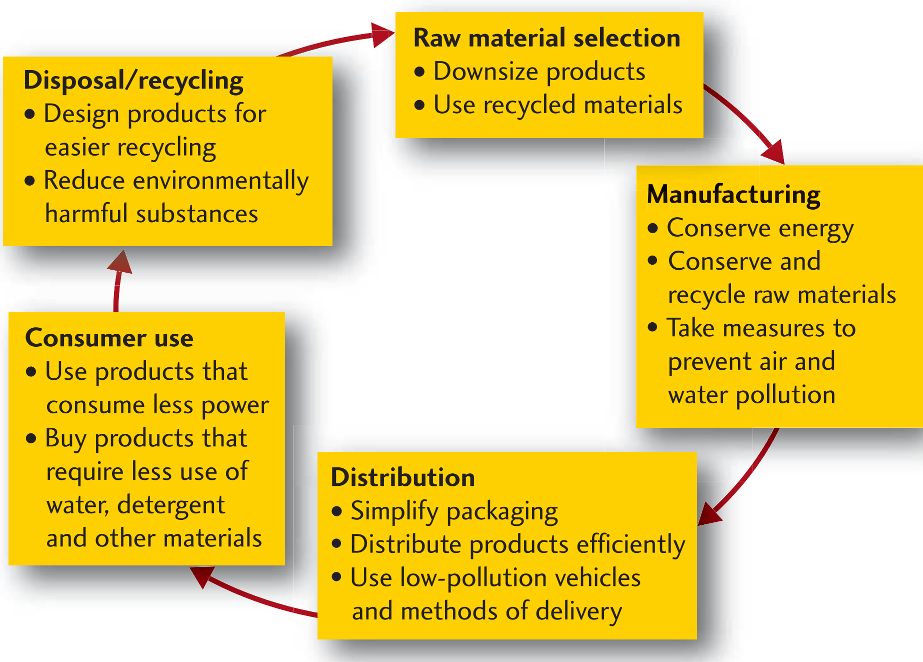


FIGURE 1.8: Cradle-to-grave approach

Switch on

1. As a class, examine figure 1.8 and make sure you understand the aims of the cradle-to-grave manufacturing process.
2. Use figure 1.8 to help you evaluate the environmental impact of your own designs, making sure that they, too, are environmentally sustainable.
3. Go to www.jaconline.com.au/switchedontech and click on the Body Shop weblink for this chapter. How does the Body Shop take a sustainable approach towards the products they develop?

Environmental guidelines

- Strive to create the greatest visual impact with the least environmental impact.
- Consider the use of tree-free paper stock such as straw. Alternative renewable paper sources reduce the need for wood pulp from forests.
- Consider the use of recycled paper stock.
- Consider the use of unbleached paper, as bleached paper requires the use of toxins that are harmful to plants and animals that live in our waterways.
- Consider the use of vegetable-based printing inks such as soy inks. Vegetable-based inks are renewable and emit fewer toxins.
- Avoid overuse of spiral binding as it is difficult to recycle. The glues and metals in such binding slow down cost-effective recycling.
- Consider the smallest paper size suitable for each job, that is, A4 instead of A3. Less paper means less energy, which could also result in less cost.
- When using inkjet printers, use the back of used sheets of paper to print rough work on.
- Keep informed of the latest environmental developments in inks, papers and printing processes. New technologies and rediscoveries of old techniques for environmentally sustainable design are occurring constantly.

Techno**bite**

'People are consuming the earth's natural resources 20 per cent faster than nature can renew them — a dangerous imbalance that is fuelling the loss of species and may lead to critical resource shortages in the years ahead,' according to a World Wildlife Fund study released in October 2004.

Switch on

List five strategies that you could use or adopt to help sustain our environment.

What is *taken* from the environment to produce a design and what is *put back* into the environment during production and on disposal require critical thought. Most products and services use up natural resources, many of which cannot be replaced or renewed.

At present, the bulk of energy we use for power comes from coal, oil and natural gas, and uranium (nuclear power). These are non-renewable resources.

Switch on

1. Use the Internet to investigate and locate examples of renewable and non-renewable resources.
2. Outline why responsible resource selection is important for a sustainable future.
3. Divide your class in half and debate the following issue: *Sustainable design is great for the environment.*

Many environmental problems are caused by the waste and pollution created through producing and using products and services. Many products have a significant effect on the environment. Cars, for example, release pollution into the air that we breathe.

When the useful life of a product is over, the product may end up in a landfill site where it may not simply break down into harmless substances. Materials in landfill sites may contain toxic contaminants and eventually poison the soil, water supply and the nearby wildlife.

Technobite

Ian Kiernan, founder of Clean Up Australia, reports that 4000 plastic bags end up in landfill every minute.

Switch on

Think, pair and share. Think about the following questions. Pair with someone in your class. Share your thoughts.

(a) Should a designer consider waste and disposal issues at the beginning or end of the design process?

(b) Should waste and disposal be an ethical consideration for designers?

Sustainable toolbox for all designers!

When designing and producing, responsible designers:

- reduce the amount of resources used
- reduce the toxic content of materials and waste
- increase their use of renewable or recycled/recyclable resources
- design products for long-term use — increase the life cycle of products
- design products that are easy to repair
- design products that are multifunctional (have multiple uses)
- design for disassembly — make things easy to take apart so they can be repaired, serviced, upgraded or recycled
- design for re-use, recyclability, biodegradability and remanufacture.

The choices we make today will have a significant and possibly lasting effect on the quality of our lives and the environment in the years to come. Designers must strive for a better way of doing things. Consumers are increasingly aware of the environment and tend to avoid products that harm it. As a result, the range of available environmentally friendly products is increasing.

Switch on

1. Visit your local supermarket and investigate the products that have been designed to be environmentally friendly. Evaluate your results and present them to your class in an interesting way.
2. Use a variety of research methods to locate examples of how sustainability and design work together.
3. Use the Internet to research advances made towards sustainability in housing.

Technobite

Sustainable products are those that are totally compatible with the environment throughout their entire life cycle.

Responsible designers:

- analyse the lifelong impact and consequences of their design
- consider the needs of the community and society as a whole

Technobite

'Always design a thing by considering it in its next larger context — a chair in a room, a room in a house, a house in an environment, an environment in a city plan,' said Eliel Saarinen (1873–1950), Finnish-born designer and architect.

- design for sustainability
- follow their profession's code of ethics
- have an awareness of consumer rights
- have an awareness of the cultural beliefs of those who may use their design
- improve the world through their design
- minimise potential environmental impacts throughout the design process
- do not use other people's intellectual property without permission
- do not invade the privacy of others
- do not harm or test their design on any human or animal
- reduce potential health and safety hazards throughout the design process.

Spotlight Eggcups

In the 1960s, the British Egg Marketing Board devised the slogan 'Go to Work on an Egg' to increase the sales of eggs for breakfast. Since then, eggs have fallen out of favour with nutritionists and the use of eggcups has diminished. Yet eggs remain one of Nature's most pleasing forms and eggcups continue to fascinate designers. Recent designs (see figure 1.9) show how this single-purpose, simple object can stimulate the imagination. Eggcups can be made from many materials besides plastic and stainless steel.

FIGURE 1.9: Recent eggcup designs

(a) Inflatable eggcup by Michael Sodeau, co-founder of Inflate (made of plastic)

(b) Eggcup that is reversible to suit the size of the egg by Nic Wood Designs (made of stainless steel)

(c) 'Cico' eggcup by Stefano Giovanonni, Alessi (made of plastic). The hat is a salt shaker.

Spotlight review

1. Design an eggcup from any material other than plastic or stainless steel.
2. Research current eggcup designs. Draw up a list of criteria for success (e.g. aesthetics, function, cost) and rank them in your order of approval.

1.3 Innovation and emerging technologies

An *inventor* is someone who creates something original or significantly different from what already exists. Inventions come about when people think of ways of doing things better, safer, faster and more efficiently. *Innovation* is the process of turning these new ideas and inventions into products and systems.

Australia has a proud history of innovation. Inventions such as the Hills hoist, Speedo swimwear and the wine cask were all developed by Australian designers.

Technobite

'What you need to invent is an imagination and a pile of junk,' said Thomas Edison (1847–1931), American inventor and physicist. The gramophone and the incandescent light bulb were two of his most famous inventions.

FIGURE 1.10: 1948: Hanging out the washing on the Hills hoist clothes line in suburban Canberra

Source: National Library of Australia/Loui Seselja, 1948/Ref: nla pic-an12942

Switch on

Use a range of recent newspapers and magazines to identify five examples of innovative Australian design. Cut out your examples and produce a collage. Next to each example, briefly outline why you think it is an innovation.

Innovation may be:

- *objects*, for example, a DVD player, cutlery or a hairbrush
- *knowledge*, for example, how to use an overlocker or program a computer
- *organisations and industries*, such as biotechnology or high-rise construction.

An *emerging technology* is a brand new material, tool or technique that is used in developing an innovation. Emerging technologies are those that are not commonplace or currently on the market, whereas *new* technologies are those that have just hit the marketplace. Examples of emerging technologies in Australia include:

- the use of wool in 'smart' medical dressings that gradually release medication into the wound while controlling moisture and temperature
- the conversion of the pig by-product methane into electricity.

New and emerging technologies make possible what was once impossible. Designers who incorporate new and emerging technologies into their designs early can achieve a competitive advantage in the marketplace.

Technobite

'Our role is to act as mediator between the designer and the needs and dreams of the market,' said Alberto Alessi, Italian producer of designs in metal, ceramic, wood and plastic.

Innovation can occur for two reasons:

1. *A push for the improvement of technology.* As consumers become more sophisticated, there is an increasing push for technologically advanced products, systems and environments. This results in the improvement of existing technology and the emergence of new technologies.
2. *Consumer demand.* The new and existing technologies are then used to develop designs to meet the demands of consumers. The Ford ute, for example, was developed in the 1930s when a farmer's wife told Ford Australia that her husband couldn't afford both a car and a truck. She asked Ford to produce a vehicle with a front to take the family on outings and a back to take the pigs to market.

The process of innovation can be simply represented as a cycle of five overlapping activities that are repeated many times as the innovation is improved, updated or extended.

1. *Evaluating* existing — and new — needs and wants of consumers.
2. *Researching* innovative ideas to meet consumers' needs and wants.
3. *Designing* an innovation that meets the needs and wants of consumers within the constraints of the design brief.
4. *Producing* assembling, finishing and packaging the innovation.
5. *Marketing* the innovation to the target market.

Innovation and emerging technologies have had an impact on both society and the environment in many ways. Impacts on society include:

- new ways of working and the creation of new jobs
- reduced working hours, providing more opportunities for leisure
- increased access to facilities and instant information
- changing perceptions and values
- improved standards of safety, performance and quality
- loss of jobs due to mechanisation and automation
- increased laziness and health issues.

Environmental impacts include:

- increased environmental monitoring and protection
- cleaner emissions and less consumption of resources
- more efficient use of resources and less consumption of non-renewable resources
- increased use of appropriate technology
- creation of less waste and new uses for waste — recycling and re-use
- increased waste due to societies' disposable attitudes.

Technobite

'For me to be building in my country, for the people I know best, in the land I know best, gives me the greatest chance of success,' said Glenn Murcutt, prize-winning Australian architect.

Switch on

Behind every innovation there is often a terrific story about how it began. Here are two to set you off on what can be an inspiring Internet journey, if you have a little time and patience.

1. Go to www.jaconline.com.au/switchedontech and click on the New Inventors weblink for this chapter to investigate the *reversible surfboard* designed by Dean and Janice Mundy and James Klobasa.

FIGURE 1.11: Dinosaur Design necklaces — the owner of these has had them for fifteen years

(a) Identify the inspiration behind the surfboard idea.
(b) Outline why the surfboard would be classified as an innovation.
(c) Click on the Patents weblink for this chapter to investigate the definition of a patent. Discuss why it was important for the designers to apply for a patent.

2. Go to www.jaconline.com.au/switchedontech and click on the Designed to Inspire weblink for this chapter.
   (a) What are the jewellery and homewares made from?
   (b) From where do these designers get the ideas for their themes?
   (c) What material do they use for modelling prototypes?
   (d) How do they make sure that their designs continue to develop?

1.4 Design specialisations

Throughout this subject, you will have many opportunities to design and develop exciting design projects using a variety of different technologies. You will explore design possibilities and various design specialisations.

Technobite

Architects — designers for the built environment — take the surroundings into account. One of Australia's most famous landmarks, the Sydney Opera House, was designed by Danish architect Joern Utzon and took from 1957 to 1973 to build. This tile-clad concrete and precast concrete structure gracefully dominates its urban waterfront context.

Areas of study

Professional designers usually specialise in particular design areas. In the technology syllabus, these are divided into *areas of study* and subdivided into *design specialisations* (see table 1.2).

TABLE 1.2: Design specialisations

Area of study: Built environments	Area of study: Products	Area of study: Information and communications
The above areas of study may include the following design specialisations.		
• Architectural design • Environmental design • Interior design • Landscape design • Structural design	• Accessories design • Agricultural product design • Food design • Industrial design • Jewellery design	• Communication systems design • Information systems design • Promotional design • Software design • Digital media design

Switch on

1. Copy table 1.2 and, for each area of study, select a design specialisation. Using a range of research methods, investigate:
   (a) the work that designers might do if they were involved in that design specialisation and their method of working — individual or collaborative
   (b) what is designed and produced
   (c) the resources, materials, tools and techniques used.
2. Choose a design specialisation from those listed in table 1.2 and investigate two new innovations occurring within that field of design.

The design process

Designing is not limited to those individuals who are employed as professional designers. It is important to realise that we all design as part of our day-to-day lives. In this chapter you will be introduced to the design process and led through it step by step.

The technology course provides many opportunities for you to work with the design process. You will have the chance to combine your understanding of numerous materials, tools and techniques with the process of design to produce many and varied quality design solutions.

Focus

By the end of this chapter you will be able to apply the following steps of the design process to a design project:

- design folio production
- ongoing evaluation
- analysis
- management
- research
- ideas generation
- communication
- experimentation and testing
- safety and risk management
- production
- final evaluation.

Switch on

1. What do you know already about design from studying an Australian designer and reading chapter 1? Compare your ideas with the rest of your class.
2. How many times each day do you design for yourself? Make a list of activities in which you are the designer.

Technobite

'Structured design processes assist people to apply technological know-how in the creative development and production of quality solutions to identified needs and opportunities.' *Technology, Years 7–8 Syllabus*, Board of Studies, New South Wales, June 2003.

The design process

DESIGN FOLIO PRODUCTION

- Communicate, through documentation, each step of the design process in your design folio.
- Compose in electronic format the design folio for at least one of your technology design projects, as required by the Years 7–8 syllabus.

ONGOING EVALUATION

- Evaluate, constantly, each step of the design process.
- Use the results gained from ongoing evaluation in the development of your design project.

ANALYSIS

- Identify a need or purpose in a given situation.
- Establish the design brief and identify any constraints on the development of the design project.
- Develop criteria to evaluate the success of the design project.

MANAGEMENT

- Develop action-management, time-management and budget-management plans.
- Evaluate and justify any changes to management plans, outlining impacts on the design project's development. This will mean re-evaluating your management plans regularly during the production of your design project.
- Plan and manage available resources effectively and efficiently.
- Evaluate the appropriateness of available resources as they relate to your design brief and your criteria for success.

RESEARCH

- Gather, analyse, interpret and present a range of specific information related to the design brief.
- Evaluate your completed research. Based on what you have discovered, make decisions about the development of the design brief.

IDEAS GENERATION

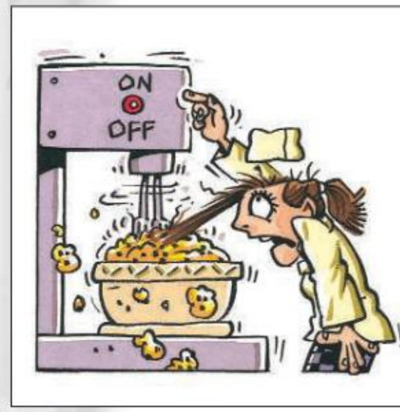
- Generate a range of creative ideas that satisfy the design brief.
- Evaluate each idea against the requirements of the design brief and criteria for success.
- Select and evaluate a solution for the design brief using the criteria for success and generated ideas.

Communication

- Communicate design ideas using a range of methods appropriate to the given audience.
- Evaluate the effectiveness of communication methods in appealing to a given audience.

Experimentation and testing

- Experiment and test the solution against the criteria for success and design brief.
- Identify, interpret and apply the results to the development of the design project.
- Evaluate the relationship of the results to the criteria for success and design brief.



Safety and risk management

- Evaluate and resolve safety aspects of the design project and process against the criteria for success and the design brief.
- Recognise and respond to situations that have the potential to cause harm to people and property.

Production

- Develop a production plan to ensure appropriate materials and techniques are used and the necessary tools are available to successfully complete a quality design project.
- Evaluate the solution against the criteria for success and design brief, adjusting the production plan if necessary.

Final evaluation

- Evaluate the completed solution against the criteria for success and design brief, providing recommendations for further improvements and developments.
- Judge the effectiveness of the completed design project in terms of the identified criteria.
- Evaluate and judge the effectiveness of the design process undertaken, providing recommendations for alternative approaches.

2.1 Exploring the design process

Note
The design process sometimes takes only a few seconds to complete. On other occasions it can take many years.

It's not always easy coming up with design ideas. Trying to develop them into quality solutions is often even more challenging. The *design process* is here to help you!

The design process is a planned series of sequenced steps used to solve design challenges that meet the needs or wants of the end-user.

Different kinds of designers — graphic, product, system or environmental — do not think or work in the same way. *This is why the steps of the design process should be used only as a guide; in practice, the exact order is not necessarily followed.*

Refer to pages 47–9.

Design process: DESIGN FOLIO PRODUCTION

Your design folio is an important communication tool for design projects. It should tell the story of your design project's development, from your first rough ideas on paper to the final evaluation of your design brief solution. You can create your design folio by hand or in electronic format.

The steps of the design process (see pages 20–1) are broken down to help you understand why each one is important and how, together, they help you to reach a quality solution.

Design process: ONGOING EVALUATION

FIGURE 2.1: 'Miss Molly Lounge Chair' by Schamburg + Alvisse Furniture — plywood chair with stainless steel base

Evaluation is central to the design process and should occur at every step. Designers often evaluate without even realising it. When you reject an initial design idea, purchase a piece of clothing or refuse to eat a certain food, you are making decisions about what you like and dislike and are taking part in the process of evaluation.

Successful design requires ongoing evaluation in which the designer considers honestly the strengths, weaknesses and possible alternatives. It's important to evaluate your work constantly throughout the project's development, from identifying the need to producing the finished design.

Ongoing evaluations do not need to be long but should provide important information about what you are doing, why you are doing it and the challenges associated with each step of the design process. Avoid unclear evaluations, such as, 'Yes, I like the colour', or 'No, I don't like the colour'. Incorporate clear, good reasons for your choices, for example, 'Yes, I am pleased with the final colour of my design because . . .' The more thought you put into your ongoing evaluations, the easier your final evaluation will be to write.

Tip
Evaluate truthfully. Try to resist writing that your design is fabulous if there are areas that need to be modified. By being honest, you will show that you have really thought about the process you have been through and learned how to avoid making the same mistakes in the future.

Tip
It's a good idea to highlight each evaluation in your design folio, for example, by using a gold star, a coloured box or a different text size, colour or font.

Evaluation methods

There are many evaluation methods that you can use. These include:

- *client* — asking the end-user to comment on your design project
- *comparison* — comparing your design project with similar products
- *expert* — consultation with an expert in the field related to your project
- *investigation* — testing and trialling the project
- *peer* — questioning your classmates for their opinion of your design project
- *self* — asking yourself questions about your project.

Switch on

1. Outline why evaluation is important in design.
2. Go to www.jaconline.com.au/switchedontech and click on the Australian Design Awards Miss Molly Lounge Chair weblink for this chapter. Read about this product (see figure 2.1). As a class, discuss how helpful this information would be to the judges evaluating this entry.

Design process: ANALYSIS

All designers follow each step of the design process in their efforts to solve challenges and meet the needs and wants of the people they are designing for. These people are usually referred to as clients or customers.

Switch on

Go to www.jaconline.com.au/switchedontech and click on the Australian Design Awards Zip HydroTap weblink for this chapter. Read about this product (see figure 2.2). Identify three ways the designers of this product meet the needs and wants of their clients.

FIGURE 2.2: 'Zip HydroTap' by Bluesky Creative Pty Ltd — dispenses filtered water that is boiling from one side and chilled from the other

Design project, situation and brief

Normally, designers are asked to work on a *design project*. The design process is used throughout the project's development so that the initial challenge can successfully be resolved.

A *design situation* provides the designer with background information about the challenge and sets the context for developing the design project.

The *design brief* is the focal point of the design process. It provides a clear and concise statement that highlights the challenge and outlines the *constraints* that may influence the successful development of the design project.

Design situation example

New research has confirmed what many Australians already know: small animals play an important part in helping people to lead a productive and fulfilling life. The cat is the chosen pet of around 37 per cent of Australian households. Cats, like many other small animals, are hunters and they play a significant role in the decline of our native animal population. Curfews, de-sexing and bells are not effective in protecting our native animals.

Design brief example

Design and produce a system for containing small animals in the domestic environment.

Writing a successful design brief

There are some general rules you can follow when writing a design brief.

- Make the statement clear and concise.
- Design briefs should always be *brief* — this is how the term originated! Write no more than three to four sentences.
- The design brief should not contain any solutions or examples.
- Do not write in the first person. For example, 'I am going to design and produce . . .' should be written, 'Design and produce . . .'

There are a number of ways in which a design brief could be established. Your teacher might:

- give you and the rest of your class the same design situation and brief and explain exactly what you are required to design and produce
- give you a range of possible design situations and briefs to choose from
- ask you to suggest a possible design brief as a response to a design situation you have discovered.

If your teacher has allowed you to choose your own situation and brief:

- start by investigating your needs or wants. Make a list of your interests or hobbies. Try to design and produce something you actually need or want.
- consider the needs and wants of those around you. Talk to family and friends about challenges they have that need solutions.
- think of a situation where something has not worked how you wanted it to. Are there any opportunities for design in this situation?

Techno*bite*

'Design is creation in or alteration of the world to meet the needs and desires of people,' said Dirk Knemeyer, Chief Design Officer, Thread Inc., USA.

How to analyse a design brief

The purpose of analysing the design brief is to generate and record ideas, statements and questions that will guide and focus your future *research*. Even ideas that you think are a bit silly should be recorded at this stage! This technique is called *brainstorming*, and is regularly used by designers to generate and record their thoughts quickly.

These thoughts are often communicated through *mind maps*. Mind maps show how ideas are related to one another by drawing lines between ideas that have

See pages 39–41 for more information on brainstorming and mind mapping.

something in common. The central bubble contains a keyword (sometimes with a simple sketch), a phrase or a question. You then place stems around the rim of the central bubble and write your ideas at the end of each stem (see figure 2.3).

FIGURE 2.3: Mind map

Another great way to analyse your design brief is to examine the *keywords* within it. This helps you understand what each word actually means and highlights the areas that will need research. Examine the mind map shown in figure 2.4. The keywords have been underlined and the mind map shows that research is needed to learn more about each area.

Through brainstorming, creating mind maps and examining keywords, you will understand more about the design brief. These techniques can often uncover additional ideas that were not obvious at the beginning. By taking the time to analyse your design brief, you can work out exactly what is required to resolve it successfully and produce a quality design project.

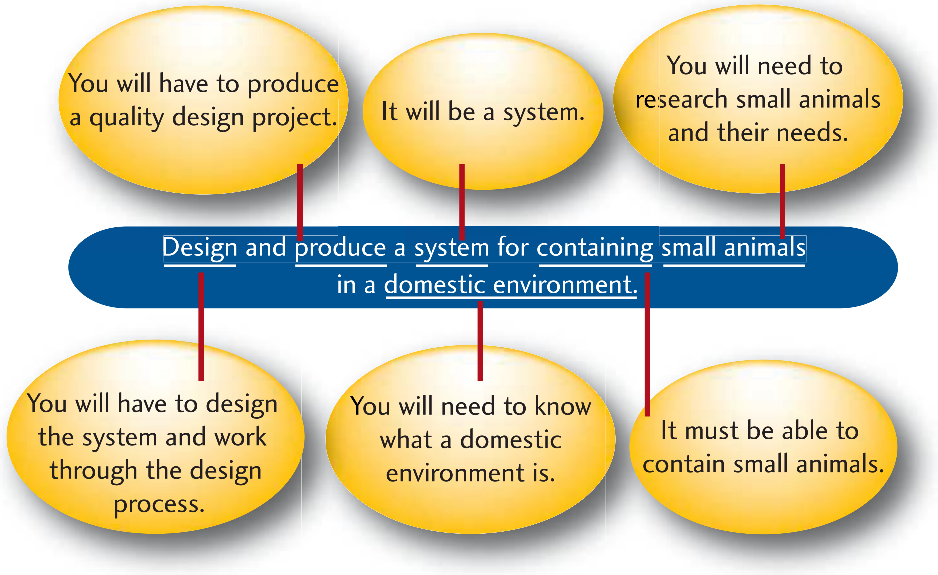


FIGURE 2.4: Mind map: analysing the design brief

Refer back to your analysis as you work your way through the design process to ensure that you are considering all your ideas, statements and questions. Your analysis will help you target potential challenges and resolve them, one by one.

Switch on

(a) Identify a challenge that you have experienced. Write a design situation and a design brief for a design project that could provide a solution to this challenge.

(b) Brainstorm and draw a mind map of things you know, things you want to find out and things you will need to know that relate to your design brief.

(c) Examine and highlight the keywords in your design brief.

Constraints

A list of constraints must be developed to guide the project in the right direction. Constraints are factors that restrict the project and they can be set by you, the design brief, your teacher or your environment.

The following list of constraints can be modified to suit the needs of your own design brief.

- *Time available:* When must the project be completed?
- *Function:* What are the purpose and main features of the project?
- *Aesthetics:* What should the project look like?
- *Cost:* Do you have enough money to complete the project?
- *Materials and tools available:* What materials and tools are required? Are they available at school?
- *Expertise:* Do you have the skills required to complete the project?
- *Environmental considerations:* Will any production waste harm the environment?
- *Safety rules and regulations:* Will the product be safe? Will it meet all legislative requirements?

Switch on

Using the design situation and design brief you wrote for the previous activity, make a list of any constraints that could affect the development of the design project.

Establishing criteria for success

The next stage involves thinking about the qualities and features that will ensure your design project is successful.

The constraints within the design brief provide a starting point for establishing criteria for success.

FIGURE 2.5: This is part of a student's design folio. She took into account constraints and considerations when drawing up her criteria for success within the design brief.

Technobite

'Design depends largely on constraints,' said Charles Eames (1907–1978), American designer.

Before you start designing, complete a table like table 2.1 for your design brief.

TABLE 2.1: Criteria for success checklist

Constraints	Criteria for success
Function	Needs to be strong and hold a large weight
Aesthetics	Needs to be black to match my bedroom
Cost	
Materials, tools, techniques	
Resource availability and use	
Health and safety	
Environment	
Ethics	

Switch on

For this activity you will need:

- one piece of A4 paper
- coloured pencils and pens.

You have ten minutes to use your piece of paper to design and produce a paper aeroplane that can be easily identified as your plane.

After ten minutes, line up alongside your classmates and send your plane into the air. The person whose plane reaches the furthest distance is the winner. Answer the following questions in your workbook.

1. Outline why the winning plane won. Describe its design features.
2. Did everyone have the same style of plane? Explain why or why not.
3. Identify the factors that influenced your design.
4. Outline any constraints that you had to consider to complete the task successfully.

Design process: MANAGEMENT

FIGURE 2.6: 'Gummy' by IdeationDesign Pty Ltd — designed with the help of dental specialists to fit snugly around a baby's gums. Gummy is available in two sizes for different stages of teething.

The quality of management determines the success of both the design process and the final design project. Management involves the planning of activities and organising, allocating and using resources to achieve desired goals. Your desired goal is being able to resolve your design brief. See figure 2.7 for an easy way to remember the management process.

Evidence of project management is an essential component of your design folio and should be documented through:

- an action-management plan
- a time-management plan
- a budget-management plan.

Switch on

1. Outline why management is an important part of designing and producing.
2. How well do you think you can manage a design project? Identify your strengths and weaknesses.
3. Go to www.jaconline.com.au/switchedontech and click on the Australian Design Awards Gummy weblink for this chapter. Read about this product (see figure 2.6). The product manufacturers, Sanbrook Holdings Pty Ltd, were responsible for managing the production of this product. What other groups would they need to have consulted in the management process?

Action-management planning

Action-management plans show all the activities required to complete your project — from initial ideas to final evaluation. The plan identifies each activity and places it in sequence, so that you can clearly see what needs to be done.

Often it is overwhelming for designers to sit down and list all of these activities, especially if it is a very large design project. An easy way to start is to use the design process on pages 20 and 21. List each step and any details that are related to or that may affect the completion of your design project, such as exams, assessment tasks, holidays, sports carnivals or other important dates, so you can plan around them. This list will form the basis of your action-management plan.

Your list of steps might include some or all of the following:

- analysis
- criteria to evaluate success
- management plans, including, time-, action- and budget-management plans
- resource identification
- research
- communication
- safety and risk management
- experimentation and testing
- production steps
- final evaluation
- ongoing evaluation
- design folio production.

Action-management plans should be linked directly to your time-management plan.

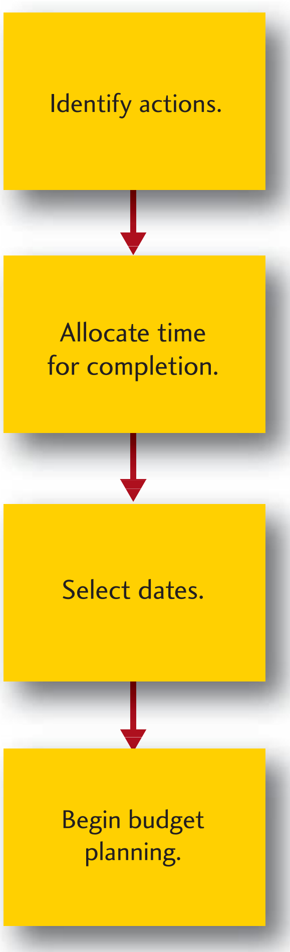


FIGURE 2.7: Management process

Time-management planning

How long do you have to complete your project? Do you have a couple of weeks, a term or a semester? This is known as your time constraint.

Estimating the amount of time you will need to complete each step is a difficult part of project management. It is really only through experience that professional designers know how much time to allocate to individual tasks. If you are uncertain about the time needed to complete tasks, ask other people, such as your teacher.

Using the list of steps in your action-management plan, estimate the time required to complete each step. Remember, it is better to overestimate your time than to underestimate it. Write the amount of time beside each step.

Add up the total number of days or weeks and compare this to the total amount of time you have to complete your project. Now decide which aspects of your project can be completed at the same time and which parts cannot begin until the preceding activity has been completed. If your plan fits comfortably within the time frame — well done!

There is no best way to develop and present action- and time-management plans. You could prepare a separate list of actions and a time-management plan, or you could combine both plans.

Figure 2.8 shows a simple grid (Gantt chart) with sample actions listed down the left-hand side and a series of weeks running horizontally across the top.

Tip
In your initial planning, you will manually sequence tasks and calculations of time and costing. For more complex design projects, designers use computer programs that can quickly reassess any changing circumstances and update times and events simultaneously.

	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8	Wk 9	Wk 10
Producing design folio										
Ongoing evaluation										
Analysis										
Management										
Research										
Ideas generation										
Communication										
Experimenting and testing										
Safety/risk management										
Production										
Final evaluation										

FIGURE 2.8: Action- and time-management plan. This is known as a Gantt chart and templates are available in various computer programs.

Switch on

Design action- or time-management plans. Use the design brief example on page 24 or the design brief you wrote for the activity on page 26.

(a) List the main steps that would form the basis of your action-management plan.

(b) Estimate the time required beside each step. Use a calendar to assist you with dates, including assessment tasks, holidays, submission dates, etc.

(c) Use a computer to design a table to display this information. Use colours and shading to communicate your plan effectively.

(d) Ask a classmate to evaluate your action- or time-management plan. Are the actions logically sequenced? Is it clear when each action will be completed?

Remember, you should be completing your ongoing evaluation and design folio throughout the development of your design project — not just at the end! Be sure to mark this clearly on your action- and time-management plans.

Budget-management planning

Tip
Computers are good for keeping financial records as they can do all of the calculations for you.

The purpose of a budget-management plan is to identify how much money is available, estimate realistically the cost of each resource needed to complete your project, and monitor the actual costs and ongoing balance as your project progresses. A budget-management plan can be presented as a list, table or spreadsheet. It should feature:

- the amount of money you wish to spend developing your design project
- a list of all of the resources you require to complete your project
- the supplier's contact details for each resource
- the amount or quantity of each resource used to complete your project
- the unit cost for each resource
- a breakdown of projected and actual costs of each resource
- a total of the difference between your projected cost and actual cost
- a running balance
- an evaluation.

TABLE 2.2: Budget-management plan

Resource	Supplier	Quantity	Unit cost	Projected cost	Actual cost	Difference
Radiata pine	Bunnings Warehouse	1 metre	$2.00	$5.00	$2.00	$3.00+
Cotton fabric	Spotlight	5 metres	$3.00	$12.00	$15.00	$3.00–

Ongoing evaluations

Good project management is always flexible. Changes to plans are to be expected and your action-, time- and budget-management plans need to show these changes. In your design folio, document any changes that have been made. Your ongoing evaluations should itemise and justify these changes as well as outline how your planning is working out.

The following questions may help you to get started with your evaluation.

- Did everything go according to plan?
- Did any unanticipated challenges occur?
- Did you meet your quality standards?
- Did you meet your time deadline?
- Did you stay within your budget?

Resource availability

Designers need to identify potential resources, determine the availability of these resources, and then use them effectively and safely. The success of any design project will depend on how well the available resources are managed.

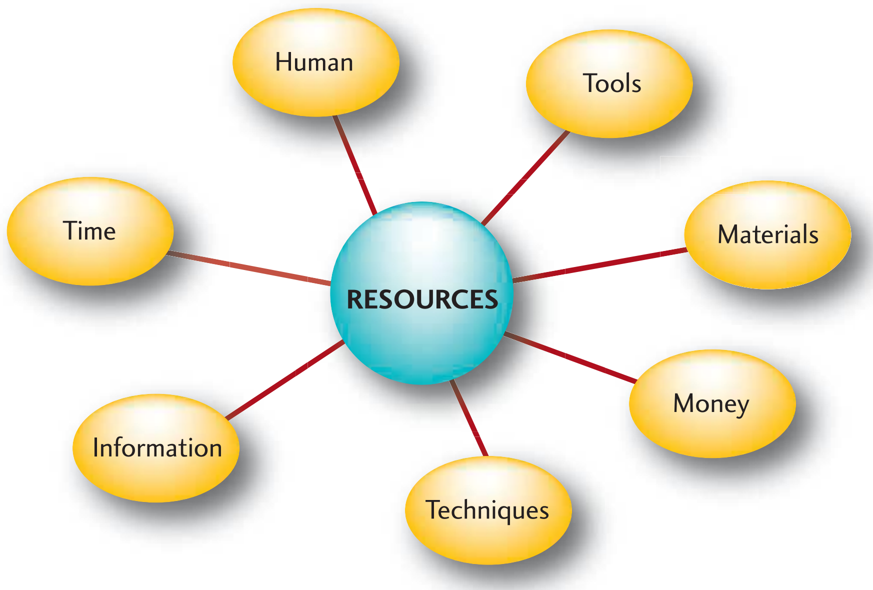


FIGURE 2.9: Make the best of your resources.

Time

Your design project will take time. The total amount will depend on how much time you have available, whether you are able to work on your project in class and when it is due for completion.

Money

Your project will generally cost money to develop. You need to manage your finances so that you do not exceed your budget. Record the money you have spent in your budget-management plan.

Materials

The materials for your project will depend on your chosen technology and whether you are designing a product, system or environment. The properties, availability and cost of each material will determine whether you can use it.

Tools

The types of tools you choose to use will vary depending on the materials you have available. You will have access to many tools in your technology workshop. Be sure that you know how to use them safely and efficiently before you start.

Techniques

The ways in which you work with the available materials and tools are known as techniques. You may already have knowledge and experience with the techniques required to complete your project, your teacher may show you alternatives, or you may even find experts outside school to advise you.

Human

People can help you with your design project in many ways. They can complete a questionnaire for you or give you design advice. People can also supply you with information, such as catalogues and leaflets.

Information

You can obtain information from a variety of sources to help you make informed decisions about your design project. Information is a valuable resource as nobody can be expected to know everything they need to about their design project.

Tip
As part of your design folio, you will need to document any resource you used in the development of your design project and provide a reason for choosing that resource.

Switch on

1. *Time*
   (a) Identify how much time you have to develop your design project.
   (b) Outline how you will manage within your time limits.
   (c) Identify which activities are likely to take you more time.
2. *Money*
   (a) Identify the budget for your design project.
   (b) Outline the technique you will use to manage your finances.
3. *Materials*
   (a) Identify three appropriate materials for the development of your design project.
   (b) Identify where you will locate them.
4. *Tools*
   Identify three tools you will require for this design project and mark the ones you will need to learn how to use.
5. *Techniques*
   (a) List any techniques you already know.
   (b) List some of the techniques you will need to learn to complete your design project.
6. *Human*
   Identify two people who could help you develop your design project and state where you might find them.
7. *Information*
   Use the same design brief you used for the activity on page 26.
   (a) Identify three sources you could use to gain information related to your project.
   (b) Outline how you might present this information in your design folio.

Design process: RESEARCH

During the research step of the design process, you will collect information and ideas to help you explore your design brief and move closer to solving it.

FIGURE 2.10: 'Ford Territory RWD/AWD' by Ford Motor Company of Australia Limited — combines features of family sedans, all-terrain wagons and people movers

Switch on

Go to www.jaconline.com.au/switchedontech and click on the Australian Design Awards Ford Territory weblink for this chapter. Read about this product (see figure 2.10). What did the 'extensive market research' find out about the likes and dislikes of motorists who drive large cars and people movers?

Research is the process of searching out new facts. It involves:

- gathering information on designs, materials, tools and techniques from many sources
- analysing and interpreting the information gathered
- presenting this information using creative methods.

Spidergrams, which are more complex than mind maps, are a great way to show the aspects of your design project that will require research. Figure 2.11 shows how a spidergram can be used to record a brainstorming session. There is no limit to the number of 'webs' that can be inspired by the main ideas.

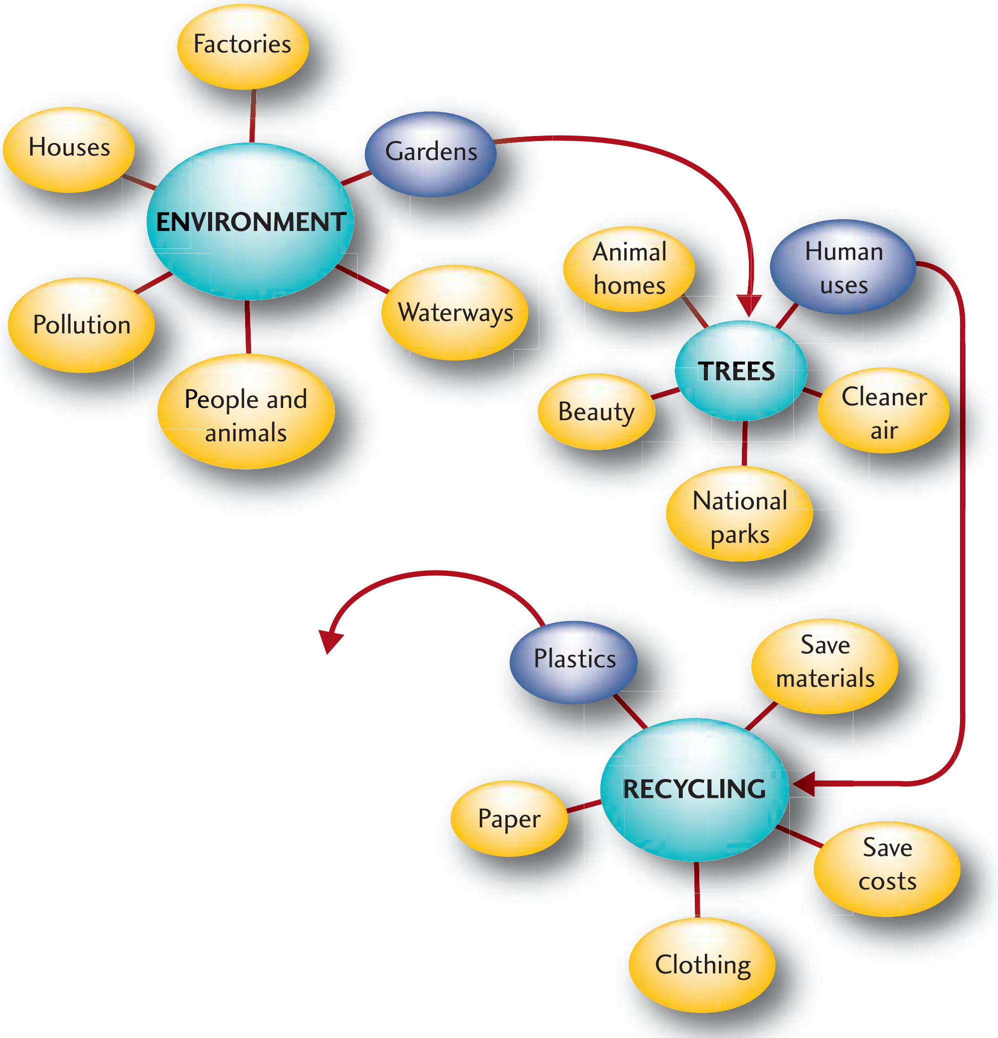


FIGURE 2.11: Spidergram

Tip
Your research needs to always be relevant and can be found in many obvious places, such as your home, school, libraries, magazines, on the Internet or on television.

Switch on

Begin by writing the design brief you are currently working with in the centre of a blank page. Write each research idea around it. Draw a line to link each idea to the centre. This will help you later if it becomes a large or complicated diagram. Allow the diagram to grow as your research ideas are recorded.

Research can be collected from *primary sources* or *secondary sources*. By using both sources, you gain a more complete and accurate picture of your topic.

FIGURE 2.12: Research can be collected from many primary and secondary sources.

Switch on

Can you think of other research methods? Copy figure 2.12 into your workbook and write your ideas in the blank bubbles.

Starting your research

One of the best ways to start your research is to investigate existing products, systems or environments that are similar to your design project. They may have the same function, or they could incorporate a material that you are interested in using or even look like the product you are designing. Identify and consider their strengths, weaknesses and anything interesting about them, and how these factors could affect your own designs. Professional designers use this method all the time to see if their designs will be successful.

Switch on

Imagine that you have been asked to design a portable CD player that can be used when swimming. Find three similar existing products and investigate them, focusing on each product's strengths, weaknesses and interesting aspects. List the points that you discover and outline how they could impact on your design. A table is a useful method of recording and presenting the results (see table 2.3, page 36).

TABLE 2.3: Analysing a portable CD player design

Strengths	Weaknesses	Interesting aspects
•	•	•
•	•	•
•	•	•

Primary research

Primary research involves gathering new and original information by interacting with other people. Primary research can be gathered through meetings, one-on-one *interviews*, focus groups and *questionnaires*.

When conducting interviews or questionnaires, ask questions to find out what people think and feel about your particular design brief. Work out exactly what information you want to find out, and then word your questions accordingly.

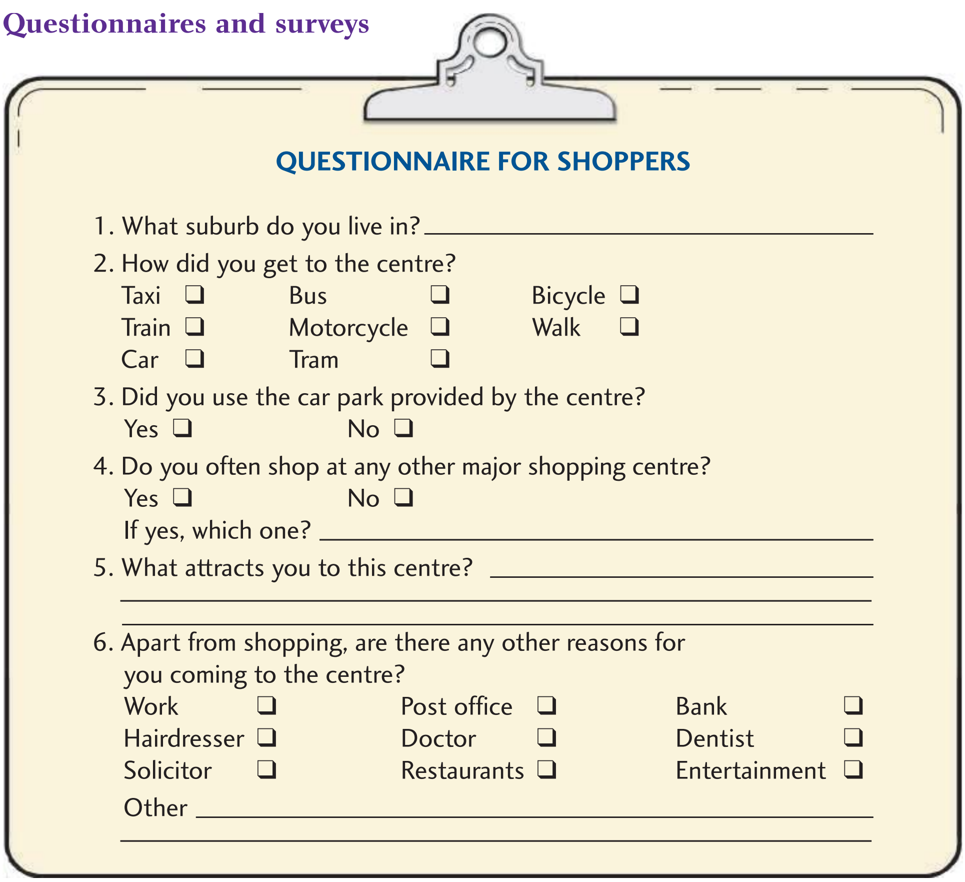
Tip

Tape your interview rather than taking notes so you can concentrate on listening to what the interviewee is saying. *Transcribe* the interview afterwards. Ask the interviewee's permission to tape the interview before you start.

Interviews

Interviews, by phone or in person, help you discover an individual's views about a particular situation. Prepare your questions carefully so that the *interviewee* clearly understands what information you require. Badly worded questions could offend the interviewee or waste time, as the answers may not be relevant to your design brief. Test your questions on a friend to practise your interviewing technique.

Questionnaires and surveys



QUESTIONNAIRE FOR SHOPPERS

1. What suburb do you live in? ____________________
2. How did you get to the centre?
   Taxi ❑ Bus ❑ Bicycle ❑
   Train ❑ Motorcycle ❑ Walk ❑
   Car ❑ Tram ❑
3. Did you use the car park provided by the centre?
   Yes ❑ No ❑
4. Do you often shop at any other major shopping centre?
   Yes ❑ No ❑
   If yes, which one? ____________________
5. What attracts you to this centre? ____________________
6. Apart from shopping, are there any other reasons for you coming to the centre?
   Work ❑ Post office ❑ Bank ❑
   Hairdresser ❑ Doctor ❑ Dentist ❑
   Solicitor ❑ Restaurants ❑ Entertainment ❑
   Other ____________________

FIGURE 2.13: Questionnaire/survey

Questionnaires and surveys are used to find out information from larger groups of people (see figure 2.13). They are popular research techniques because the results indicate what people are prepared to buy. Begin by writing a brief statement of what you want to find out.

Questionnaires and surveys include one or more written questions, which are given to the participants to complete in writing. List appropriate questions — start with some easy *closed questions* requiring yes/no, multiple-choice or true/false answers. Then add some *open questions* — these ask people for their views or opinions and do not usually have a right or wrong answer.

Analyse the answers and then present the results in a creative way.

Switch on

A company is designing a new range of skateboards. They need to know whether their designs will appeal to teenagers. As a class:

(a) prepare a questionnaire suitable for distribution at your school

(b) prepare a range of questions suitable for individual interviews

(c) compare the two research methods and identify their strengths and weaknesses.

Tip

Note resources or Internet sites you get information from so that you can find them again easily.

Tip

If you forget to write down a web address (URL), but have a printed or disk copy of the article, you can see the URL printed at the top of the page. Or you can use a search engine to locate the article. Type in a four- or five-word phrase from the article containing the most unusual words you can find. Then perform an advanced search by exact phrase to search for these words. The engine will almost always take you right to the article.

Tip

Just because information is in books or on the Internet doesn't always mean that it's true. Think critically about any information that you find.

Secondary research

Secondary research involves investigating information already collected by other people. This information can be gathered from existing documents, such as library books and magazines or by searching the Internet, watching television or listening to the radio.

You need to have a very clear idea about what you are researching before you use secondary sources. A lot of time can be spent gathering information that is only partially relevant to your design project. This is why it is important to think about the areas that require research before you start.

Your school and local libraries will have books, journals, magazines and newspapers. Access both past and up-to-date information. Encyclopaedias are useful for gathering general information about a topic, journals tend to have up-to-date information, and newspapers focus on breaking news.

Many libraries now have journal articles and newspapers available on CD-ROM. The Internet has an enormous quantity of information from around the world, with thousands of newsgroups and billions of web pages.

Using *a little creativity*, *some patience*, and *a few search engines*, you will be able to find just about anything you need.

- *A little creativity* means that you need to be able to generate some words or phrases related to the idea or topic you are searching for.
- *Some patience* means spending more than five minutes in the library looking in the catalogue or on the shelves. People who say 'there is nothing on the Internet about my topic' are often those who sit down at the computer, type one phrase into one search engine and find nothing relevant. Spend an hour looking around, however, and you will almost certainly be well rewarded.
- *A few search engines* means using a variety of tools to find what you want.

You may need to ask your teacher or librarian to show you appropriate search engines or websites to locate relevant information about your topic.

Once you have completed your research and analysed the information, you will need to make a series of decisions based on what you have discovered. These decisions will form the basis of your *ongoing evaluation*.

Some of the information that you have collected through your research can be presented using tables, graphs, pie charts or pictograms.

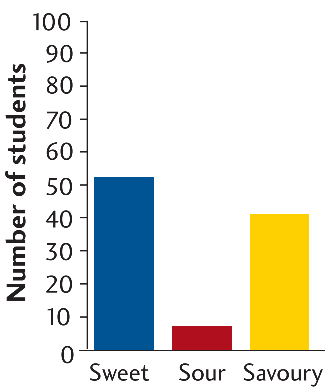
TABLE 2.4: Collating answers to the question: 'Which type of food do you enjoy eating from the school canteen?'

Food type	Responses
Sweet	52
Sour	07
Savoury	41

Tables

A table should be easy to read and not include a lot of words. A table is a statement about the way various factors are related to one another. For example, if you are designing a new food for the school canteen, you need to know what students at your school like and dislike. You could distribute a questionnaire to 100 students and communicate the results using a table.

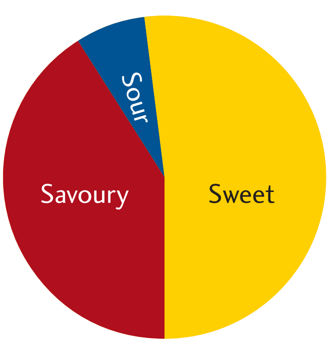
From table 2.4, you can clearly see that 52 per cent of the 100 students questioned enjoy sweet foods. These results could also be graphically presented.



Graphs

A graph is a method of using a straight or curved line to show the relationship between two factors. A vertical line divided into equal parts is used to represent one factor, and a horizontal line, also divided equally, is used to represent the second factor. For example, the vertical line in the graph in figure 2.14 indicates the number of students taking part in the questionnaire and the horizontal line indicates the three different food types available at the school canteen.

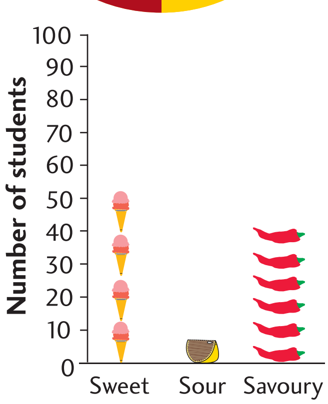
FIGURE 2.14: 'Which type of food do you enjoy eating from the school canteen?' — results as a bar graph



Pie charts

A pie chart is circular in shape and is divided into sectors. The combined sectors represent the total. This method of presenting information is easy to understand and takes little effort to draw on a computer. To make a pie chart, draw a circle and divide it into sectors (the pieces of the pie) according to your results. Each section must be clearly labelled (see figure 2.15).

FIGURE 2.15: 'Which type of food do you enjoy eating from the school canteen?' — results as a pie chart



Pictograms

Pictograms are a fun and creative way of presenting information. They use symbols or simple drawings to record and communicate research results. Pictograms should use pictures that reflect the question that has been asked (see figure 2.16).

FIGURE 2.16: 'Which type of food do you enjoy eating from the school canteen?' — results as a pictogram

Switch on

As a class:

(a) design a questionnaire to find out the average amount of pocket money your year group receives

(b) conduct the questionnaire with 10–20 people

(c) present your results in an interesting way and display them in your classroom.

FIGURE 2.17: 'Hannibal' tape dispenser by Julian Brown — made from polymer that encloses a heavy metal weight. When the elephant's trunk is closed with a flick of the finger, the 5-metre roll of tape is protected as if by a warrior's helmet.

Design process: IDEAS GENERATION

The information gained from researching will help you to generate a range of possible design ideas aimed at solving your design brief. Select one of these ideas or a combination of several to be developed further. During this step, you will also consider and record the reasons for selecting your preferred design, making reference to your previously developed criteria for success.

Switch on

1. Brown's interest in Hannibal — a Carthaginian general (247–182 BC) — led to a design for a tape-dispenser in the shape of an elephant (see figure 2.17). Why? Go to www.jaconline.com.au/switchedontech and click on the Hannibal weblink for this chapter to find out.
2. Go to figure 2.19, page 42, to look at another design for a tape dispenser. Note how ideas generation can lead designers in very different directions.

Technobite

'Design always springs from an idea; it is the form given to an idea,' said Emmanuel Dietrich, French designer.

Generating design ideas requires you to think creatively. The trick is thinking 'outside the square' — thinking laterally. A creative thinker has the ability to imagine or invent new ideas by combining, changing or reapplying existing ideas. Some creative ideas are amazing and brilliant, while others are just simple, practical ideas that no one seems to have thought of yet.

Everyone has the ability to be creative — just as everyone has the ability to be a designer. You just need to let yourself look at things in new ways. For example, the creative person realises that there are endless possibilities, like pink sandwich bread, chocolate-coated pears or solar-powered shoes.

There are many techniques that can be used to generate creative ideas.

Brainstorming

The purpose of *brainstorming* is to generate as many ideas as possible in a short time. It's important not to judge the suitability of an idea at this stage as it is often the craziest thoughts that spark the most creative and original designs!

You can brainstorm individually or as a group. Group brainstorming can be very productive as it uses the experience and creativity of all members of the group. When one group member reaches his or her limit on an idea, another member's creativity and experience can take the idea to the next stage. Therefore, group brainstorming tends to develop ideas in more depth than individual brainstorming.

A brainstorming session should be fun, so be as creative as you can! It's useful to follow some simple guidelines.

- Choose someone to record the ideas. They can be written on a whiteboard, blackboard or on a large sheet of butcher's paper.
- Write down everything that is related to the topic. Remember, any idea is worth writing down at this stage.
- Do not be negative about anybody's contributions; remember, the more outrageous the ideas the better!
- Don't be tempted to discuss the ideas as you think of them. Write them down first and discuss them later.
- Aim to create as many ideas as possible in a short time. Set a time in which to work: 15–20 minutes should be long enough.

Switch on

Divide the class into groups of five or six people.

(a) Each group should choose a leader who will need butcher's paper and a pen to record the group ideas.

(b) Give each group a design brief for a new product (see suggestions below). Several groups could have the same brief.

(c) For 15–20 minutes, work in groups to generate as many creative ideas as possible. Record all ideas on the butcher's paper.

(d) At the end of the time period, the group should present to the rest of the class the design brief and the ideas generated by the group.

(e) Write down the most appropriate solution generated by each group. Does it solve the design brief?

Example design briefs

1. Design and produce a child's toy, constructed mainly out of timber. It must have several safety aspects added to the design.
2. Design and produce a greeting card that, when opened, uses an electronic output such as a light-emitting diode (LED), light bulb, or buzzer. Use this output to make a humorous message.
3. Design and make an informative and innovative poster that has a message about the theme 'recycling in the classroom'.
4. Design a coordinated range of beachwear items for your age group. Construct two items, using different fabrics and decorative techniques.
5. Design and construct a candleholder made from metal. The candleholder must be designed for a specific location.
6. Using seasonal produce from a region in New South Wales, design and produce a three-course meal for a visitor from overseas.

Mind maps

See figure 2.3 on page 25.

When brainstorming, it's helpful to use mind maps to arrange and develop design ideas and explore options and possible consequences.

Switch on

In small groups, choose a product that interests your group, for example, a surfboard, food product or fashion item. Imagine a manufacturer has asked for an updated version of your product using a different material that is more cost-effective. You are worried about using this material and need to work out if the material is suitable.

(a) Draw a bubble on a piece of butcher's paper and use a mind map to help you generate design options that you could present to the manufacturer.

(b) Complete the mind map so that it could be used to communicate your group's ideas to the manufacturer.

Thumbnail sketches

Once you've generated a range of design ideas using the techniques described above, start drawing *thumbnail sketches*. These can literally be as small as the nail on your thumb. They are intended to capture the basic ideas of your designs and should be quickly sketched allowing rapid generation of ideas. If you don't like the thumbnail that took you 30 seconds to draw, then simply start another one right beside it! Start with small sketches and slowly increase their size as more design details are worked out.

Ongoing evaluations and your design folio

It isn't enough to draw or sketch lots of ideas. You must *evaluate* each idea and refer back to your design brief and criteria for success. Highlight the most promising features of each idea and why a particular idea might be taken on to the next stage. Add basic dimensions, colours and materials. Show how the project meets the needs of the end-user and describe how the product is suitable for its intended use.

Your evaluations could be presented as a written paragraph beside, under or around each idea. Figure 2.18 shows how an idea with its notes can be set out in your *design folio*.

See pages 22–3.

Tip
Make sure that your notes are easy to understand and well presented. Use a simple writing style throughout this step of the design process.

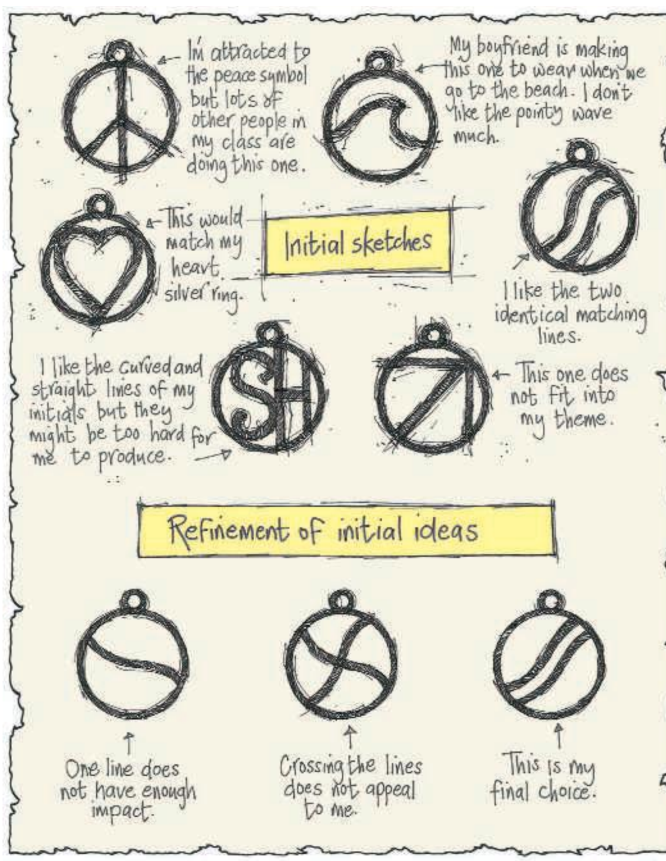


FIGURE 2.18: Initial sketches and refinement of ideas

FIGURE 2.19: Tape dispensers are available in many different designs. Remember Julian Brown's tape dispenser, figure 2.17, page 39.

Design process: COMMUNICATION

Your final idea may be one of the designs that you developed or it may be a combination of several ideas for different designs. This chosen idea must be presented in a way that allows others to understand how the design is going to work — the key to this presentation is effective *communication*.

Communication skills are used by designers to convey information about their ideas. Designers need to produce written reports and oral and digital presentations. They need the ability to communicate complex information using graphical methods. A report, video, digital presentation or drawing is only as good as the messages it leaves with the reader or viewer.

Switch on

Design advertisements for the tape dispensers shown in figures 2.17 and 2.19 to be displayed in an office products catalogue.

Oral presentation

In conversation, we regularly rephrase a point in response to another person's failure to understand us. Spoken language seems so easy to send and yet the meaning can be so difficult to receive.

Throughout this subject, you need to present your work through informal or formal presentations to convey information clearly and persuade your audience. Some elements of effective oral communication include:

- *structure and organisation*. This includes identifying and emphasising key points and messages.
- *audience*. The only reason for giving an oral presentation is to communicate with an audience. Your main aim should be to gain their attention and keep it. Make your presentation exciting and your audience will listen.
- *delivery*. Speak clearly and loudly enough to be heard by all of the audience. Vary your tone. Avoid reading from slides or notes. Make eye contact with the audience. Don't fidget. Your delivery will improve with practice!
- *PowerPoint*. Most designers use PowerPoint presentations, but few do it effectively. If you are using slides, make sure they are easy to read. Use images and diagrams wherever possible. Avoid unnecessary and annoying multimedia 'bells and whistles' as they can be distracting.

Written reports

Written reports are required to present an opinion or idea, persuade the reader and, in the case of professional designers, sell designs. Elements of good written communication are:

- *structure and organisation*. Written reports should be organised in a logical way, with clear headings and subheadings. They should be consistent in layout and font style. The writing should be clear and concise.
- *grammar and spelling*. Poor grammar and spelling suggest carelessness and reduce the effectiveness of communication. The message will be lost if your audience is distracted by mistakes in the text.
- *audience and objective*. You need to know *who* you are writing for (your audience) and *why* you are writing for them (your objective). If you have a clear objective and know your audience, writing your report will be much easier.

Tip
Use the toolbar buttons to explore what the word processor can do. Use 'Help' to learn new tricks. You will find that there are many ways to carry out most functions.

It's always a good idea to type your reports on a computer. This is known as *word processing*. Word processing enables you to create a document, store it electronically on a disk, display it on a screen, modify it by entering commands and characters from the keyboard, and print it on a printer. The great advantage of word processing is that you can make changes without rewriting the whole document.

ITC Bookman medium italic:
The quick brown fox jumped over the lazy dog.

Futura light:
The quick brown fox jumped over the lazy dog.

Palatino roman:
The quick brown fox jumped over the lazy dog.

FIGURE 2.20: Different word processing fonts

Switch on

Take a piece of plain text that you have typed and give it a more interesting layout. Use an attractive font for the heading that fits the theme and is appropriate for the audience and objective.

Graphical communication

Reports often include graphical communication and the old saying 'a picture is worth a thousand words' is true. Graphics can help us to understand complex information; for example, bar graphs, pie charts and dynamic PowerPoint presentations can make information meaningful and memorable.

Graphics have always been an important method of communicating design ideas effectively. Every design document, book or paper is full of photos, diagrams and illustrations.

Switch on

Think about the words *dog*, *people* and *aeroplane*. By using pictures, each word could be communicated easily without any chance of uncertainty to their meaning. Could you say the same for the images in figure 2.21?

FIGURE 2.21: Match the meaning of each workplace safety sign with the key below. Is the meaning of these images communicated clearly without the words?

Key:
1. DUST MASKS MUST BE WORN IN THIS AREA.
2. HEARING PROTECTION MUST BE WORN ON THIS SITE.
3. EYE PROTECTION MUST BE WORN ON THIS SITE.
4. SAFETY FOOTWEAR MUST BE WORN IN THIS AREA.
5. PROTECTIVE CLOTHING MUST BE WORN IN THIS AREA.
6. HANDS MUST BE WASHED BEFORE RETURNING TO WORK.

FIGURE 2.22: Would the message of this graphical design be clear without the words?

Sketching

Sketching is used to communicate initial ideas, especially when time is limited. It's the fastest and best way of communicating an idea quickly — a visualisation of what's in your head. You used this communication technique to develop thumbnail sketches. There is still no computer software to replace sketching.

Sketches have several purposes in design, including:

- *ideas generation.* Sketches help you to think through a problem. They may be abstract representations, block diagrams, flow charts or outlines. These sketches have limited detail and are generally completed very quickly. Your design folio should have many of them.
- *discussion.* Designers use sketches all the time to communicate with other designers. You may have used this technique to support an oral description of one of your design ideas.
- *detailed representation.* These sketches are more careful drawings containing sufficient detail so that they could be put into a computer-aided design (CAD) system, or used to produce an accurate computer drawing. An example would be a sketch with multiple views and dimensions.

Tip

Use appropriate colouring techniques and don't put all your ideas on one page. Two to three ideas per page is just about right.

Final sketches and working drawings

A *working drawing* is the final 'constructed' drawing, produced as part of the design process. It usually consists of a front view, a side view and a view from the top of the proposed design. Dimensions are added so that any person using the working drawing can produce the design. The working drawing should be precise and drawn to scale.

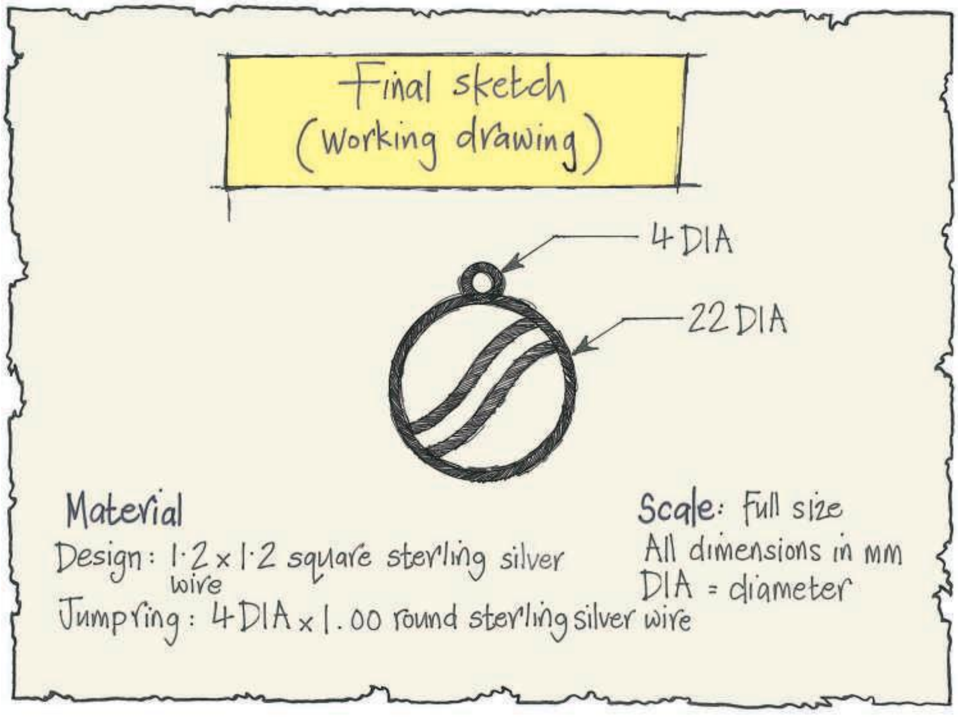


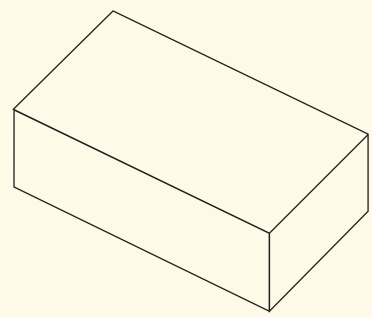
FIGURE 2.23: Final sketch (working drawing)

Working drawings are used, for example, to check measurements or indicate what materials are to be used. They are usually orthogonal drawings and have the measurements of the project included on the drawing.

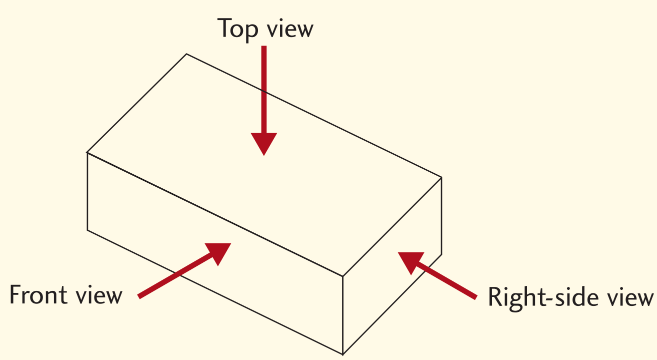
An *isometric drawing* views an object from one corner. All the lines that are usually horizontal are drawn at a 30° angle. The vertical lines stay vertical. An isometric drawing is a single drawing that lets you see the object from the front, the side and the top (three views) all at once. Isometric drawings are a particular type of three-dimensional (3-D) drawing as three sides and three dimensions of the object are shown *on the one drawing*.

Orthogonal drawings are two-dimensional (2-D) drawings showing three views of a project *on the same page*. These drawings show shapes and sizes accurately so you can use them to show exactly what a design is like.

(a) Isometric drawing of a box. *Note:* The longest part of the object is always at the front.



(b) Isometric drawing of a box with top view, front view and right-side view labelled.



(c) Orthogonal drawing of the box shown at (b).

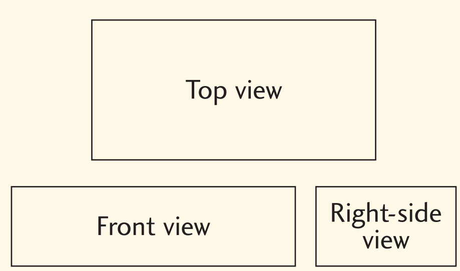


FIGURE 2.24: Isometric and orthogonal drawings

Whatever type of drawing you are doing, there are some simple guidelines that need to be observed.

See page 6 for more information on scale.

- *Scaling*. This means to enlarge or reduce a design by a set ratio so the drawings are easily understood and fit onto one page.
- *Dimensions*. Basic sizes need to be shown.
- *Accuracy*. Where appropriate, all drawings should be accurate. Designs should be drawn lightly in pencil and firmed in after speaking with your teacher.
- *Neatness*. All drawings should be free from stray lines or smudge marks.
- *Labels*. Drawings must be neatly labelled, or annotated, to show additional information about the design, for example, parts and materials. Write the labels neatly and clearly, either vertically or horizontally.

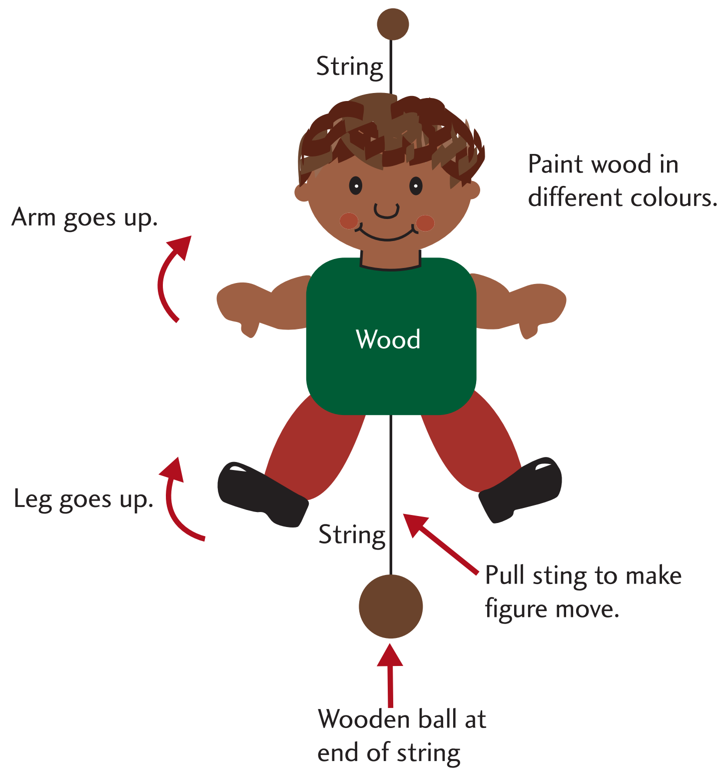


FIGURE 2.25: Labelling, also known as annotation

Model making

Model making allows designers to develop, test and present their design ideas before they actually produce them. Models, also known as mock-ups or prototypes, can help you improve your solution before spending time and money making the actual design project to scale. A model will often help you identify faults or design problems that cannot be spotted in a drawing or sketch.

Models can be made using the same materials as for the finished product, but usually they are made from cheap and easily accessible material, such as paper or cardboard or specialist modelling materials like Styrofoam and plaster of Paris. Choose materials that are easy to cut, shape and colour.

Digital communication

Manufacturers today use computer-aided design (CAD) and computer-aided manufacturing (CAM) tools to design and produce pens, jewellery, TV sets, shoes, phones and even the doors of your house. These tools help reduce time in the design process, the number of errors in the initial stages of production and the time it takes to put the design on the market.

- CAD is the use of computers to assist the design process. Specialised CAD programs exist for various types of design, for example, textile, architectural and electronics. CAD enables you to prepare fast and accurate drawings with the flexibility to change the drawings with minimal effort. Depending on which CAD package you have at your school, you could:
  – create a 3-D surface textured drawing of your design idea
  – produce detailed working drawings
  – work out the arrangement of your design's components.
- CAM is the use of computers to assist the manufacturing process. CAD and CAM are combined (CAD/CAM) so that the output of the CAD module is fed to the CAM system.
- *Animations.* In many cases, the design may exist only as a CAD model. Most CAD systems can create animations of mechanical assemblies. Many multimedia packages can create animated illustrations.
- *Interactive models.* Unlike animations, interactive models allow the user to interact with the display by changing viewpoint, zooming in and out, hiding and showing parts and so on. Many CAD systems can also create interactive models.

Switch on

Imagine you are a graphic designer working for a graphic design firm. The design director has asked you to design a menu using only two colours.

(a) Complete three thumbnail sketches of your menu design.

(b) Choose one thumbnail sketch to develop further.

(c) Complete one detailed sketch of your final choice.

(d) Using a computer, complete a mock-up of your menu to present to the design director.

(e) Evaluate your mock-up and outline how you could improve your design.

(f) Identify additional communication methods that could be used to present your design to the design director.

(g) Display your completed menu design in your classroom.

Design folio

Designers often present their written work and design drawings in a design folio. As you work, it's important to keep a record of everything you have done, just as a professional designer would. Often, the amount of information you have compiled can be enormous but a design folio can help you organise this information and show your work at its best.

The design folio is an important communication tool for design projects. The folio is used to communicate the purpose of your design project and the process you went through to complete it. Your design folio tells the story of your design project's development, from your first rough ideas on paper to the final evaluation of your solution.

Tip
Photograph your finished project so that you have a record of what you produced!

Your design folio should be neat and suitable for displaying to others. Each section should lead on from the previous one and should clearly show what took place and the reason why. Section titles and individual page titles can help guide the reader through your story.

It's important to make full notes as you work and to keep all your sketches, inspirations, research notes and the results of your experimental work to show how your design developed. Documentation in your design folio is part of the design project and process, not something to be added at the end!

How you present your design folio is up to you — be original and innovative.

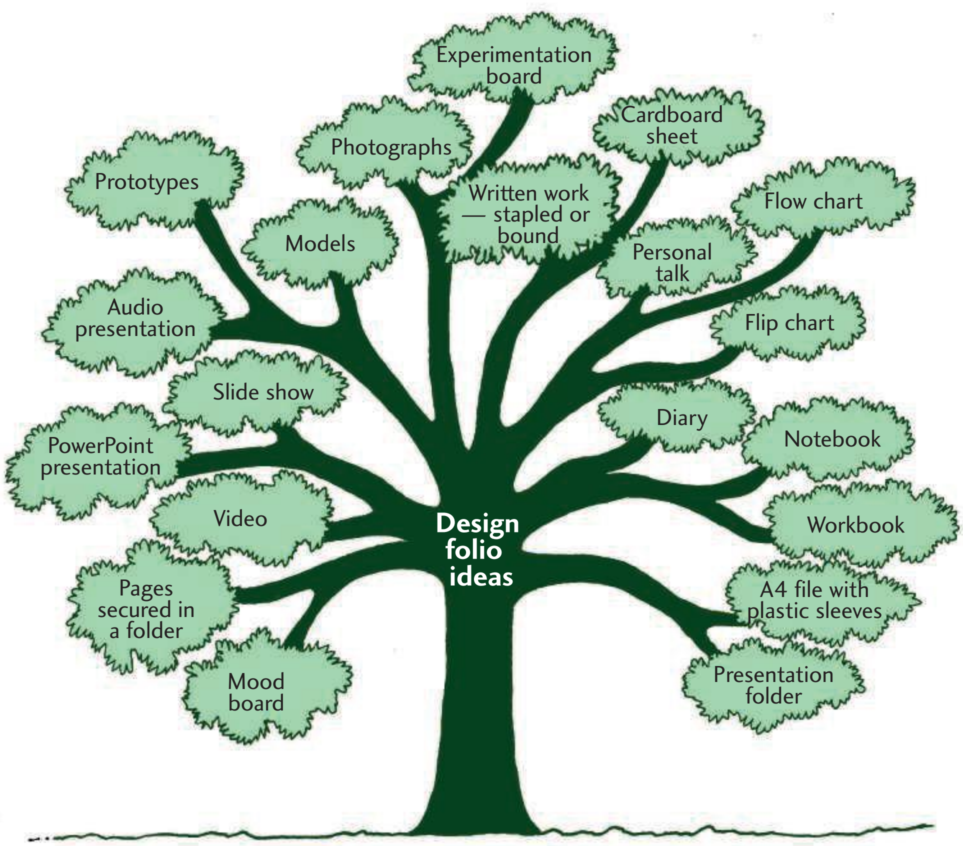


FIGURE 2.26: Design folio ideas

Handy hints for design folios

The following hints will help you to produce an effective design folio.

- Design a cover with a title and an appropriate picture of your project — maybe a photograph of it completed.
- Feature headings on each page to guide the reader through your design folio.
- Use a clear layout to help you organise and make your folio easier for other people to read and understand.
- Think about your format — landscape (horizontal), portrait (vertical) or a mixture of both?
- Use borders to make your text, drawings or photographs more appealing.
- Wherever possible, computer-generate your design folio. If you need to write by hand, be sure that your handwriting is neat and attractive to give your design folio a professional finish.

Tip
Remember to run your final decision past your teacher so that he or she is aware of what you would like to do. This way, your teacher can help you achieve your end result.

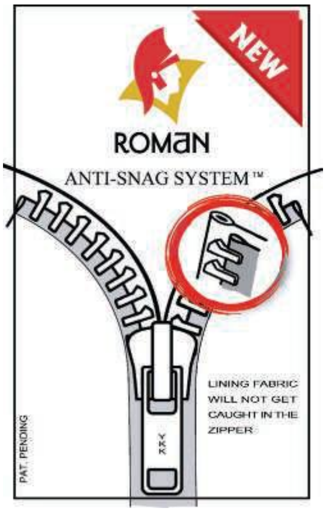


FIGURE 2.27: 'Anti-Snag Zipper System' by Roman Camping Equipment Pty Ltd — mainly used in sleeping bags. It stops loose fabric jamming the zipper puller.

- Start a new sheet of paper for each new section.
- Use both written text and visual illustrations on each sheet — this will make your design folio interesting.
- Use colour and coloured paper — this will attract the reader to your design folio.
- Glue pictures and diagrams neatly — *do not* use sticky tape.
- Bind all the pages together in some way. A folder is an easy way of doing this.
- Allow margins around the edges of the paper, especially if your folio is to be bound along the left hand edge.
- Check that you have included all sections.
- Remember to try to be different and original. The design folio is an extension of your design project!

Design process: EXPERIMENTATION AND TESTING

Designs need to be tested rigorously before they go into production to ensure that they fit the intended purpose and meet all safety legislation. There are many simple tests you can do, under supervision, to test your own design.

Switch on

Go to www.jaconline.com.au/switchedontech and click on the Australian Design Awards Anti-Snag Zipper weblink for this chapter. Read about this product (see figure 2.27). How long has Roman Camping Equipment Pty Ltd been experimenting with this system?

Devising and recording tests

All design projects involve the use of materials, tools and techniques. One of the best ways to collect information about them is to carry out tests or experiments that will imitate their use in your project. Different materials have different properties and characteristics that make them suitable for different end-uses. For example, if you know that the materials required for your project must be lightweight so that the finished article can be carried easily, devise a test to try out several possible materials. Rank each material according to its weight and ease of transport.

You can devise tests for almost anything, including waterproof properties, impact resistance, flexibility and rigidity. The results from these tests will help you to decide which material is the most suitable to use for your project.

Experiments and tests can also find out how good your design is. For example, you may have designed a system for storing CDs. Test this design by seeing if a CD fits within the storage system, how many CDs fit and how easily they can be removed.

The best way to test the success of your final product is to let the end-user test it for you. For example, if you have designed and produced a toy for your dog, let your pet test it out while you observe and record their reactions. This form of testing is often carried out in industry before a new product is launched. Groups of potential users are asked for their opinions about the new product.

Tip

If you carry out a test involving humans or animals, be absolutely sure that your design project meets all safety regulations and is completed under strict supervision.

Remember that any experiment should be relevant and should be used to improve the design ideas.

Documentation of experiments that you conduct needs to contain more than just the results. Figure 2.28 is an example of how you might go about presenting your experiment or test. Within each section, there is a detailed description of what you need to include and why it is important.

Title: A clear and concise statement relating to your experiment, for example, *Resistance Test*

Aim: Clearly identify the aims of your experiment and write down what you are trying to find out by completing the experiment. This should be clear and concise, in a sentence or two.

Method: Write down the steps you will take to complete the experiment, so that it can be repeated by yourself or others at a later date. These steps are like those you would find in a recipe. You could even add drawings to represent your experiments.

Result: Once you have completed the experiment, record all of your observations and results very carefully — try not to miss any details, even if you think they are minor, as the results of experimentation will usually have some implications for your design. It is important to keep a record of exactly what happened during your experiment as it might be necessary for you to modify your design after it has been tested.

Using photographs, a video, drawings or samples is an excellent way of showing results of experimentation visually. Remember presentation and communication are very important when you are designing and producing! Refer to the section within this chapter (page 38) on presenting research results for further details.

Conclusion: Look thoroughly at your results so that you can come to a conclusion about what actually happened and modify your design if you need to. Try to link your conclusion back to the aim of the experiment, your pre-established criteria and the design brief.

FIGURE 2.28: Standard format page for an experiment report

Switch on

1. In groups of three or four, brainstorm ways you could test the following designs:
   (a) a new biscuit recipe for diabetics
   (b) a garden designed for people who use wheelchairs
   (c) a container for holding DVDs
   (d) a zoo enclosure for elephants.
2. Now think about a design you are working on — how could you test it out?
   (a) Identify four different tests and write a brief aim for each.
   (b) Share your ideas with the rest of your class.

Design process: SAFETY AND RISK MANAGEMENT

FIGURE 2.29: 'Orthopak Student Backcare Pak' — lightweight, ergonomic backpack designed to carry heavy loads

Switch on

Go to www.jaconline.com.au/switchedontech and click on the Australian Design Awards Orthopak weblink for this chapter. Read about this product (see figure 2.29).

(a) What particular health risks does this backpack aim to overcome?

(b) Summarise the good points of the frame design.

We are all responsible for our own safety and the safety of others. We must avoid situations or avoid creating situations that place us or others in danger. In the technology workshop, be aware of areas of potential dangers and ways in which you can prevent them developing into hazards.

Switch on

Safety first!

1. List five situations in your technology room that you think could be dangerous. Underneath each situation, outline a way the situation could be prevented.
2. In groups of three or four, use the computer to design a safety poster that outlines the importance of safe working practices when designing and producing.
3. In the same groups, create a roleplay that shows how important safety is in everyday life. Perform your roleplay for the class.

Basic safety

Whether you are in the workshop, design room or computer room, you are responsible for behaving in a mature and sensible way so that you and those around you are safe.

Before you can use equipment and machines or attempt practical work, you must learn some basic safety rules.

- Note emergency exits and make sure they are clear.
- Be patient. *Never* run, rush or push in your work area!
- Pass objects to other class members. Never throw them!
- Always watch what you are doing and concentrate on your work.
- *Never* work alone in the workroom. Your teacher must always be present.
- Clean up any mess or spills immediately.
- Obtain permission from your teacher before using any tool or equipment.
- When learning how to use a tool or complete a technique, always listen to your teacher's instructions. If you are unsure, ask for help. **Never** guess how to use a tool!
- Ensure all electrical cords are clear of the work area.
- Do not work towards your body. Use the tools away from yourself.
- Work on a flat surface and always work with projects securely clamped.

- Do not wear loose garments. Wear appropriate clothing and the correct safety items: safety glasses, protective clothing, solid shoes and gloves, and hearing protectors when using noisy equipment.
- Always tie the bow of your apron at the back.
- Make sure that long hair is tied back and jewellery removed.
- Use toxic substances only in a well-ventilated area and close the lid of the container tightly as soon as possible.
- Dust is dangerous. Do not inhale it. When working in a dusty area, make sure that the dust extractors are turned on and you are wearing a dust mask
- Always wash your hands when finished, especially if you have used paints or other chemicals.
- Label all adhesives and keep them in a locked metal cupboard.
- Keep rags or paper that have been in contact with resins, solvents, cements or cleaners away from naked flames.
- Know the location of the first aid cabinet and how to operate emergency stop buttons for all machinery.
- If equipment is damaged or broken or an accident occurs, report it to your teacher immediately.
- Keep an organised and tidy work area. Store your work carefully at the end of each lesson. Leave tools sharp and correctly set and return them to the correct place when you have finished using them.

Switch on

1. Draw a two-column table with at least ten of the above safety rules in the first column. In the second column, write a consequence of not following each safety rule.

TABLE 2.5: Safety rules and consequences

Safety rule	Consequence
Pass objects to other class members. Never throw them!	Could cause serious physical injury to others.

2. Go to www.jaconline.com.au/switchedontech and click on the NSW Office of Fair Trading weblink for this chapter. Use the website to investigate (a) a baby walker, (b) a motorcycle helmet, and (c) a beanbag. Outline the specific safety standards that designers are required to meet for each product.

Risk management

The *Occupational Health and Safety Act 2000* and *Occupational Health and Safety Regulation 2001* deal with the principle of risk management. Risk management is the process of recognising situations that have the potential to cause harm to people or property and doing something to prevent them. Your teacher is also responsible for implementing effective risk management strategies.

The risk management process involves four steps that, when taken in sequence, allow informed decisions about how best to avoid or control the impact of risks.

1. *Hazard identification* — identifying the problem.
2. *Risk assessment* — determining how serious the problem is.
3. *Risk control* — deciding what needs to be done to resolve the problem.
4. *Reviewing risk assessments* — always being aware of new information about the hazardous nature of a substance or process.

There are four ways to control hazards (see table 2.6).

TABLE 2.6: Controlling hazards

Action	Reason for action
Eliminate the hazard	This is the most effective way to make things safer. You should always try to do this.
Change equipment or materials	If the hazard cannot be eliminated, it may be necessary to redesign the equipment or processes. For example, using exhaust fans will mean people are less likely to be affected by fumes.
Change work methods	If the hazard cannot be eliminated or changed, work practices may need to be reviewed and appropriate work procedures developed.
Use personal protective equipment (PPE)	PPE is the least effective way of dealing with hazards. If possible, use PPE only until a better way of doing things can be found.

FIGURE 2.30: Personal protective equipment (PPE) — apron, mask, safety spectacles and earmuffs

Personal protective equipment

The following items are types of personal protective equipment (PPE).

1. *Safety spectacles* protect you from dust and pieces of material thrown up by tools and machinery.
2. *Safety goggles* provide all-round eye protection.
3. *Hearing protectors*, also known as *earmuffs*, protect your ears from excessive noise from power tools and machines.
4. *Face masks* protect you from fumes, gases and dust. Wear them when working with varnishes, solvents, adhesives and paints.

Dust extraction systems and vacuums attached to portable sanders also minimise dust and fumes.

Ergonomics in the computer room

Ergonomic principles govern the safe use of computers.

Overuse syndrome

Overuse syndrome is uncommon in schools because students don't spend long periods in a computer room. They walk to other classes and take recess and lunch breaks. Overuse syndrome is also known as repetition strain injury (RSI). RSI sufferers usually sit at a computer most of the day, every day, straining their wrists, back and necks because they are not positioning them correctly. Remember to limit the number of hours you spend at your computer if you have one at home.

Keyboarding posture and technique

TABLE 2.7: How to sit on a chair

Body part	Position
Feet	Flat on the floor and not crossed.
Back	Not stiff but upright and sitting straight.
Head	In line with the body — that is, in a straight line.
Shoulders	Relaxed — don't drop or stiffen them too much.
Seat/bottom	Weight should be distributed evenly on the seat.

Adapting to a poorly designed computer workstation may cause discomfort.

- Sitting at the edge of your chair can give you back and neck pain.
- Reaching for the mouse can give you shoulder and neck pain.
- A poorly positioned monitor can give you neck pain.
- Poor wrist placement on the keyboard can give you wrist/hand pain.

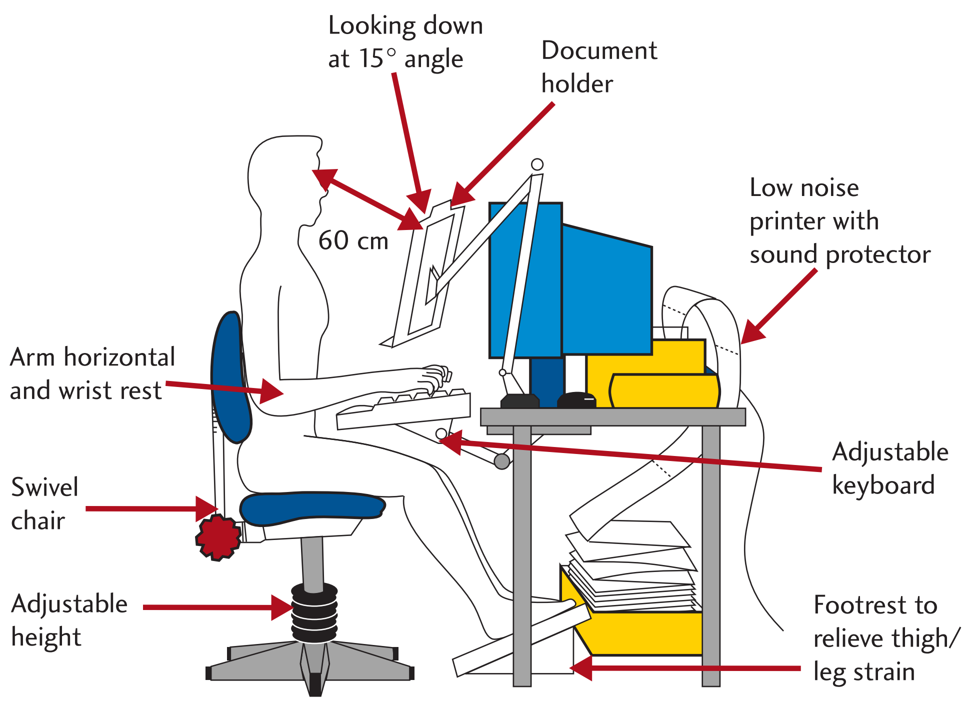


FIGURE 2.31: Some ergonomic features of a computer workstation

TABLE 2.8: Work areas and environmental factors

Work area	Environmental factor
Desk design	The mouse should be the same height as the keyboard. Adjustable desks are also available.
Desk height	The keyboard height should be between 58 and 71 cm; that is, normally suitable for all users.
Chair design	Everyone is a different height. Your chair height and backrest should be adjusted so that your legs and torso are 90˚ to each other.
Screen height	The top of the screen should be at or below eye level.
Screen distance	About 45–71 cm is a good distance.

Risk assessment checklist

- Make sure the cables at the back of the central processing unit (CPU) are neatly stowed away and out of the way of the mouse and keyboard cables.
- Make sure the lighting is good and that you can see the screen without straining your eyes.
- Take regular breaks.
- Make sure that you are saving your work every 5–10 minutes and you are backing up your data regularly.

Switch on

Occupational health and safety and designers

Go to www.jaconline.com.au/switchedontech and click on the WorkCover New South Wales and the National Occupational Health and Safety Commission weblinks for this chapter. These websites provide useful health and safety information that you can download and/or print, including information specific to different design specialisations.

Copy table 2.9 into your workbook. For each design occupation, list several occupational health and safety challenges and suggest how they may be overcome.

TABLE 2.9: Occupational health and safety challenges

Design occupation	Occupational health and safety challenge	Solution
Food technologist		
Textile artist		
Graphic designer		
Builder		

Design process: PRODUCTION

You are now ready to turn your ideas into reality. For many designers, this is the most enjoyable and exciting part of the design process as you are now able to put into practice all of your previous decisions and transform your design work into a quality product, system or environment.

FIGURE 2.32: 'Micky Ha-Ha' — Power Point Safety Cover. The safety cover prevents crawling babies and young children from having access to live power outlets.

Switch on

Go to www.jaconline.com.au/switchedontech and click on the Australian Design Awards Micky Ha-Ha weblink for this chapter. Read about this product (see figure 2.32). In bullet point form, list four reasons for producing this item.

In the production of any design, the order of producing individual components needs to be considered, in addition to the materials, tools and techniques that will be required. By taking the time to do this you will be prepared, have a plan to follow and the production process will be uncomplicated.

Production-management planning

A production-management plan identifies the sequential steps required to produce your design. It requires a similar process to the one you went through to complete your action-management plan. Follow these steps.

1. Refer back to your action-management plan.
2. Identify and list everything you are going to require to produce your design. Modify your earlier list to include these additions.
3. Use a computer to present your adapted production-management plan in an interesting way that will be easy to follow. Use arrows to link one step to another. This production-management plan can now form part of your design folio.

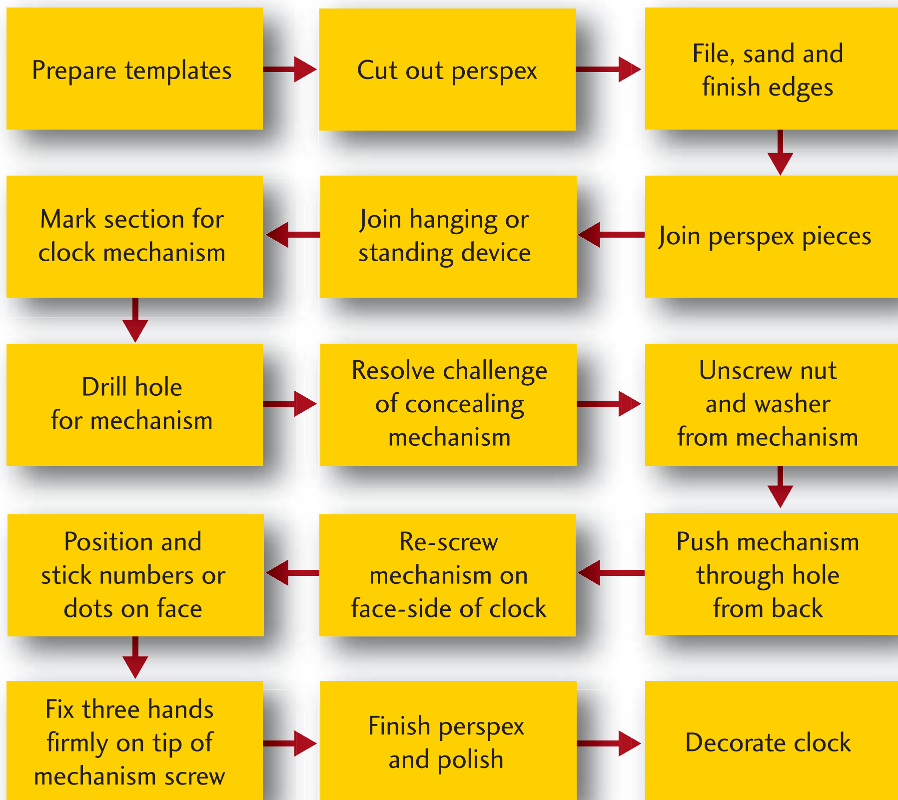


FIGURE 2.33: Production flow chart from chapter 5

Tip
When many small mistakes are not corrected, they combine. This can result in the design project not working the way that you initially wanted it to and the overall quality being poor.

Look again at the design process on pages 20–1.

Quality control

Use your drawings and production-management plan so that your design is produced just as you planned it. Always aim to produce work of the highest quality. At each stage of production, the quality of the work should be checked and any mistakes corrected. This is called quality control.

Be as accurate as you can when working with materials, using tools and carrying out techniques, especially if you have not worked with them before. Select and match materials that will help you create a quality piece of work. Practise your techniques and be familiar with all the materials and tools before using them in your project work.

The overall quality of the product should be checked by comparing it against your pre-established criteria for success and your design brief. The results of this comparison should be written up as an ongoing evaluation.

Safety

Safety is very important to consider at this point, as accidents are more likely to occur during production. There are safety requirements for each material, tool and technique you choose to work with. These requirements are made clear in each technology chapter of this book. Observe them!

You may need to ask for help with materials, tools and techniques that are new to you. Your teacher will always be available for help, so don't forget to ask.

Design process: FINAL EVALUATION

FIGURE 2.34: 'MarkitCarts' — New Generation Shopping Carts by PROdesign, manufactured by MarkitCart Pty Limited

Switch on

Go to www.jaconline.com.au/switchedontech and click on the Australian Design Awards MarkitCarts weblink for this chapter. Read about this product (see figure 2.34). In bullet point form ranked in order of importance, list four points you would highlight in an evaluation of this item. Compare your list and order of importance with others in your class.

Tip
If you have recorded your ongoing evaluation as you developed your design project, you should have no problems with evaluating the completed design project.

By this stage of the design process, you should be quite good at completing ongoing evaluations. Once you have produced your design, you are ready to complete your final evaluation. This step of the design process returns you to the design brief and is carried out to see how well things went and what improvements you could make in the future. During your final evaluation, you reflect on how successful your design is and how well you have worked through the process to resolve the challenge presented in your design brief.

Always judge your completed design solution against what you set out to achieve. No design is ever perfect — there is always room for adaptation and modification. No matter how carefully you plan, unforseen challenges will affect the final design project. Because of this, your final evaluation may send you back to the production stage to make adjustments.

The final evaluation is often neglected because it is the last part of any design project. Don't make the mistake of completing it quickly or not doing it at all. Your overall findings will be extremely helpful if you decide to develop and improve your design project further.

Techno*bite*
'I believe that quality level is determined by the actual design of the product itself, not by quality control in the production process,' said Hideo Sugiura, retired chairperson of the Honda Motor Company.

To evaluate your completed design project you need to have something to judge it against. Use your criteria for success to assess your design project and whether it resolves the challenges outlined in the design brief.

Comment on many aspects of your design project, especially those relating to your criteria and design brief constraints. They may include aesthetics, materials, product quality, cost of materials, time taken, function, safety, tools and techniques, and processes used.

Professional designers often ask ten questions when carrying out a final evaluation.

1. Is my project aesthetically pleasing?
2. Does my project function well?
3. Is my project safe to use?
4. Does my project meet all of my pre-established criteria for success?
5. How effectively did I work within the constraints of the design situation and brief?
6. Does my project resolve the design brief?
7. What changes or improvements could I make to the final project?
8. Am I pleased with the result?
9. If I had more time to develop my design further, what would I do?
10. What are the views of other people regarding my design?

It's important also to think about how your design project affects others. In this chapter, we have looked at many aspects of design, all of which can affect the environment or other people. Analyse figure 2.35 and evaluate your design project in relation to each area.

Technobite

'Design is about creatively exploiting constraint.' Inflate Design, a British design company, makes this statement a principle of their design processes.

FIGURE 2.35: How does your design project affect others?

Also evaluate how effectively you worked through and followed the design process. Outline any steps you added or deleted and the reasons you did so. Use table 2.10 to help you. Evaluate each step of the design process.

Tip
There are professional 'evaluation' associations whose job it is to evaluate products and ideas. The best known is *Choice* magazine, published by the Australian Consumers' Association. This magazine is in most local and school libraries and shows a large range of methods by which products can be evaluated. To access some free information from *Choice*, go to www.jaconline.com.au/switchedontech and click on the Choice weblink for this chapter.

TABLE 2.10: Design process evaluation

Process steps	Strengths	Weaknesses	Improvements
Design folio production			
Ongoing evaluation			
Analysis			
Management			
Research			
Ideas generation			
Communication			
Experimentation and testing			
Safety and risk management			
Production			
Final evaluation			

See pages 42–9.

There are several ways you can communicate your evaluation findings, for example, written, graphical, audiovisual or oral. Use the most appropriate method of communication for the information you have collected. There is no reason why you can't use multiple methods to communicate your findings.

CHAPTER Three

Timber technologies

How many times have you touched something made from timber today? Perhaps you've walked barefoot on floorboards; opened timber doors, windows, cupboards or drawers; sat on a chair or at a table or a desk made from wood; played a stringed or woodwind instrument; stirred a pot with a wooden spoon; travelled on a wooden ferry; emptied the shavings from a pencil-sharpener; or had a hit with a cricket bat or hockey stick?

Timber is suitable for making projects in all areas of study: Built Environments, Products, or Information and Communications. Chapter 3 provides general information about the materials, tools and techniques used in timber technologies. This chapter also contains detailed information to help you design and produce a timber photo frame.

Focus

By the end of this chapter you will be able to:

- identify, select and use appropriate materials for a design project
- select and correctly use tools of timber technology for a design project
- cut, shape and finish timber or timber products
- select and use appropriate techniques for the purposes of a design project
- use appropriate surface preparations and finishes for a design project.

Switch on

1. Name the trees in your garden or nearest park. Sketch the leaves of three and compare their shapes.
2. Participate in a class discussion on the uses of timber.
3. What does the term 'manufacturing' mean?

Technobite

More than half of the plantation trees harvested in Australia are used to make paper and paperboard. Nearly three-quarters of the trees harvested from native forests are chipped for paper products, including woodchip for overseas paper production.

3.1 Materials

Technobite

'For some people a tree is something so incredibly beautiful that it brings tears to the eyes. To others it is just a green thing that stands in the way,' wrote William Blake (1757–1827), English poet.

Knowing a bit about the materials you're going to work with is a helpful introduction to any technology. Things made from timber can be purely functional but they can also be very decorative.

A tree is a woody plant with one main stem. It is usually more than three metres tall when it reaches maturity. Figure 3.1(a) shows the parts of a tree from its roots to its crown. The trunk is made up of layers of bark, phloem, cambium and xylem. Figure 3.1(b) shows a cross-section through the trunk of a tree and names the different layers within it, which are:

- *bark:* the outside of the trunk that you can see. Bark protects the trunk from weather, insects and fungi.
- *phloem:* inside the rough, tough outer covering of bark, a pale inner layer of bark, called the phloem, transports sugar and nutrients along elongated cells to other parts of the tree.
- *cambium:* inside the phloem, the cambium layer produces phloem and xylem cells to form new inner bark.
- *xylem* (or *sapwood*): this is the trunk's innermost layer. Sapwood grows to be *heartwood*, the mature wood that gives the tree its strength and support. The majority of the timber used in industry comes from this part of the tree.
- *growth ring:* a growth ring represents the layer of wood produced every growing season — one for every year that that tree has been alive. These tree rings slowly increase the diameter of the tree. The rings vary in density, size and colour, according to the type of tree.

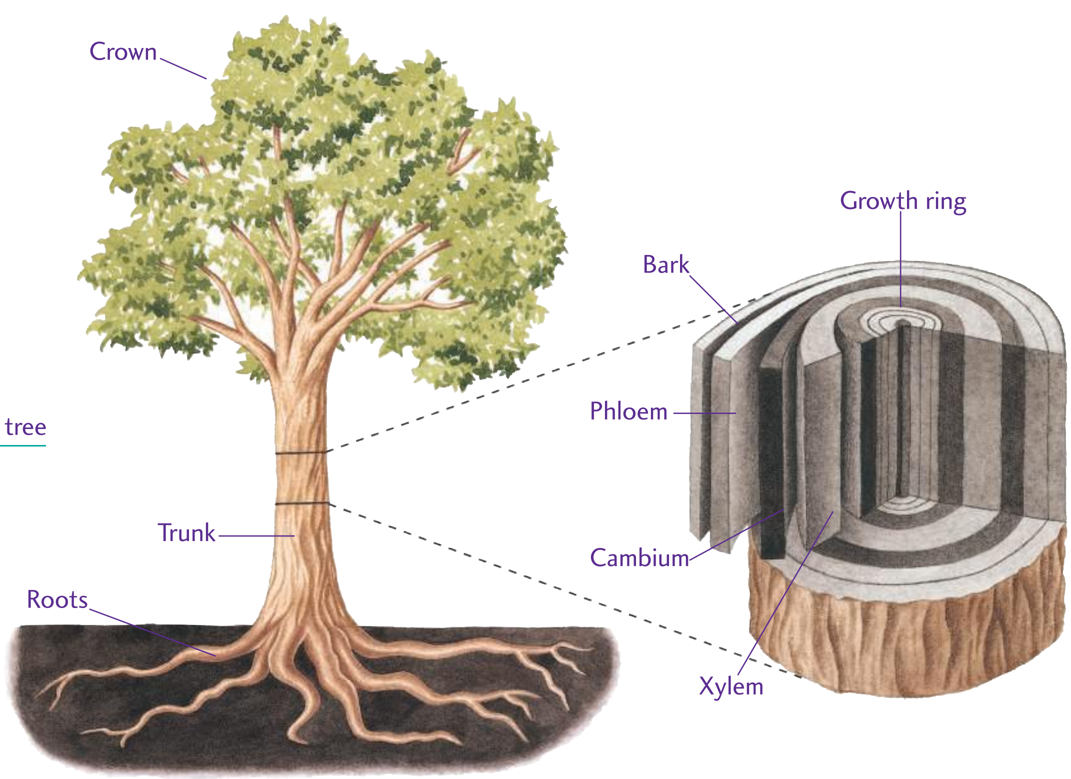


FIGURE 3.1: Parts of a tree

(a) A mature tree

(b) Cross-section through the trunk of a tree

Natural timber

The timber trade divides trees into two main categories:

1. *hardwood*. These are also called angiosperms. They have broad leaves, generally shed their leaves in autumn and bear seeds enclosed in fruit. Blackbutt, red cedar, jarrah and Pacific maple are examples of hardwoods.
2. *softwood*. These are also called gymnosperms. They have narrow or needle-like leaves, are evergreen, and bear naked seeds in cones. Cypress pine, western red cedar, Douglas fir and Radiata pine are examples of softwoods.

The basic structural difference is that hardwoods have pores or vessels like the pores in your skin. Softwoods do not have these vessels.

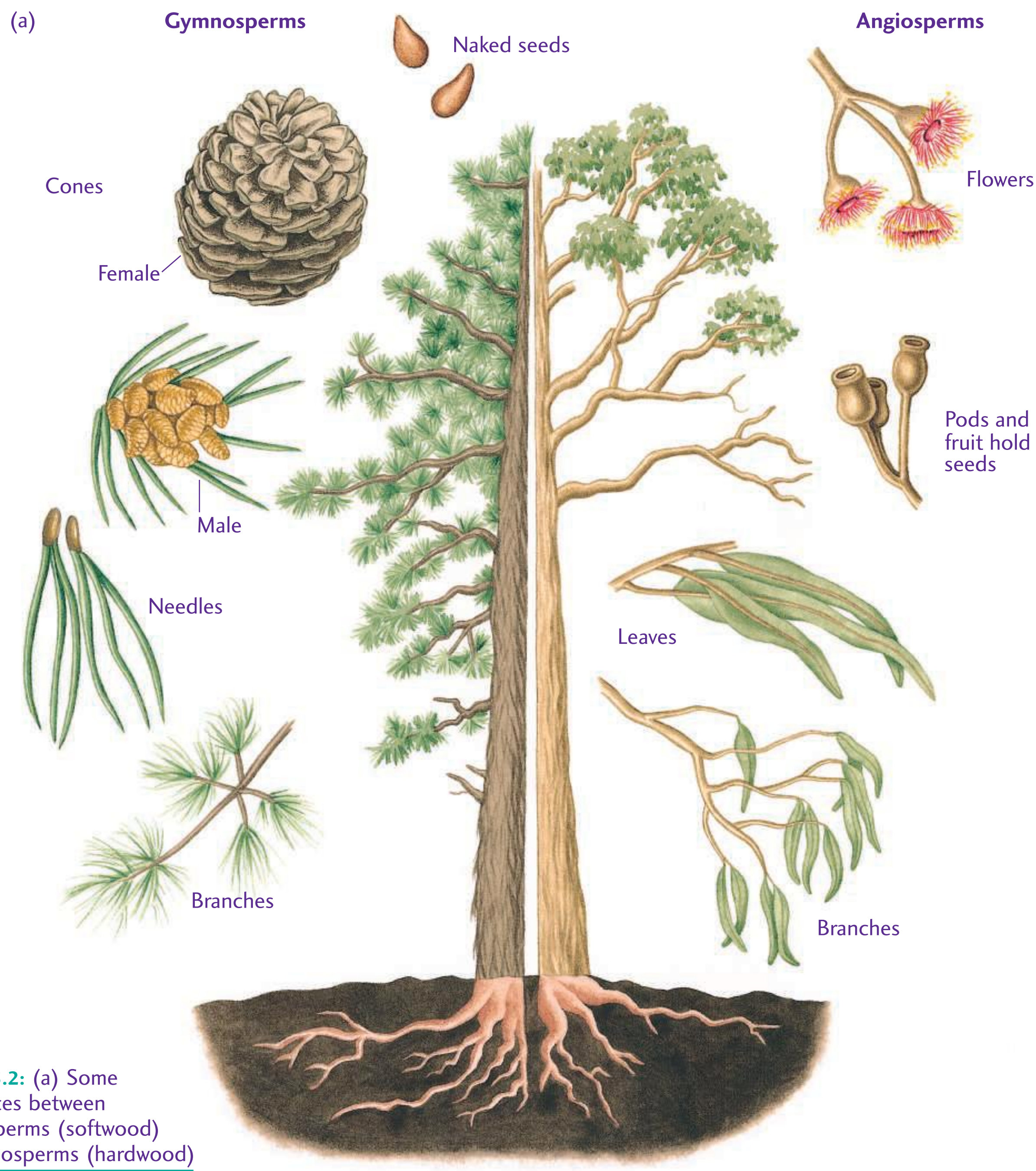
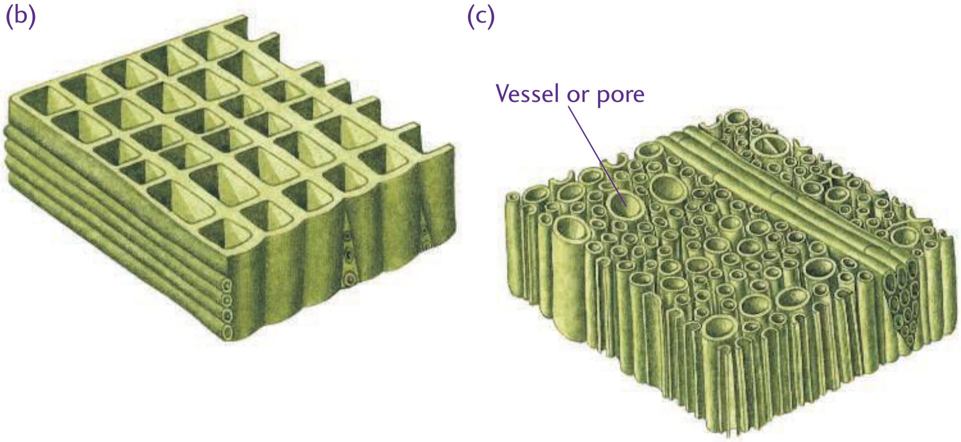


FIGURE 3.2: (a) Some differences between gymnosperms (softwood) and angiosperms (hardwood)



(b) Close-up section of softwood, (c) close-up section of hardwood

Techno**bite**

The terms hardwood and softwood do not always accurately describe the hardness of the wood that trees produce. For example, balsa, the softest of all woods, comes from a hardwood tree.

TABLE 3.1: Properties of natural timber

Property	Information
Colour	The colour of wood in its natural state varies considerably and has an effect on the choice of finishing. Tallowwood, for example, is pale yellow-brown; Cooktown ironwood is a dark, rich brown.
Grain	The arrangement or direction of fibres in wood is known as the grain. Types of grain include straight, wavy, irregular, spiral and birds-eye. Some woods have a more pronounced grain than others and have a very distinctive appearance after sanding and polishing, for example, walnut and olive.
Durability	Woods vary in durability and are graded into five classes according to how well they resist decay. Cherry, for example, is very resistant. Preservatives can be applied to wood to assist durability.
Texture	Texture refers to the size of grain cells in a piece of wood and is described as coarse, medium, fine or ultra-fine. Texture is also uniform or uneven according to the cell structure of the tree.
Other properties	Other properties of timber include figure, density and moisture content. Ask your teacher for more information on the properties of wood.

From forest to products

Figure 3.3 (p. 64) shows the processing of timber from tree felling to manufactured timber products. Once the sawn timber boards are produced, they are prepared for short- or long-term storage. The boards are treated with preservatives to protect against fungal diseases and borers.

Green timber (freshly felled) contains a large amount of water. It is seasoned by air drying or kiln drying to get the best moisture content for the timber's eventual use.

Manufactured board

Not all trees are suitable for use as solid timber. Manufactured boards are made from whole trees or from parts of trees that would otherwise be wasted. The demand for more versatile materials in the construction and building industry has led to the large-scale production of three main types of manufactured boards: plywood, particle board, and fibreboard. These are often cheaper and more solid than forest-grown timber, and they come in wide sheets.

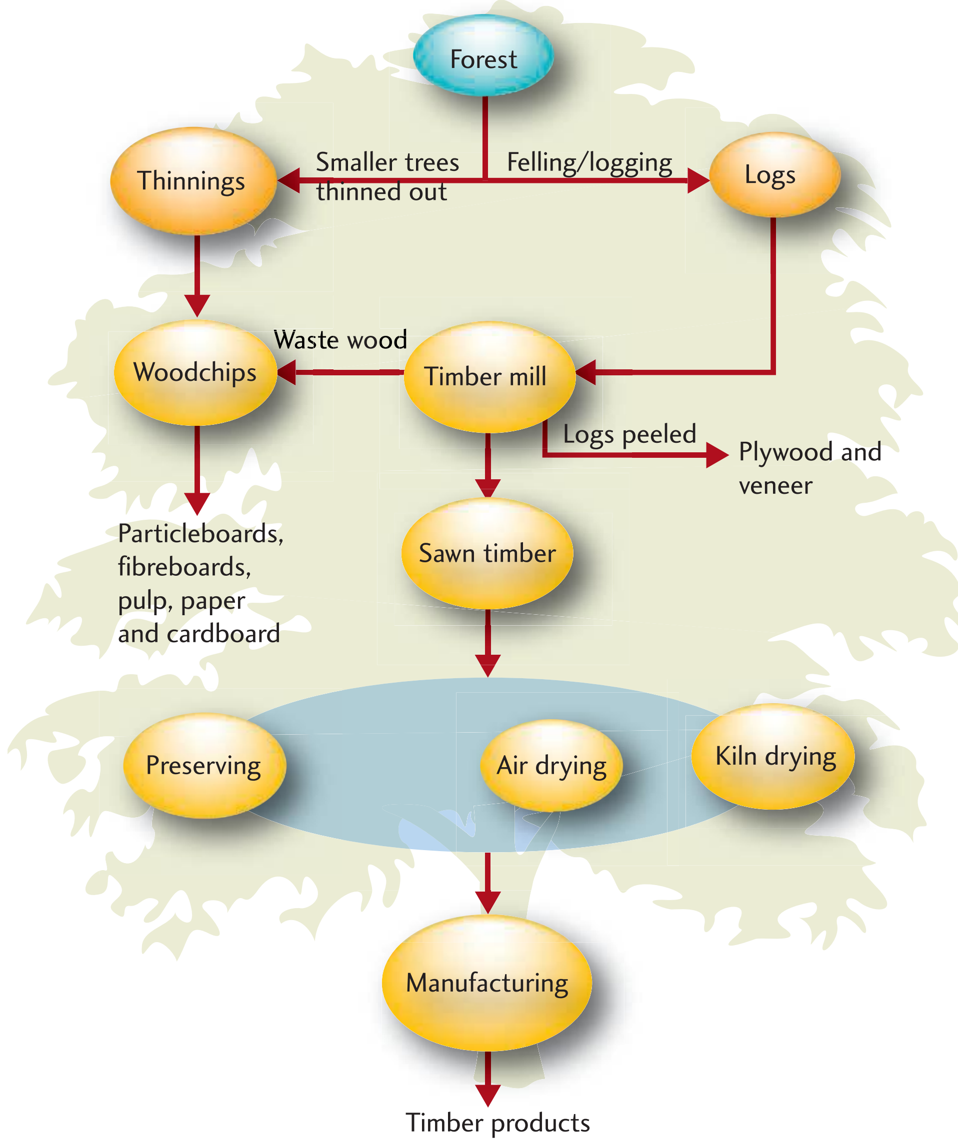


FIGURE 3.3: Forest to products

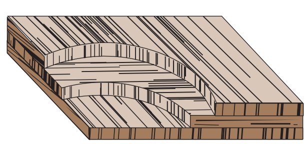


FIGURE 3.4: Cross-section through plywood — note the changing direction of the grain.

Plywood

Plywood is a laminated material made from sheets of wood called *plies, laminates* or *veneers*. These are glued together, usually in an odd number of layers (from three to twenty-one) to form a strong board. To give maximum strength, the grain of one sheet lies at a right angle to the next sheet. See figure 3.4.

TABLE 3.2: Advantages, disadvantages and uses of plywood

Advantages	Disadvantages	Uses
1. Strength is increased by the grains being at right angles to each other 2. Available in bigger sheets than those from natural timbers 3. Able to have panels with matching grains 4. Can be bent or formed to make curves	1. Need to finish edges, as they can look untidy 2. Not as easy to work as solid timber due to the layers	1. Construction — wall cladding, partitions, doors and decks 2. Furniture — frames, backs, drawers, shelves and panels

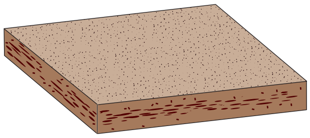


FIGURE 3.5: Cross-section through particle board. It contains both larger chips and smaller particles.

Particle board

Particle board (also known as *chipboard*) is made from sawdust, wood shavings, offcuts, and thinnings and trimmings from pine forests. It is made by bonding small chips together with a synthetic adhesive (resin). Particle board has uniform strength because there is no general grain direction. See figure 3.5.

TABLE 3.3: Advantages, disadvantages and uses of particle board

Advantages	Disadvantages	Uses
1. Cheaper than plywood 2. Easily worked by hand and with power tools and easily finished with paint 3. Available in large sheets 4. No grain direction so has uniform strength 5. Retains its shape well	1. Edges require special treatment 2. Has a flaky structure and may break close to corners 3. More moisture absorbent than most timbers but can be treated with a water-resistant finish	1. Furniture — tops of cupboards, drawer parts and shelves 2. Shop fittings and shelving 3. Floorings (in construction) to go under carpets etc.

FIGURE 3.6: Manufacturing masonite

Fibreboard

Hardboard (for example, Masonite™) is high-density fibreboard, made in Australia from offcuts and trimmings from eucalyptus trees. The material is converted into chips, heated up and ground. Hardboard is similar to particle board, except that natural resins in the timber do all the bonding. Resins are not added to hardboards.

TABLE 3.4: Advantages, disadvantages and uses of hardboards

Advantages	Disadvantages	Uses
1. No grain direction so has uniform strength 2. Can be formed into curved shapes 3. Available in different colours and finishes 4. Available treated for greater weather resistance and hardness 5. Can be worked with all power and hand tools	1. More moisture absorbent than timber 2. Affected by atmospheric conditions such as dryness, heat and humidity 3. Punctures and breaks more easily than plywood	1. Wall and ceiling linings 2. Guitars and acoustic instruments 3. Display and peg boards 4. Furniture construction, e.g. bottom of drawers

Fittings and hardware

Fittings and hardware is a general term for everything you need to hold your timber products together and make them work efficiently. Small fixtures, such as hinges, catches, nails and screws, are usually hidden. Handles, and sometimes locks, often form decorative features of doors and furniture.

Handles can be a useful clue to working out when antique furniture was made because styles changed in different times. Take drawer pulls, for example: in the middle of the eighteenth century, these were commonly curvy brass loops but later in the century, plain brass circles became fashionable. Many older styles of handles are now copied by present-day manufacturers.

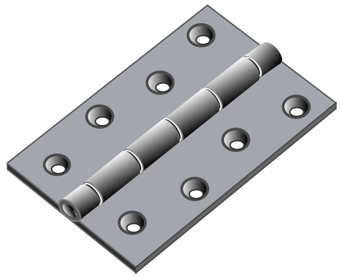
Technobite

Hinges are a good example of how technology has changed over the years. Builders used to make their own. Now hinges, designed for different types of joinery, are mass-produced.

Hinges

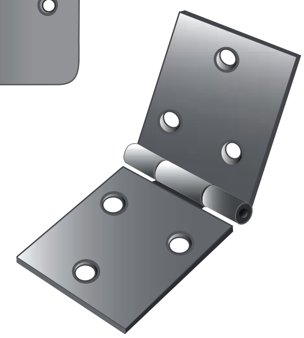
Hinges are usually made from brass or steel. A hinge has three parts: two leaves and the overlay of the leaves.

(a) Butt hinge — a traditional hinge for doors in cabinet-making



(b) Flush hinge — similar to a butt hinge but appropriate for lightweight work. No rebating is needed for this hinge.

(c) Piano hinge — sold in lengths up to two metres and cut to the necessary length. These hinges are malleable.



(d) Backflap hinge — for attaching cupboard doors; has wider leaves than other common hinges

FIGURE 3.7: Four common types of hinge

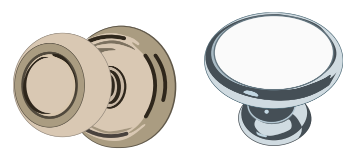
See page 73 for information on rebating.

Handles

Handles are available in many styles for opening and shutting doors or drawers. They are made from brass, steel, wood, porcelain and other materials.

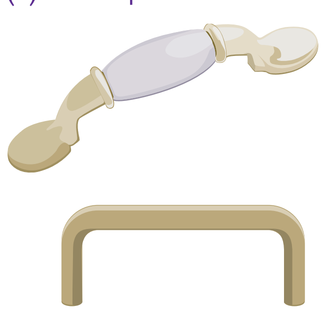
(a) Sliding door handles

(c) Doorknobs

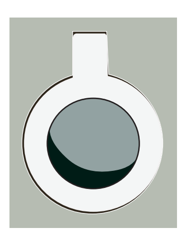


(d) Cabinet handles

(b) Drawer pulls



(e) Flush handles



(f) Drop handles

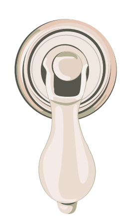
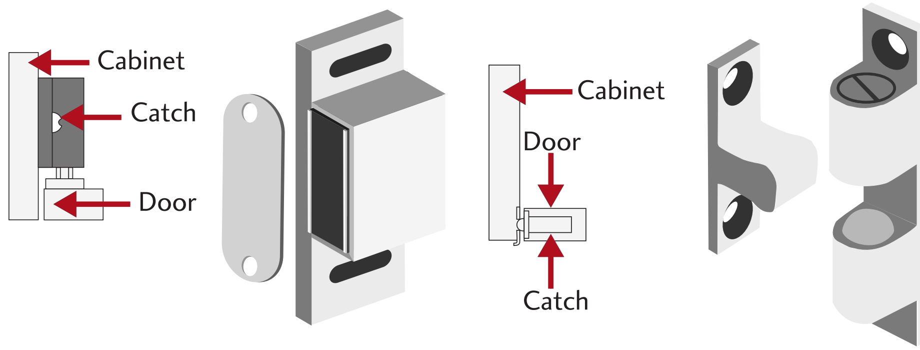


FIGURE 3.8: Handles

Catches

Catches enable a drawer or door to be secured without using a lock and key.

FIGURE 3.9: Catches



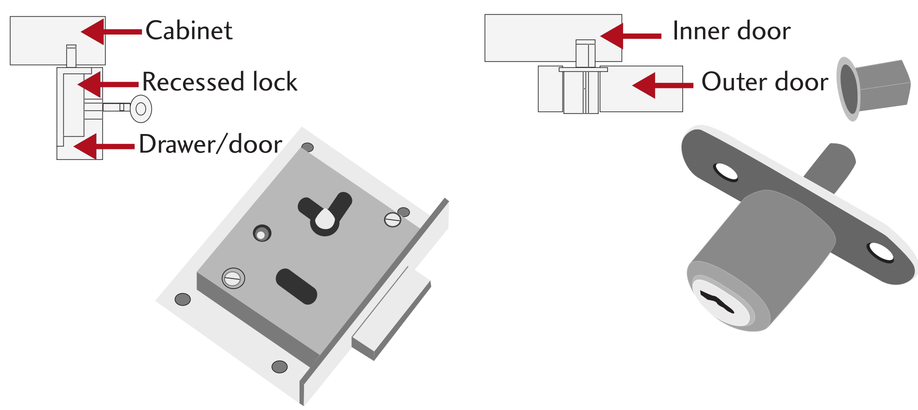
(a) Magnetic catch — places two magnets opposite each other: one on the door and the other just inside the cupboard, so that the door stays closed by magnetic attraction.

(b) Ball catch — sets a spring-loaded ball in a compartment on the door. The ball is attracted to a ball-sized space in the cupboard.

Locks

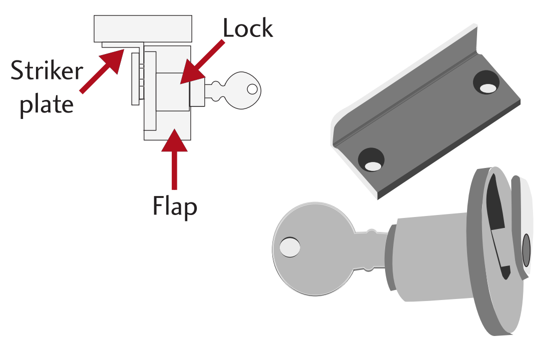
Locks provide security for your possessions in a drawer or cupboard.

FIGURE 3.10: Locks



(a) Cabinet lock — most common type of lock; used for drawers and cupboards

(b) Sliding door lock — a special circular lock pushed into a recess on the inner door



(c) Fall-flap lock — for fold-down counter doors and bureau desks; designed so that the key can be removed only when the door is closed

Screws and nails

Screws, which are used for attaching hinges, handles, catches and locks to doors or cupboards, come in many sizes. Slotted screws and Phillips head screws are the most common types.

Nails are used for joining pieces of wood. The most common types are bullet head nails and flat head nails.

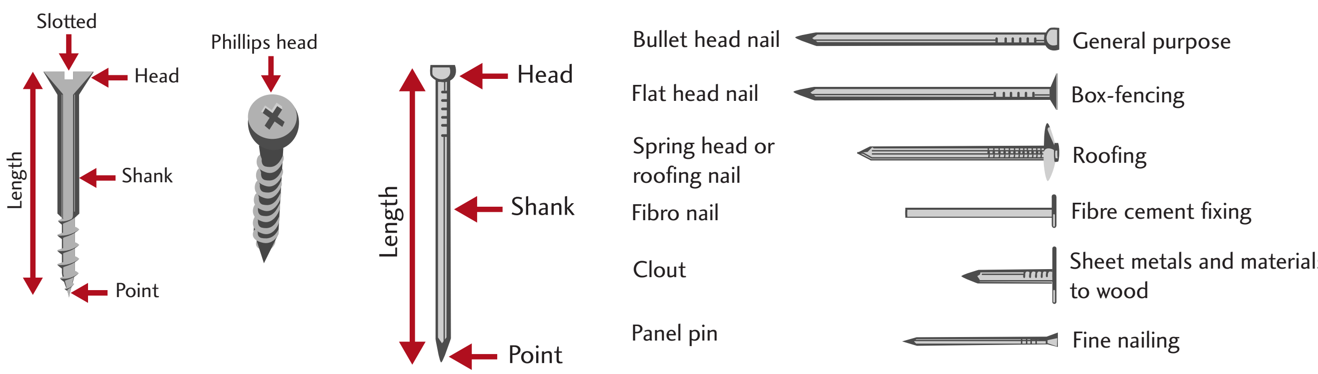


FIGURE 3.11: Screws and nails

Switch on

1. Identify four parts of a tree's trunk that are responsible for growth.
2. Identify five differences between angiosperms and gymnosperms.
3. Use the Internet or your school library to complete table 3.5.

TABLE 3.5: Profiles of selected timbers

Hardwood	Where found	Qualities	Uses
Blue gum			
Red cedar			
Pacific maple			
Softwood	**Where found**	**Qualities**	**Uses**
Cypress pine			
Douglas fir			
Radiata			

4. List the advantages and disadvantages of plywood and solid timber.
5. Why does plywood normally have an odd number of plies, laminates or veneers?
6. Research and complete table 3.6, making a brief comment beside each property.
7. Compare a catch and a lock. Sketch and label the differences.
8. Identify the five groups of timber fittings and hardware. How do fittings and hardware help you when fastening and attaching wood?
9. What would be the best lock or catch for a kitchen cupboard holding saucepans? Why?

Techno**bite**

Australia's oldest tree is Huon pine (*Lagarostrobus franklinii*) endemic to Tasmania, which means that it grows nowhere else on Earth. Some specimens are more than 2000 years old. Huon pine trees grow very slowly — about 1.2 metres in a century. The wood is honey coloured, fine grained and has a distinctive fragrance.

Techno*bite*

Jarrah from the south-west of Western Australia was exported to England to make railway sleepers for the London Underground and is still listed there as a timber suitable for sleepers.

TABLE 3.6: Some properties of selected timbers

Hardwood	Colour	Grain	Durability	Texture
Blackwood				
Blackbutt				
Jarrah				
Softwood	**Colour**	**Grain**	**Durability**	**Texture**
Radiata pine				
Huon pine				
Western red cedar				

3.2 Tools and techniques

There are many techniques for measuring and marking out, constructing, joining and finishing timber. Many of the tools you will use are hand tools but timber construction techniques also require the use of machine tools. Some of the required tools for these techniques have disadvantages or are more difficult to use than others. Knowing which tool to use for each step will help you achieve the best results.

This section does not cover every tool and technique for working with timber. As your projects become more complex, you will learn to use others.

But before you can begin, you must understand and learn the general rules for working safely with timber.

General rules for working with timber

Safety

- Always use appropriate PPE (personal protective equipment). See pages 51–3.
- Be aware of the special safety requirements of the tools and techniques you will be using with timber technologies. At Stage 4 level, some tools must be operated by the teacher only. Others you can use only with teacher supervision.
- When lifting and moving heavy timber, make sure to bend your knees and keep your back straight.
- Identify the grain direction and any knots or defects in the timber.
- Practise using a tool before you use it on your project.
- Remember that cutting tools have sharp, and often jagged, edges.
- Remember many marking and measuring tools have sharp points.
- When working with timber, remember to:
  - use adhesives in well-ventilated areas
  - take care not to inhale timber dust
  - be careful of splinters
  - take care not to cut yourself on the edges of the timber.

Safety rules that apply to specific aspects of timber technologies appear later in this chapter. Observe them!

Measuring and marking out

Measuring and marking out are used for:

- measuring and marking where cuts will be made in timber
- marking where hinges, handles, locks and catches will be attached
- marking the locations of screws and nails
- marking the position of decorative details.

Many of the measuring and marking-out tools used for timber are also used for metals and polymers. They include:

Pencil: Use to make marks on wood.
Carpenter's pencil: Makes marks on wood. Sharpen the squarish lead with a chisel or blade. It lasts longer than a regular pencil.
Chalk: Makes marks on wood, which can be brushed or wiped off easily.
Awl: Use to scribe (or scratch) a mark more permanent than pencil.
Steel rule: Use to rule straight lines and to test the straightness of lines.
Try square: Use to mark out and measure 90° angles.
Sliding bevel: Use to mark out and measure angles.
Retractable tape measure: Use to measure lengths greater than 300 mm. Ask your teacher if you are allowed to use a retractable tape measure.
Compass: Use to draw circles and arcs.
Protractor: Use to mark angles.

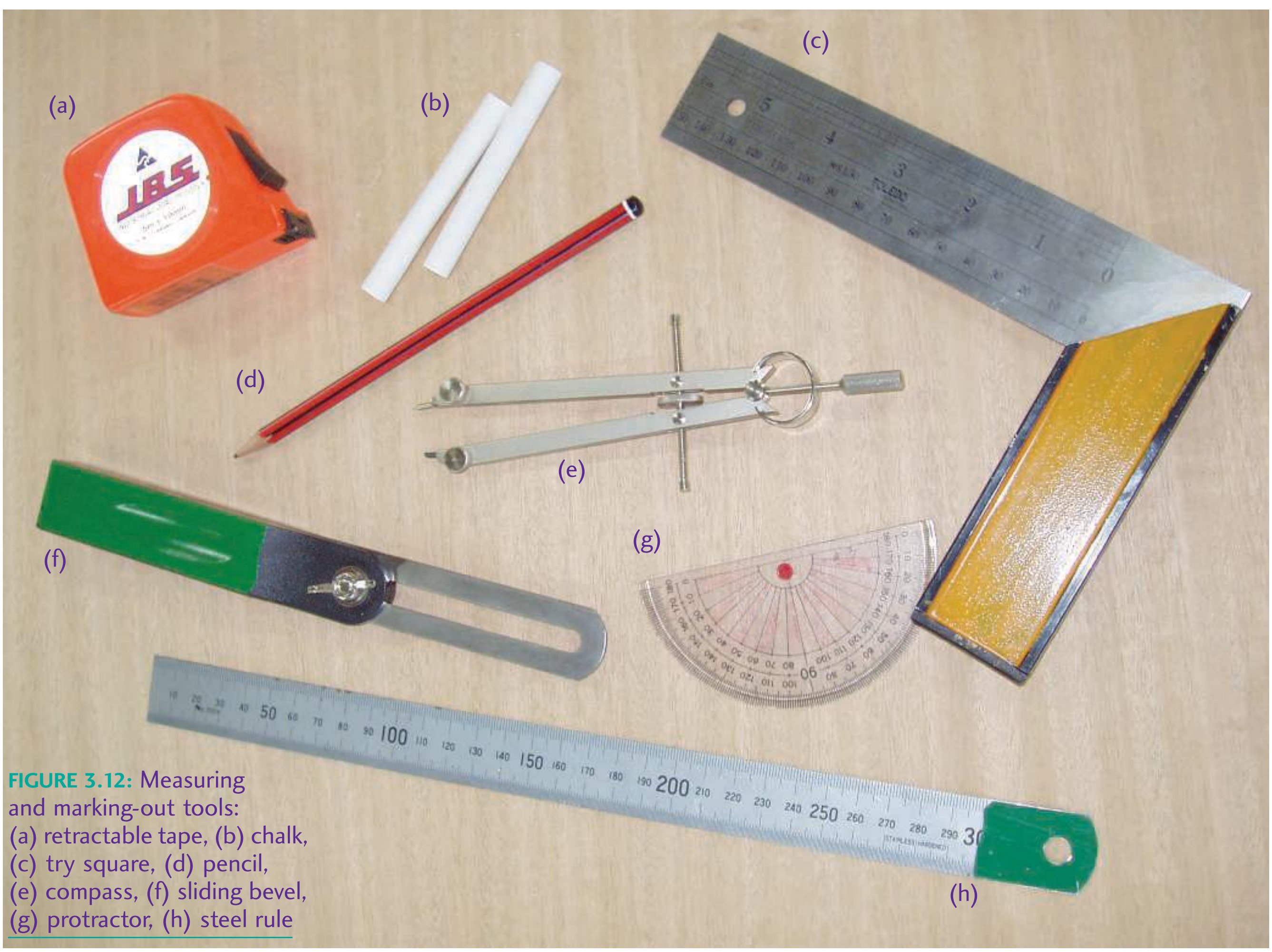


FIGURE 3.12: Measuring and marking-out tools: (a) retractable tape, (b) chalk, (c) try square, (d) pencil, (e) compass, (f) sliding bevel, (g) protractor, (h) steel rule

Additional measuring and marking-out tools for timber technologies include:

Marking gauge: An important tool for marking a straight line that is parallel to the edge of the timber. A marking gauge consists of a flat piece of wood called a stock through which runs a stem. The pre-fixed pin is set against a rule to a required measurement by moving the stock through the stem and tightening the thumbscrew. Apply a little pressure to the pin to mark the wood lightly as you move the gauge.

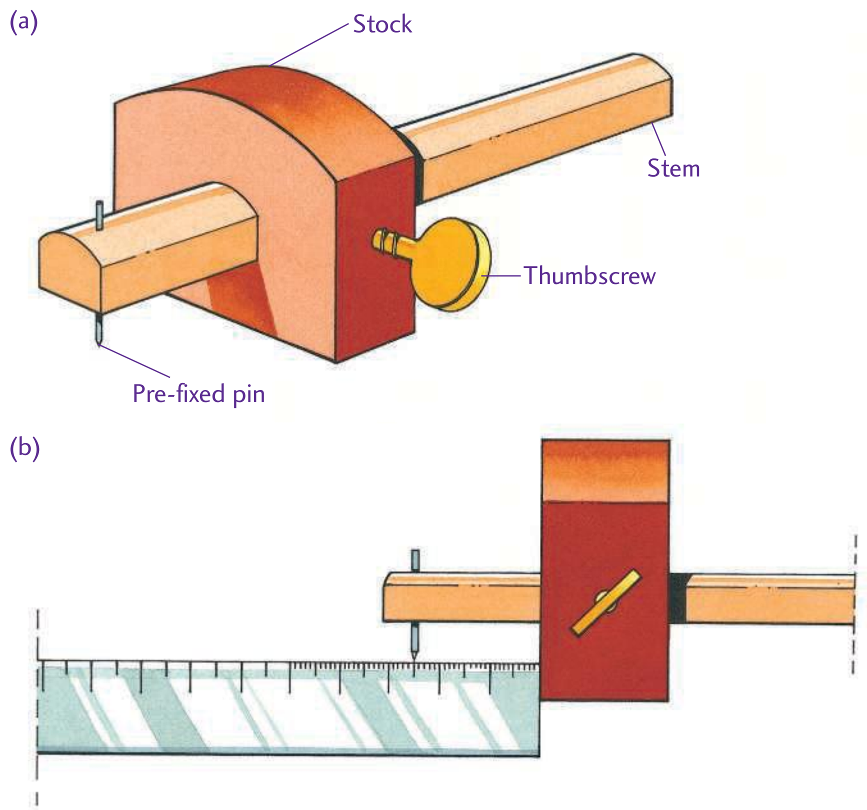


FIGURE 3.13: (a) Marking gauge, (b) setting a marking gauge to a rule. Loosen the thumbscrew, set the distance, then tighten the thumbscrew.

Tip
Apply pressure to the bradawl to make it work.

Bradawl: Use for starting a hole for a screw so that you can place the screw accurately.

Cutting

Handsaws are the most common type of cutting tool in the woodwork room but you will also learn to use some machines. Handsaws have long, flexible, deep blades and continuous teeth that are alternately bent to the right and left.

General-purpose saw: Use for cutting metal, wood and plastic into straight and curved shapes.

FIGURE 3.14: General-purpose saw

PANEL SAW: This general-purpose handsaw has fine teeth suitable for cutting large panels of wood. This is a saw for cutting straight lines — it is not suitable for curves.

Disadvantage: A panel saw is too large for small pieces of work.

FIGURE 3.15: Panel saw

TENON SAW: Use with a bench hook to cut small pieces of wood. A tenon saw has a piece of steel attached to the top of the blade. You can also use a tenon saw for cutting wood for small joinery work.

Disadvantage: A tenon saw is not good for through cuts because of the piece of metal along the top of the blade.

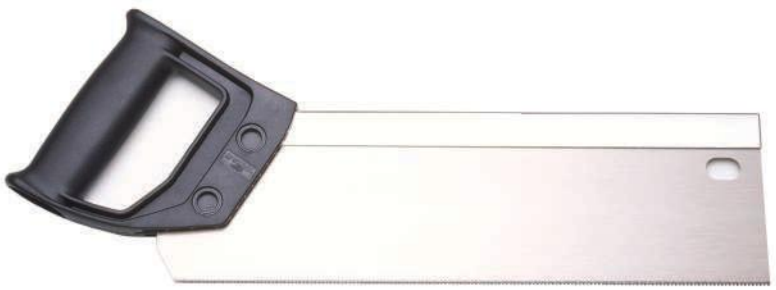


FIGURE 3.16: Tenon saw

BENCH HOOK: Allows you to hold small pieces of wood and dowel for accurate crosscutting without the need for clamps. A bench hook protects the surface of the workbench.

CHISELS: Chisels consist of a handle made from hardwood or moulded from plastic, and a steel blade. The blade width ranges from 2 to 50 millimetres. Use chisels for cleaning up waste and finishing off joint work.

Disadvantages: Chisels can be inaccurate and cause splitting with the grain.

FIGURE 3.17: Chisels

A rebate is a groove or recess at the edge of a cut piece of wood. A tenon saw is suitable for cutting rebates but other tools are used for this, too.

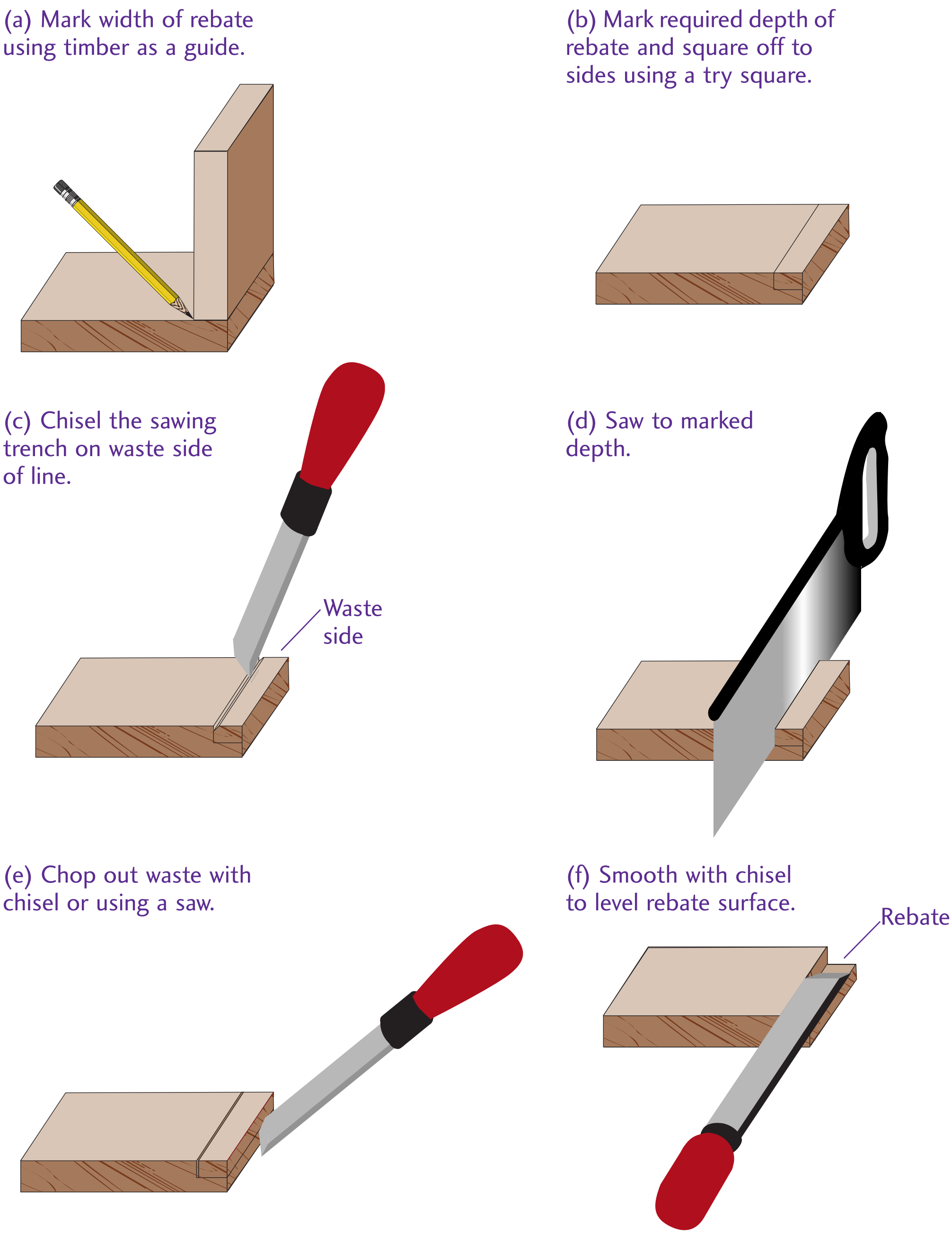


FIGURE 3.18: Cutting a rebate

Technobite

People have been using saws for at least 4000 years.

Coping saw: Suitable for cutting curves and arcs in wood, metal and perspex sheets. Pins hold the blade to the handle and the blade can be rotated in the direction of the desired cut. The blade can also be removed from the end of the frame, put through a hole and then re-attached to the frame so an internal cut can be made. The teeth on the blade should point towards the handle. Coping saws cut during the pull rather than the push stroke. Make sure the material you are cutting is securely held in a vice. The vice should be gripping the area being cut.

Disadvantage: A coping saw has a very thin blade, which can snap. It is limited to thin wood, perspex and softer metals.

FIGURE 3.19: A coping saw can be used to make an internal cut.

Enlarging a hole with a coping saw

1. Mark on the material the shape to be cut out.
2. Drill a small hole in the material inside the area to be cut out.
3. Disconnect the coping saw's blade from the handle and thread it through the small hole.
4. Reconnect the coping saw's blade to the main part of the body of the coping saw.
5. Use the coping saw to cut the marked shape starting from the smaller hole.

BANDSAW: A bandsaw cuts all materials and can rip, cut curves and crosscut.

This tool **must not** be used by Years 7–8 students. Ask your teacher to show you a bandsaw. If your project requires work with a bandsaw, your teacher will do it for you.

Construction

HAMMERS: Hammers, for driving in nails, are the most common construction tool in the woodwork classroom. They come in two types: *claw* and *cross-pein*. You can also *remove* nails with a claw hammer. Use a cross-pein hammer with smaller nails and tacks to avoid bending them. A Warrington hammer is a large cross-pein hammer with a cylindrical end on one side and a rounded sphere-like end on the other.

MALLETS: Use to hammer wood into place for joints or for work with chisels. Wooden mallets are generally made from beech trees.

FIGURE 3.20: Hammers and mallet

(a) Claw hammer

(b) Warrington hammer

(c) Mallet

Screwdrivers: There are two main types of screwdriver for driving in screws: *slotted* and *Phillips*. Make sure that the tip of the screwdriver fits the screw's slot.

FIGURE 3.21: Screwdrivers

(a) Slotted

(b) Phillips head

Safety

Biscuit jointer: Biscuit jointers are used to join two pieces of wood.

This tool **must not** be used by Years 7–8 students. Ask your teacher to show you a biscuit jointer. If your project requires work with a biscuit jointer, your teacher will do it for you.

Timber can also be joined together by making a dowel joint or a rebate butt joint, which are shown below.

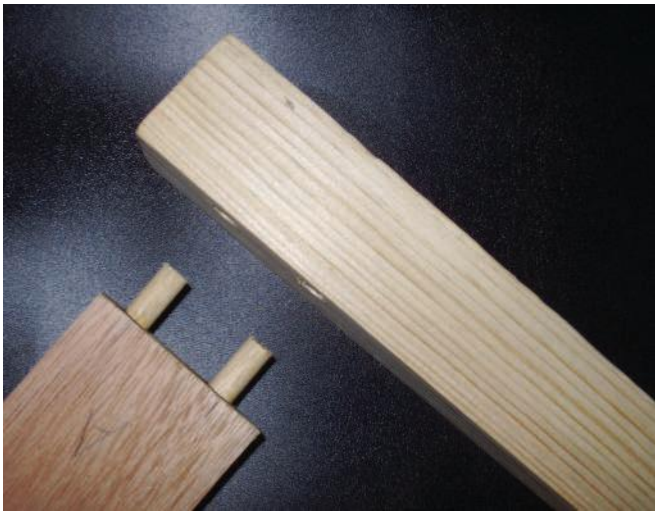


FIGURE 3.22: Making a dowel joint

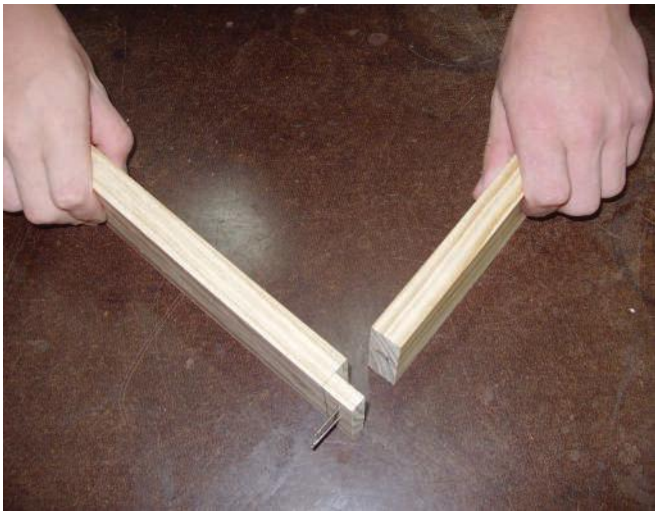


FIGURE 3.23: Making a rebate butt joint

Drills: Hand drills are not used as much as they used to be. Power drills are much faster and can be used with a range of attachments and at varying speeds for different functions. Power drills are either plugged into a power point or are cordless and use batteries.

Safety

Years 7–8 students may use only cordless drills.

FIGURE 3.24: Drills

(a) Hand drill (b) Cordless drill (c) Power cord drill

Jigsaw: A jigsaw is a power cord or cordless portable tool used for cutting straight lines, curves and arcs in timber, metals and polymers. This saw is fitted with a fine-toothed blade and the workpiece is securely fastened with a clamp during cutting. The narrow blade works in a vertical motion and cuts when the blade moves up.

A power cord jigsaw **must not** be used by Years 7–8 students. Your teacher will use it for you. Years 7–8 students may use only a cordless portable jigsaw.

Power sanders: Belt and orbital power sanders are used to smooth surfaces. Use a portable *orbital sander* for finer work.

Safety

Years 7–8 students **must not** use a fixed or portable *belt sander*.

FIGURE 3.25: Jigsaw

FIGURE 3.26: Power cord sanders

(a) Belt sander (b) Orbital sander

Tip
Hold the orbital sander with an even pressure.

Nail punch: Nail punches are used for punching nail heads below the surface of the timber.

Pincers: Pincers are used to pull out many different types of nails; they grab nails more efficiently than a claw hammer, which is also used for this purpose.

Routers: Routers are high-speed cutting tools and are used to mould and cut shapes, rebates and grooves.

Safety

This tool **must not** be used by Years 7–8 students. Ask your teacher to show you a router. If your project requires work with a router, your teacher will do it for you.

Adhesives

Timber can be joined together with adhesives, as well as with nails and screws. Table 3.7 shows the characteristics of adhesives commonly used for timber. Observe the following safety rules.

Safety

- Always work under teacher supervision.
- Take extreme care when dealing with solvents and adhesives.
- Always read the directions on the bottle or the tube.
- Wear a mask and work in a well-ventilated area. Adhesives give off toxic gases, which can cause giddiness and fainting. If inhaled, some adhesives could cause damage and/or are carcinogenic (can cause cancer).
- Wear eye protection (goggles and/or glasses) in case of accidental splashing. Most hardeners (found in epoxy resins) contain peroxide that can irritate or cause damage to the eyes. If the glue comes into contact with your eyes, wash your eyes immediately and seek medical advice.
- If any solvent or glue comes into contact with your skin, wash the affected area immediately. Wear gloves if you are using polyester resins.
- Store substances according to the recommended safety advice.

Tip
Make sure you have chosen the right glue for the purpose, materials and location, for example, furniture that will be used outdoors rather than inside the house.

TABLE 3.7: Common adhesives and their characteristics

Type	Preparation	Pressing time	Time until full strength	Characteristics
Contact (liquid rubber)	None needed	Several seconds to minutes	Several weeks	Common adhesive; weakest of the wood glues
PVA (polyvinyl acetate)	None needed	10 minutes to 2 hours	1 week	Strong adhesive, except when under a heavy load
Epoxy resin	Mix with hardener	Up to 48 hours	2 days to several weeks	Waterproof; will glue any material together
Hot melt (solid stick)	Heat in a glue gun	30 seconds to 1 minute	30 minutes to 1 hour	Multipurpose adhesive suitable for bonding most materials

Finishing

Finishing tools assist in preparing the edges and surfaces of the timber for lacquering, priming, painting, waxing and/or staining.

Removing and smoothing wood

Planes: Planes are used to straighten and smooth timber and reduce it to the required size. Two types of planes are commonly used. The *jack plane* — used for planing wood flat — is 350 mm long. The *smoothing plane* — used for finishing, planing end-grain and smoothing — is 250 mm long and generally lighter.

Plane in the direction of the grain rather than against it. Make sure the plane is sharp and the blade is protruding at the required amount of cutting size.

Disadvantage: Planing against the grain can cause 'tearout'.

FIGURE 3.27: Smoothing plane

FIGURE 3.28: Spokeshave

Metal spokeshave: A metal spokeshave is similar to a plane, but is designed to smooth and straighten curved pieces of wood. Use spokeshaves with the timber grain.

Disadvantages: Spokeshaves can be used on only minimal amounts of timber and can damage the wood.

Surform plane tools: These tools are used to remove large quantities of material quickly. Surform plane tools are recent developments of the rasp and are mixed with a plane. They cut faster and reduce the waste from cutting that can clog the tool.

Files: Wood files are used after using a rasp to smooth the roughened timber further. There are three grades: bastard cut, second cut and smooth cut. Clean out shavings with a file card or wire brush, using the wire bristles on one side to loosen the shavings and the coarse brush on the other to remove them. (The sequence of tools from coarsest to finest is surform tool, rasp, smooth rasp, bastard-cut file, second-cut file, smooth-cut file.)

Rasps: A rasp looks like a file but is coarser.

Disadvantage: Rasps easily get clogged by wood debris.

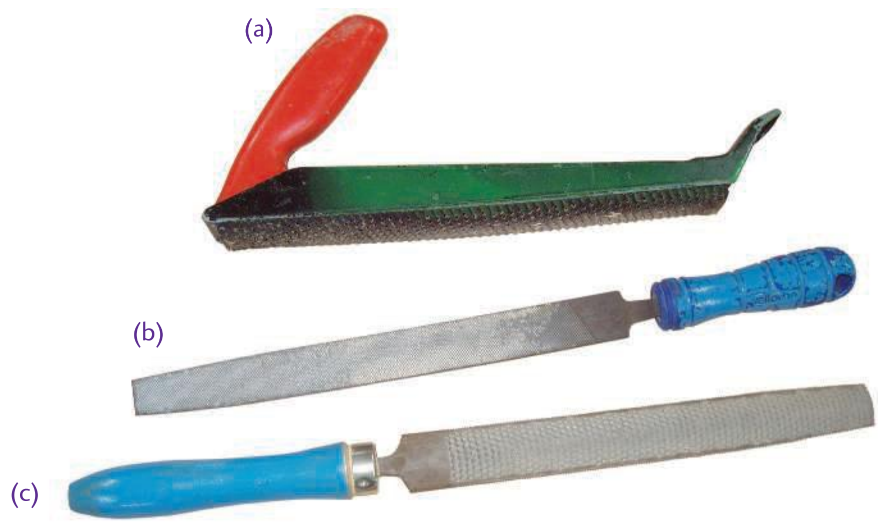


FIGURE 3.29: (a) Surform plane — suitable for planing wood, aluminium, copper, plastic and laminates, (b) wood file, (c) rasp — suitable for wood and plastics

TABLE 3.8: Sandpaper grades

Surface	Grade
Very coarse	30
Coarse	60
	100
Medium	120
	130
	150
Fine	220
	230
	240
Very fine	320
	360
	400 — wet and dry
	500 — wet and dry
	600 — wet and dry

ABRASIVE PAPER: Abrasive paper (commonly known as sandpaper) is used during the last part of the finishing process to produce a silky smooth surface. Sandpaper is cheap but it wears quickly. Abrasive paper is also available in *wet and dry* paper. This is more efficient for smoothing surfaces because of its fineness. Table 3.8 shows the sandpaper grades.

Disadvantages: Abrasive paper clogs easily and requires a lot of effort to use.

CLAMPS AND CRAMPS: Use clamps and cramps to ensure pieces of timber, metal and plastic are held firmly when working with some tools.

FIGURE 3.30: Tools for holding work firmly

(a) Using a sash cramp

(b) G-clamp

Machine tools

Machine tools are powered by electricity and usually complete the task faster than hand tools.

SCROLL-SAW: A scroll-saw is a versatile tool in the workshop for cutting timber, metal and plastics in intricate curves and along the straight. The movement of the scroll-saw's blade is similar to that of the *jigsaw* but, unlike a jigsaw, the scroll-saw is mounted on a table.

Disadvantage: Sometimes the material gets caught on the blade and pulls up and down (jumps) if it is not held flat on the scroll saw's cutting platform.

FIGURE 3.31: Using a scroll-saw

Safety

Observe the following safety rules.

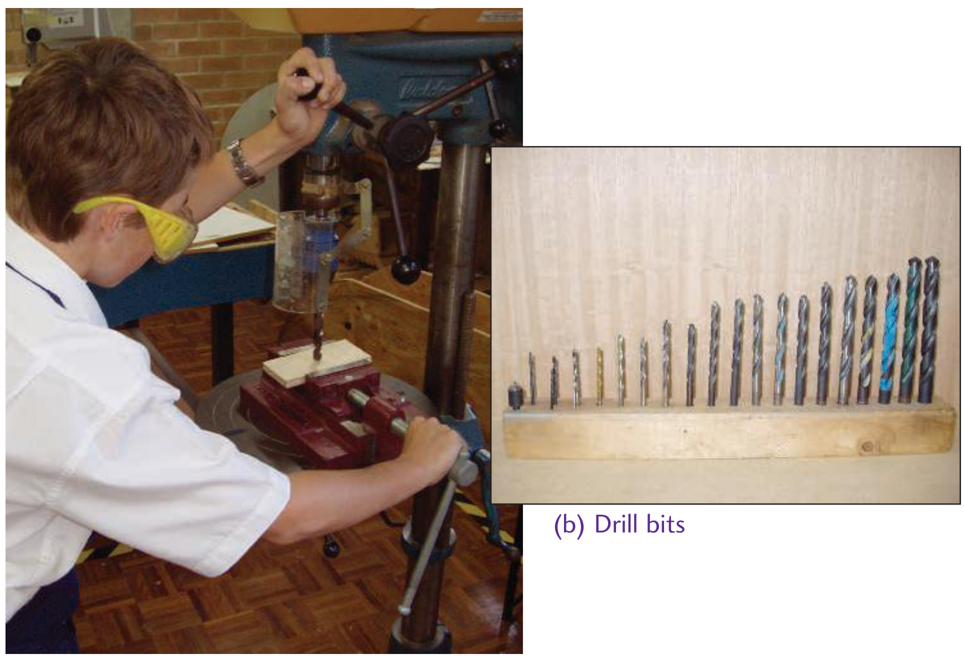
- *Do not* use a scroll-saw on smaller pieces of wood because the saw is too close to your fingers. Keep fingers out of the direct line of the scroll-saw's blade.
- Check that the switch is not on when putting the electrical plug into the socket.
- Always wear safety glasses and an apron (PPE).

DRILL PRESS: A drill press has a similar function to a hand drill but is faster. The drill press is fixed in place. Project work is easily secured in a machine vice or clamped to the drill press table. A lever lowers the drill bit into the work. Available drill bits include a *twist drill bit* for making all common holes and a *dowel drill bit* for drilling dowels and dowel joints. A *countersink bit* is used for cutting a tapered recess for the head of a woodscrew so that the head lies flush with the surface of the work.

Observe the following safety rules.

Safety

- Always remove the chuck key before you start to drill.
- Lower the drill press's safety guard before switching on.
- Clamp the work to the table or hold in a machine vice.
- Always wear safety glasses and an apron (PPE).
- Never use hands to hold down your work.



(a) Using a drill press

(b) Drill bits

FIGURE 3.32: Drill press and a set of bits

Safety

CIRCULAR SAW: A circular saw cuts all types of timber and can be used for making partial cuts, angle cuts and through cuts.

This tool **must not** be used by Years 7–8 students.

HOLE SAW: A hole saw is used with a drill press (bench or floor mounted) to cut plastic and wood. The diameter of a hole saw ranges in size from 20 mm to 75 mm. It is attached to a chuck and turns a certain amount of revolutions per minute (rpm).

FIGURE 3.33: Using a hole saw

DISC AND BELT SANDER: Disc sanders and belt sanders are very versatile finishing tools and can be combined in the one machine. A *disc sander* is suitable for sanding objects the size of half the diameter of the disc. A *belt sander* is suitable for sanding end-grain pieces of timber.

Disadvantage: Disc and belt sanders can be dangerous when sanding small pieces of timber because the spinning disc and belt are too close to your fingers.

Safety

Years 7–8 students **must not** use a belt sander.

Observe the following safety rules.

- Do not hold a thin width of wood too close to the revolving disc.
- Work against the downside of the rotation of the disk to ensure that the work is driven down onto the table.
- Always wear safety glasses and an apron (PPE).

Switch on

1. What is meant by the term *marking out*? Why is marking out used and how is it done?
2. Name four marking-out and measuring tools.
3. If you were making a rebate joint, what saw would you use? List the other tools that would assist you in completing the joint.
4. What is a marking gauge used for, why is it used, and how is it different from a try square?
5. Choose a tool and research the year it was invented. Sketch what it looked like then. Sketch what it looks like now. How has it changed? List the developments and changes.
6. What adhesive would be suitable for gluing a plastic rain gauge to a wooden post outside? The adhesive must be strong enough to withstand storms.
7. Sketch a flow chart of the safety aspects of using a cordless drill. Start with getting the cordless drill from a storeroom and finish by drilling the desired hole. Give three examples of how a cordless drill has been used in your home and/or at school.
8. Compare and contrast the difference between using a jigsaw and a coping saw.
9. Name five advantages of a cordless power drill over a drill press.
10. What tool would you use to shape a curve on a piece of wood?
11. Describe the differences between the three handsaws and the machine saws.
12. Define construction techniques and give three examples of a construction technique.
13. Compare and contrast using a rasp and using a file. When and where would you choose to use each method?

3.3 Timber technologies at work

Timber industry

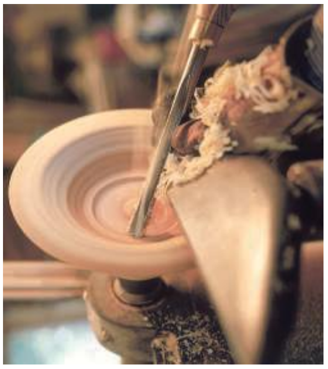
The choice of jobs that involve working with timber is extremely varied. The timber industry makes full use of modern technology, both in design and production.

Forestry is the science and art of cultivating, managing and developing forests. Foresters try to ensure that our supplies of timber will be adequate for the future. Much of their work is done outdoors.

Technobite

Australia's tallest tree is the mountain ash, found in Victoria and Tasmania. Mature trees may reach more than 100 metres.

Technobite



Woodturning is the art or process of shaping wood into forms on a lathe. This Norfolk pine is being shaped into a bowl.

Timber mills process and prepare timber for use in the building industry where it becomes frames for houses, doors, windows and floors. Some timber still goes to boatyards. Pulp and paper mills produce paper. The furniture business is huge — factories mass produce furniture, smaller manufacturing companies turn out high-quality items and craftspeople make exclusive single pieces. Small items, such as photo frames, bowls and wooden spoons, are produced in factories or handcrafted. And such is the beauty of wood that sculptors also choose to work with it, making the very best of its properties.

Spotlight Interview with Andrew Smith, Bush and Country Furniture

What is your title at work?
Proprietor (owner).

What would you do during a normal day at work?
I would:

- meet with customers
- order and purchase materials
- sketch plans and designs
- work out the best construction methods
- organise production schedules
- supervise construction
- organise deliveries
- pay bills and wages.

What are the main types of technologies that Bush and Country Furniture uses?

- Compressed air tools
- Fixed machines such as stroke sanders, thicknesser (a machine used in industry to plane or shave off a large amount of wood), jointer and a table saw
- Portable power tools including chainsaws
- Computer in the office for invoicing and accounts, and to access the Internet and our website.

What particular software and hardware do you use?
The only software used in Bush and Country Furniture is MYOB for accounts and invoicing. Hardware in the office includes a scanner, printer and modem.

Why is design important in your area of work?
Design is important in my work, as furniture needs to work well and look good. Customers make purchases when these two things are balanced, in conjunction with the price. I have a fascination for wood and the money is a secondary concern. I believe small manufacturing companies in Australia require more than just an interest in making money to survive.

What is fun to do in your workplace?
The fun times in my workshop are when I see the customer's face when they are happy with the work we have done. To create something beautiful is very satisfying. Coming up with new designs is also fun.

How different is your workplace from the classroom?
The workshop is different from the classroom because everyone is qualified. We have tradespeople and apprentices. Also, commissions need to be made within a certain time as all work is already sold. There's not much time for experimental learning and there are few young kids in a workshop setting.

FIGURE 3.34: Pieces from Bush and Country Furniture

Spotlight review

1. Evaluate the professional's job description and compare your task as a student in the classroom with the job in the workplace.
2. Consider the phrase 'a fascination for wood'. Investigate the work of woodturners. Do you think they find wood a fascinating material?

Switch on

1. Research how a simple photo frame would be made in industry. What are the advantages and disadvantages of mass production compared with one-off production?
2. Research how a simple butt joint would be made in industry.

Techno**bite**

'You can't judge a tree by its bark' is an old proverb meaning you shouldn't judge a person or a situation by appearance alone.

3.4 Design process

Design project

Your design project for timber technologies is to make a timber photo frame.
Area of study: Products. The focus of this area of study is on objects, systems and artifacts.
Design specialisation: Industrial design. Industrial designers create products such as toys, mechanisms, furniture, leisure goods and production systems.

Design situation

Photo frames display photos of family, friends, favourite places and events. They can be different sizes, different shapes and made from different materials.

Timber photo frames are normally designed to display specific photos in specific locations. For example, a large photo frame made from rosewood to display and protect a university degree or a wedding photo might stand on a mantelpiece. Think of other examples.

Design brief

Design and produce a timber photo frame for a *chosen photo* (or *photos*). For this task, you must choose the photo(s) first and then design the frame to suit your choice. You must also use some form of joinery in your timber photo frame. The design brief describes the product you will design and produce, but the look of the photo frame is up to you.

Project materials:

- a variety of timber including natural timber (light and dark) and manufactured board (for example, plywood). *You must identify the timber before you start to use it.*
- different offcuts of timber — all shapes, sizes and types
- hinges, hooks, latches and/or scraps of metal to hold the back plate on the photo frame
- a piece of perspex for the front to keep the photo in place and to stop it from being damaged.

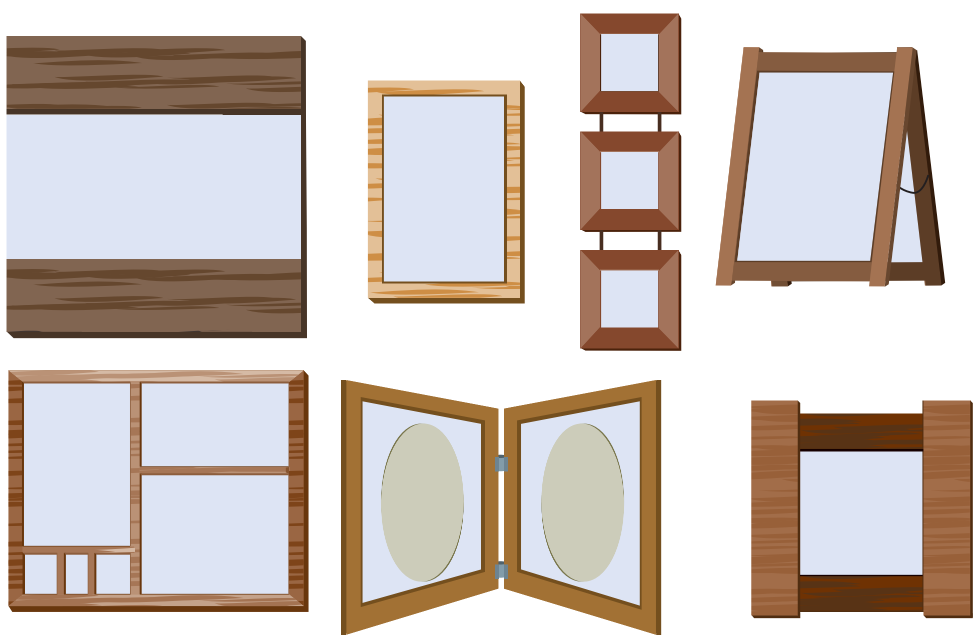


FIGURE 3.35: Selection of today's timber photo frame designs

Look again at the design process in chapter 2, pages 20–1.

Be flexible in your approach to this design process. The order of the steps is not set in concrete and you may not always follow them in the sequence presented here. Some steps go hand in hand with others throughout the design project.

Other steps need to be completed before you can move on. You should concentrate on using the combined steps to form a process that guides the development of your design.

Design Folio **Production**

Your design folio is an important communication tool for design projects. It should tell the story of your design project's development, from your first rough ideas on paper to the final evaluation of your design brief solution.

Consider composing your design folio in electronic format for this technology.

Design process: ONGOING EVALUATION

Essential for success

Remember that ongoing evaluation is central to the design process and should occur at every step. Regular evaluation helps to identify problems and challenges at the right time for you to deal with them. Putting evaluation off until later is asking for trouble, for example:

- wasted resources
- lost time
- failure to meet deadlines
- increased costs.

Design process: ANALYSIS

Thinking about the design situation

When you answer the following questions, you have already started to research and create design ideas. These analysis questions could help you plan your timber photo frame's placement, size, shape and design.

1. What rooms in your home or school need photo frames?
2. Where are the possible places that you could put a photo frame? Will it hang on a wall or stand on a bench, table or mantelpiece?
3. Is the look (aesthetics) or the function of the photo frame more important? Why and how?
4. Are you designing your frame for a single photo or a series of photos on the same theme?
5. What size is the photo or series of photos?
6. How can you best use the pieces of timber that you've been given?
7. What are the weight, shape and size of the frame? If you hang up the frame, what will be the maximum weight you can hang?
8. Where and what are you going to research about materials and tools that you could use for the photo frame?
9. How are pieces of timber joined? What are the common joints for joining on a right angle? What form of joinery will you use?
10. How will you use the hinges, latches, hooks and/or pieces of scrap metal?

Technobite

If a forest is to be a healthy habitat, there must be an almost perfect balance between the different species that live there.

FIGURE 3.36: Photo frames occupy many places.

Switch on

Thinking about the design brief
Write the design brief in your design folio; then underline, circle or highlight words that give you specific information or instructions, as indicated below:

> Design and produce a timber photo frame for a *chosen photo (or photos)*. For this task, you must choose the photo(s) first and then design the frame to suit your choice. You must also use some form of joinery in your timber photo frame. The design brief describes the product you will design and produce, but the look of the photo frame is up to you.
>
> *Project materials*:
> - a variety of timber including natural timber (light and dark) and manufactured board (e.g. plywood). *You must identify the timber before you start using it*.
> - different offcuts of timber — all shapes, sizes and types
> - hinges, hooks, latches and/or scraps of metal to hold the back plate on the photo frame
> - a piece of perspex for the front to keep the photo in place and to stop it from being damaged.

Think about the main points and keywords and ask what, where, why, how and when. Record your analysis ideas in your design folio.

Limitations to the design brief

There are always limitations to designing a product or solving a problem. Identify constraints for the development of the project.

- *Time available.* When does the project need to be completed?
- *Function.* What are the purpose and main features of the project?
- *Aesthetics.* What does the project need to look like?
- *Cost.* Do you have enough money to complete the project?
- *Materials and tools available.* What materials and tools are required? Are they available at school?
- *Expertise.* Do you have the skills required to complete the project?
- *Environmental considerations.* Will any production waste harm the environment?
- *Safety rules and regulations.* Will the product be safe? Will it meet all legislative requirements?

In your design folio, list the factors that will limit you when making the timber photo frame. What is going to be the biggest limitation? Why?

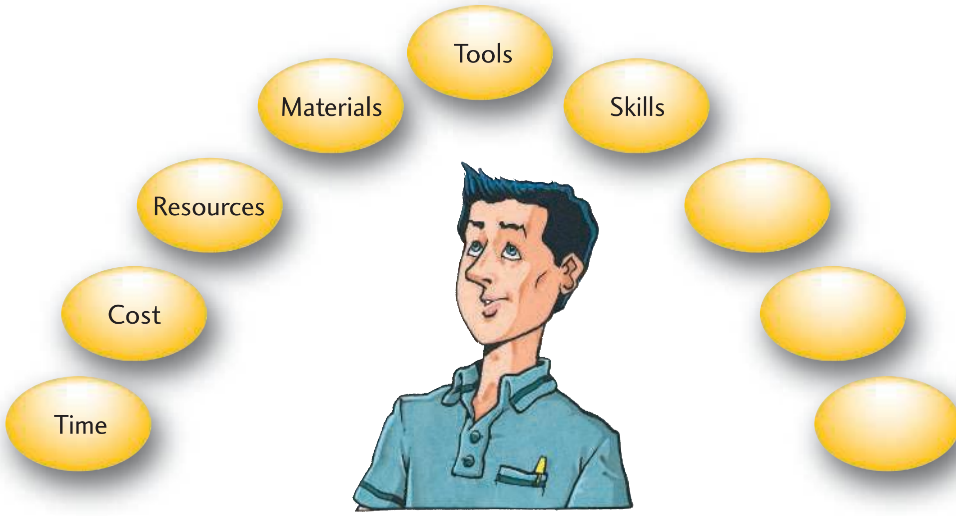


FIGURE 3.37: What is going to limit you in making this project? Fill in the blank bubbles.

Criteria for success

Criteria to evaluate success spell out exactly what the design must achieve, while taking into account the design limits that could affect the final solution. For example, the product must:

1. hold the chosen photo
2. use a latch, hook, hinge and/or scrap metal to keep the photo in the frame
3. be made from timber.

Think of another five criteria. Write your criteria and the ones above in your design folio.

Design process: MANAGEMENT

Getting organised

Management is a step that must be considered alongside other steps throughout your project. Management needs constant reviewing as you progress with your work.

- Develop action-management, time-management and budget-management plans.
- Evaluate and justify any changes to management plans, outlining impacts on the design project's development. This will mean re-evaluating your management plans regularly during your design project.
- Plan and manage available resources effectively and efficiently.
- Evaluate the appropriateness of available resources as they relate to your design brief and the criteria for success that you developed.

Design process: RESEARCH

Investigating the design brief

You can discover much interesting information about your project through research. Find information to help you design a range of options from which to make your final choice. You can use various techniques to do this, such as interviewing and emailing professionals for information on timber and photo frames that are currently available.

Look also in your local and school libraries, magazines, catalogues, brochures and shops, and on CD-ROMs, databases and the Internet to gather information on timber and timber photo frames.

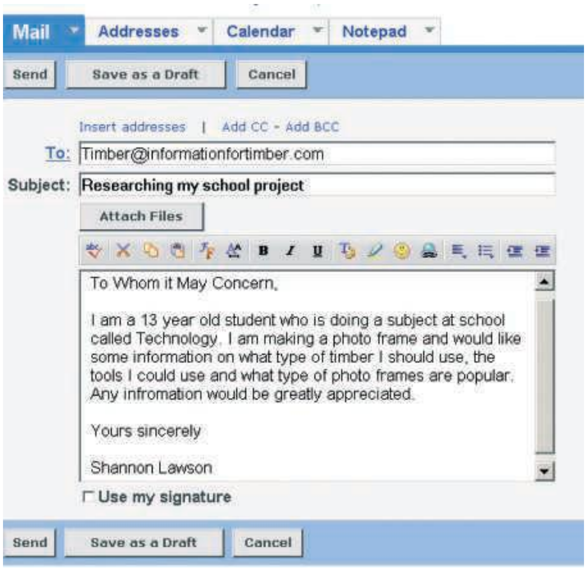


FIGURE 3.38: Email a professional to find out about timber.

Switch on

1. What size photos, from smallest to largest, are developed at outlets such as Kodak and Camera House?
2. Research photo frames in as many books, catalogues, brochures, junk mail, libraries, shops, and on as many Internet sites as you can find. Report your market research on two A4 pages and add it to your design folio.
3. Find out more about timber and other materials you will use. For example, write an A4 page on timber and how it is used; on the difference between manufactured board and natural timber; on latches, hooks and hinges and their uses, and so on. Add this research to your design folio.
4. Select the tools for making your photo frame. You will need to mark, measure, cut, shape, join and finish the timber.
5. Select the techniques for making your photo frame. How and what are you using to cut, join and finish the timber? Research the terms: stain, wax and lacquer.

FIGURE 3.39: Applying lacquer

Design process: IDEAS GENERATION

Brainstorming

Remember the purpose of brainstorming is to generate as many ideas as possible in a short period of time. It's important not to judge the suitability of an idea at this stage — often the craziest thoughts spark the most creative and original ideas!

Preliminary sketches and plans for the solution

Before you begin your project, identify any problems and work out your solutions. This part of the design process requires you to brainstorm again, but this time in a graphical form. Draw five to six thumbnail sketches, showing size, style, colour, method of joinery, and method of standing or hanging the frame. Think about materials, tools and techniques for all the designs. After you have finished, choose your three favourite designs. Label these three designs with materials, tools and techniques.

Review your time-management plan for completing your project.

Materials
- Mahogany (red or rosewood)
- Plywood for backing and to hold the photo in place
- Clasps for holding plywood in place
- Perspex to protect the photo
- Hook to hang on wall

Tools
- Bandsaw
- Chisel
- Bevel
- Tenon saw
- Sandpaper

Techniques
- Cutting a mitre
- Making a rebate
- Decorative edge (optional)
- Attaching hooks and clasps

FIGURE 3.40: Timber photo frame labelled with materials, tools and techniques

Switch on

Table 3.9 is an example of a cutting list for a timber photo frame. Copy this table into your design folio, amend any information that is different for your frame and complete the list.

TABLE 3.9: Sample cutting list for a timber photo frame

No. of parts	Material	Width × length × thickness	Hardware/decoration
2	Rosewood timber	40 mm × 100 mm × 19 mm	4 × metal latches (5 mm × 5 mm × 4 mm)
2	Rosewood timber	40 mm × 80 mm × 19 mm	

Design process: COMMUNICATION

Final sketches and working drawings

Produce final concept sketches and working drawings. These will help you to plan what the timber photo frame will look like and identify any problems that may arise. Often an excellent design idea cannot be made because resources are unavailable or the adhesives or other joinery methods do not work.

See chapter 2, pages 44–6.

Promotion

Design a promotional package for your timber photo frame. Consider the four Ps: *price, place, promotion* and *product*. The promotional package should contain:

- an A4-sized brochure that can be placed on a shop counter to present and promote your timber photo frame
- a packaging idea for selling your timber photo frame
- a letterhead you can use to promote your product.

FIGURE 3.41: Using a cardboard template to mark out timber

Design process: EXPERIMENTATION AND TESTING

Construct and evaluate a model

When designing and making your project, a template or model constructed from stiff paper or cardboard helps you to see what your photo frame will look like. This could be done by hand or on a computer.

When experimenting and testing, you need to:

- test material properties (see 3.1 Materials)
- test tools and construction techniques (see 3.2 Tools and techniques)
- test decorative techniques (see 3.2 Tools and techniques).

Safety

Look again at the rules for basic safety in chapter 2, pages 51–3, before beginning to make your project. Revise the general rules for working with timber on page 69.

Design process: SAFETY AND RISK MANAGEMENT

Switch on

1. Recall all the safety points for working in the timber workshop.
2. Why would an industrial vacuum be used in a classroom?
3. What safety procedure should you follow when using any power tools?
4. Describe all your PPE (personal protective equipment).
5. Identify ten dangers that you are faced with in the timber workshop.

The tools and techniques you will need for making the frame are described on pages 70–81.

Design process: PRODUCTION

Materials

You have timber for the four sides and the back of the frame, and perspex for the front. The need for timber offcuts, hinges, hooks, and/or latches depends on whether you want to hang your frame on a wall or stand it on a surface. Or you might want to make a standing frame in hinged parts or put doors on the frame.

Production steps

Use the following steps as a guide to completing a successful project.

1. Prepare a template for the four sides of the frame. Use a rule and a pencil to mark, and then cut across the corners of each side piece of the frame at an angle of exactly 45° so that each corner will form a 90° angle. This is called mitring (see figure 3.42). Precise marking out is the key to neat mitring. This is just one idea — think about how you could assemble your frames in other interesting ways.
2. Rebate the inside edge of your frame to allow the perspex protector, photo and backing to sit snugly within it. Rebates are best done when the pieces of your frame are still separate. The timber is cut at angles of exactly 90°.

FIGURE 3.42: Mitred corners

Techno**bite**

Humans have used timber from the earliest times: as fuel for their fires and to make shelters, canoes, rafts, weapons, utensils, musical instruments, furniture, statues and religious objects, such as totem poles.

Tip

Wrap a square of sandpaper around a cork block or scrap piece of timber and then sand the surface of your work. This will increase the even surface and will prevent fingerprints marking your work. It also decreases friction, which could cause blisters on your hands.

Use a chisel and tenon saw or ask your teacher to cut out the rebates with a spindle moulder or router.

3. Work out how much plywood backing timber you will need for the recessed area and make a template for it. Don't waste timber when cutting out your frame and backing.
4. After rebating, join the four pieces of the frame. There are many ways to join mitred corners but the best for this project are biscuit joints or dowel joints. Your teacher will help you with this. Remember that you need to be very accurate.
5. Sand your frame with abrasive paper. Use medium to coarse sandpaper first and gradually work down to fine sandpaper for very smooth timber that's ready for finishing.
6. Now attach the bits that make the frame stand or hang, and any other 'extras' that you want. For example, you may decide to hinge parts together.
7. Cut the perspex to the same size as the backing plywood. Be careful not to scratch the perspex.
8. Test the frame, making sure the perspex, photo and plywood backing fit. Once you have tested this, remove the perspex, photo and backing so the frame is ready for finishing.
9. All frames must have a final finish: stain, wax or lacquer. Ask your teacher what is available at your school.
10. Now add the fittings to hold the perspex, photo and backing securely in place.
11. Think of a way you could package your completed frame.

Design process: FINAL EVALUATION

Test the product

Now you are ready for final testing. This means making sure that the chosen photo fits and the back encloses the photo snugly in the frame. Does the frame stand or hang securely? Photo frames that suddenly drop from the wall or keep falling over are irritating at the very least and could be dangerous.

FIGURE 3.43: Is your product safe?

Technobite

'He plants trees to benefit another generation,' wrote the Roman statesman Cicero (106–43 BC). Some trees grow so slowly that they do not reach full maturity for hundreds of years.

Professional, peer and self-evaluations

Ask your teacher and your classmates for objective evaluations of your photo frame. Then self-evaluate your project by asking the following questions.

1. Does the product hold the chosen photograph?
2. Is the design safe?
3. Did you use the most suitable materials, tools and techniques?
4. If you were to make your photo frame again, what changes/improvements would you make?
5. Did you enjoy this unit of work? Why or why not?

ONLINE RESOURCE BANK

Design process checklist

Go to the Online Resource Bank at www.jaconline.com.au/switchedontech and click on the Design Process Checklist. Use the checklist questions to self-evaluate your project and to help you finalise your design folio.

You can also find more ideas for design projects at the Online Resource Bank.

Metals technologies

Metals form about a quarter of the weight of the Earth's crust. They are strong, opaque and good conductors of electricity. Without metals, we couldn't have large structures such as buildings, bridges, railway lines, factory machinery, jet planes or spacecraft. Yet many metals are so easily shaped that they can be made into tiny pieces of jewellery or sculptures that appear to be very delicate. Metals are also very durable — bells cast centuries ago still ring true.

It's possible to design and produce projects in metal in all areas of study: Built Environments, Products, or Information and Communications. Chapter 4 includes general information about the materials, tools and techniques used in metal technologies. This chapter also provides detailed information to help you design and produce your own prototype multi-tool from aluminium.

Focus

By the end of this chapter you will be able to:

- select and use metals in the development of a design project
- investigate and use accessories where appropriate for a design project
- select and correctly use appropriate hand and machine tools for a design project
- cut, shape and finish metals
- select and use appropriate techniques for the purpose of a design project.

Switch on

1. Use the Internet or your school library to search for the word 'metal'. Write up your findings for your design folio.
2. Use the Internet or your school library to search for the word 'alloy'. Write up your findings for your design folio.
3. What do you own that is made of metal? Name the metals and list their properties.

Technobite

It takes five tonnes of bauxite (aluminium ore) to make one tonne of drink cans. Producing twenty cans from recycled aluminium uses the same amount of power as making one can from raw materials. Recycling one aluminium can saves enough energy to run a television for three hours. Recycling aluminium saves millions of tonnes of greenhouse gases. In Australia, the recycling rate for aluminium cans is more than 70 per cent.

4.1 Materials

Technobite

About 70 per cent of all metal is used just once and then discarded. The remaining 30 per cent is recycled. About 15.3 million tonnes of steel waste are generated annually in the world; overall, about 15.4 per cent of that steel waste is recycled.

Before beginning to work with a material, it's useful to have some knowledge of where it comes from and its properties.

Many different metals are used in manufacturing industries. Most metals are extracted from ores in rocks or minerals found in the Earth's crust. Aluminium is found in bauxite, which is a common ore. Iron ore, from which iron is extracted, is also common.

All metals have good and bad properties. Some metals, for example, copper and lead, are used in their pure form to take advantage of their good properties. An *alloy*, which is formed by combining a metal with other materials, can promote the good properties and/or eliminate the bad properties of the metal. Various words you may not have seen before are used to describe metals. These include:

- *brittle:* breaks easily
- *compressive strength:* ability to resist a force that tends to crush or buckle
- *corrosion resistant:* able to withstand surface change due to chemical attack
- *ductile:* able to be drawn out into wire or threads
- *durable:* hard-wearing and long-lasting
- *malleable:* able to be shaped by hammering or rolling
- *tensile strength:* the maximum stress that a material can withstand without breaking.

Metals can be divided into two groups: *ferrous* metals, which contain iron, and *nonferrous* metals, which do not contain iron.

FIGURE 4.1: Gold bearing rocks in Papua New Guinea

Ferrous metals

Pure iron is too soft to be used in construction. Adding carbon to the iron produces a range of alloys with different properties. These are called *carbon steels*. There are five main types of carbon steels (see table 4.1).

TABLE 4.1: Ferrous metals — carbon steels

Carbon steel/properties	Added content	Uses
Mild steel — most common type of steel used today. Can be cut and machined easily and can be soldered, brazed and welded.	0.25% carbon	Hinges, nuts, bolts, nails, screws, bicycle frames, builders' scaffolding, pipe, round bar, flat bar, sheeting, car bodies
Medium carbon steels — tough and hard-wearing. Harder and less ductile than mild steels.	0.25%–0.55% carbon	Executive toys, screwdriver blades, gear wheels and bodies of G-clamps
High carbon steels — very hard and brittle. Mainly used for cutting tools and products that must withstand wear.	0.55%–1.4% carbon	Springs, twist drill, guillotine blades, cutter blades in planes

Technobite

Making cans (for example, food, paint and aerosol cans) from recycled steel takes only one quarter of the energy needed to make them from new steel and creates only one quarter of the water and air pollution that's created by making cans from new steel.

FIGURE 4.2: Stainless steel sink

Stainless steel — chromium creates an oxide film, which prevents rusting. Shiny, attractive and very versatile.	1% carbon 10%–27% chromium nickel magnesium	Cutlery, saucepans, surgical instruments, sinks, boat fittings
Grey cast iron — very hard and brittle. Can be cast (melted and poured into a mould) easily. Has high compressive strength but low tensile strength. Fractures if struck with force. Good machineability.	2.5%–4% carbon Traces of magnesium, sulfur and phosphorus	Many tool bodies, including spokeshaves and planes, pedestal drill bases, motor car engines

Nonferrous metals

Nonferrous metals contain no iron (see table 4.2).

TABLE 4.2: Nonferrous metals

Nonferrous metal/properties	Content	Uses
Aluminium — most abundant metal found today and, after steel, the most used. Resists corrosion. Good conductor of electricity and heat. Cuts and machines easily. Polishes to a good shine.	In its pure state, too soft for construction purposes, so alloys are added: copper, magnesium, chromium, tin and silicon.	Kitchen cooking utensils, packaging, cans, foils, window frames, some door handles; aluminium alloys are used in aircraft industry
Copper — world's third most important metal. Fairly ductile and moderately strong; good conductor of electricity and heat. Can be cut, sawed, filed and machined very easily. Polishes to a good shine.	Pure metal	Car radiator cores, electrical wire, roofing
Brass — gold in colour and can be polished to a deep shine. Easily cut, joined and machined.	Alloy of copper and zinc	Screws, hinges, plumbing fittings, musical instruments, ornaments, electrical plug pins
Bronze — strong and tough. Wears well. Corrosion resistant.	Alloy of tin and copper	Statues, coins, bearings
Tin — soft and weak. Very ductile and malleable — very useful due to this property.	Pure metal	Protective coating on steel plate, e.g. tin cans, tin roofs
	Alloyed with zinc and lead	Solder
	Alloyed with copper, antimony and lead	Bearings
Lead — very heavy, weak, soft, malleable and ductile. Easy to work with.	Pure metal	Roof, flashing, sinkers used for fishing, various plumbing applications
Zinc — very weak. Expensive.	Pure metal	Protective coating on steel, e.g. dustbins, corrugated iron sheet roofing

FIGURE 4.3: Copper wire and copper grains

Techno**bite**

The word plumber comes from *plumbum* — the Latin word for lead. Water pipes used to be made of lead but this ceased when lead was found to be poisonous. Lead-free petrol has recently been introduced to protect the atmosphere from toxic lead fumes.

For information on these items, see chapter 3, pages 65–8.

Fittings and hardware

Hinges, handles, catches, locks, screws and *nails* are all types of fittings and hardware used with metals.

Rivets and *self-tapping screws* are also used to join metals. See page 101.

Switch on

1. List six objects made of different metals you can see in the classroom or at home. Group them into ferrous and nonferrous metals. List some of their uses and properties.
2. Tables 4.1 and 4.2 list the common metals. Place the items listed below in the ferrous or nonferrous metal group. Explain why they would be grouped this way. There could be more than one answer.
   (a) Window frames
   (b) Electrical plug pins
   (c) Statues
   (d) Fan blade
   (e) Metal food bin
   (f) Kitchen foil
   (g) Bodies of tools
   (h) Plumbing fittings
3. Research the meaning of the term *tensile*. First, see page 94 and table 4.1 and then look further in a library or on the Internet. Document all your sources and produce an A4 page for your design folio with a detailed explanation and images to support your explanation.
4. Research the terms *ductile* and *malleable*. First, see page 94 and table 4.2 (page 95) and then look further in a library or on the Internet. Provide examples, explanations and images and list your sources on an A4 page for your design folio.
5. Research zinc plating in a library or on the Internet. List some uses of zinc plating.

Techno**bite**

The practice of shoeing horses with U-shaped metal plates almost certainly began with the ancient Romans, more than two thousand years ago. The shoes protect horses' hooves on rough or hard surfaces. They can be attached securely by nailing because the hoof has no feeling in that area.

4.2 Tools and techniques

This section introduces some of the tools and construction techniques suitable for working with metal, for example, measuring and marking out, cutting, shaping, joining and finishing. But before you can begin, you must understand and learn the general rules for working safely with metals.

General rules for working with metals

Safety

- Always use appropriate PPE (personal protective equipment).
- Be aware of the special safety requirements of the tools and techniques you will use with metal technologies. At Stage 4 level, some tools must be operated by the teacher only. Others you can use only with teacher supervision.
- Practise using a tool before you use it on your project.
- Be aware of each machine's safety zone.
- Ensure machine guards are in place.
- Keep machines clear of all debris and excess shavings or scraps of unwanted materials.

Safety rules that apply to specific aspects of metals technologies appear later in this chapter. Observe them!

Measuring and marking out

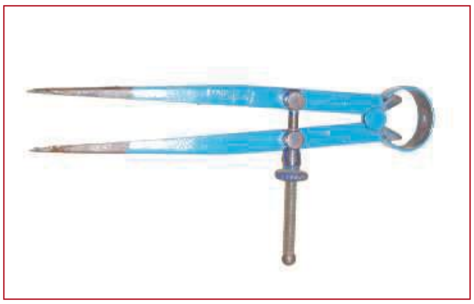
See chapter 3, page 70.

Many of your design projects in metals technologies will be made from sheet metal because this material is readily available. Basic tools for measuring and marking out metals are the same as for timber.

Additional measuring and marking-out tools for metals include:

MARKING-OUT DYE: Coloured wash applied to metal so that lines scratched on the surface of the metal can be seen more easily.
DIVIDERS: For drawing arcs or circles on metal.
SCRIBER: For scratching lines onto metal surfaces.
ENGINEER'S SQUARE: A right-angle rule used for drawing lines and judging squareness.
CENTRE PUNCH: For making a depression in the surface of the metal to be drilled so that the drill bit will start in the correct place.

FIGURE 4.4: Measuring and marking-out tools used for metals



(a) Dividers

(b) Nail punch

Cutting

Many cutting tools are hand tools but you will also learn to use some machine tools.

Hand tools

GENERAL-PURPOSE SAW: A useful saw for working with metal.
PIERCING SAW: May be used to cut metal to the shape of the template.
HACKSAW: A hand tool for cutting metal tubes, round bars and flat bars. Use also to cut sheet metal. Check three things before cutting material with a hacksaw.

1. *Tension of the blade.* Move the centre of the blade sideways; it should move 7 mm either side of the centre.
2. *Direction of the blade.* The teeth should point away from the handle as the teeth of a coping saw do.
3. *Condition of the blade.* Look closely at the condition of the teeth. The saw should have a line of clear and unbroken teeth.

FIGURE 4.5: Hacksaw

See chapter 3, pages 71–4 for more information on handsaws.

SCROLL-SAW: Use to cut curved and straight lines.

Disadvantage: Scroll-saws cannot cut small pieces of metal because your fingers are too close to the saw's blade.

Safety

TINSNIPS: Use to make straight and curved cuts.

Tinsnips **must not** be used by Years 7–8 students without teacher supervision.

FIGURE 4.6: Tinsnips

FIGURE 4.7: Pliers

CUTTING GUILLOTINE: For cutting both metal bar and sheet metal.

SHEARS: Shears are foot operated and will cut metal exactly at right angles to the guides on the side of the machine.

Safety

Years 7–8 students **must not** use a cutting guillotine or foot-operated shears. Ask your teacher to show you these tools. If your project requires work with a cutting guillotine or with foot-operated shears, your teacher will do it for you.

See chapter 3, pages 79–81, for more information on machine tools.

Machine tools

COLD SAW: Use to cut metals. A metal lubricant is sprayed onto the cut to cool the cutting area and prevent sparking.

JIGSAW: Use to cut metals.

BANDSAW: The narrow-bladed bandsaw will cut metal, wood and plastic.

CIRCULAR SAW: This is a multi-purpose cutter for metal, wood and plastic.

Safety

Jigsaws, bandsaws and circular saws **must not** be used by Years 7–8 students. Your teacher will use them for you.

Bending, shaping, folding, rolling

After marking out and cutting to the shape required, metal is then bent, shaped by beating, folded or rolled into its finished form by hand or machine. The processes for doing this may be hot-working or cold-working. Heating the metal and then moulding it is an example of hot-working. Using a mallet on unheated metal is an example of cold-working.

PLIERS: Bend very small pieces of metal with pliers.

MALLETS: Use mallets to beat metal into shape.

FIGURE 4.8: Mallets

(a) Flat rubber mallet

(b) Bossing mallet

Stakes and anvils: When working with larger pieces of sheet metal, bend the metal over stakes or an anvil. Stakes and anvils come in many shapes and sizes.

See chapter 3, page 79, for more information on clamps and cramps.

Clamps and cramps: Use clamps and cramps to complete long bends in metal, plastic and wood.

Magnabend™: The magnabend is a relatively new machine for making angular bends in metal. It clamps the workpiece with a powerful electromagnet rather than by mechanical means. The bend occurs when you raise the machine's arm. Sheet metal can be bent up to 90° along a straight line.

Safety

A magnabend is a low risk tool and may be used by Years 7–8 students only with teacher supervision.

Disadvantage: Because the magnabend relies on magnetic attraction, it can be used only with light gauge material.

FIGURE 4.9: Using an anvil to shape metal

FIGURE 4.10: Using a magnabend

Technobite

Copper's natural colour is brown red to deep brick red. It is a softly reflective metal, but exposure to oxygen makes it corrode and turn green — a colour often seen in outdoor statues. One famous example is the Statue of Liberty in New York Bay. The outer skin is made from 300 overlapping copper plates, which have corroded in the air.

Joining

There are four ways to join metal: seams, rivets, screws and solder. The first three are mechanical fasteners, which create a physical joint without any molecular (chemical) bonding of the materials. Many fastenings, such as nuts and bolts and self-tapping screws, are also suitable for timber and polymers.

Seams

There are two types of seams: straight and angle (see table 4.3).

TABLE 4.3: Seams

	Seam type	Use/property
Straight seams	Lap	Main seam used for riveting or soldering
	Grooved	Common seam for sheet metal. Does not need soldering; soldered only to make the joint waterproof.
	Standing	For roofs and walls of buildings
	Countersunk	Adds to the strength of the join
Angle seams	Double angle lap	Very strong and neat
	Knocked up	Hard to do but a good strong seam
	Countersunk double	For sealing food containers to make them airtight

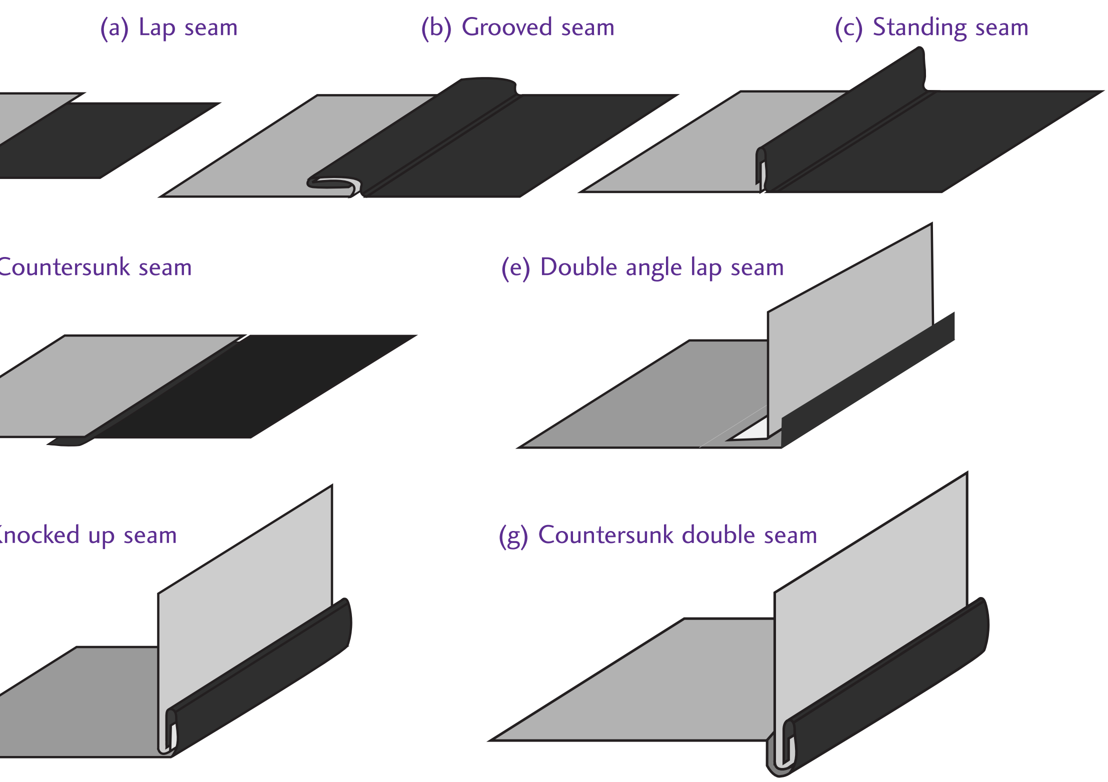


FIGURE 4.11: Seams

Rivets

Two types of rivets — pop and solid — are used for joining lap seams in sheet metal when the seam does not need to be airtight or waterproof. Pop rivets are the most common method of securing sheet metal.

FIGURE 4.12: Pop riveting

Technobite

Approximately six million rivets were used to build the Harbour Bridge in Sydney, Australia.

Technobite

Approximately two and a half million rivets were used to build the Eiffel Tower in Paris, France.

See chapter 3, page 76.

Screws

Self-tapping screws: Self-tapping screws are made from hardened steel. They cut their own *thread* through sheet metal after a pilot hole has been drilled and are used in electrical appliances and motor vehicles. They can be removed and used again.

Cordless electric drill: Use to drill holes for screws in metal, wood and plastic.

Soldering

Soldering is the process of joining two metals with solder, using a **soldering iron**. Solder is an alloy of tin and lead, which has a low melting point.

Flux is a substance that dissolves and prevents the formation of oxides. Oxides are the scaly covering on the surface of metals where the metals have combined with oxygen. If left on the surface of the metal during joining, oxides will cause corrosion under the joint. Flux assists the flow of molten metal during soldering.

Technobite

Australia produces more than one million tonnes of aluminium. This accounts for about eight per cent of world aluminium production.

Complete these steps for successful soldering.

1. The metal pieces to be joined must be clean. Remove all rust, grease and paint.
2. Different materials need different fluxes. Make sure you have chosen the correct flux.
3. Make the seam to join the two pieces of metal. Make a series of tacks to hold the two pieces together temporarily.
4. Place the soldering iron on both pieces of the metal. Pull it along the seam.
5. Cool the joint and then wash all unwanted flux off the joint.

Safety

Observe the following safety rules.

- You must be supervised by your teacher when soldering.
- The end of the soldering iron is very hot. Do not touch it with your hands.
- Solder contains lead, which is poisonous. Do not use solder on any food utensils.
- Wash your hands thoroughly after using solder.

FIGURE 4.13: Soldering

Finishing

There are several ways to finish metals to enhance their overall qualities. When you finish a piece of metal by polishing its surface, you remove the protective layer that stops it rusting. Smearing grease or petroleum jelly on a finished piece of metal will prevent the finished surface from rusting. A finishing coat of clear spray can also prevent oxidising.

To produce the desired finish on a piece of metal, you will need:

- a file that does not clog up with soft particles of metal. Use a needle file for intricate and difficult areas, hard-to-reach scratches and an even smoothness.
- emery cloths (abrasive grit bonded on a cloth backing) — grades P40 to P600
- a buffing wheel. This tool **must not** be used by Years 7–8 students. Your teacher will use it for you.

See chapter 3, page 79, table 3.8: Sandpaper grades.

See figures 5.8 (page 122), 5.9 (page 123) and 4.21 and 4.22 (page 114).

FILES: Files smooth and finish metal edges. There are several varieties: *triangular, square, half-round, flat, needle* or *round*.

Draw filing in one direction achieves a bright finish and removes burrs. To do this, place the metal in a vice. Place the file at 90° to the metal and pull the file towards you in a firm sweeping motion.

ABRASIVE PAPER: When using soft metals such as aluminium, you will need to remove the scratches made from filing. Start with a coarse abrasive paper and finish with a fine one.

BUFFING WHEEL: Use a buffing wheel with calico or swansdown mops covered with either Brasso or Silvo to polish the edges of the metal. This achieves a smooth, shiny finish.

Tip
Wrap the abrasive paper around a cork block to avoid putting fingerprints on the edges of your work.

TABLE 4.4: Finishing metals

Finishing technique	Properties/uses
Draw filing	Achieves a bright finish and removes burrs.
Emery cloth	Gives the edge or surface a better quality finish. Be careful not to scratch the surface.
Polishing with Silvo or Brasso	Apply a polishing compound (Silvo or Brasso) either by hand (polishing cloth) or by machine (buffing wheel with calico or swansdown mops).
Painting	The surface must be very clean before painting. Apply an oil-based undercoat, a primer, an oil-based paint and then a topcoat.
Plastic coating	Coats handles, racks and crates with plastic. Provides non-slip, comfortable handles on tools.
Enamelling	Fuses powdered glass to a metal surface to achieve a hard, colourful, protective finish — for jewellery or anything decorative.
Anodising (only associated with aluminium)	Thickens the natural oxide film on the outside of aluminium, making it hard and tough. Used for cookware, torch bodies and many other items.
Shot blasting	Cleans metal surface and removes scale. Sometimes gives a particular look to the surface. The shot can be sand, small steel balls, granules of silicon carbide etc.
Pickling	Removes scale from steel to produce a clean surface. Objects are immersed in diluted sulfuric acid at a temperature of about 80°C.
Electro-plating	Puts a metallic coating on a metal by using an electric current. Improves surface appearance, protects against corrosion and is used to make plates for printing.

Technobite
So much electricity is needed for aluminium production that the smelting plants (factories that make aluminium) need their own power stations.

Switch on

1. Name two methods of cutting metal with hand tools and with machine tools. Describe the four processes and each method's advantages and disadvantages.
2. Compare and contrast cutting metal sheeting with a scroll-saw, bandsaw, tinsnips and a circular saw.

3. Why would you use a magnabend instead of a stake or an anvil? What are the differences in the processes?
4. Explain the safety issues involved when:
   (a) bending sheet metal
   (b) using tinsnips to cut sheet metal.
5. Describe how to solder two pieces of sheet metal. Start with the process of making a seam.
6. Research and describe two finishing processes for sheet metal. State why they would need to be completed and what the metal's properties would be after completion.

4.3 Metals technologies at work

Industrial production methods

All the processes of the classroom are carried out in industry but on a much larger scale. Some industrial machines are bigger than your classroom. Two common methods of manufacturing steel are traditional *basic oxygen steelmaking* and a newer method called *electric arc furnace steelmaking*.

An *electric arc furnace* is used to produce new steel from scrap metal, which is a less costly method than the traditional blast furnace process. Electric arc furnace steelmaking conserves raw materials, such as iron ore, coke and fluxes. Iron from other sources can also be used as feed for the electric arc furnace.

Switch on

For detailed explanations and diagrams of basic oxygen steelmaking and electric arc furnace steelmaking, go to www.jaconline.com.au/switchedontech and click on the BlueScope Steel weblink for this chapter. From there, follow the prompts: About BlueScope Steel → Student Information → Steelmaking.

Technobite

The Holtermann Nugget is the largest lump of gold ever found in Australia. It was discovered in the Star of Hope mine at Hill End, New South Wales, on 19 October 1872, and was named after the mine manager and part-owner, Bernard Holtermann. This enormous piece of reef gold yielded 99.8 kg of pure ore.

Spotlight Silver

One day you may work with silver in a design project. The design brief in figure 2.5 on page 27, for example, asks you to design and produce a silver pendant based on a theme of your choice.

Silver is one of the precious metals, so called because of their greater resistance to corrosion and oxidisation than non-precious metals. When polished, silver has a brilliant metallic finish, but it does tarnish with time if it isn't specially treated. Silver comes second to gold in being the most malleable metal in the world. Silver has high electrical conductivity, melts at 962°C and boils at about 2212°C. It can be melted down and used again. Silver is often more suitable for specialised industrial uses than other metals.

Apart from being found as pure ore, a large amount of silver is combined in the ground with lead, copper, zinc and other ores including gold. Australia's silver production ranks after Mexico, Peru and the United States, and most of Australian ore comes from the silver-bearing lead mineral called galena.

FIGURE 4.14: Silver is used to make everyday objects such as cutlery and coins, as well as having specialised industrial uses.

Silver was mined by ancient civilisations — the process of separating it from lead was known as early as 3000 BC. In the sixteenth century, the Spanish colonised South America and found rich deposits of silver in Mexico, Peru and Bolivia. This greatly increased the world's supply of silver at that time.

Silver is mainly used in:

- jewellery, silverware, coins and trophies — *sterling silver*, from which jewellery is usually made, contains 92.5 per cent silver; the rest is copper or another metal
- photography
- industrial applications including dental alloys, alloys for soldering and brazing, electrical contacts and batteries, and mirrors.

Spotlight review

1. Research in a library or on the Internet for more information about the use of silver.
2. Apart from gold, find out the name of one other precious metal and list its properties.
3. Using the above Spotlight as a model, write a profile of another metal.

Use the skills you have learned about designing questionnaires in chapter 2, pages 36–7, to ensure your questionnaire is suitable.

Switch on

Complete your own case study. Choose a professional, such as an engineer, nurse, doctor, dentist, vet, teacher, accountant or lawyer, and prepare ten questions about why metals are important in their area of work. Present your findings about the importance of metals to the class.

4.4 Design process

Design project

Your design project for metal technologies is to make a prototype multi-tool out of aluminium.

Area of study: Products. The focus of this area of study is on objects, systems and artifacts.

Design specialisation: Industrial design. Industrial designers create products such as leisure goods.

Design situation

Multi-tools are handy for jobs around the house or for use outdoors by campers, backpackers and climbers. They have a number of attachments for different purposes, for example, ruler, bottle-opener, points of the compass, screwdriver and can-opener.

Multi-tools come in many different styles, shapes, materials and sizes. They are normally designed to be kept in a wallet or a small pocket in a backpack.

Design brief

Design and construct a prototype multi-tool. The tool must have five functional tools and be the size of a business card/credit card (90 mm × 50 mm). The material to be used is aluminium. The design brief describes the product you will design and make, but the look of the prototype multi-tool is up to you.

Project materials:

- 90 mm × 50 mm piece of aluminium
- attachments (for example, pizza cutters) made from scrap aluminium and tin
- cord.

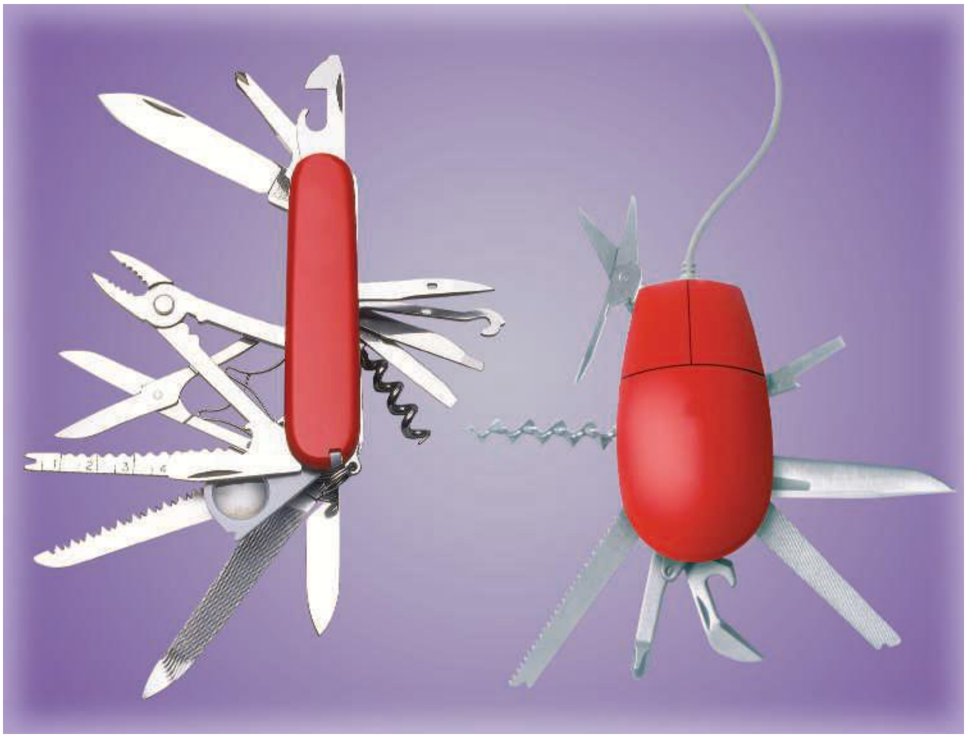


FIGURE 4.15: Top-of-the-range multi-tools that are available today

Look again at the design process in chapter 2, pages 20–1.

Be flexible in your approach to this design process. The order of the steps is not set in concrete and you may not always follow them in the sequence presented here. Some steps go hand in hand with others throughout the design project. Other steps need to be completed before you can move on. You should concentrate on using the combined steps to form a process that guides the development of your design.

Design Folio **Production**

Your design folio is an important communication tool for design projects. It should tell the story of your design project's development, from your first rough ideas on paper to the final evaluation of your design brief solution.

Consider composing your design folio in electronic format for this technology.

Design process: ONGOING EVALUATION

Essential for success

Remember that ongoing evaluation is central to the design process and should occur at every step. Regular evaluation helps to identify problems and challenges at the right time for you to deal with them. Putting evaluation off until later is asking for trouble, for example:

- wasted resources
- lost time
- failure to meet deadlines
- increased costs.

Technobite

The first Victorinox 'Swiss army knife' was legally registered in 1897. Now more than 34 000 pocket knives, in a range of models, leave the factory in central Switzerland daily. Ninety per cent are on their way to over 100 countries. Every recruit to the Swiss army is given a pocket knife with seven practical features.

Design process: ANALYSIS

Thinking about the design situation

When you answer the following questions, you have already started to research and create design ideas. These analysis questions could help you plan your multi-tool's size, shape and choice of functional tools.

1. Who would use this multi-tool and what would they want it to do?
2. Where will this multi-tool be used?
3. Is the look (aesthetics) of the multi-tool or the function more important? Why?
4. What would be the most wanted and popular tool on a multi-tool? Why?
5. What four other functional tools will you include?
6. How are you going to create the functional tools?
7. Where are you going to research about aluminium and the tools that you could use for making the prototype multi-tool?
8. What are the weight, shape and size of your prototype multi-tool?

Switch on

Thinking about the design brief

Write the design brief in your design folio and then underline, circle or highlight words that give you specific information or instructions, as shown below.

> Design and construct a prototype multi-tool. The tool must have five functional tools and be the size of a business card/credit card (90 mm × 50 mm). The material to be used is aluminium. The design brief describes the product you will design and make, but the look of the prototype multi-tool is up to you.
>
> *Project materials:*
>
> - 90 mm × 50 mm piece of aluminium
> - attachments (for example, pizza cutters) made from scrap aluminium and tin
> - drilled hole for a key ring.

Think about the main points and keywords and ask what, where, why, how and when. Record your analysis ideas in your design folio.

Technobite

History, before the development of writing, is divided into broad periods named for the technology that was in use. After the Stone Age, when there were no metal tools or weapons, archaeologists recognise the Bronze Age and the Iron Age.

Limitations to the design brief

There are always limitations to designing a product or solving a problem. Identify constraints for the development of the project:

- *Time available.* When does the project need to be completed?
- *Function.* What are the purpose and main features of the project?
- *Aesthetics.* What does the project need to look like?
- *Cost.* Do you have enough money to complete the project?
- *Materials and tools available.* What materials and tools are required? Are they available at school?
- *Expertise.* Do you have the skills required to complete the project?
- *Environmental considerations.* Will any production waste harm the environment?
- *Safety rules and regulations.* Will the product be safe? Will it meet all legislative requirements?

In your design folio, list the factors that will limit you when making the prototype multi-tool. What is going to be the biggest limitation? Why?

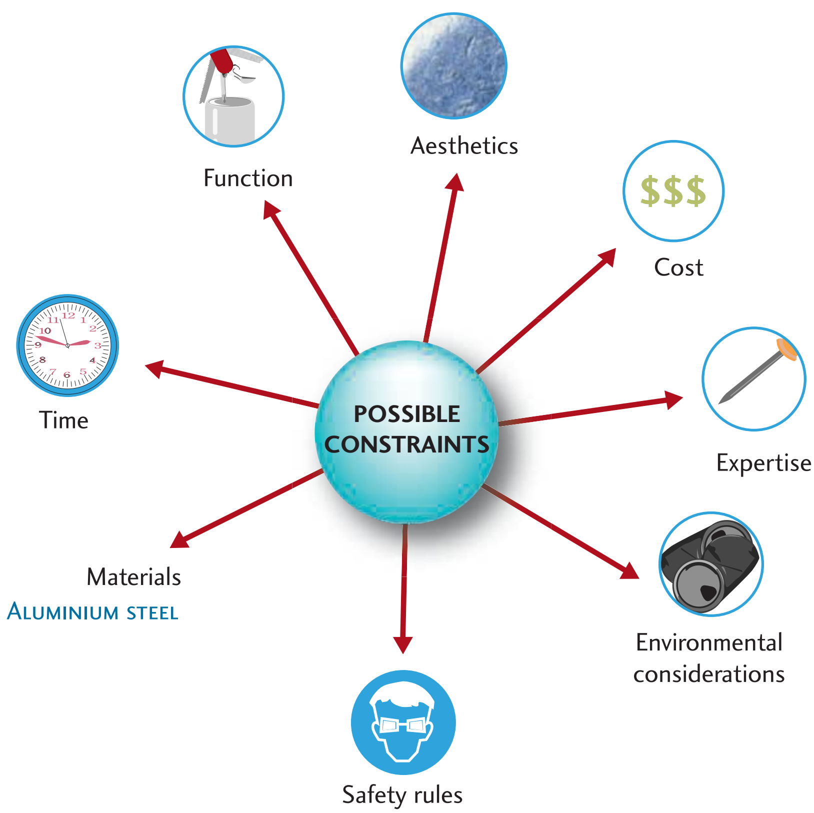


FIGURE 4.16: Considering constraints

Criteria for success

Criteria to evaluate success identify exactly what the design must achieve, while taking into account the design limits that could affect the final solution. For example, the product must:

1. have five functional tools
2. be the size of a 90 mm × 50 mm credit card so it can be easily stored
3. be made from aluminium.

Think of another five criteria. Write your criteria and the three provided here in your design folio.

FIGURE 4.17: Your multi-tool will be the size of a credit card.

Design process: MANAGEMENT

Getting organised

Management is a step that must be considered alongside other steps throughout your project and needs constant reviewing as you progress with your work.

- Develop action-management, time-management and budget-management plans.
- Evaluate and justify any changes to management plans, outlining impacts on the design project's development. This will mean re-evaluating your management plans regularly during the making of your design project.
- Plan and manage available resources effectively and efficiently.
- Evaluate the appropriateness of available resources as they relate to your design brief and criteria for success.

Design process: RESEARCH

Investigating the design brief

Gather information on metal multi-tools to give you a range of options from which to make your final design choice. You can use various techniques to do this, such as brainstorming, mind maps, interviews, questionnaires and research. Also look in your local and school libraries, magazines, catalogues, local shops, on CD-ROMs, databases and the Internet.

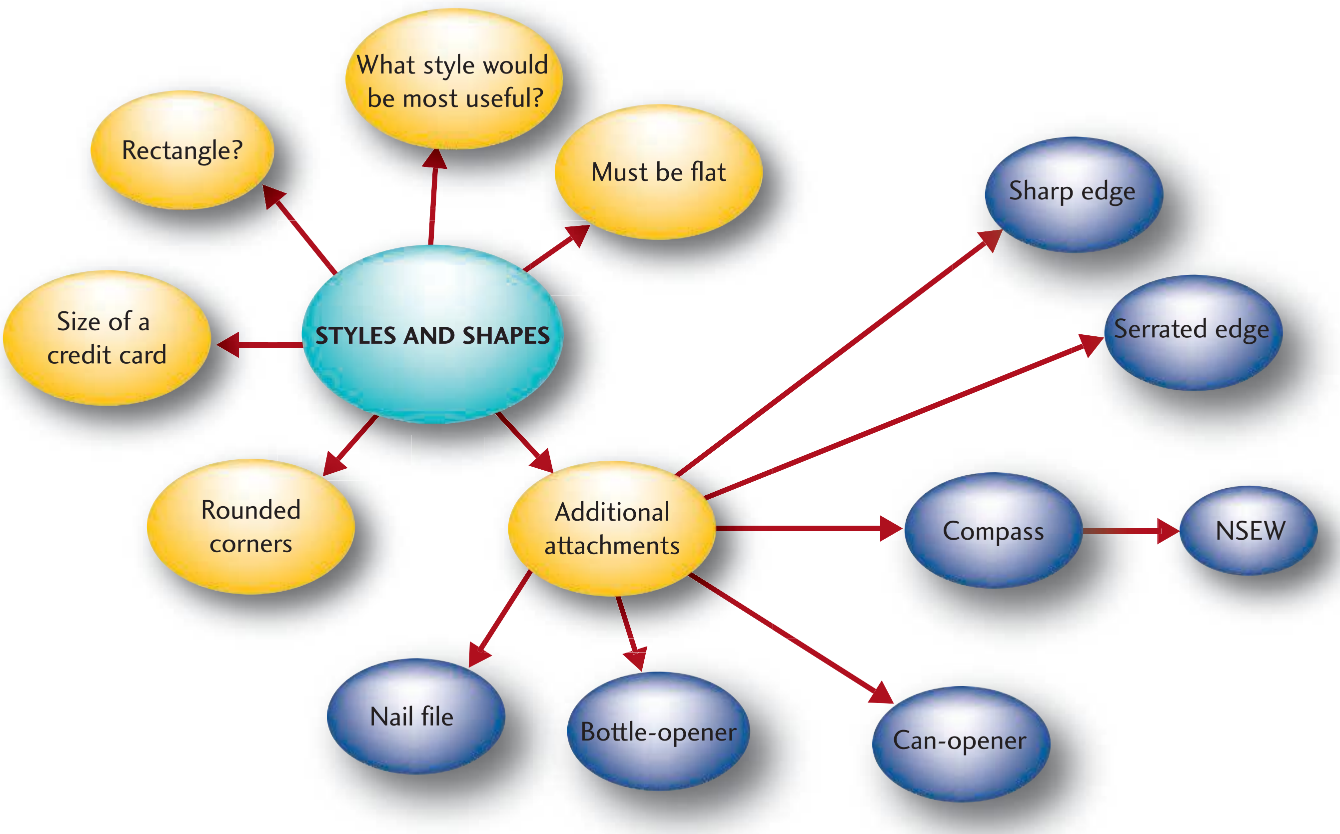


FIGURE 4.18: Mind map exploring design ideas for the multi-tool

Switch on

1. Access the websites in table 4.5. Look at the multi-tools on offer and complete the table. Put the finished table in your design folio.

TABLE 4.5: World Wide Web research

Website URLs	What I found out by going to the websites
www.leatherman.com	
www.victorinox.com	

2. Research multi-tools in as many books, catalogues, brochures, junk mail, libraries and shops, and on as many CD-ROMs/DVDs and Internet sites as you can find. Complete two A4 pages of market research. Label every image you find with your likes and dislikes. Add these pages to your design folio.
3. Recall information you have learned about aluminium. Find out as much as you can about any other possible materials you can use with this project.

4. Research tools you could use to make the prototype multi-tool. You will need tools to cut, shape, mould, bend, join, score and work the aluminium.
5. Research techniques for making the prototype multi-tool. How and what will you use to bend, join and work the aluminium? For example, you could use a file to make a sharp edge.

See chapter 2, pages 39–40.

Design process: IDEAS GENERATION

Brainstorming

Remember the purpose of brainstorming is to generate as many ideas as possible in a short period of time. It's important not to judge the suitability of an idea at this stage — often the craziest thoughts spark the most creative and original ideas!

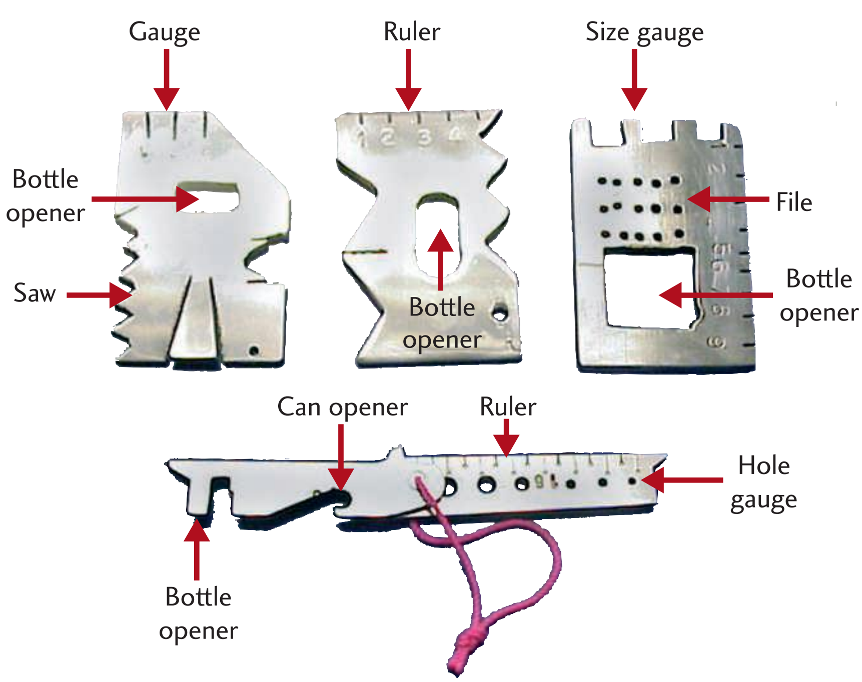
Technobite

Since 1980, the weight of an aluminium can has been reduced by more than thirty per cent.

Preliminary sketches and plans for the solution

Before you begin the project, identify any problems and work out your solutions. This part of the design process requires you once again to brainstorm but this time in a graphic form. Draw five to six thumbnail sketches showing size, style and layout of the five tools you will include and the method of adding them to the multi-tool. Think about materials, tools and techniques for all the designs. Then choose your three favourite designs. Label these with materials, tools and techniques.

Review your time-management plan for completing your project.



Techniques
- Filing
- Cutting
- Punching
- Drilling
- Sawing

Materials
- Aluminium
- Cord

Tools
- File
- Scriber
- Punch
- Piercing saw
- Drill press
- Emery cloth
- Sandpaper

FIGURE 4.19: Prototype multi-tools labelled with materials, tools and techniques

Switch on

Table 4.6 is an example of a cutting list for a prototype aluminium tool. Copy this table into your design folio, amend any information that is different for your multi-tool and complete the list.

TABLE 4.6: Sample cutting list for a prototype aluminium multi-tool

No. of parts	Material	Width × length × thickness	Hardware/decoration
1	Aluminium	90 mm × 50 mm × 4mm	e.g. pizza cutter

See chapter 2, pages 44–6.

Design process: COMMUNICATION

Final sketches and working drawings

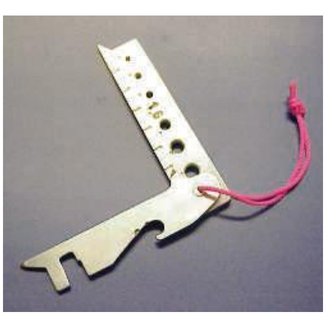
Make concept sketches and working drawings. These will help you to plan what the multi-tool will look like and identify any problems that may arise. Often an excellent design idea cannot be made because of unavailable resources or unworkable joinery methods.

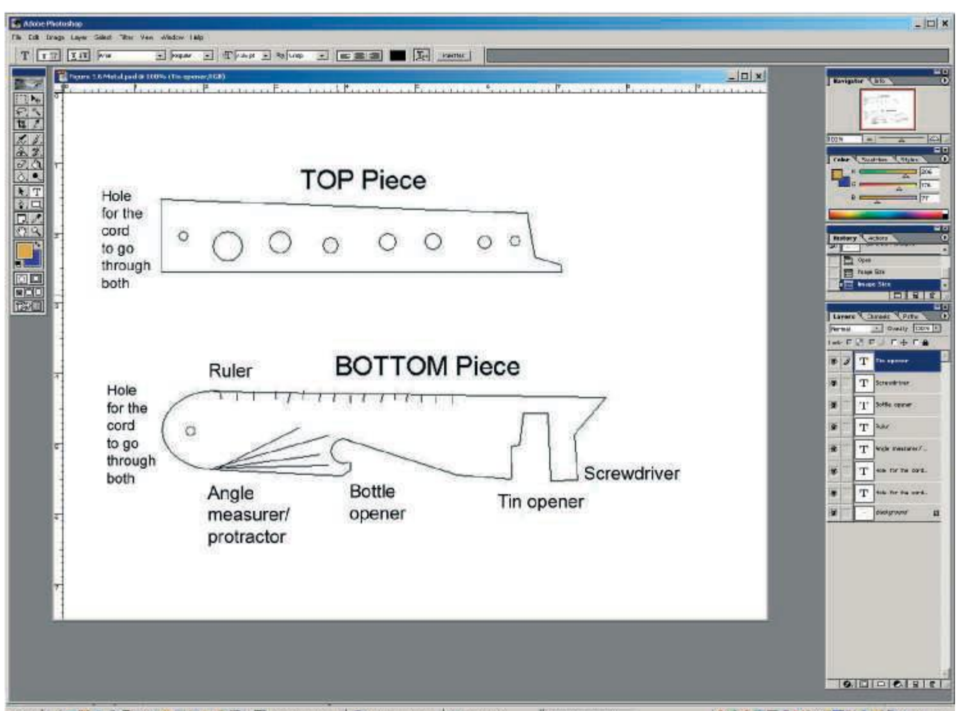
Promotion

Design a promotional package for your prototype aluminium multi-tool idea. Consider the four Ps: *price, place, promotion* and *product*. The promotional package should contain:

- an A4-sized brochure to present and promote your multi-tool
- a business card for your company, stating the business's name and contact details and summarising its activities
- a packaging idea for your multi-tool — think about making a casing from fabric or another material.

FIGURE 4.20: A template (right) and working model (below) for a prototype aluminium multi-tool





Design process: EXPERIMENTATION AND TESTING

Construct and evaluate a model

When designing your project, it helps if you construct a template or model to see what your prototype aluminium multi-tool will look like. You could do this by hand or on computer.

When experimenting and testing, you need to:

- test material properties (see 4.1 Materials)
- test tools and construction techniques (see 4.2 Tools and techniques).

Design process: SAFETY AND RISK MANAGEMENT

Switch on

1. Recall the general rules for working safely in the metal workshop.
2. Make a checklist of ten safe practices in the metals workshop. Share your checklists as a class.
3. What safety procedure should you follow when using any power tools?
4. List the metals technologies tools you are not allowed to use in Years 7 and 8.
5. Identify ten dangers that you face in the metals workshop.

Look again at the rules for basic safety in chapter 2, pages 51–3.
Revise the general rules for working with metals on pages 96–7 before you start to make your project.

Design process: PRODUCTION

Make the prototype aluminium multi-tool from your working drawing labelled with materials, tools and techniques.

Materials

You are provided with a 90 mm × 50 mm piece of aluminium to use for your prototype. Aluminium is a soft metal and will not last a long time. Remember that this is a prototype — a metal multi-tool in industry would be made out of stainless steel.

You may also plan to use mechanical fasteners on your multi-tool.

Tools and techniques

Practise on scrap pieces of aluminium before using a new tool or technique on your project.

Make sure that you work to your time-management plan.

The tools and techniques you will need for making your prototype multi-tool are described on pages 96–103.

Production steps

Use the following steps as a guide to completing a successful project.

1. Examine your design and the list of all the tools you plan to use.
2. Produce your chosen design on paper and make a template.
3. File the edges of your piece of aluminium.
4. Mark out your design on the aluminium with marking-out dye.
5. Use a scriber to mark out features of all the main tools, an engineer's square to mark straight lines, or a pair of dividers to mark out circles and arcs.

6. If you are including a bottle-opener, the design for the opener begins with a drilled hole. You will need to centre punch a mark and then drill the hole, observing the correct safety measures. Once the main hole has been drilled, thread a piercing saw through and cut the rest of the bottle-opener design with the piercing saw.
7. Use a hacksaw or piercing saw for all exterior shapes and cuts.
8. Drill the key ring hole.
9. Use a range of files, such as triangular, flat, half round and round, to clean the edges — internal and external.

Safety

10. To finish, rub the aluminium with an emery cloth and then steel wool. After that, rub again with wet and then dry sandpaper. Wrap the sandpaper around a cork block to protect your hands from the edges of the metal.
11. Finally, polish with an abrasive polish, such as Brasso, and rub with a clean cloth.

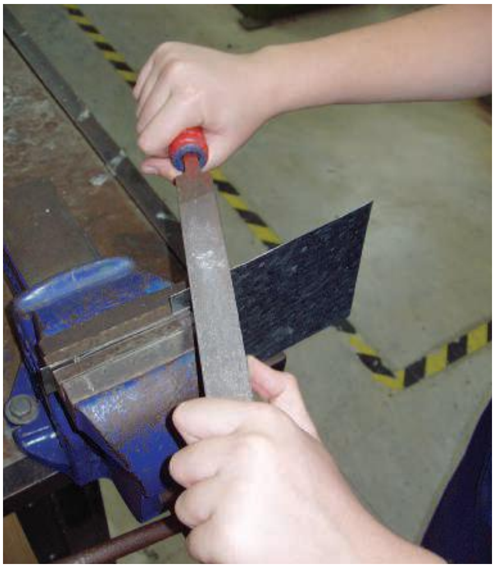


FIGURE 4.21: Draw filing the metal

FIGURE 4.22: Polishing the metal

Design process: FINAL EVALUATION

Test the product

Now you are ready for final testing. This means making sure that the prototype multi-tool works; that is, that the five tools function as intended.

Professional, peer and self-evaluations

Ask your teacher and your classmates for objective evaluations of your prototype metal multi-tool. Then self-evaluate your project by asking the following questions.

1. Does the product have five functional tools suited to a specific use?
2. Is the design safe to use?
3. Did you use the most suitable materials, tools and techniques?
4. If you were to make your prototype multi-tool again, what changes/improvements would you make?
5. Did you enjoy this unit of work? Why or why not?

Switch on

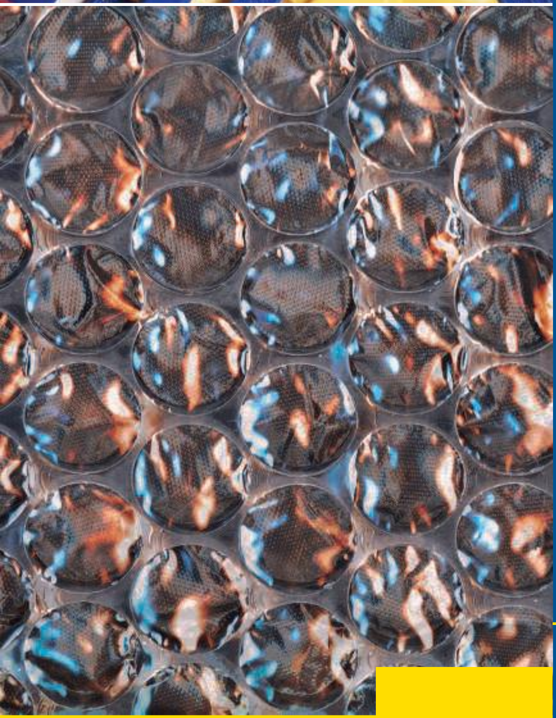
1. Name three cutting tools. How are these different or similar to tools for cutting wood?
2. Identify three safety rules to be followed when working with metal. Explain why the rules are necessary.
3. Working with a partner or in a group, prepare a presentation on how to finish metal materials. The purpose of your presentation is to teach other students the skills you have learned. Use multimedia, Microsoft PowerPoint, cardboard, models or flow charts.
4. Find out more about industrial methods of making metal products:
   - Ask your teacher to organise an excursion to a factory. After the excursion, complete a report on 'industry versus classroom' and outline some of the similarities and differences you have noticed. For example, compare the measuring and marking-out techniques used in the classroom and in industry.
   - Search the Internet or visit websites to find out about how everyday things are made. To get started, go to www.jaconline.com.au/switchedontech and click on the Manufacturing weblink for this chapter.

Design process checklist

ONLINE RESOURCE BANK

Go to the Online Resource Bank at www.jaconline.com.au/switchedontech and click on the Design Process Checklist. Use the checklist questions to self-evaluate your project and to help you finalise your design folio.

You can also find more ideas for design projects at the Online Resource Bank.



CHAPTER **Five**

Polymer technologies

Which material is strong, lightweight, sometimes transparent, sometimes black, also available in bright colours, can be moulded into any shape, often imitates other materials such as leather and silk, is cheap to produce and can usually be recycled? The answer is the synthetic (manufactured) material we know as *plastic*. All plastics are *polymers* and we can't do without them.

Polymers can be made into many different things: car and bike tyres, food containers, drink bottles, kitchen benchtops and much more. They are suitable for projects in all areas of study: Built Environments, Products, or Information and Communications. Chapter 5 provides general information about the materials, tools and techniques used in polymer technologies. It also gives detailed information to help you design and produce a plastic clock.

Focus

By the end of this chapter you will be able to:

- identify and select materials appropriate to a design project
- select and correctly use polymer technology tools for a design project
- select and use techniques appropriate for the purposes of a design project.

Switch on

1. **Why are plastics used for making so many things?**
2. **Identify 20 items in your kitchen at home made from plastic.**
3. **Use websites and books to research the development of plastics. Summarise your findings on an A4 page and use them as the introduction for your design folio.**

Techno**bite**

In 1907, Leo Baekeland invented a new material. He named it Bakelite after himself. Soon, telephones, radio parts and car parts were being made out of Bakelite. Baekeland believed that 'from the time a man brushes his teeth and hair in the morning with bakelite-handle brushes, until the moment he falls back on his bakelite bed … all that he touches, sees, uses, will be made of this material of a thousand uses.' Bakelite, a polymer, is still being used widely today.

5.1 Materials

Technobite

The word polymer comes from two ancient Greek words: *poly* meaning many and *meros* meaning part. The word plastic also comes from Greek: from *plastikos* meaning fit for moulding.

It shouldn't be hard to think of objects made from plastics and examples of materials they imitate — for instance, glass (eyeglasses) and terracotta pottery (flower pots). Because plastics are synthetic and their composition can be altered, scientists are able to keep improving their properties and range of uses.

Knowing a bit about the structure and behaviour of the material you're going to work with is a good beginning to making a project in polymer technologies. Remember that all plastics are *polymers*. Polymers are very large molecules that consist of many small molecules (*monomers*) linked together. Polymers are divided into two groups: *thermoplastic* polymers and *thermosetting* polymers.

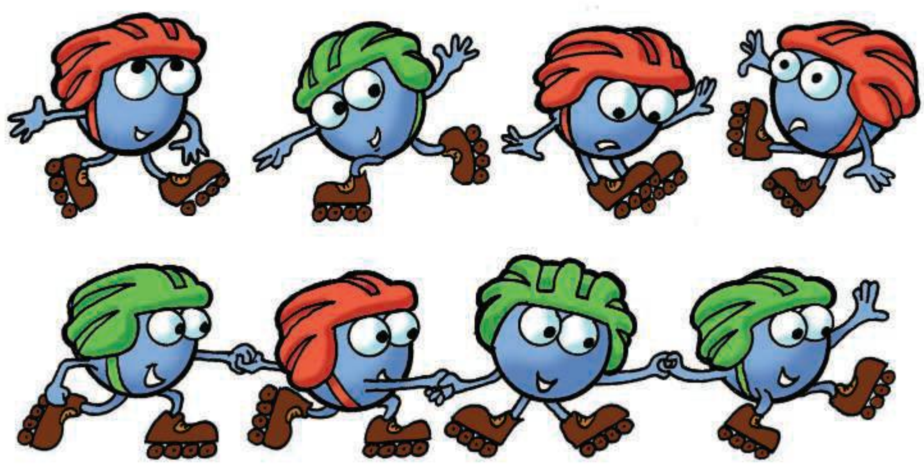


FIGURE 5.1: Small molecules (monomers) link together to form a large molecule (polymer).

Thermoplastic polymers: characteristics and properties

The chains of monomer molecules in a thermoplastic polymer slide past each other when the polymer is heated, allowing the plastic to soften and melt easily. Thermoplastics can be shaped by *extrusion, moulding* or *pressing* into useful products such as soft drink bottles, mouthguards or cling wrap. Thermoplastics are used widely in food packaging because they are easily formed into any shape. Perspex® is a transparent thermoplastic acrylic resin.

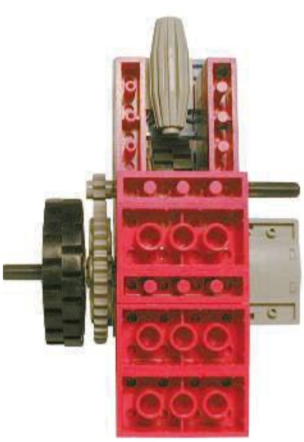


FIGURE 5.2: An electricity generating turbine built with Lego, the Danish construction toy made from thermoplastic polymer
Source: Dan Hartman www.dansworkshop.com

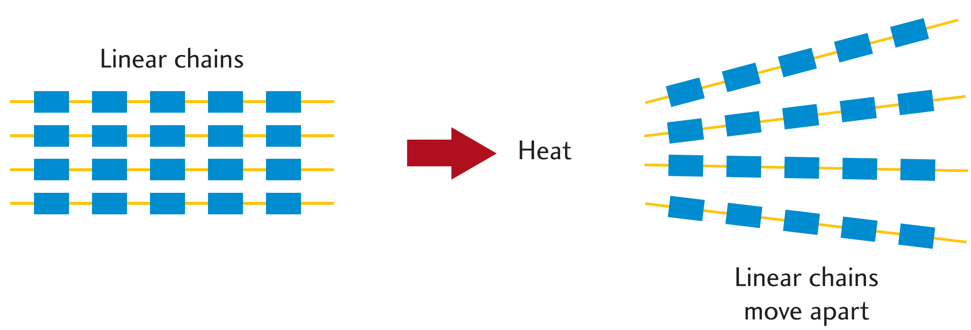


FIGURE 5.3: Structure of a thermoplastic polymer. When heated, the chains of molecules can slide past each other and the plastic melts.

Thermosetting polymers: characteristics and properties

The chains of monomer molecules in a thermosetting polymer are locked together firmly by chemical bonds between the chains, known as *crosslinks*. Thermosetting polymers do not soften when heated. They are hard and sometimes brittle. These plastics are used to make toilet seats, benchtops, car parts and other products that require strength and rigidity. Their strength and durability makes them especially useful in the construction and automobile industries.

FIGURE 5.4: Pool, snooker and billiard balls are made of a rigid thermosetting polymer. Before this they were made from ivory, but ball manufacturers were quick to take advantage of the development of polymers when elephant hunting was forbidden in the early 1970s.

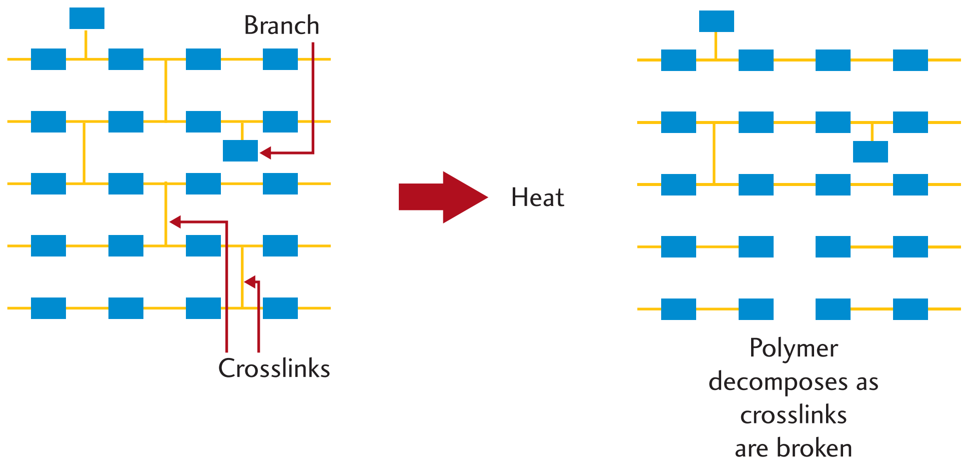


FIGURE 5.5: Structure of a thermosetting polymer. When heated, the polymer does not melt but decomposes (breaks down).

Common uses of polymers

Table 5.1 lists some of the different types of polymers and their common uses. You can probably add to this list from the research you've already done.

Technobite

Manufacturers call Gore-Tex fabric the *space-age polymer*. It keeps water out in the wettest weather and allows perspiration to evaporate so that the wearer stays cool, even during the most strenuous exercise.

TABLE 5.1: Common uses of polymers

Name	Type	Uses
Vinyl or polyvinyl chloride (PVC)	Thermoplastic	Car interiors, plumbing pipes, credit cards
Polyethylene	Thermoplastic	Food containers, soft drink bottles, water and milk bottles, cling wrap
Bakelite	Thermosetting	Electrical switches, telephones and radio parts
Polystyrene	Thermoplastic	Egg cartons, foam cups to keep drink hot or cold, insulation for walls of houses
Neoprene	Thermoplastic	Wetsuits
Vulcanised rubber	Thermoplastic	Tyres
Acrylic	Thermoplastic	Paints and varnishes, perspex

Recycling

Many polymer products can be recycled as other products. Table 5.2 lists the seven categories used in recycling plastics.

TABLE 5.2: Identification codes for recycled plastics

Code	Type	Primary uses	Recycled as …
PET or PETE 1	Polyethylene terephthalate	Soft drink bottles, pillow and sleeping bag fillers	Plastic bottles, T-shirts, jackets, carpets
HDPE 2	High-density polyethylene	Shopping bags, shampoo bottles, buckets, milk crates, freezer bags	Compost bins, stormwater pipes
VINYL (PVC) 3	Polyvinyl chloride	Cordial containers, plumbing pipes	Drain pipes, cables, hoses, bottles
LDPE 4	Low-density polyethylene	Garbage bags, ice-cream container lids	100% recycled shopping bags
PP 5	Polypropylene	Potato chip packets, straws, plastic kettles	Plastic storage boxes
PS 6	Polystyrene	Plastic disposal cups, low-cost brittle toys, plates	Not recycled in many places
OTHER 7	All other resins and mixes of plastics	Lids, assorted containers, nylon	Generally not recycled

Techno**bite**

In the year 2000, more than 37 000 tonnes of HDPE plastic and 23 113 tonnes of PET plastic was recycled in Australia. Recycling PET bottles uses 84 per cent less energy than making the bottles from raw materials.

FIGURE 5.6: A collection of radios, desk clocks and dice made from Bakelite

Switch on

1. List ten plastics you can see at home. Name the polymer group to which they belong.
2. Table 5.2 shows the recycling code for each polymer group, with examples of the primary and secondary uses of those groups. From the list below, state what code the items would have on them.
   (a) Soft drink bottle
   (b) Old vinyl record
   (c) Yoghurt container
   (d) Fan blade
   (e) Plastic food bin
   (f) Kettle
   (g) Covering of a neon light
   (h) Plastic zipper
3. How different do you think life was in the early twentieth century, before Leo Baekeland invented Bakelite, compared with life now? How would the invention of Bakelite have affected people's lives?

5.2 Tools and techniques

Working with polymers involves a range of tools. The construction techniques you might use in your design project include scoring and snapping, sawing, filing, abrading, applying adhesives (joining) and polishing. Heat is used to bend, mould and form perspex sheets.

But before you can begin your project, you must understand and learn the general rules for working safely with polymers.

General rules for working with polymers

Safety

- Always use appropriate PPE (personal protective equipment).
- Always work under teacher supervision.
- Be aware of the special safety requirements for the tools and techniques that you will use with polymer technologies.
- Be aware of the specific dangers of each machine.
- Be aware of each machine's safety zone.
- Ensure machine guards are in place.
- Keep machines clear of all debris and scraps of unwanted materials.

Safety rules that apply specifically to polymer technologies appear later in this chapter in the most appropriate places. Observe them!

Measuring and marking out

See chapter 3, page 70.

The basic tools used to measure and mark out perspex sheets are the same as for timber. Use an **HB PENCIL** for marking out on the protective paper covering. If the covering has been removed, use a **WAX CRAYON** or a **WHITEBOARD MARKER**.

Tip
Perspex sheets have protective paper on both sides to prevent the surface being scratched. Leave this on as long as you can.

Cutting

Cutting tools can be divided into hand saws and machine saws.

Hand saws

COPING SAW: A hand tool used to cut templates out of perspex. It is also used to cut intricate curves and large bends.
GENERAL-PURPOSE SAW: A useful tool for cutting straight and curved shapes.

See chapter 3, pages 71–4, for more information on cutting tools.

SCORER: Perspex can also be cut by scoring. Lay the perspex flat. Hold a metal ruler firmly where the cut is to be made and pull a metal scorer along the ruler. Snap the perspex at the scored edge.

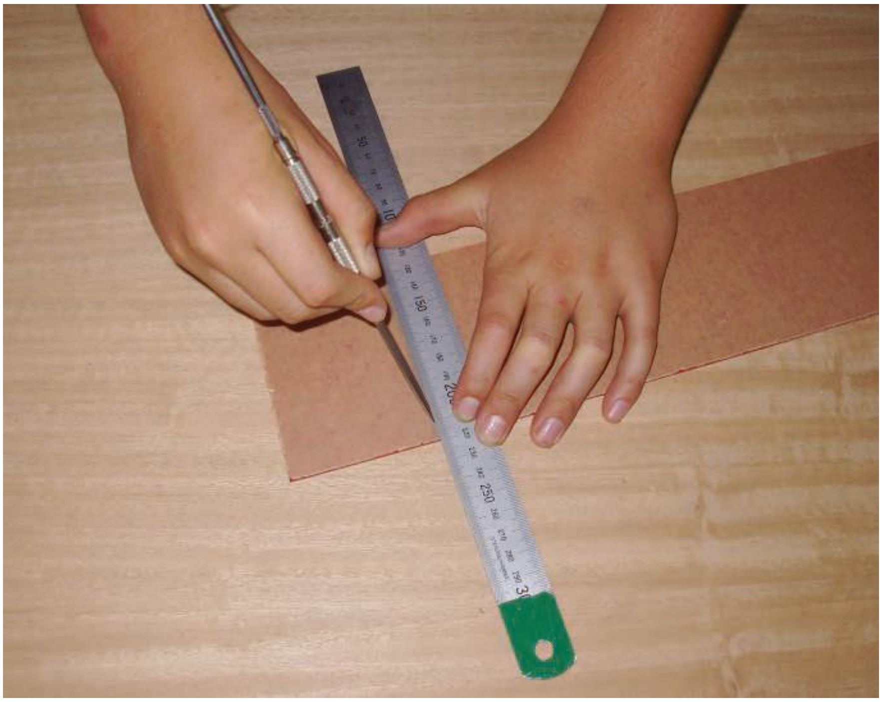


FIGURE 5.7: A metal scorer can be used to cut and snap the perspex.

Tip
Note any special requirements for using saws with perspex. Knowing these special requirements will help you choose the right tool for the job.

Machine saws

There are five machine tools used for cutting acrylic sheet: *scroll-saws*, *jigsaws*, *bandsaws*, *hole saws* and *circular saws*.

SCROLL-SAW: A small mechanical saw.

JIGSAW: May be used for cutting perspex sheet. Years 7–8 students must use only a cordless jigsaw.

BANDSAW: Makes quick cuts, especially along straight lines.

Safety

Power cord jigsaws and bandsaws **must not** be used by Years 7–8 students. Your teacher will use them for you, if necessary.

HOLE SAW: Set the drill at 2000–3000 rpm for drilling perspex sheet.

Finishing

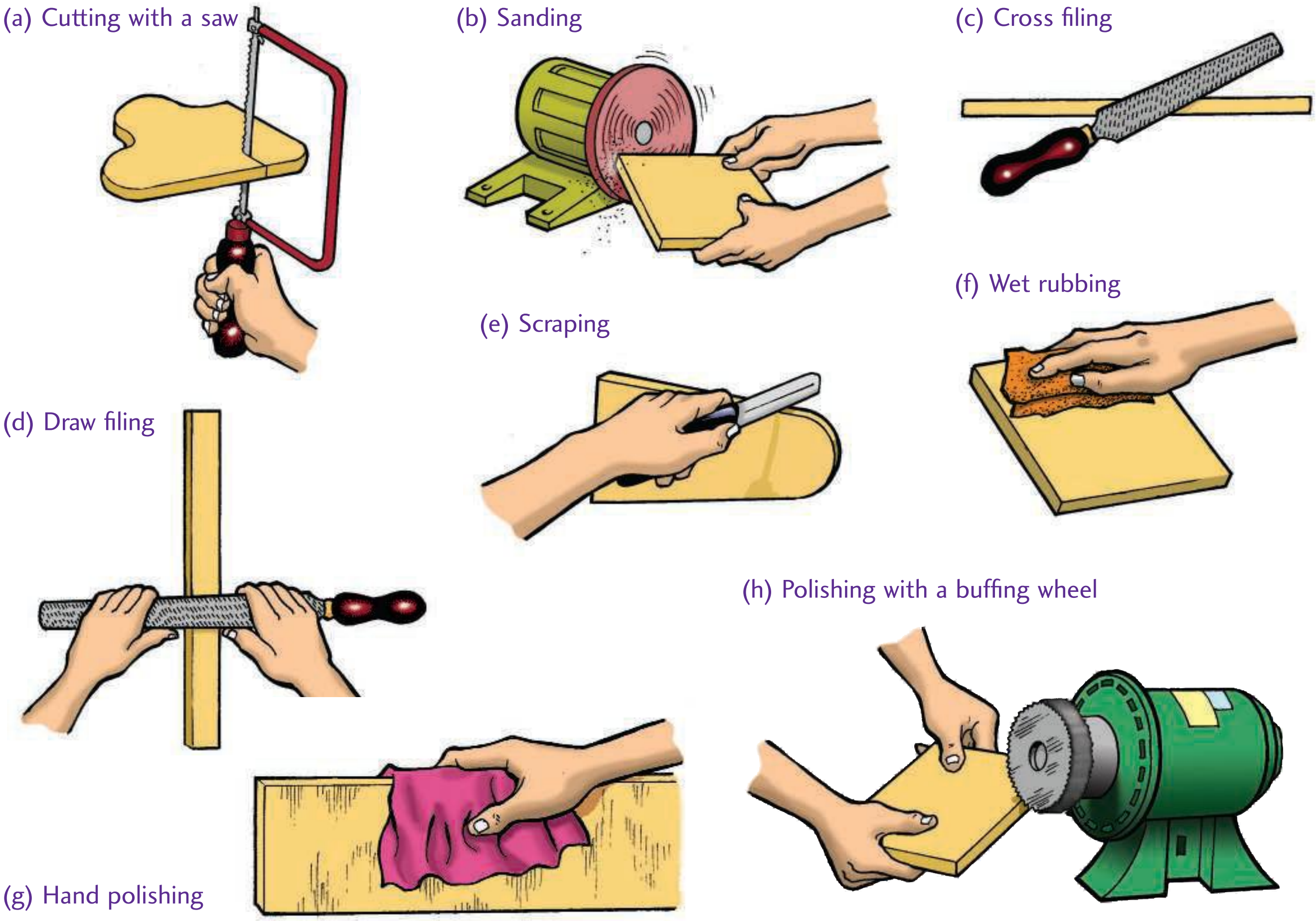
See chapter 3, pages 77–9.

To create the desired finish on the perspex sheet you will need a:

- **DISC SANDER** to produce a smooth surface and the required shape
- **HALF-ROUND MILLED-TOOTH FILE** that does not clog with the soft particles of perspex
- **NEEDLE FILE** for intricate and difficult areas and a variety of profile shapes
- **TEMPERED-STEEL SCRAPER** (or the back of a **HACKSAW** blade) to remove scratches
- **EMERY (ABRASIVE) PAPER** — grades P40 to P600
- **BUFFING WHEEL**. This tool **must not** be used by Years 7–8 students. Your teacher will use it for you.

Tip
Be careful when drilling with a hole saw. Apply pressure slowly to the material to avoid damage or snapping around the hole.

FIGURE 5.8: Shaping, smoothing and polishing



Switch on

1. Briefly explain why the protective paper attached to a perspex sheet should be left in place as long as possible.
2. Research the revolutions per minute (rpm) required when using a drill press to cut metal and wood. How does this speed differ from that recommended for cutting perspex sheet? Is it faster or slower? Why?
3. Describe what might happen in each of the following situations and explain the safety issues involved:
   - you apply too much pressure on a hole saw
   - a circular saw's blade is positioned too high
   - your workpiece is not held securely when being cut.

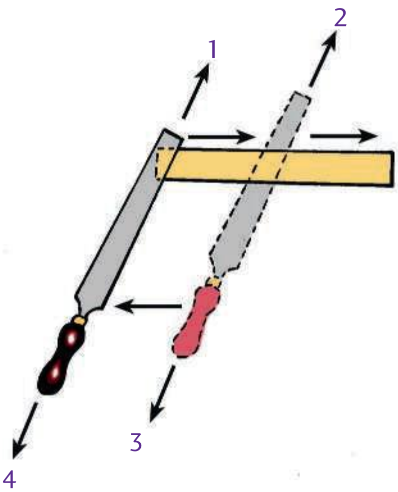
Technobite

Plastics are 14 times lighter than glass; thus, there are considerable energy savings when transporting plastic products.

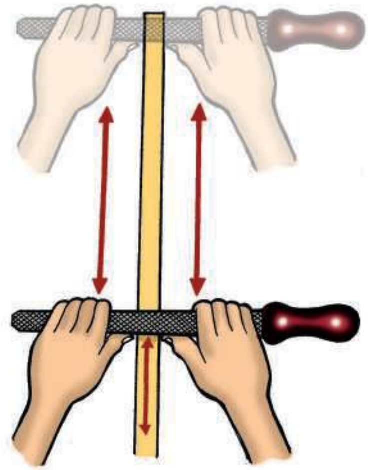
Filing

After being cut, the material will usually have cut marks, burrs and/or splits. To remove these, use two types of filing: cross filing and draw filing. Do not remove the protective paper at this stage. *Cross filing* involves holding the file at an angle and pushing the flat surface of the file both forward and across the surface of the acrylic at the same time. *Draw filing* involves holding the file at a 90° angle to the surface of the acrylic and drawing the file along the surface towards you and pushing along the surface away from you. Use a **NEEDLE FILE** or a **FINE-TOOTHED FILE** to get an even smoother surface.

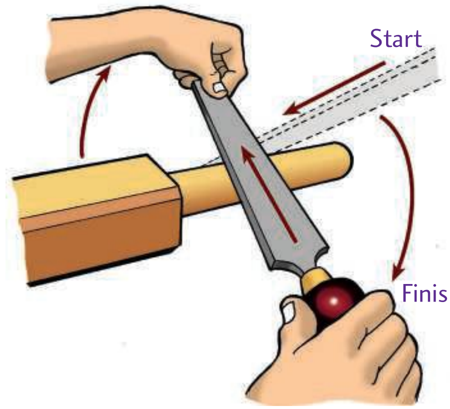
FIGURE 5.9: Methods of filing



(a) Cross filing a flat surface



(b) Draw filing a flat surface



(c) Cross filing a curved surface

See chapter 3, page 79.

Tip
It's very important to use the abrasive paper only on the edge of the perspex sheet. It can cause severe scratching if it comes into contact with the flat surface. Wrap a square of sandpaper around a cork block or scrap piece of timber and then sand the surface of your work. This will prevent fingerprints marking your work.

Abrading

ABRASIVE PAPER: Use abrasive paper after filing. If your scraping and filing processes are done well, you should need to use only a fine abrasive paper (P220 to P600).

Moulding and forming

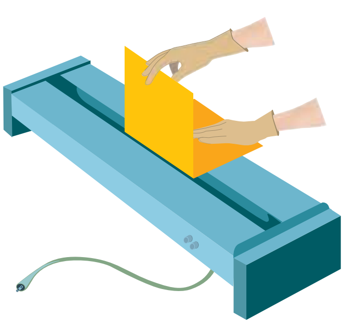
Heating tools for perspex include ovens, moulds and strip heaters. Once the material is heated, moulding and forming can be done either by hand with plug and ring moulds or by machine with vacuum formers and blow moulders.

CONVENTIONAL AND MICROWAVE OVENS: Ovens are used to heat a whole perspex sheet and make it malleable (bendable). Once heated, the perspex can be placed in a plug mould and pushed into the style, size and shape of the mould.

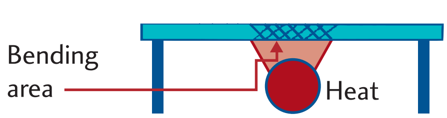
Remove the protective paper and place the perspex sheet on a shelf in the centre of the oven so it is heated evenly. The temperature must not exceed 160°C to 170°C. Once the perspex sheet is flexible, it is ready to go into a mould for shaping.

STRIP HEATER: This device heats only a localised area of the perspex sheet. Use a strip heater for bending pieces of perspex along a line at an angle of up to 90°.

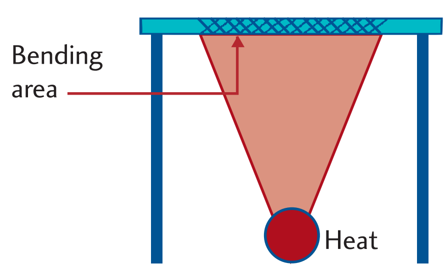
FIGURE 5.10: Strip heater



(a) A strip heater is used to bend perspex.



(b) The nearer the heat, the narrower the bending area



(c) The further away from the heat, the wider the bending area

Remove the protective paper, place the area to be bent over the electric element and heat gently. Turn the piece frequently to ensure thorough heating. Once soft, you can bend the piece into position. On cooling, the perspex sheet will retain this new shape. If the angle is incorrect, reheat the material and bend it again.

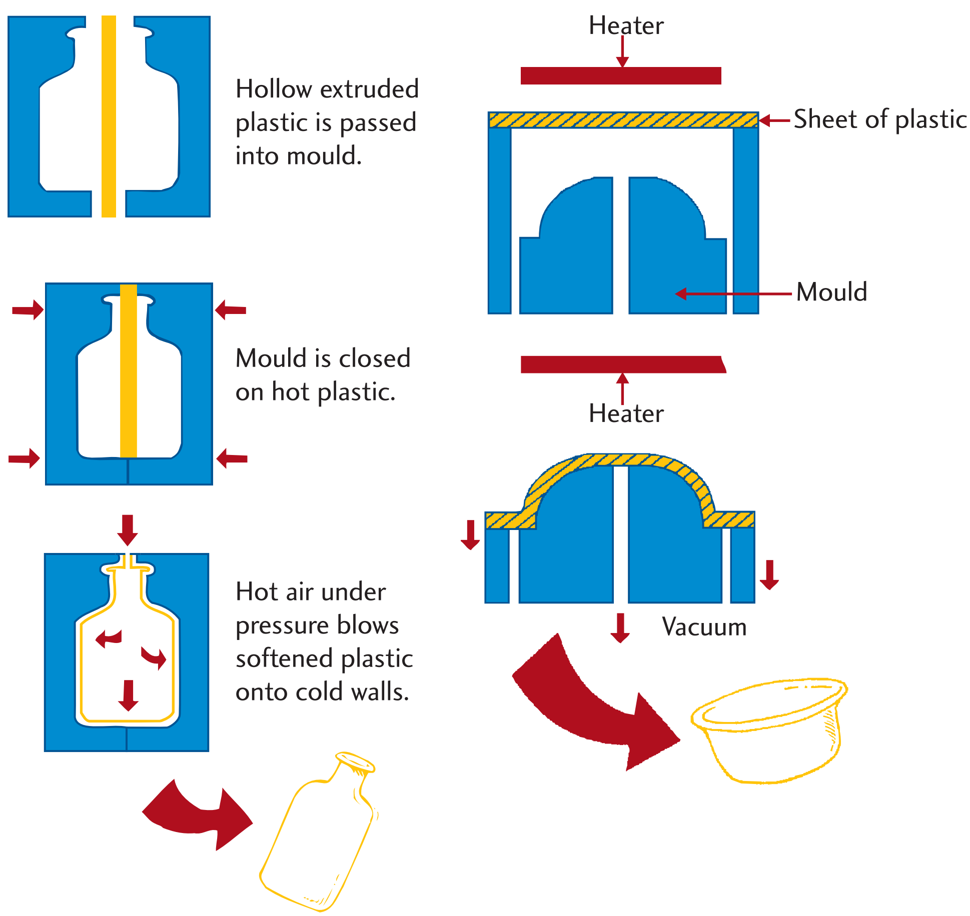
PLUG AND RING MOULDS: These moulds consist of two or more forming parts made from metal (aluminium), timber (radiata pine) or manufactured board (craftwood). Place the preheated thermoplastic material in the mould. Press the two parts of the mould firmly together to stretch and shape the perspex. It will retain the mould's shape when it cools.

Safety

Wear dry industrial leather gloves when heating plastics to form or mould them either on the strip heater or in the oven.

VACUUM FORMERS AND BLOW MOULDERS: These are similar to plug and ring moulds but are attached to a machine. All surfaces must be smooth and free from sharp edges. A tube of softened plastic is placed in a mould, and air under pressure is blown through the tube. This forces the heat-softened perspex into the contours of the mould. Upon cooling, the perspex retains the mould's shape.

FIGURE 5.11: Moulding and forming perspex



(a) Industrial blow moulding (b) Industrial vacuum forming

Joining

There are two ways to join thermoplastics: mechanical fastenings and glues.

1. Mechanical fasteners create a physical joint without any molecular bonding of the joined materials. Many of the fasteners, such as nuts and bolts and self-tapping screws, can also be used for wood and metal.
2. Glues, more commonly known as cements and adhesives, involve a bonding of molecules. Examples of glues are *acrylic cement* and *epoxy resin*.

Safety

Observe the following safety rules.

- Always work under teacher supervision.
- Take extreme care when dealing with solvents and adhesives.
- Always read the directions on the bottle or the tube.
- Wear a mask and work in a well-ventilated area. Adhesives give off toxic gases, which can cause giddiness and fainting. If inhaled, some adhesives can cause damage and/or are carcinogenic (can cause cancer).
- Wear eye protection (goggles and/or glasses) in case of accidental splashing. Most hardeners (found in epoxy resins) contain peroxide that can irritate or damage the eyes. If glue comes into contact with your eyes, wash them immediately in cold water and seek medical advice.
- If any solvent or glue comes into contact with your skin, wash the affected area immediately. Wear gloves if you are using polyester resins.
- Store substances according to the recommended safety advice.

FIGURE 5.12: Epoxy resin and acrylic cement are two common adhesives.

TABLE 5.3: Glues used with perspex, wood and metal

Purpose	Adhesive to use
Adhering wood to perspex Adhering metal to perspex Adhering polystyrene to perspex	Epoxy resin — resin and hardener mixed together; e.g. Araldite
Adhering perspex to perspex	Acrylic cement specifically for perspex

Polishing or buffing

Safety

The final process of finishing is polishing or buffing. If you do this by hand, use a polishing compound and keep rubbing until the desired shine is achieved. A buffing wheel gives a more highly polished surface. Years 7–8 students **must not** use a buffing wheel. Your teacher can use it for you, if required. Buff, using a swansdown mop, for the best finish on perspex.

Switch on

1. Place the following terms in the correct order in a flow chart: scraping, calico buffing, sawing, P220 abrasive paper, needle filing, marking out, measuring, P600 abrasive paper, buffing with a swansdown mop, cross filing, hand polishing using a polishing compound, P400 abrasive paper, draw filing.
2. Why would a calico mop not be suitable for buffing perspex?
3. State the difference between P80 and P600 abrasive paper. List some uses of these grades.

5.3 Polymer technologies at work

Industrial production methods

All the processes used in the classroom, such as blow moulding and vacuum moulding, are used in industry. But everything is on a much larger scale and some industrial machines are the size of, or bigger than, your classroom.

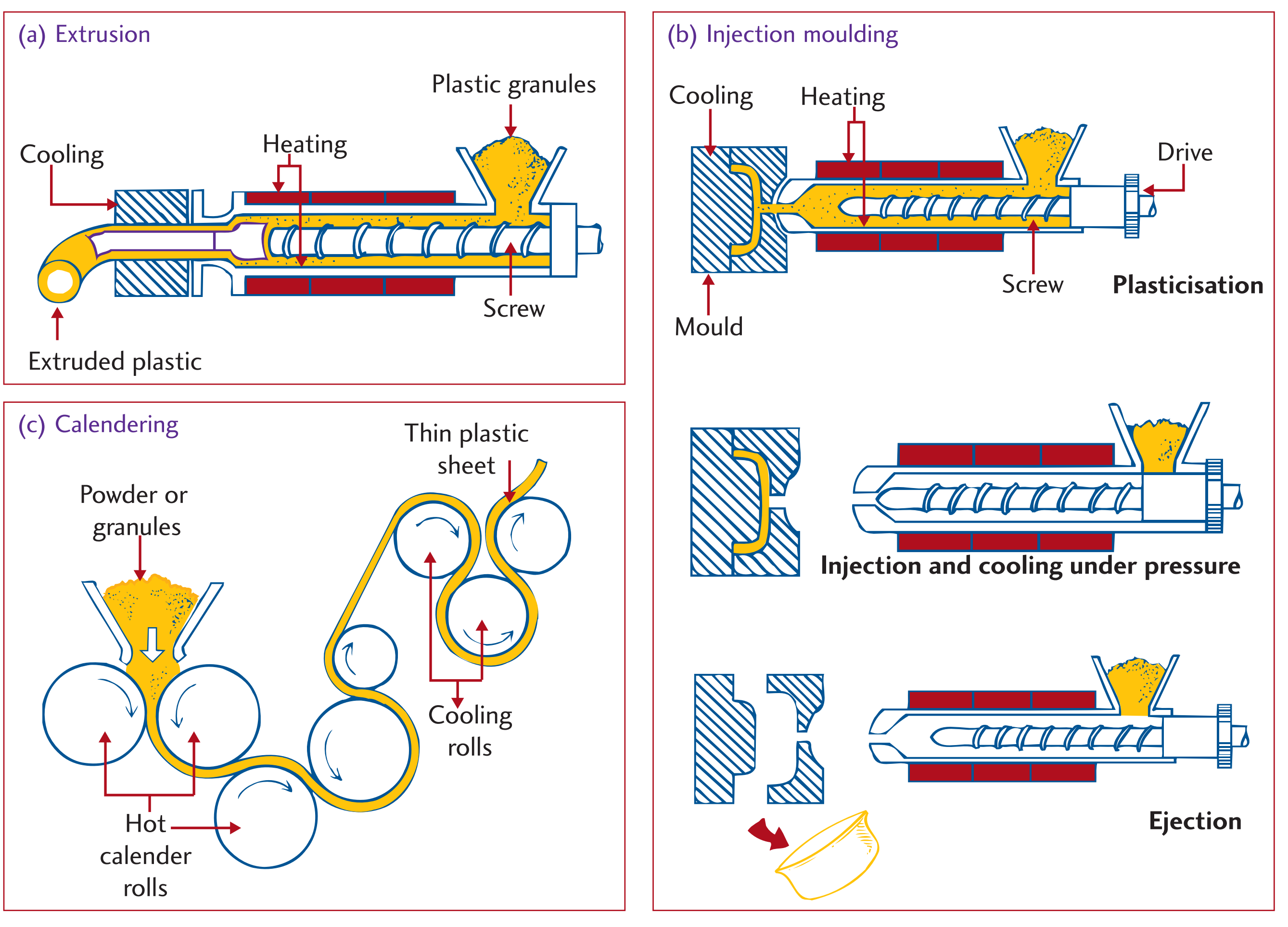
Common industrial methods of manufacturing plastics are:

- *extrusion*. The plastic material is heated in a container. A turning screw in an extruder forces the molten plastic through a small opening called a die that is cast in the shape of the required product. Heaters in the wall of the extruder keep the plastic soft. It cools and hardens on contact with the air. Pipe, sheeting, tubes and window trim are examples of extruded products.
- *injection moulding*. Injection moulding is widely used, mainly for thermoplastic polymers. The plastic is melted and forced into a closed mould, where it is left to cool before the mould is opened and the finished product ejected. Kitchen utensils, butter and margarine tubs, yoghurt containers, toothbrushes and disposable razors are examples of parts produced by injection moulding.
- *calendering*. Calendering compresses softened plastic through a series of rollers. It is used to make thin plastic films for food wrapping.

Techno**bite**

In 1839, Charles Goodyear discovered that latex — a natural polymer from the sap of a tropical tree — when heated with sulfur, or *vulcanised*, remained *elastic* at a wide range of temperatures. This led to the manufacture of tyres. Vehicles have travelled billions of kilometres on tyres made from vulcanised rubber. Goodyear is still the brand name of a make of tyres.

FIGURE 5.13: Manufacturing plastics



Spotlight 1 Polymer banknotes

Polymer banknotes are increasingly replacing cotton rag-based paper banknotes. The new notes, developed in Australia, are already circulating in more than twenty countries. The polymer banknotes, with their protective overcoats, resist moisture, sweat, oil and grime and, therefore, stay cleaner and suit environments where the weather is wet and humid.

Polymer banknotes are durable and difficult to tear and this makes them cost-effective. Plastic currency lasts four to five times longer than paper money, which means that countries adopting polymer technology need to reprint their banknotes far less often.

The plastic banknotes have combined modern and traditional security features to frustrate most would-be forgers. Since 1988, when Australia became the world's first country to circulate polymer banknotes, reports of counterfeiting have dropped significantly.

Polymer is also environmentally friendly. Old Australian paper notes used to be burned or buried, but the polymer ones are shredded, granulated and recycled as plastic wheelbarrows, compost bins and other things — a true cradle-to-grave approach. And the notes are produced on the same equipment that produces paper currency plus one extra machine that overcoats the notes.

See chapter 1, page 12, for more about the cradle-to-grave approach.

FIGURE 5.14: Polymer banknotes

Spotlight review

Go to www.jaconline.com.au/switchedontech and click on the Note Printing Australia weblink for this chapter. Read the article, 'Note Printing Australia produced Australia's first polymer banknote in 1988' or search the web for information on polymer banknotes.

(a) What part does the Reserve Bank of Australia play in the production of the polymer banknotes?

(b) Identify four advantages (for example, clean) and four disadvantages (for example, slippery) of polymer banknotes.

Spotlight 2 Tupperware

FIGURE 5.15: Tupperware is still sold at Tupperware parties, as well as in shops.

Earl S. Tupper (1907–1983) first heard of polyethylene around 1940. This soft plastic, developed in the UK, was being used as a protective coating for electric wire. The Tupper-Dupont team in Massachusetts, United States, produced a finer version of the new material and developed an injection moulding process to shape it. The Tupper Plastics Factory was founded in 1945 and the following year Tupperware parties were launched — a method of selling in homes. Prospective buyers were able to handle the items and watch demonstrations of what they could do. Sales improved almost immediately and eventually Tupperware marketing spread through many countries. Tupperware is still extremely successful — the range expands and updates in response to customers' needs. It is said that every few seconds, somewhere in the world, someone is giving a Tupperware party.

Spotlight review

Research the Tupperware range available in the 1940s and compare it with what is being produced today.

(a) In what ways have the products changed 'in response to customers' needs'?

(b) Make a list of the design features that keep Tupperware up to date and rank them in an order of priority.

(c) Share your findings with the rest of the class.

FIGURE 5.16: Swimmer Matt Welsh tests the new Fastskin II swimsuit.

Spotlight 3 Speedo Fastskin II

We might say that we live in an 'age of polymers' because polymers turn up everywhere in our environment. The swim gear company Speedo produced bodysuits of Fastskin II for the 2004 Olympic swimmers in Athens. Fastskin II is a fabric containing a polymer component — silicon. It is modelled on the skin of one of the ocean's most streamlined swimmers — the shark — and developed through biomimetics, which is the science of taking good design principles from nature.

The suits have fabric panels with unique seaming and fit the human form like a second skin. Fastskin II reduces drag on the body and helps the wearer to go faster through the water.

Spotlight review

Investigate the science of *biomimetics*. Note that many Europeans call it *bionics* and many North Americans refer to it as *biognosis*.

Switch on

1. Use the Internet or your school library to complete table 5.4.

TABLE 5.4: Everyday examples of polymer products

Industry process	Classroom or household example
Extrusion	
Injection moulding	
Blow moulding	
Rotational moulding	

2. Investigate other processes of moulding plastics, such as rotational moulding and compression moulding.
3. Complete your own case study. Choose a professional, such as an engineer, nurse, doctor, dentist, vet, teacher, accountant or lawyer, and prepare ten questions about why plastics are important in their area of work. Present your findings about the importance of plastics to the class.
4. Identify and draw the plastics classification recycling codes for high-density polyethylene, polypropylene and polystyrene.

Use the skills you learned about designing questionnaires in chapter 2, pages 36–7, to ensure your questionnaire is suitable.

5.4 Design process

Technobite

‘Nowadays, plastics are taken so much for granted that it seems quite inconceivable that there was ever a time when they were not quite such familiar objects of daily life,’ said Sonal Panse, Indian writer and artist, 5 July 2004.

Design project

Your design project for polymer technologies is to make a plastic clock.
Area of study: Products. The focus of this area of study is on objects, systems and artifacts.
Design specialisation: Industrial design. Industrial designers create products such as toys, mechanisms, furniture, leisure products and production systems.

Design situation

Clocks have a single purpose — to tell the time — but are manufactured in many different styles, shapes, colours and sizes. They are designed for specific locations, for example, a colourful clock with a cartoon face for a young child’s room, or a plain, polished-timber clock for a company boardroom.

Design brief

Design and produce a plastic clock for a specific decor. For this task, you must choose the decor first and then design the clock to suit that decor. You must also use some form of joinery in your clock. The design brief describes the product you will design and produce, but the look of the clock is up to you.

Project materials:

- 400 mm × 400 mm sheet of perspex — choose from red, blue, clear, white or black
- different coloured offcuts of perspex
- *recycled* materials, such as small pieces of fabric, timber, aluminium foil, cardboard or ribbon, that can be included in the design of the clock
- analogue clock mechanism with battery
- clock hands — second, minute and hour
- stick-on numbers — 3, 6, 9 and 12, Arabic numerals 1–12, Roman numerals or dots
- hook for hanging on the wall or design a way of standing the clock from a perspex offcut bent with a strip heater.

Tip

You can buy clock mechanisms at shops or even online. For example, go to www.jaconline.com.au/switchedontech and click on the Clock weblink for this chapter.

FIGURE 5.17: Some of the many clock designs that are available today

Look again at the design process in chapter 2, pages 20–1.

Be flexible in your approach to the design process. The order of the steps is not set in concrete and you may not always follow them in the sequence presented here. Some steps go hand in hand with others throughout the design project. Other steps need to be completed before you can move on. You should concentrate on using the combined steps to form a process that guides the development of your design.

Design Folio **Production**

Your design folio is an important communication tool for design projects. It should tell the story of your design project's development, from your first rough ideas on paper to the final evaluation of your design brief solution.

Consider composing your design folio in electronic format for this technology.

Techno**bite**

Plastics help to save lives. Their low toxicity or non-toxic nature allows them to be used successfully in modern surgical techniques and medical appliances, such as hearing aids and heart pacemakers.

Design process: ONGOING EVALUATION

Essential for success

Remember that ongoing evaluation is central to the design process and should occur at every step. Regular evaluation helps to identify problems and challenges at the right time for you to deal with them. Putting evaluation off until later is asking for trouble, for example:

- wasted resources
- lost time
- failure to meet deadlines
- increased costs.

Design process: ANALYSIS

Thinking about the design situation

When you answer the following questions, you have already started to research and create design ideas. These analysis questions could help you plan your clock's decor, placement, size, shape and design.

1. Is the look (aesthetics) or the function of the clock more important? Why?
2. Which rooms in your house, school or other places in your community need clocks?
3. Where are the possible places in the room for a clock? Why would a clock be useful there?
4. Will the clock hang on a wall or stand on a bench, table or mantelpiece?
5. What are the weight, shape and size of the clock?
6. Where will the mechanism go? How will you conceal the mechanism?
7. How can you best use the piece of perspex? Will you add any recycled products to your clock?
8. Where and what are you going to research about materials and tools that you could use?
9. What form of joinery will you use to join the pieces of perspex together?

FIGURE 5.18: Possible materials for decorating your clock

Switch on

Thinking about the design brief

Write the design brief in your design folio and underline, circle or highlight words that give you specific information or instructions as indicated below.

> Design and produce a plastic clock for a specific decor. For this task, you must choose the decor first and then design the clock to suit that decor. You must also use some form of joinery in your clock. The design brief describes the product you will design and produce, but the look of the clock is up to you.
>
> *Project materials:*
>
> - 400 mm × 400 mm sheet of perspex — choose from red, blue, clear, white or black
> - different coloured offcuts of perspex
> - recycled materials, such as small pieces of fabric, timber, aluminium foil, cardboard or ribbon, that can be included in the design of the clock
> - analogue clock mechanism with battery
> - clock hands — second, minute and hour
> - stick-on numbers — 3, 6, 9 and 12, Arabic numerals 1–12, Roman numerals or dots
> - hook for hanging on the wall or design a way of standing the clock from a perspex offcut bent with a strip heater.

Think about the main points and the keywords and ask what, where, why, how and when. Record your analysis ideas in your design folio.

Techno**bite**

Many household appliances, such as vacuum cleaners, are made from one form of plastic or another. Plastic computers, fax machines, phones and photocopiers help businesses all over the world to keep in touch and make money.

Limitations to the design brief

There are always limitations to designing a product or solving a problem. Identify constraints for the development of the project.

- *Time available*. When does the project need to be completed?
- *Function*. What are the purpose and main features of the project?
- *Aesthetics*. What does the project need to look like?
- *Cost*. Do you have enough money to complete the project?
- *Materials and tools available*. What materials and tools are required? Are they available at school?
- *Expertise*. Do you have the skills required to complete the project?
- *Environmental considerations*. Will any production waste harm the environment?
- *Safety rules and regulations*. Will the product be safe?

In your design folio, list the factors that might limit you when producing the clock. What will be the biggest limitation? Why?

Criteria for success

Criteria to evaluate success identify exactly what the design must achieve, while taking into account the design limits that could affect the final solution. For example, the product must:

1. tell the time
2. suit a specific decor
3. be made from perspex.

Think of another five criteria. Write your criteria and the ones above in your design folio.

Design process: MANAGEMENT

Getting organised

Management is a step that must be considered alongside other steps throughout your project. Management needs constant reviewing as you progress with your work.

- Develop action-management, time-management and budget-management plans.
- Evaluate and justify any changes to your management plans, outlining impacts on the design project's development. This will mean re-evaluating your management plans at regular intervals during the production of your design project.
- Plan and manage available resources effectively and efficiently.
- Evaluate the appropriateness of available resources as they relate to your design brief and developed criteria for success.

Design process: RESEARCH

Investigating the design brief

First, find information that will help you design a range of options from which you can make your final choice. Use various techniques, such as primary and secondary research, questionnaires and interviews. Presenting your results in your design folio is a good way to organise this information.

FIGURE 5.19: Questionnaires are useful tools for gathering data and ideas.

QUESTIONNAIRE FOR SHOPPERS

1. *Open question:* If you were to buy a clock from a shop, what would it look like?

____

____

____

2. *Closed question:* What would be the three most important features of a clock for you?

Size	❑	Silent mechanism	❑
Appearance (aesthetics)	❑	Colour	❑
Cost	❑	Country of manufacture	❑
Brand name	❑	Length of guarantee	❑

3. *Closed question:* If you were to buy a clock, would you:

buy from a shop?	❑	buy online?	❑

Switch on

1. How do the terms *primary research* and *secondary research* relate to your market research for your clock design?
2. Research clocks in books, catalogues, brochures, junk mail, libraries, shops and on Internet sites. Compile a market research report on two A4 pages and add this to your design folio.
3. Investigate the materials you have been given and any other possible materials you can use for this project. For example, complete an A4 page on perspex and how it is produced, the mechanism and how it works, or any recycled materials that could be added.
4. Identify the tools used to cut, score, shape, join, heat, bend, mould and finish perspex.
5. Investigate and recommend techniques for producing the clock. How and what are you using to join, bend and finish? For example, will you use a microwave oven or a conventional oven to heat the perspex?

FIGURE 5.20: Perspex and clock mechanism

See chapter 2, pages 39–40.

Design process: IDEAS GENERATION

Brainstorming

Remember the purpose of brainstorming is to generate as many ideas as possible in a short period of time. It's important not to judge the suitability of an idea at this stage — often the craziest thoughts spark the most creative and original ideas!

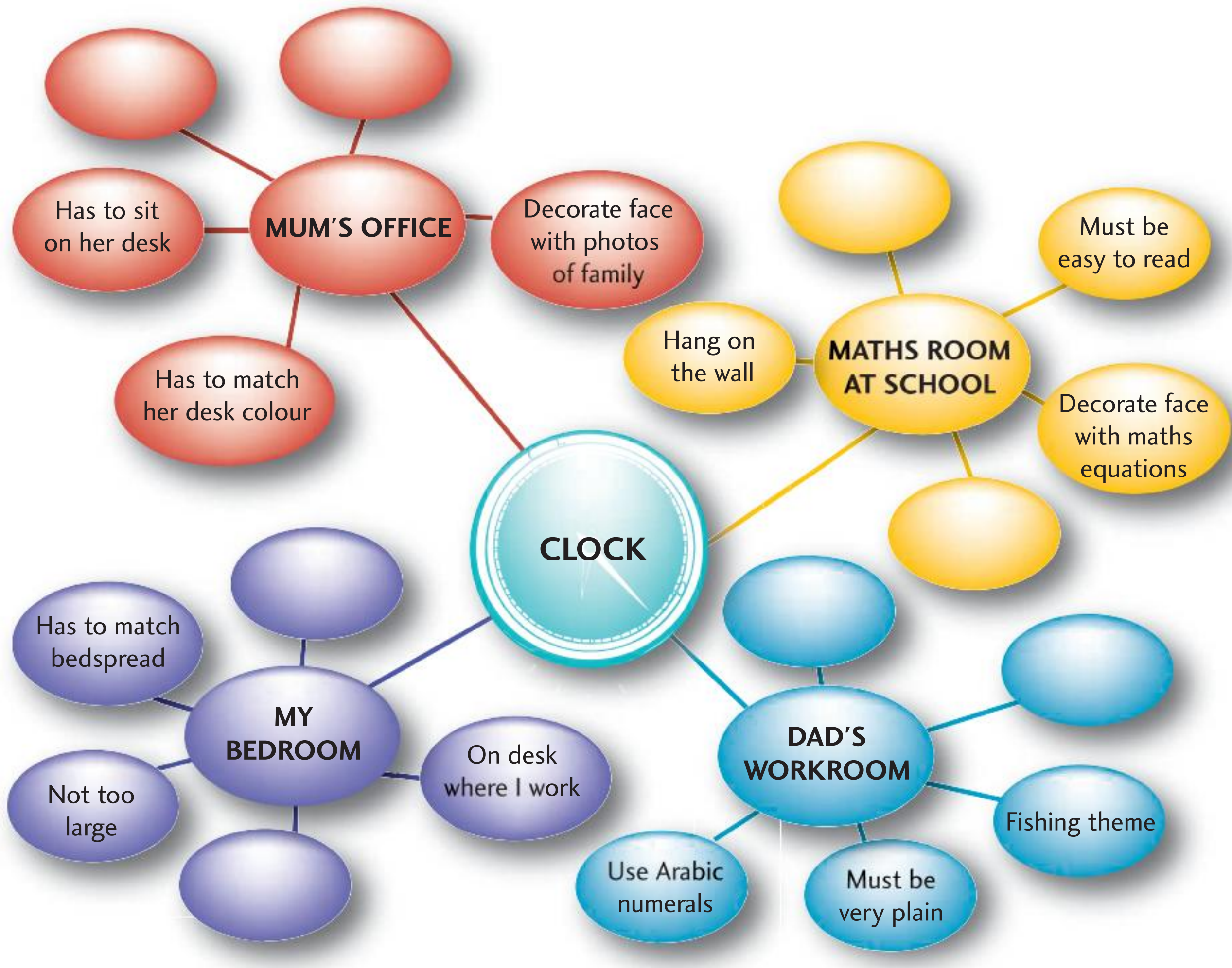


FIGURE 5.21: Spidergram showing possible locations for your clock — add your own ideas

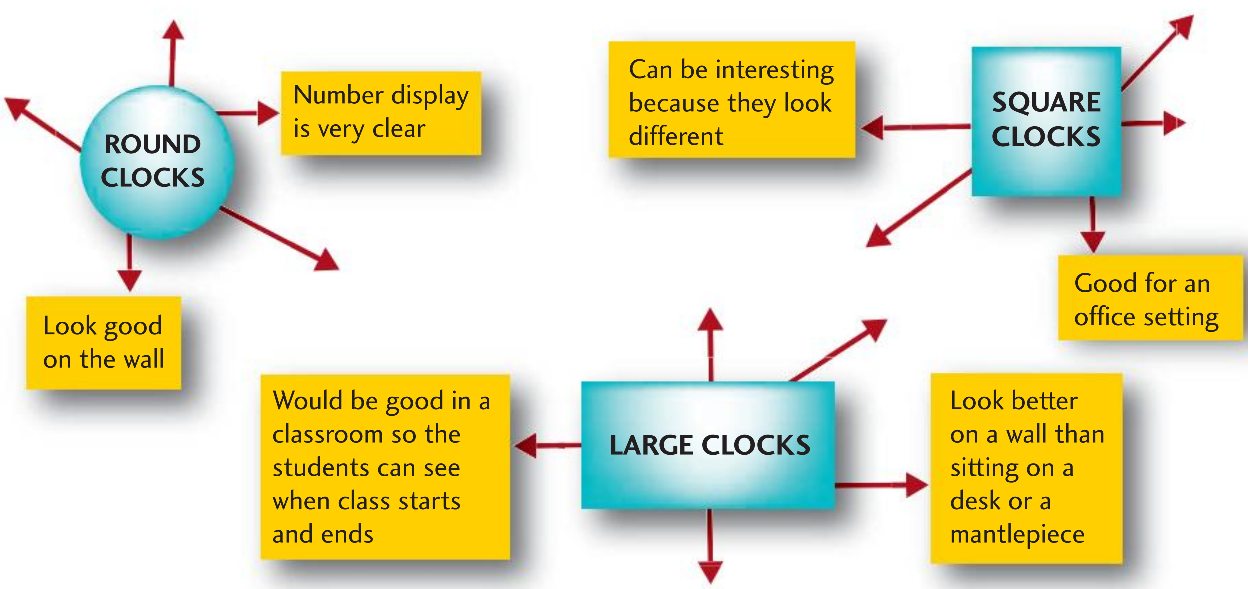


FIGURE 5.22: Three mind maps suggesting shapes and sizes for the clock. Copy into your design folio and add your thoughts to the ends of the blank arrows.

Preliminary sketches and plans for the solution

Before you begin your project, identify any problems and work out your solutions. Brainstorm again, but this time in a graphical form. Draw ten thumbnail sketches, showing style, colour, method of joinery, and method of standing or hanging. After you've finished, choose your three favourite designs. Label these three designs with materials, tools and techniques.

Review your time-management plan for completing your project.

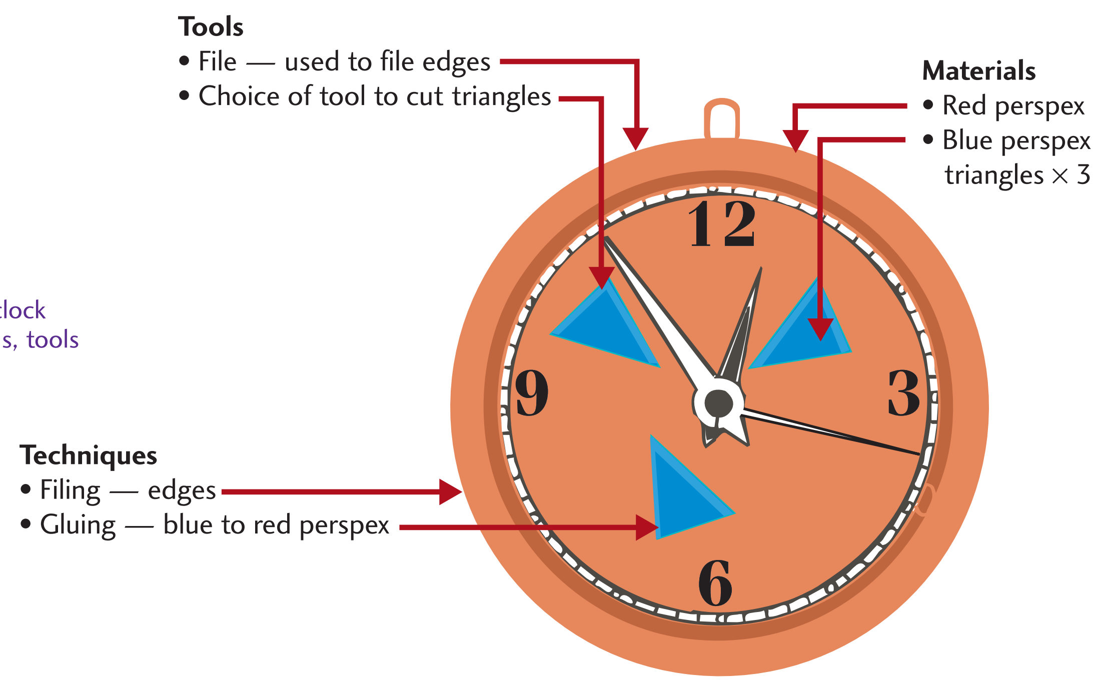


FIGURE 5.23: Plastic clock labelled with materials, tools and techniques

Technobite

Plastic bags require less energy to make than paper bags and are lighter and stronger. But, unlike paper, very few plastics are biodegradable at present, which means they cannot be broken down by bacteria or other living organisms. Discarded plastic bags form ugly litter and can kill aquatic life when the bags end up in waterways. Some organisations are now taking positive steps to reduce the usage of plastic bags. Can you help?

Switch on

Table 5.5 is an example of a cutting list for a plastic clock. Copy this table into your design folio, amend any information that is different for your clock and complete the list.

TABLE 5.5: Sample cutting list for a clock

No. of parts	Material	Width × length × thickness	Hardware/decoration
2	Red perspex	220 mm × 20 mm × 3 mm	1 × clock mechanism (60 mm × 60 mm × 40 mm)
3	Blue perspex	20 mm × 50 mm × 3 mm	1 × second hand (8 mm × 120 mm × 1 mm)

DESIGN process: COMMUNICATION

Final sketches and working drawings

When designing the clock, produce concept sketches and working drawings. These will help you to plan what the clock will look like and identify any problems that may arise. Often, an excellent design idea cannot be made because resources are unavailable or the adhesives or other joinery methods do not work.

See chapter 2, pages 44–6.

Promotion

Design a promotional package for your clock idea. Consider the four Ps: *price*, *place*, *promotion* and *product*. The promotional package should contain:

- an A4-sized pamphlet to present and promote the clock idea
- a business card for your company, stating the business's name, contact details and summarising its promotional activities
- an idea for packaging your clock.

Design process: EXPERIMENTATION AND TESTING

Prototyping and modelling

When designing and producing your project, it helps to construct a prototype or model to let you see what your clock will look like. This could be designed by hand or on computer, and be made out of cardboard.

When experimenting and testing, you need to:

- test material properties (see 5.1 Materials)
- test tools and construction techniques (see 5.2 Tools and techniques).

Design process: SAFETY AND RISK MANAGEMENT

Safety

Look again at the rules for basic safety in chapter 2, pages 51–3. Revise the general rules for working with polymers on page 120.

Switch on

1. Evaluate your final clock design. Is it safe to use?
2. Make a poster stating the safety rules for working with moulding and forming equipment. Try to use images only.
3. Describe all your PPE (personal protective equipment).
4. Identify three safety rules that need to be followed when using solvents and adhesives. Explain why the rules are necessary.
5. Investigate the risks associated with industrial methods of cutting plastic. Are there any similar risks to cutting plastic in the classroom?

Design process: PRODUCTION

Materials

You will be provided with a 400 mm × 400 mm sheet of perspex. Your choice of extra materials for decorating the clock is large and varied: scraps of timber, metal, perspex, aluminium foil, fabric, cardboard and recycled products such as ribbons, bottle tops, rubber, and so on.

An analogue mechanism, powered by a battery, makes the hands move and sits at the back of the clock. You must devise a way of making the mechanism invisible from the front.

Hands come in different sizes, shapes and colours, mainly black, silver, red and gold. Stick-on numbers — in Arabic or Roman numerals — are also available in different sizes and mainly in black, silver, red and gold. You could also use dots to indicate the four quadrants: 3 o'clock, 6 o'clock, 9 o'clock and 12 o'clock.

Tip

Remember that perspex sheets have protective paper on both sides to protect the surface from being scratched. Leave this on as long as you can.

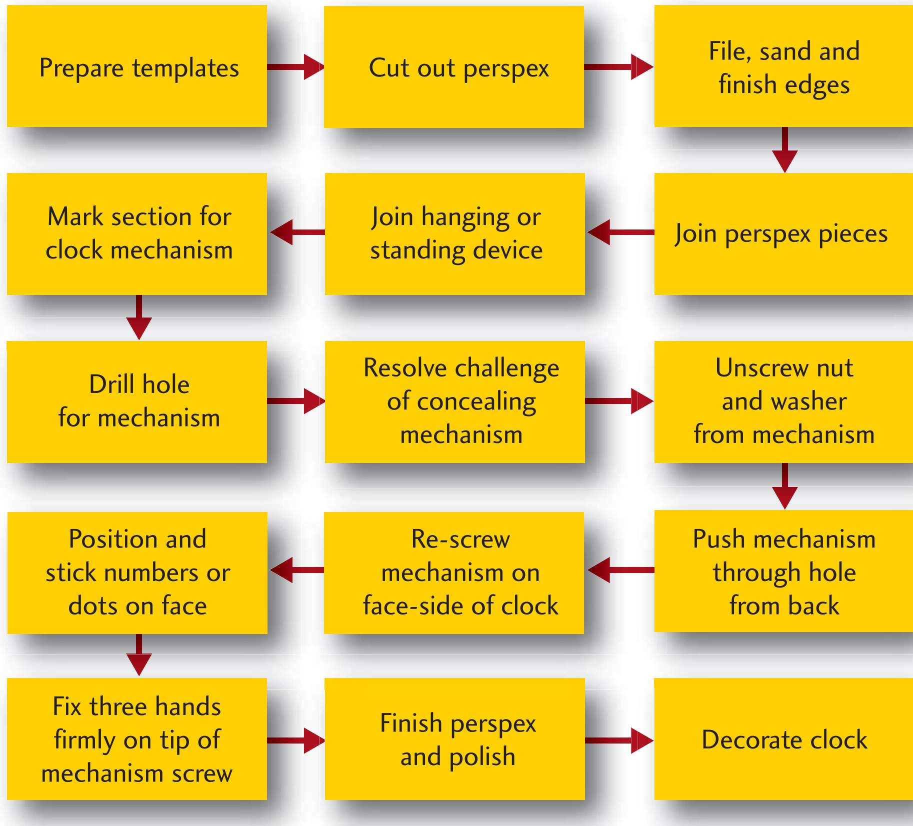


FIGURE 5.24: Production flow chart

Technobite

Plastic packaging allows food to be kept fresh and uncontaminated, attractively presented, easily transported and stored.

Tools and techniques

You may have to learn how to use several new tools. Selecting the correct tool and using it well will help you to produce a quality product. Make sure you are thoroughly familiar with how a tool works before using it on your project.

Cutting

Prepare paper templates of all the plastic pieces you need. You will have the basic clock face and optional other pieces, depending on how you decide to decorate your clock face. If you are making a standing clock, you will also need a template for the stand. Place these templates on the perspex and cut around them with the most appropriate tool.

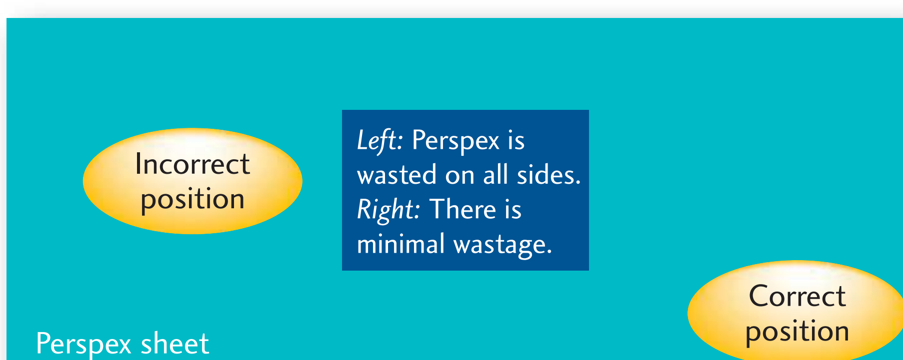


FIGURE 5.25: Position your template on the perspex sheet to avoid wastage.

Tip
Don't take the protective paper coating off the perspex sheet before finishing because it will scratch very easily if it comes in contact with files, abrasive paper, dust and so on.

See pages 121–2 for filing, sanding and finishing.
See pages 123–5 for bending, moulding and forming.
See page 125 for joining.
See page 125 for polishing and buffing.

Finishing
File, sand and finish the edges of the perspex. Once the clock pieces have been cut out and all parts are ready, finish the rough edges of the perspex *before* you begin the joinery because the joinery may cover some of the edges.

Applying heat
To bend, mould or form the plastic parts for your clock, you need to apply heat.

Joining
The next step is to join the pieces of perspex by mechanical fastenings or glues.

You should consider whether your clock is to hang or stand on a surface. This might be the right time to fix the device that will allow your clock to do one or the other, or you may wish to wait until the end of the project.

Clock mechanism
Mark out the centre of the clock face on the back of the perspex. Drill a hole, 9 mm in diameter, so that the mechanism to drive the hands can be guided into place. Unscrew the washer and nut from the mechanism screw. Push the mechanism screw through the hole in the clock face. Re-screw the washer and nut on the front side so that they hold the mechanism in place. You now have the challenge of hiding the clock mechanism from the front. How could you do this?

Clock face
Clocks are about getting us to places on time. Take great care to position the numbers on the face with accuracy. Stick the numbers in place. Firmly fix the hands on the plastic tip of the brass screw with a washer and nut.

Finish the perspex and polish.

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1	2	3	4	5	6	7	8	9	10	11	12

FIGURE 5.26: Roman and Arabic numerals — whichever you use, make sure they are clear and correctly positioned.

Decoration
Different materials have different properties. Some are easier to cut and manipulate than others. You can use different types of offcuts for this project. Add the recycled materials to the face after you have filed the edges and polished it. Remember the decoration on the face must not obstruct the hands.

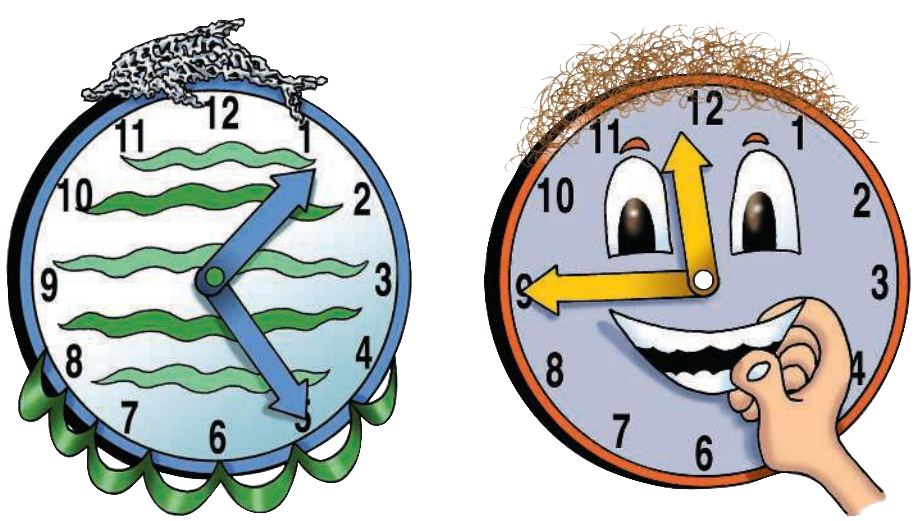


FIGURE 5.27: Ideas for decoration

Switch on

1. Design a project that joins polystyrene, acrylic and metal. Sketch and label the method of joinery, the products that would be used and the best order in which to use them.
2. Working with a partner or in a group, prepare a presentation on how to cut perspex. The purpose of your presentation is to teach other students the skills you have learned. Use multimedia, PowerPoint, cardboard models or flow charts.
3. Find out more about industrial methods of making polymer products:
   (a) Ask your teacher to organise an excursion to a plastics factory. After the excursion, complete a report on 'industry versus the classroom', and outline some of the similarities and differences you have noticed. For example, compare measuring and marking-out techniques that are used in the classroom to those used in industry.
   (b) Search the Internet or visit websites about how everyday things are made. To get started, go to www.jaconline.com.au/switchedontech and click on the Manufacturing and How Things Work weblinks for this chapter.
4. Use the Internet to search for more information about clocks, for example, the differences between analogue and digital clocks, or how the mechanism in the back of a clock actually works.

Techno**bite**

Plastic products and packaging make up approximately 30 per cent of Australia's manufacturing industry. Australia's plastics industry employs about 70 000 people and has an output of $4.1 billion every year. The plastics industry uses 2.7 per cent of the total energy consumed in Australia.

Design process: FINAL EVALUATION

Test the product

You have evaluated the product several times during the production process. Now you are ready for final testing to make sure that the clock works. Does the battery power the mechanism to turn the hands? Do the hands have a safe margin of clearance above the clock face decorations?

FIGURE 5.28: Does your clock work?

Professional, peer and self-evaluations

Ask your teacher and your classmates for objective evaluations of your clock. Then self-evaluate your project by asking the following questions.

1. Does your clock suit its intended location?
2. Check your product against your criteria for success. Did it meet them all?
3. Ask your teacher and your classmates for objective evaluations of your clock.
4. If you were to make your clock again, what changes or improvements would you make?
5. Did you enjoy this unit of work? Why or why not?

Design process checklist

ONLINE RESOURCE BANK

Go to the Online Resource Bank at www.jaconline.com.au/switchedontech and click on the Design Process Checklist. Use the checklist questions to self-evaluate your project and to help you finalise your design folio.

You can also find more ideas for design projects at the Online Resource Bank.

Textile technologies

Astronauts, elite sportspeople, stage and screen celebrities, musicians, fast cars, sailing ships, outdoor entertainment venues, soft furnishings and smart formal wear all have one thing in common — they use textiles to meet special needs.

We all wear textiles in the form of clothing to keep us warm and protect us from the environment. But textiles also enrich our lives in many other ways and give us opportunities to have fun and express our creativity.

There are so many types of textiles that the design possibilities are almost limitless. Textiles can be used to produce design projects in all areas of study: Built Environments, Products, or Information and Communications. Chapter 6 contains detailed information to help you design and produce your own pyjamas. While undertaking this project, you will learn about some of the materials, tools and construction techniques used in textile technologies. General sections in the chapter on materials, tools and techniques, and industry will extend the knowledge that you learn from the design project.

Focus

By the end of this chapter you will be able to:

- investigate fibre properties and fabric characteristics appropriate to the design project
- select and use appropriate textile materials for a design project
- select and correctly use appropriate tools and equipment for a design project
- select and use techniques appropriate for the purposes of a design project.

Technobite

The earliest textile structures were nets and baskets. Nets were made from a single thread, using a repeated movement to form loops. Baskets were woven by interlacing flexible reeds, canes or other suitable natural materials.

Switch on

1. **Make a list of 20 different textile items around your home. Choose two textile items from your list that you think could be improved in some way. Explain your choices.**
2. **What is the difference between the functional and aesthetic aspects of a design?**
3. **Invite a community member to demonstrate or teach a new textile skill to your class, for example, machine embroidery, spinning, machine quilting, lace making, shibori dyeing or silk painting. Sometimes it's just amazing to watch!**

6.1 Design process

Design project

Your design project for textile technologies is to produce a pair of pyjamas.
Area of study: Products. The focus of this area of study is on objects, systems and artifacts.
Design specialisation: Fashion design. Fashion designers create clothing and presentations to display their fashion designs.

FIGURE 6.1: Pyjamas can be fun as well as being comfortable to wear.

Design situation

Pyjamas keep us warm in winter and are comfortable to wear while we're asleep, but they're not just for that! We often wear pyjamas for relaxing at home and to sleepovers with friends. They can be fun garments that provide an opportunity to show our interests and feelings and say something about who we are. There are lots of pyjamas available; however, it is sometimes hard to find ones that express our personality.

Pyjamas are usually designed for a specific season and often for a target market, for example, children or babies.

Design brief

Design and produce a pair of pyjamas for your age group for the coming season. Include some type of decorative textile work on the pyjama top. The style, fabric prints, motifs, decoration and colours are up to you.

Project materials:

- a commercial pattern for the pants or shorts
- woven fabric for the pants or shorts (purchase your own)
- a ready-made singlet or T-shirt
- thread, elastic, fabric offcuts, dyes, fabric paints, fabric stabilisers, computer transfer-paper.

Techno**bite**

The word *pyjamas* comes from India where it described a loose two-piece suit of silk or cotton, originally worn during the day.

Designing and producing your pyjamas will involve a number of stages. You will need to think about the design brief, investigate the possibilities and carry out some research and experiments before finalising your fashion design.

Be flexible in your approach to this design process. The order of the steps is not set in concrete and you may not always follow the sequence presented here. Some steps go hand in hand with others throughout the design project. Other steps need to be completed before you can move on. You should concentrate on using the combined steps to form a process that guides the development of your design.

Look again at the design process in chapter 2, pages 20–1.

Design Folio **Production**

Your design folio is an important communication tool for design projects. It should tell the story of your design project's development, from your first rough ideas on paper to the final evaluation of your design brief solution.

Consider composing your design folio in electronic format for this technology.

Design process: ONGOING EVALUATION

Essential for success

Remember that ongoing evaluation is central to the design process and should occur at every step. Regular evaluation helps to identify problems and challenges at the right time for you to deal with them. Putting evaluation off until later is asking for trouble. For example:

- wasted resources
- lost time
- failure to meet deadlines
- increased costs.

Design process: ANALYSIS

Thinking about the design brief

All the words underlined in the design brief help you to analyse it. Copy this brief into your folio, then write down any questions or thoughts you have about the underlined words.

> Design and produce a pair of pyjamas for your age group for the coming season. Include some type of decorative textile work on the pyjama top. The style, fabric prints, motifs, decoration and colours are up to you.
>
> *Project materials:*
>
> - a commercial pattern for the pants or shorts
> - woven fabric for the pants or shorts (purchase your own)
> - a ready-made singlet or T-shirt
> - thread, elastic, fabric offcuts, dyes, fabric paints, fabric stabilisers, computer transfer-paper.

FIGURE 6.2: Inspiration can come from many sources, such as from shells.

Analysing the design situation and design brief

When you answer the following questions, you have already started to research and create design ideas. These analysis questions could help you design your pyjamas.

1. What season are you designing for?
2. What age is your target market?
3. What decorative techniques will you experiment with? Which one do you enjoy the most?
4. What are your favourite interests, colours and objects?
5. Try these ideas for gaining inspiration for your designs.
   (a) Assess existing designs in your local shopping centre, in brochures and on the Internet.
   (b) Play your favourite music and doodle a few thumbnail sketches.
   (c) Brainstorm some design ideas based on something you like, for example, shells, a colour or cars.
   (d) Choose and research a culture in which you are interested. Draw inspiration from the colours and designs of that culture.
6. Where will you buy patterns, fabric and ready-made tops?

Resources

Now think about the resources you will need to make your pyjamas. Make a list of the specific resources you already have. Also list where you might obtain some additional resources. Here are three to get you started:

- sewing machine (available in the classroom)
- commercial pattern (need to buy)
- dyes and equipment for tie-dyeing (available at school).

Copy the points above into your design folio and add the other resources you have thought of to this list.

Design process: MANAGEMENT

Getting organised

Managing your project must be considered alongside other steps in the design process. You will need to constantly review your work and your progress.

- Develop action-management, time-management and budget-management plans.
- Evaluate and justify any changes to your management plans, outlining impacts on the design project's development. This will mean re-evaluating your management plans regularly during your design project.
- Plan and manage available resources effectively and efficiently.
- Evaluate available resources to determine how appropriate they are to your design brief and the criteria you have developed.

Design process: RESEARCH

Investigating the design brief

To meet the needs of your target market and to enable you to come up with a successful final design, you will need to investigate the design brief. There are many ways of doing this.

FIGURE 6.3: Pyjama party

Technobite

One of the earliest sewing machines was invented by Frenchman Barthélemy Thimonnier in the late 1830s. He wanted to mass-produce uniforms for the French Army. The tailors thought that was a very bad idea! Fearing they would be put out of work, they stormed Thimonnier's workshop and destroyed every machine he had made.

Market research

Try one of these ways to test the market for your teenage pyjama designs.

- Hold a pyjama party with several of your friends. Bring your preliminary sketches and vote for the most popular designs.
- Scan your sketches into the computer. Email them to your friends and get their opinions.
- Take digital photos of your class in pyjamas they already own. Make a class noticeboard and add your sketches around the photos. Choose the top five designs.

Materials

The pants or shorts could be made from polyester-cotton plain weave, firm polyester-satin or flannelette. Try sewing a seam in each of these fabrics. Which did you find easiest to sew? Which one do you like best? Which type of fabric will you choose? Why?

The T-shirt or singlet you buy will be made from a knitted fabric. Compare the feel and characteristics of a *woven* fabric to a *knitted* fabric. Why do you think knitted fabric is a good choice for pyjamas?

Tools

The tools you are likely to use include scissors, pins, a tape measure, a sewing machine, an overlocker and an iron. Find out where all these tools are kept and research the skills you need to be able to use them.

FIGURE 6.4: Sewing machine

Techniques

Learning to use a sewing machine takes time and practice, much the same as learning to ride a bicycle, play a musical instrument or drive a car.

See page 153 for some fun ideas and exercises that will help you learn how to use a sewing machine.

Switch on

1. Investigate several of the following decorative techniques:
   - tie-dyeing
   - fabric printing
   - appliqué
   - machine embroidery
   - heat transfer using computer transfer-paper.
2. Your teacher may have other techniques to share. Which ones are attractive and easy to do? Look back at your sketches and consider which technique would apply to each design.

Design process: IDEAS GENERATION

Brainstorming

See chapter 2, pages 39–40.

Remember the purpose of brainstorming is to generate as many ideas as possible in a short period of time. It's important not to judge the suitability of an idea at this stage — the craziest thoughts may spark the most creative and original ideas!

Often, clothing companies have a team of designers and they produce a range of garments for the coming season that are linked with a theme.

Switch on

In a group of three or four students, brainstorm ideas for a pyjama range theme. Figure 6.5 shows a few ideas to get you started.

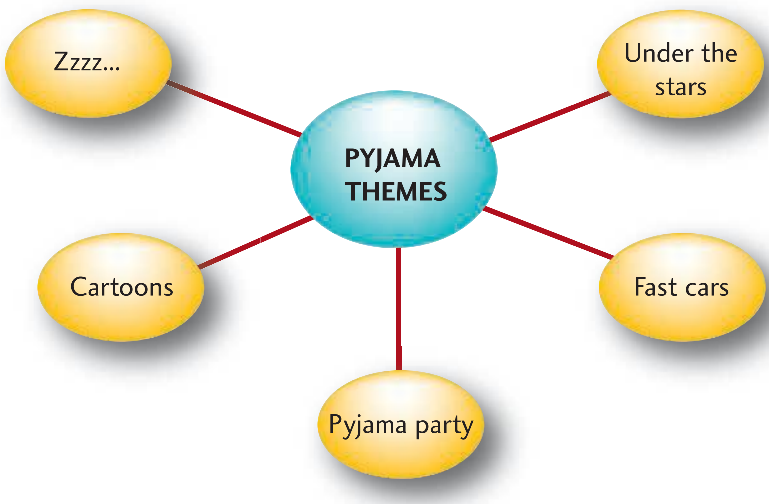


FIGURE 6.5: Brainstorm ideas

Mind maps

Prepare a mind map in your design team for at least two of the ideas you came up with in your brainstorming session (see figure 6.6).

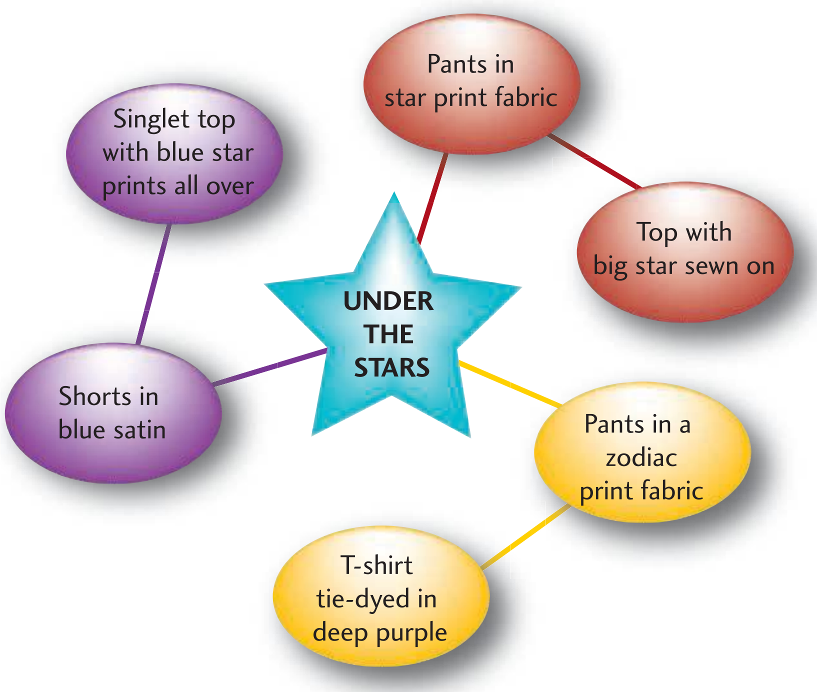


FIGURE 6.6: Mind map: possible designs based on a theme

Sketches

Thumbnail sketches are tiny, quick, rough sketches of your initial ideas. Use a page in your design folio to draw at least five to six thumbnail sketches of your ideas. Add labels.

FIGURE 6.7: Examples of thumbnail sketches for pyjama designs

Look again at the information on interviews and questionnaires in chapter 2, pages 36–7.

Interviews and questionnaires

Your questionnaire could be based around six to eight pictures from catalogues or magazines or you could use your own sketches. Include closed and open questions.

- What is your aim?
- Who should you survey? Why?

Predictions

Fashion designers often work several seasons in advance so they have to predict fashion trends. Use magazines, store brochures and the Internet to look at current trends. Predict how you think the trends will change in the year to come.

Switch on

1. Convene a meeting of your design team. Choose a catchy name for your fashion company.
2. Use magazines and brochures to make a collage that illustrates current trends in pyjamas.
3. Research fashion trends for pyjamas for your age group. Imagine you are writing an article for your favourite magazine. Present this article using computer software such as Microsoft Publisher, Microsoft Word, Adobe Photoshop or Adobe PageMaker and a magazine-style layout with graphics and text.
4. In your design team, put together a presentation to the class of your thumbnail sketches. You could enlarge them or put them onto an overhead transparency. You may like to watch an appropriate segment in a movie first, such as *Small Soldiers*, *What Women Want*, or *Elf*, when designers present their ideas to management. Set your classroom up like a boardroom.

Criteria for success

Consider your limitations. It takes time to learn new techniques, so this may limit the style of your pyjamas. List other constraints. You are aiming for an outfit of good quality, so it is important to consider your limitations carefully.

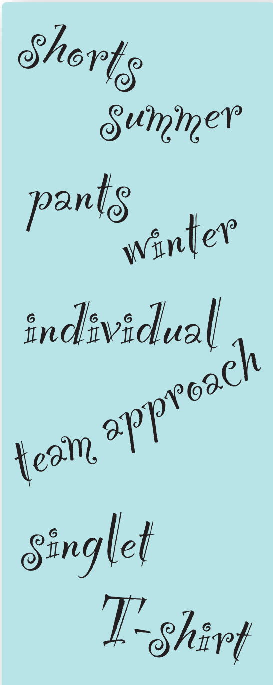


FIGURE 6.8: Circle the words that apply to the type of design you are thinking about.

Answer the following questions:

1. What is your budget?
2. How will the time you have available affect your design?
3. Where can you buy fabric?
4. How many sewing machines are available to your group and how often are they available?
5. Do you already have some skills at operating a sewing machine or is it new to you?
6. What decorative techniques will you need to learn about?

Creating a successful project depends on a number of factors. You will evaluate your success by referring back to your criteria as your project develops and when it is complete.

Reconvene your design team and come up with a list of eight to ten criteria. The first two are listed below for you.

1. The design is a fun one suited to my age group.
2. The pyjamas are easy to put on and take off.

Copy these and the rest of your criteria for success into your design folio.

Preliminary sketches and plans for the solution

It's now time to make some decisions about the details of your design. See figure 6.8 to help you with these decisions.

Draw three full-page sketches of possible designs. Label all the design details, colours, fabric types and decorative techniques.

FIGURE 6.9: Labelled drawing

Refer to page 163 for some tips on fashion drawing.

Design process: COMMUNICATION

Final sketches and production drawings

Fashion designers prepare drawings to communicate their designs to the pattern makers. Fashion drawings are often very artistic and stylised and the proportions are exaggerated. Choose your final design and do a fashion drawing of it.

Production drawings are another type of drawing done by clothing designers. These are structured drawings (without a figure) that communicate design details, construction features, measurements and materials. The pattern maker and the manufacturer are able to understand the designer's intentions from this type of drawing.

Complete a simple production drawing for your pants or shorts.

Many fashion designers now use computer-aided design (CAD) to prepare their fashion and production drawings. You could develop your computer skills by researching how to draw your design using a CAD program.

Many companies have logos and registered trademarks. Recent trends have seen these printed as motifs on clothing. It is illegal and unethical to copy these logos and trademarks, but you can create your own.

Switch on

Design a logo for your fashion label. Think of three ways that you could include it on your design.

Design process: EXPERIMENTATION AND TESTING

Constructing a prototype and evaluating the model

It's a good idea to ensure that the construction of your project will be successful by preparing a prototype. In the clothing industry, prototypes are called sample garments, or *toiles*. Your class as a group might like to construct two or three sample pants in different sizes from calico or poplin. This will enable you to check the size before you cut your fabric.

Before you cut out your garment, use a small piece of the fabric to test out a sample seam and hem. Are you happy with your skill level? Do you need to make any changes to your design now that you have prepared samples?

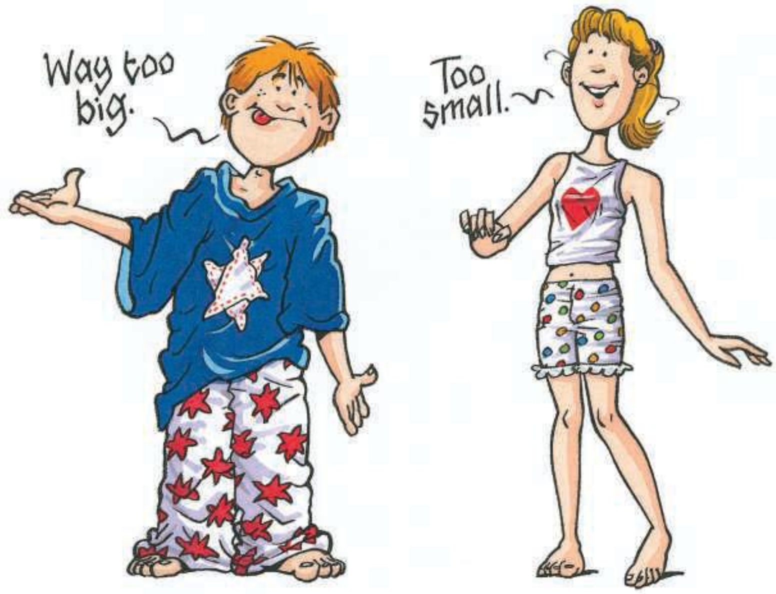


FIGURE 6.10: Testing pyjamas for fit

Safety

Look again at the rules for basic safety in chapter 2, pages 51–3, before you start to make your project.

Design process: SAFETY AND RISK MANAGEMENT

General rules for working with textiles

- Use safe cutting techniques with scissors.
- Remember correct posture at the sewing machine (see page 153).
- Only one person at a time should operate a sewing machine.
- Keep your fingers clear of the needle area of a sewing machine.
- Always turn off the iron after use and stand it up.
- Wear a dust mask when mixing up dyes.
- Wear protective gloves when dyeing and printing fabrics.

You will find more safety rules that apply specifically to textile technologies throughout this chapter. Observe them!

Design process: PRODUCTION

What to do first

Your pyjamas will be constructed in two main sections:

1. using a commercial pattern to make the pants or shorts
2. applying a decorative technique to the top.

Check your time-management plan, considering the detail, skills and resources required in each of the above sections. Refer to your production drawing, which indicates the materials, tools and techniques you will use.

In the textile industry, the designer works out a list of requirements including fabrics, threads, buttons, zippers and other notions. These are called *manufacturing specifications*. Calculate how much fabric you need to buy from reading the back of a commercial pattern envelope.

The back of the envelope lists notions. What are they? Make a list of the notions you should buy when you purchase your fabric.

You will use a variety of materials, tools and techniques to produce your pyjamas.

Technobite

The ancient Egyptians used cotton, silk, wool and flax fibres. Cotton fabric was woven in India as early as 3000 BC and Chinese records of about the same time mention silk production.

Materials

Fabrics

Different fabrics have different properties. Some are easier to sew than others and they feel different to wear. Plain weave fabrics are easy to sew and are therefore a good choice for beginners. Your pyjama pants or shorts are made from woven fabric.

T-shirts and stretchy singlet tops are made from knitted fabrics. Because they stretch they are very comfortable to move around in, especially as you sleep.

Switch on

Fabric investigation. Work in pairs to complete the following.

(a) Obtain some samples of plain weave, satin, flannelette and knitted fabrics.

(b) Examine each sample carefully, feel its texture and describe the weave.

(c) List the properties of each fabric.

(d) Predict which fabric will be easiest to sew.

Threads

Choose a good-quality sewing thread for constructing your garment. Machine-sewing threads made from polyester are very strong and smooth.

For appliqué and machine embroidery, you may like to use special machine-embroidery thread — a fine, shiny thread made from rayon.

Dyes and paints

There are several types of dyes and fabric paints available. Most dyes work best on 100 per cent cotton fabrics. Use a dye fixative and steam iron on painted or printed fabric so that the fabric is colour-fast.

Heat transfer-paper

You can use the computer to create an image, logo or catchy saying. Print it onto heat transfer-paper, and then iron it directly onto your garment. Don't forget about the ethical and legal restrictions if you choose this technique.

FIGURE 6.11: Tape measure

Tools and techniques

Using the correct tool and using it well will help you to create a quality garment.

Tape measure: You will need to take some measurements of your body to ensure you make your pyjamas to the correct size. Work in pairs and measure your partner so that the measurements are accurate. Hold the tape measure carefully, measuring from the zero end. Aim for a comfortable fit rather than pulling the tape measure too tight. You will need hip, waist, and length measurements. Write them down and then check the pattern envelope to determine your size.

Patterns: The pattern envelope contains two parts.

1. *Pattern guide*. This has detailed written instructions on how to make the item.
2. *Tissue pattern*. Patterns often include pieces that are multisized. That is, they come in three sizes — for example, small, medium and large — usually on the one pattern piece. Select the size you need and cut on the appropriate line or use a combination to get a perfect fit: for example, your waist may be small and your hips medium. Multisized patterns do not show the stitching line; however, a seam allowance of 1.5 cm is always included.

Patterns have special markings on them that help you to construct the article well. Look at your pattern to identify some important markings:

- *Grain line*. This arrow or line shows you the direction for placing the pattern onto the fabric. A lengthwise grain line is called the straight grain and it should be placed parallel to the selvedge of the fabric.

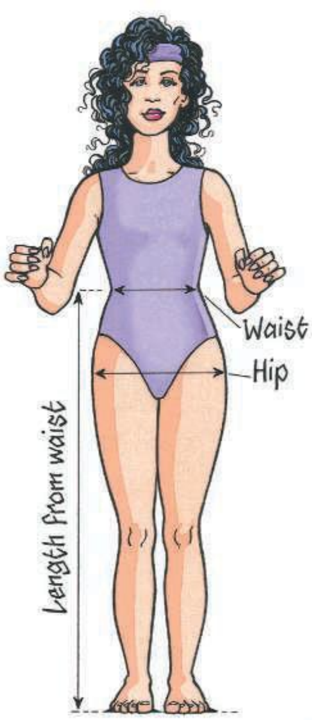


FIGURE 6.12: Measuring your hips, waist and length

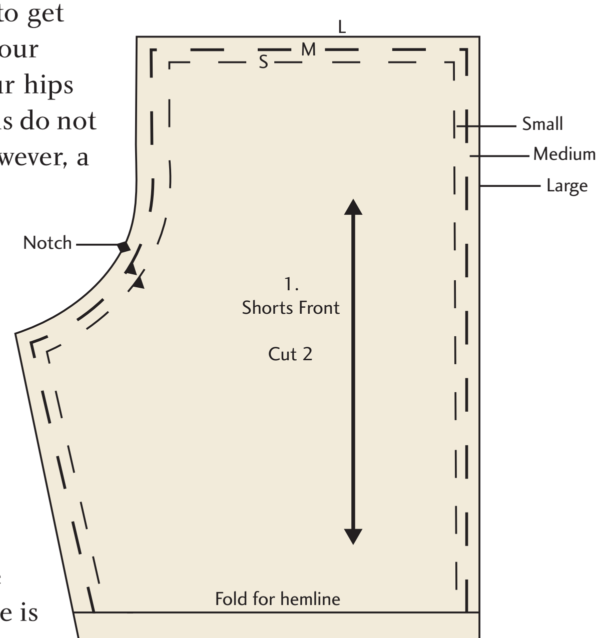


FIGURE 6.13: Commercial pattern piece showing markings

- *Notches*. These are small diamond shapes on the pattern edge that help you match the pieces up correctly. Notches are really useful as they provide little clues (like a jigsaw puzzle) so you know whether you are putting the pieces together correctly. Always cut around notches. A single notch usually indicates the front and a double notch the back.

Pattern layout

Woven fabric has a firm edge on each side of the length of the fabric, made during the weaving process on the loom. This is called the selvedge.

Fold the fabric lengthwise so that the two selvedges meet. Place the patterns on the fabric so that the grain line is parallel to the selvedge. Measure from each end of the arrow to the edge of the fabric to check that the pattern is parallel.

Some fabrics have a one-way print. This is called a *nap*. Make sure you cut all the pattern pieces up the one way if your fabric has a nap.

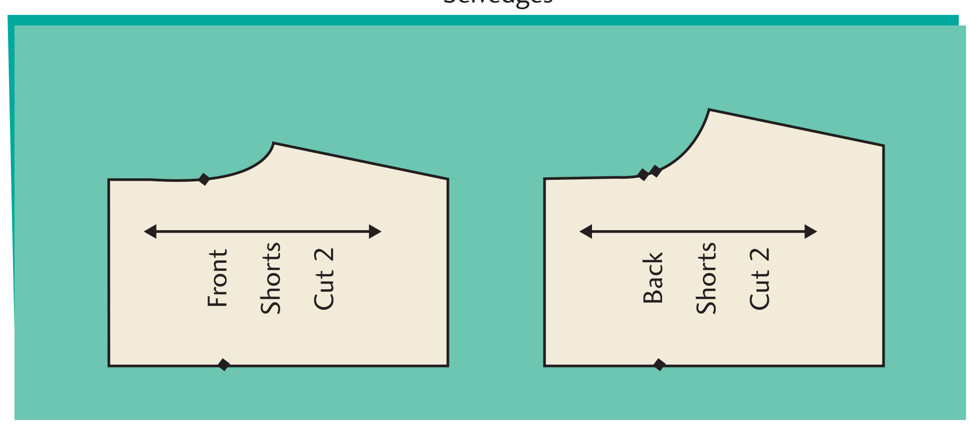


FIGURE 6.14: Pattern layout

PINS: Use fine, sharp pins that are suited to the weight of your fabric. Pearl-head pins are good because they are fine and easy to use. Satin fabrics may need fine lace pins to prevent snagging.

SCISSORS: *Dressmaker's shears* (or scissors) are large and sharp. Use them on fabric only — paper will blunt them. Keep a pair of sharp *embroidery scissors* near the sewing machine for trimming threads.

FIGURE 6.15: Dressmaker's shears (top) and embroidery scissors (bottom)

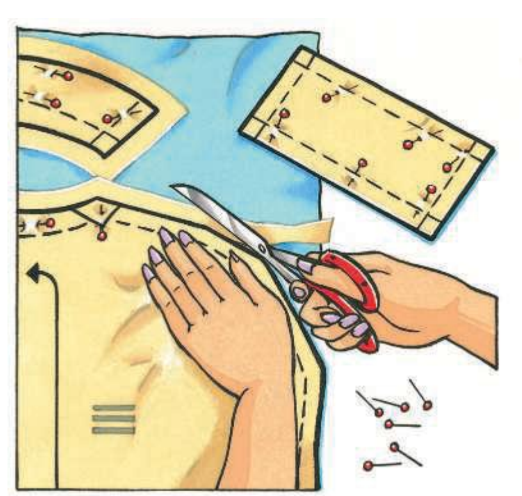


FIGURE 6.16: Correct cutting technique. Place your left hand (or right hand, if you are left-handed) on the pattern and fabric. Use your other hand to carefully cut with the scissors around the pattern without pulling the fabric from underneath the pattern. Use the full length of the blade rather than little snips.

Tip
The fine point on a sewing machine needle wears out after only eight hours of sewing. A blunt needle can cause missed stitches and snags. Change the needle regularly.

Technobite
Modern sewing machines are usually powered by an electric motor. This hasn't always been so and foot-treadle machines are still used in many parts of the world. China produces the most sewing machines. Japanese manufacturers pioneered the versatile zigzag machine.

Sewing machine: This is a major tool for textile technologies. Correct posture at a sewing machine means:

- sitting with a straight back
- eyes and body in front of the stitching area
- your right heel on the floor in front of the foot control
- both hands guiding the fabric.

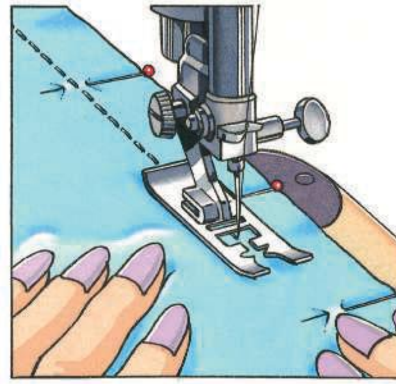


FIGURE 6.17: Place pins in the seam perpendicular to the edge of the fabric and stitch 1.5 cm from the edge.

Your teacher will show you how to thread the sewing machines in your classroom. You will use a machine for sewing the seams, hems and top casing of your pyjama pants. Practise straight stitching using the guideline marks on the machine to help.

All patterns allow seams that are 1.5 cm wide. To construct a seam, place the two pieces of fabric right sides together. Place the pins perpendicular to the edge of the fabric at 10 cm intervals. Stitch a straight line 1.5 cm from the edge.

Once you know the basics, have fun exploring and developing skills. Sewing machines are available with many specialised features. For example, machines can make buttonholes, stitch your name, create amazing graphics, sew on buttons and beads, gather and ruffle exquisite frills, and make lace. It takes time to learn how to use all the features on your sewing machine, but practice is the key!

Switch on

1. Try this activity with a friend.
   (a) Use small adhesive notes to write the following labels: stitch length, stitch width, presser foot lever, hand wheel, stitch selector, reverse, feed dogs, needle screw.
   (b) Examine the sewing machine, and use a double layer of fabric to stitch carefully. Work out where each label belongs on the machine as you practise sewing. Move only one dial at a time so you can work out what it does. Attach the labels to the machine.
2. Write your initials in very large letters on an A4-sized piece of fabric. Stitch around the letters using a zigzag stitch.
3. Thread every machine in the classroom with a different colour cotton. Each student sews a row of a fancy stitch on a piece of coloured fabric, black fabric or felt. Then every student takes his or her fabric to the next machine to sew a row of different stitching. Keep moving until everyone has a crazily stitched piece of fabric! You could mount this into a card or use it to make crazy decorations for parties or Christmas trees!
4. Design a Christmas decoration or birthday gift using your crazy fabric.

FIGURE 6.18: Overlocker

Overlocker: An overlocker cuts and stitches over the edge of the fabric to prevent it fraying. This neatens the edges and gives a professional finish.

Safety
You will need permission from your teacher before using an overlocker. Keep your fingers away from the cutting blade area of the overlocker.

Tip
Check there are no pins in your seam. They will blunt and ruin the overlocker's blade.

Safety

Switch on

Ask your teacher to thread an overlocker with four different coloured threads. You should be able to see what each thread does. Practise stitching edges on sample fabrics.

IRON: You will get a more professional finish if you press each seam with an iron after it is stitched. It is also easier to stitch the casings and hems if they are pressed first. Irons have temperature and steam settings that you will need to adjust to suit your fabric type.

You will need permission from your teacher before using an iron.

Tip
Check and adjust the iron's temperature every time you use it. An iron that is too hot will melt polyester fabric such as the satin used in boxer shorts!

Switch on

Iron investigation. Work in groups to investigate the following queries.

1. What is the best height and position for the ironing board? Why?
2. How do you put water into the iron?
3. What settings do you need to adjust for different fabrics?
4. At what temperature would you iron cotton, wool, silk and nylon?
5. What would happen if you ironed very fine polyester satin with a hot iron?
6. What is the difference between *pressing* and *ironing*?
7. Make a fun poster of handy hints for using an iron in your classroom.

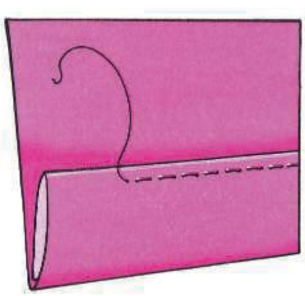


FIGURE 6.19: Double hem

Special techniques

Hems

A double hem is a good choice for pyjamas as it is firm, neat and strong. Try the pants or shorts on and mark the length you would like. Allow 4 cm for the hem. Turn the edge of the fabric up 2 cm, then 2 cm again. Press, pin and neatly stitch by machine.

Fit the product

You will need to test the fit of your pyjamas after the first seams are sewn and again to check the hem length. You can make adjustments at this stage. After the pyjamas are complete, evaluate your project by referring back to your criteria for success.

Casings for elastic and cord

The casing for the elastic or drawstring is constructed the same way as the hem. A second row of stitching at the top of the casing prevents the top of the pants from rolling and looks neat. Don't forget to leave an opening for the elastic or cord to be threaded through.

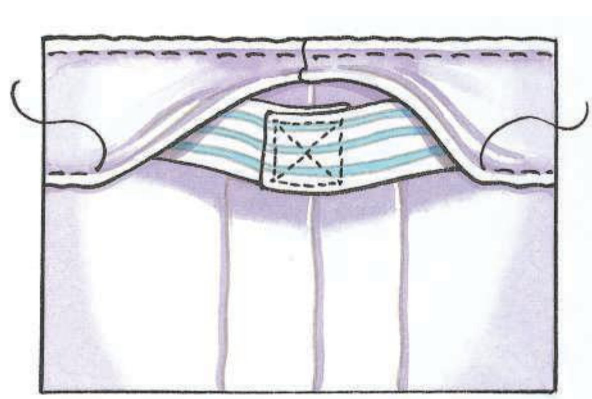


FIGURE 6.20: Top casing

There are lots of decorative techniques you could use on the T-shirt or singlet top. Refer to page 162 for ideas and tips.

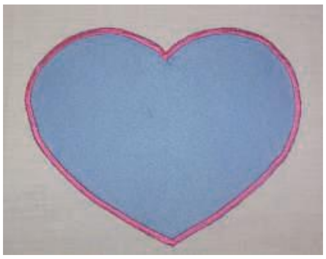


FIGURE 6.21: Appliquéd heart

Decorative techniques

Appliqué

This is a fun method of applying different fabrics to a base fabric and stitching them down with a decorative stitch. You could use motifs from your pants fabric or design your own using offcuts. A heart is a good shape to practise with.

Follow these instructions.

1. Use double-sided fusible webbing such as Vlisofix to prepare a motif. Iron it to the back of the contrast fabric.
2. Cut out your motif. Peel off the backing.
3. Iron it onto your T-shirt.
4. Use a fabric stabiliser, such as Stitch-n-Tear®, on the back.
5. Set the machine to a short zigzag, for example, length: 0.3, width: 3.
6. Stitch around using a zigzag stitch.

Switch on

1. What first aid treatment would you give a classmate who burnt his or her hand while using the iron?
2. Cotton is a popular fibre used to make plain weave fabrics that are used for summer pyjamas. Go to www.jaconline.com.au/switchedontech and click on the Cotton Australia weblink to find out three reasons for this.
3. What does colour-fast mean?
4. Research other ways to finish the lower edge of the pyjamas. A few ideas to find out about include lace, contrast fabric bands, piping and frills.
5. The pattern for pyjama pants includes a straight grain line and notches. Patterns can have many other markings. Look at a pattern and investigate the meanings of five other markings.
6. Make up a group promotional campaign such as a photo shoot, fashion parade or television advertisement. Video or photograph it at a class pyjama party.
7. Invite a senior textile student to your class to demonstrate some advanced sewing machine techniques and to show you his or her major project. Perhaps several students could come and demonstrate these techniques to small groups.

Technobite

From the 1600s, *sadirons* were used in Europe for smoothing fabric. These slabs of cast iron, pointed at the front and with a handle, were heated on or by the fire. An iron box filled with hot coals came later. But irons are no longer made of iron. The first electric irons with thermostatically controlled temperatures and light aluminium *sole plates* went on sale in the 1920s. Steam irons followed, and some of today's irons may even be cordless.

Design process: FINAL EVALUATION

Peer and self-evaluations

Hold a class pyjama party. Use a digital camera or video camera to record it. Answer the following questions at the party:

1. Are the designs popular with your age group (your target market)?
2. Have you met a market need?
3. Are the pyjamas well made and comfortable to wear?
4. Did you learn and develop new skills?
5. How could you develop these skills in the future?

6.2 Materials

Fabrics

There are many different fabrics available. You can probably identify some of them, for example, denim, corduroy, calico, satin, flannelette, polar fleece and rugby knit.

Fabrics are grouped according to the way they are made. Although there are many methods of fabric construction, the main three types of fabric are woven, knitted and non-woven.

Designers choose a fabric type according to the end use of the item made from it. Sometimes designers have a fabric specially created for a particular design. Understanding the characteristics of the main fabric types will help you to make good fabric choices when you are designing and producing your own textile projects.

Technobite

Evidence of Egyptian weaving dates back to 5000 BC. Very fine woven linen that is dated to around 3000 BC has been found with up to 64 warp threads per centimetre.

Woven fabrics

Woven fabrics are made on a loom using two sets of yarns (also called threads). The *warp yarns* are the parallel yarns that run the whole length of the fabric. The *weft yarns* pass across the warp going over and under, over and under, creating a crisscross effect. This is often referred to as *interlacing* (see figure 6.22).

Imagine how many variations of fabric designs you could create by changing the thickness or smoothness of the yarn, by pushing the yarns close together or spreading them apart, by using different coloured yarns or by crossing over two, three or four warp threads each time. In fact, this is exactly what happens, and it results in hundreds of different fabrics all with different characteristics. *Plain*, *twill* and *satin weave* are the most common.

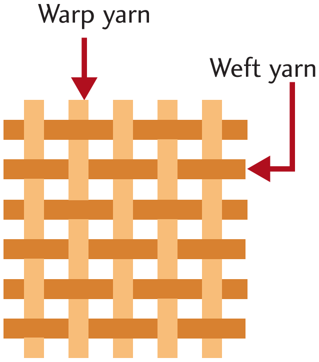
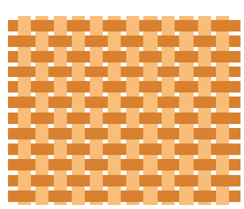
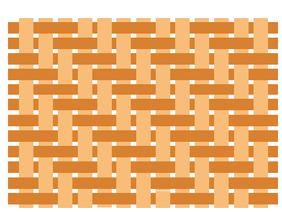
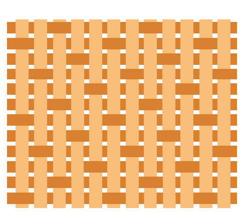


FIGURE 6.22: Plain weave fabric showing warp and weft yarns

TABLE 6.1: The three most common fabrics

Weave		Characteristics
Plain		Plain weaves are fast and easy to make, so they are often economical. They are usually firm, open, light fabrics that are smooth and easily printed on.
Twill		Twill weaves have a diagonal line formed by the weaving pattern. The yarns can be pushed more closely together resulting in a fabric that is very firm, strong and durable.
Satin		Satin weaves have a very smooth surface due to the long floats formed. The resulting fabric is lustrous, soft and drapes well; however, it can be weak and snag easily.

Technobite

Joseph-Marie Jacquard invented a weaving loom in 1801 that used a system of punch cards and hooks. This information storing system led to the development of the first computers.

Techno**bite**

The newest circular knitting machines can knit 1500 stitches every second!

FIGURE 6.23: Knitted fabrics allow for movement.

Knitted fabrics

Knitted fabrics are produced on knitting machines using special needles. Knitting involves forming rows of loops of yarn, then pulling new loops through. This is referred to as *interlooping*. The loops in a knitted fabric allow the fabric to stretch. Knitted fabrics are easy to care for, comfortable to wear, drape well and don't crease as much as woven fabrics.

Variations in knitted fabrics result in a wide range of fabrics with different characteristics. Some of the most common knitted fabrics are jersey knit, rib knit and polar fleece.

Non-woven fabrics

Look at the stabiliser fabric you used when doing appliqué or a similar non-woven fabric that your teacher provides. Pull some apart. How do you think it is made?

Non-woven fabrics are made by laying out a web of fibres that are then bonded in some way. This could be by applying friction to matt the fibres together, for example, felt, or by using glue, heat bonding or stitching, for example, Stitch-n-Tear®. Non-woven fabrics do not use yarns and the process to produce them is quite simple and fast so they are often very economical.

Switch on

1. Research non-woven fabrics on the Internet or in libraries. What are their disadvantages?
2. Non-woven fabrics have become a very popular fabric in the medical and cleaning industries. Why do you think this has happened?

FIGURE 6.24: Non-woven fabric is widely used in the medical industry.

Fibres

As a designer, you would probably choose twill fabric or denim for jeans because they are strong, durable and fashionable fabrics. Designers also need to decide which fibre suits their product. For example, would you choose cotton, wool, polyester, another fibre, or a combination for your pyjamas? Why?

Knowing the characteristics of fibres, such as where they come from, and how they look, feel and act will help you to select and use fibres that are appropriate for your project.

Textile fibres are grouped or classified according to where they come from. The two main classifications of fibres are natural and artificial.

Natural fibres

Natural fibres occur in our natural environment. They come from animals or plants. Natural fibres must be removed from the animal or harvested from a plant, and are then processed into yarns and fabrics. Cotton, wool, silk, linen, angora and sisal hemp are natural fibres.

Artificial fibres

Artificial fibres are created in two ways:

1. chemically changing fibres or substances found in nature. This is called a *regenerated* fibre. Regenerated fibres include rayon, acetate and lyocell.

2. using a chemical solution to create a continuous strand or filament. This is called a *synthetic* fibre. Synthetic fibres include nylon, polyester, acrylic and elastomer.

Choosing textiles

When choosing a textile for a particular purpose, the designer needs to consider the characteristics and properties of the fabric and the fibre. For example, an umbrella made from brightly coloured cotton knit fabric might look great but wouldn't function well. Why not?

It's a good idea to carry out tests on fabrics you think might be suitable and to research the properties of the fibre. Fibre properties can be generalised but the fabric structure can alter this a little. Use table 6.2 to help you make decisions about which fibre to choose. For each property, the best performers are at the top of the table and the lowest performers are at the bottom.

TABLE 6.2: Fibre properties

Strength	Resilience	Absorbency	Flammability	Drape	Conductivity	Care
Strong	*Springs back well*	*Very absorbent*	*Very flammable*	*Drapes well*	*Good — a cool fibre*	*General care*
Nylon	Nylon	Wool	Cotton	Silk	Cotton	Cotton
Polyester	Elastomeric	Silk	Polyester	Wool	Silk	Polyester
Acrylic	Polyester	Cotton	Nylon	Cotton	Polyester	Nylon
Elastomeric	Wool	Polyester	Elastomeric	Acrylic	Elastomeric	Elastomeric
Silk	Acrylic	Acrylic	Acrylic	Polyester	Acrylic	Acrylic
Cotton	Silk	Nylon	Wool	Nylon	Nylon	Silk
Wool	Cotton	Elastomeric	Silk	Elastomeric	Wool	Wool
Not very strong	*Does not spring back well (creases)*	*Not very absorbent*	*Not flammable*	*Does not drape well*	*Poor — a warm fibre*	*Special care*

Technobite

Nanotechnology is a newly emerging field in the production of textiles. It could lead to advances such as insect-repellent clothing, shirts that never rip, and clothes that change colour to adjust to their surroundings.

Fibre blends

A designer will often decide that one fibre may not meet all the requirements for a specific end-use. Some disadvantages can be overcome by blending two or more fibres. On a label, the fibres are listed with the fibre used in the highest percentage first. Some popular blends include:

- polyester/cotton — popular for shirts and bed linen
- cotton/wool — commonly known as denimwool, for jeans
- cotton/nylon — often used to make socks.

Quality control

In industry, fabrics and garments undergo testing for quality control. We don't want our clothes to shrink or stretch, fade, lose their colour in the wash or crease too much, so manufacturers will conduct tests to ensure their textiles meet these requirements and are generally of a high quality.

Technobite

The golden orb spider's web is four times stronger than steel of the same diameter. Scientists are trying to copy this textile to create bulletproof vests.

Switch on

1. *Test it!*
   (a) Cut four 10 cm × 10 cm pieces of the fabric you are using for your project.
   (b) Zigzag or overlock the edges, taking care to keep the size of the squares even.
   (c) Number the squares 1–4 using a permanent marker.
   (d) Treat the squares in the following ways:
      (i) Do nothing to square 1 — this is the control piece.
      (ii) Wash square 2 by hand in cold water and dry in the sun.
      (iii) Wash square 3 by machine and tumble dry at a hot temperature.
      (iv) Iron square 4 with a hot iron.
   (e) Did you notice any changes? What recommendations would you make to the consumer about caring for the fabric?
   (f) Mount your samples with labels in your folio and record the results and conclusions.
2. Name a textile item that is made from each of the following fabrics: denim, corduroy, calico, satin, flannelette, polar fleece and rugby knit.
3. Name three fabrics other than those in the previous question.
4. Select three pictures of teenagers from your favourite magazine and paste them into your design folio. Write labels around the pictures identifying the possible fabric and fibre types that their clothing and accessories may be made from.
5. Match the fabric type to the most appropriate end-use.

Plain weave	Evening gown
Twill weave	T-shirt
Satin weave	Singlet
Jersey knit	Cleaning cloth
Rugby knit	Work overalls
Rib knit	Football jersey
Non-woven	Business shirt

6. What is sisal hemp made from? Find out the names of two other less common natural fibres.
7. Create a poster or class display board on the theme '101 uses for nylon'. Challenge the group to find pictures or labels for 101 uses!
8. Research how one synthetic fibre is made. Present your information using a PowerPoint presentation.

Technobite

New fibres made from corn are fast becoming a success, particularly because corn is an easily renewable resource, unlike the petrochemicals used to make synthetic fibres.

6.3 Tools and techniques

Many special tools are used in textile technologies. You have already come across a number of them when making your pyjamas. A few other special tools can help you to create better quality projects as well as being fun to use!

Measuring and cutting tools

ROTARY CUTTER, RULER AND CUTTING MAT: Rotary cutters are like a pizza cutter and are great because they can cut several layers of fabric accurately and quickly. They are perfect for quilting projects and textile arts.

Observe the following safety rules.

Safety

- Always use the safety features of the rotary cutter to lock the blade when not in use.
- Always use a large plastic ruler and press down firmly.
- Always cut away from yourself.
- Always use a cutting mat to protect the table and the blade.
- Keep your fingers away from the blade — it's a razor blade!

FIGURE 6.25: Rotary cutter

(a) Cutting blade is protected (b) Cutting blade is exposed

Tip

Never use pinking shears on paper because it blunts them.

PINKING SHEARS: Pinking shears cut the fabric with a zigzag edge. This can sometimes be used instead of an overlocked edge to prevent fraying, and it gives a decorative edge for special projects such as toys, and fabric pieces on cards and decorations.

FIGURE 6.26: Pinking shears

Switch on

List three safety rules for using cutting tools such as scissors and rotary cutters.

Joining textiles

Sometimes a project may require a different construction technique to meet specific needs.

Flat fell seam

A flat fell seam is a very strong seam — perfect for clothes, such as jeans and overalls, and for projects, such as bags and floor cushions. A contrast thread can be used to highlight its decorative nature.

Techno**bite**

The design of jeans changed in 1873 when Jacob Davis, a tailor working with Levi Strauss, added copper rivets to the pockets for strength. Designers decided to do the decorative stitching in the now classic copper-coloured thread to match the rivets. Jeans were actually called waist overalls until 1960!

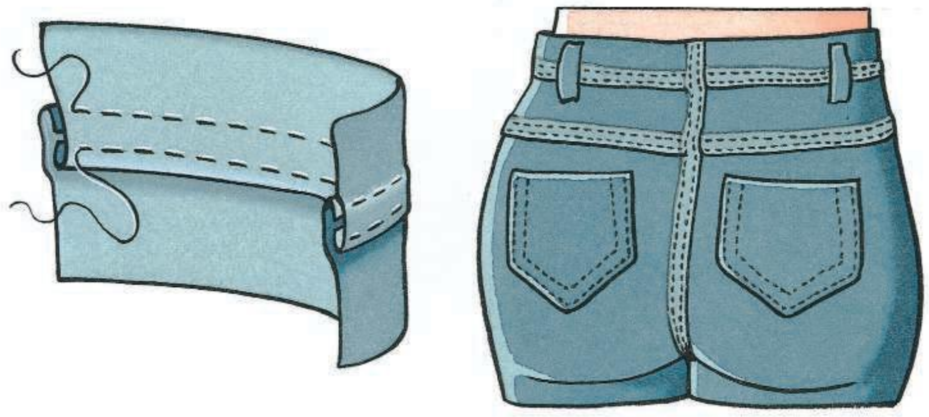


FIGURE 6.27: Flat fell seams are used for decoration and strength, for example, on jeans.

Stretch seams

Garments made from stretch fabrics, such as T-shirts, need seams with a small amount of stretch in them; otherwise the stitching could break while you are wearing them.

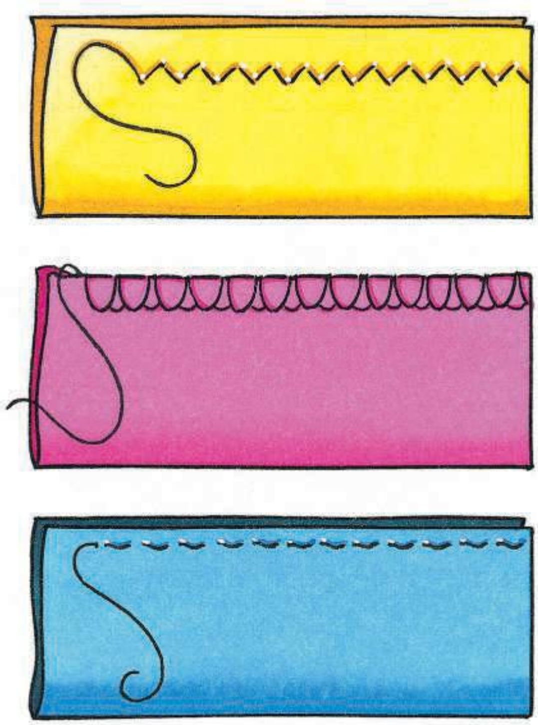


FIGURE 6.28: Seam types for knit fabrics

Finishing

A plain double hem is described on page 154.

You could try hand stitching your hem, using a blind hem foot on your machine or using a twin needle for an even, decorative and slightly stretchy hem. All these techniques require some skill. Your teacher could help you, if these techniques are suited to your project.

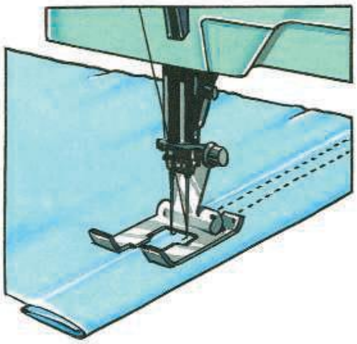


FIGURE 6.29: Hemming with a twin needle

Appliqué is described in this chapter on page 155.

Colouring and decorating techniques

There are lots of ways to apply colour to and decorate textile fabrics.

FIGURE 6.30: Mind map — decorative techniques

Technobite

Dyed fabrics have been found in Roman ruins that date from the second century BC. Chinese silk producers in the T'ang dynasty (AD 618–907) used tie-dye effects.

Tie-dyeing

To tie-dye fabric, follow these steps:

1. Prepare the fabric — tie up parts of it so that the dye reaches only some parts of the fabric.
2. Wet the fabric before dyeing.
3. Place the fabric in the dye for at least 30 minutes.
4. Add a dye fixative to the mixture.
5. Remove the fabric from the dye, rinse well, and remove the ties.

FIGURE 6.31: Tying the fabric to create a pattern

FIGURE 6.32: Tie-dyeing can create interesting effects.

Designers present their ideas using many different styles of drawing — refer to page 149.

Fashion drawing

In the textile industry, fashion drawing is a specialised technique that is used extensively, especially when presenting designs to clients.

You may like to include large fashion drawings in your design folio or as part of your class presentation. Use A4- or A3-sized paper. You could use the figures in figure 6.33 as a starting point. The fashion figure is longer than a normal figure, with the legs quite exaggerated. Features such as hands, face and feet are often stylised.

Rendering gives a feel for the fabric type and texture. The body is posed giving a sense of realism and style.

FIGURE 6.33: Fashion drawings

Switch on

1. Why do seams need to be overlocked or finished in a special way?
2. Give three reasons for using flat fell seams in jeans.
3. Find three pictures of textile items showing different hem styles.
4. Research and experiment with a fabric decoration technique that you haven't used.
5. Investigate colouring and decorating techniques used by another culture.

Tip
Digital heat transfer printing is great for our environment because there are no waste dye products.

6.4 Textile technologies at work

Careers in the textile industry

Many people think instantly of fashion designers when they think of careers in the textile industry, but there are many other areas of work. Analyse all the work you have done on your textile project. What parts involved you in design, pattern making, buying, manufacturing, modelling, advertising and marketing? In industry, these areas become careers.

Spotlight Peter Alexander

Peter Alexander is a leading Australian designer and marketer of sleepwear and other textile products. He started out as a salesperson for Sportsgirl and then moved into promotion and merchandising.

FIGURE 6.34: Peter Alexander pyjamas

After a trip to Hong Kong, Peter realised that there was a gap in the market for eye-catching, fun, funky sleepwear. With some knowledge of retail, but no formal business training, he set up his business in the dining room of his mother's home.

After a major department store cancelled an order for 2000 pyjamas, Peter placed an advertisement in the mail-order section of *Cleo* magazine, hoping to sell 1000 pairs to recoup the $10 000 cost. He received 4000 orders and his successful mail-order business began.

Techno**bite**

In 2001, Julien MacDonald was the first leading fashion designer to broadcast his London Fashion Week Show live on the Internet. This use of the web has changed the way that fashion is marketed.

Spotlight review

Go to www.jaconline.com.au/switchedontech and click on the Sleepwear weblink for this chapter. Refer to the website to answer the following questions.

(a) Describe the market that you think Peter Alexander wants to reach with his pyjama designs.

(b) Why did Peter choose pyjamas as a design area to pursue?

(c) How does Peter market and sell his pyjamas?

(d) What other products does Peter's company sell?

(e) Who would sew Peter's pyjamas? What work do you think Peter would now do in his career?

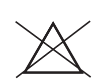
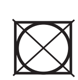
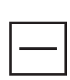
Care and maintenance of textile products

All textile products in Australia must be labelled with fibre content and care suggestions. Usually this label is sewn to the item but there are exceptions.

Sometimes the care instructions are written in words, but it is becoming more common to use the international symbols for care. These symbols are the same worldwide.

Table 6.3 includes the symbols commonly found in care instructions and their meanings. When a symbol is crossed out, it means *do not*.

TABLE 6.3: International care symbols for textiles

Symbol	Meaning	Symbol	Meaning	Symbol	Meaning
	Recommended washing temperature		Do not wash		Hand wash only
	Iron temperature — cool iron		May be bleached		Do not bleach
	Iron temperature — medium iron		Dry-cleaning recommended		Do not dry-clean
	Iron temperature — hot iron		May be tumble-dried		Do not tumble-dry
	Do not iron		Dry flat		Drip-dry

Safety labelling

Safety

There are standard labelling rules worldwide for labelling items that could be dangerous. This applies to children's sleepwear. The labels are coloured and worded according to the standards. In Australia these standards are established by Standards Australia.

Technobite

Australia is recognised as one of the world leaders in the recycling of clothing. The Smith Family recycles over 14 million kilograms of textiles every year.

Textiles and the environment

Think about the life of a textile product, such as a pair of jeans, from the growth of the cotton used to make them to the time when you no longer need them because they don't fit or are worn out. Use of chemicals, water pollution, noise pollution, dye effluent, fabric wastage, packaging and disposal of old clothing are all environmental issues that concern the textile industry.

Switch on

1. Using the international symbols, design a care label for your textile item.
2. Write an article for a parenting magazine or newspaper on safety and children's sleepwear.
3. What work is performed by each of the following in the textile industry: designer, fashion stylist, patternmaker, buyer, model, advertising and marketing personnel, merchandiser, machinist, interior designer, salesperson, manager and textile technologist?
4. Research a male and a female designer in the textile industry. Find out what inspired them to take up this career.
5. Produce a catalogue of your designs for marketing.
6. Draw a timeline for the life of a pair of jeans. Record the impact each stage may have on the environment. Go to www.jaconline.com.au/switchedontech and click on the Jeans weblink for this chapter for a great poster called 'How to make a pair of jeans'.
7. Investigate one environmental concern relating to the textile industry. Report on it to your class.
8. Purchase a garment from your local op-shop and use it to create a new design project.
9. Select a Technobite from this chapter. Use it as a starting point for a research project.

Design process checklist

ONLINE RESOURCE BANK

Go to the Online Resource Bank at www.jaconline.com.au/switchedontech and click on the Design Process Checklist. Use the checklist questions to self-evaluate your project and to help you finalise your design folio.

You can also find more ideas for design projects at the Online Resource Bank.

CHAPTER **Seven**

Food technologies

People cannot live without food and, for many, eating is an enjoyable daily routine. Food also has cultural and social significance, reflecting national origins and bringing families and friends together. Food often plays a central part in celebrations, for example, birthday parties.

Food design can mean deciding what ingredients to put in tonight's stir-fry, developing new food products, designing a menu, formulating recipes and even arranging food to enhance its visual appeal. We consume few foods in their natural state; most must be cooked, combined or arranged to make them more palatable. The decisions we make during these processes are food design.

Chapter 7 presents facts about nutrition and cooking techniques to help you decide what food combinations will work best in recipes. You will learn how to work safely and hygienically, and some tricks for presenting food. This chapter helps you design an iron-rich meal, analyse its nutritional content and produce a recipe card using computer software. Five practical lessons give you an opportunity to practise your food technology skills.

Focus

By the end of this chapter you will be able to:

- identify common properties of food within each of the food groups
- select and prepare food for a design project
- select and correctly use a variety of appropriate food utensils and appliances to prepare quality food items for a design project
- select, interpret and/or modify/develop recipes for a design project
- select and use techniques appropriate for the purposes of a design project.

Switch on

1. **List ten products that have been introduced on your local supermarket shelves in the past 12 months.**
2. **Interview an older family member to discuss the changes in eating patterns he or she has noticed since being a teenager, or the progress in technologies available in the kitchen.**
3. **Keep a food diary for three days and analyse the nutritional content of what you ate.**

Techno**bite**

Nobody quite knows when humans first began cooking their food. Evidence suggests that the first controlled use of fire was about 1 420 000 years ago, but it wasn't until about 7000 BC that people discovered that fire could be made reliably by using friction-producing tools, such as firesticks. Despite this discovery, it was more convenient to keep a fire alive permanently than to reignite it when needed.

7.1 Design process

FIGURE 7.1: Iron helps you stay active.

Design project

Your design project for food technologies is to design an iron-rich meal and produce a recipe card using computer software.
Area of study: Products. The focus of this area of study is on objects, systems and artifacts.
Design specialisation: Food design. Food designers design products and systems, such as food products, menus, food-preparation systems, diets for special purposes and methods of food presentation.

Design situation

In Australia, most teenagers get plenty of the nutrients they need. For most, it is a problem of *over*consumption rather than *under*consumption. But many adolescents lack sufficient quantities of the mineral iron in their diets. This deficiency can lead to tiredness and poor concentration.

Design brief

Design a range of healthy, iron-rich recipes that teenagers would enjoy. Produce one of these recipes and devise a promotional strategy that would encourage teenagers to eat more iron-rich foods. Using a digital camera and graphics software, produce a recipe card or cards that could be used as part of your promotional strategy.

Look again at the design process in chapter 2, pages 20–1.

Be flexible in your approach to this design process. The order of the steps is not set in concrete and you may not always follow them in the sequence presented here. Some steps go hand in hand with others throughout the design project. Other steps need to be completed before you can move on. You should concentrate on using the combined steps to form a process that guides the development of your design.

Design Folio **Production**

Your design folio is an important communication tool for design projects. It should tell the story of your design project's development, from your first rough ideas on paper to the final evaluation of your design brief solution.

Consider composing your design folio in electronic format for this technology.

DESIGN PROCESS: ONGOING EVALUATION

Essential for success

Remember that ongoing evaluation is central to the design process and should occur at every step. Regular evaluation helps to identify problems and challenges at the right time for you to deal with them. Putting evaluation off until later is asking for trouble, for example:

- wasted resources
- lost time
- failure to meet deadlines
- increased costs.

DESIGN PROCESS: ANALYSIS

Analysing needs, problems and opportunities

Before you can start coming up with ideas for your recipes and are able to promote your product, you will need to think about the following questions.

- What is iron and what does it do in the body?
- How much iron do teenagers need every day?
- What foods are rich sources of iron?
- Which of these foods do teenagers like?
- How am I going to make this product?
- How do I write a recipe that works?
- What factors influence teenagers' eating habits?
- What types of promotions will get teenagers to eat more iron?

Establishing criteria for success

There are several constraints that will limit the type of recipes you will be able to design and produce.

- What equipment and utensils are available in our food technology room? What do I have available at home?
- What skills do I have?
- How much time do I have?
- What is my budget?
- What foods can I select that are rich in iron?
- What foods can I select that are suitable for teenagers?

How are you going to judge if your meal is a successful design? Individually or as a class, you will need to establish criteria that everyone's meal must meet. Write these in your design folio. The criteria would need to include the following:

1. The meal is healthy. You may need to establish further criteria to determine this.
2. The meal provides iron. What percentage of the recommended dietary intake (RDI) do you think it should contain as a minimum?
3. The meal appeals to teenagers.

For more detailed information on RDIs, refer to pages 169 and 183.

DESIGN PROCESS: RESEARCH

Before you can start on the design solution, you need to find out a bit about iron and look into your market.

Refer to pages 180–3 on nutrition.

Iron

Iron is a mineral that forms part of red blood cells (specifically haemoglobin). Red blood cells transport oxygen from the lungs to where it is needed in the body, mainly the brain and muscles. That is why without enough iron you feel tired and may find it difficult to concentrate. Iron also helps us fight infection. Without enough iron we are at risk of developing anaemia.

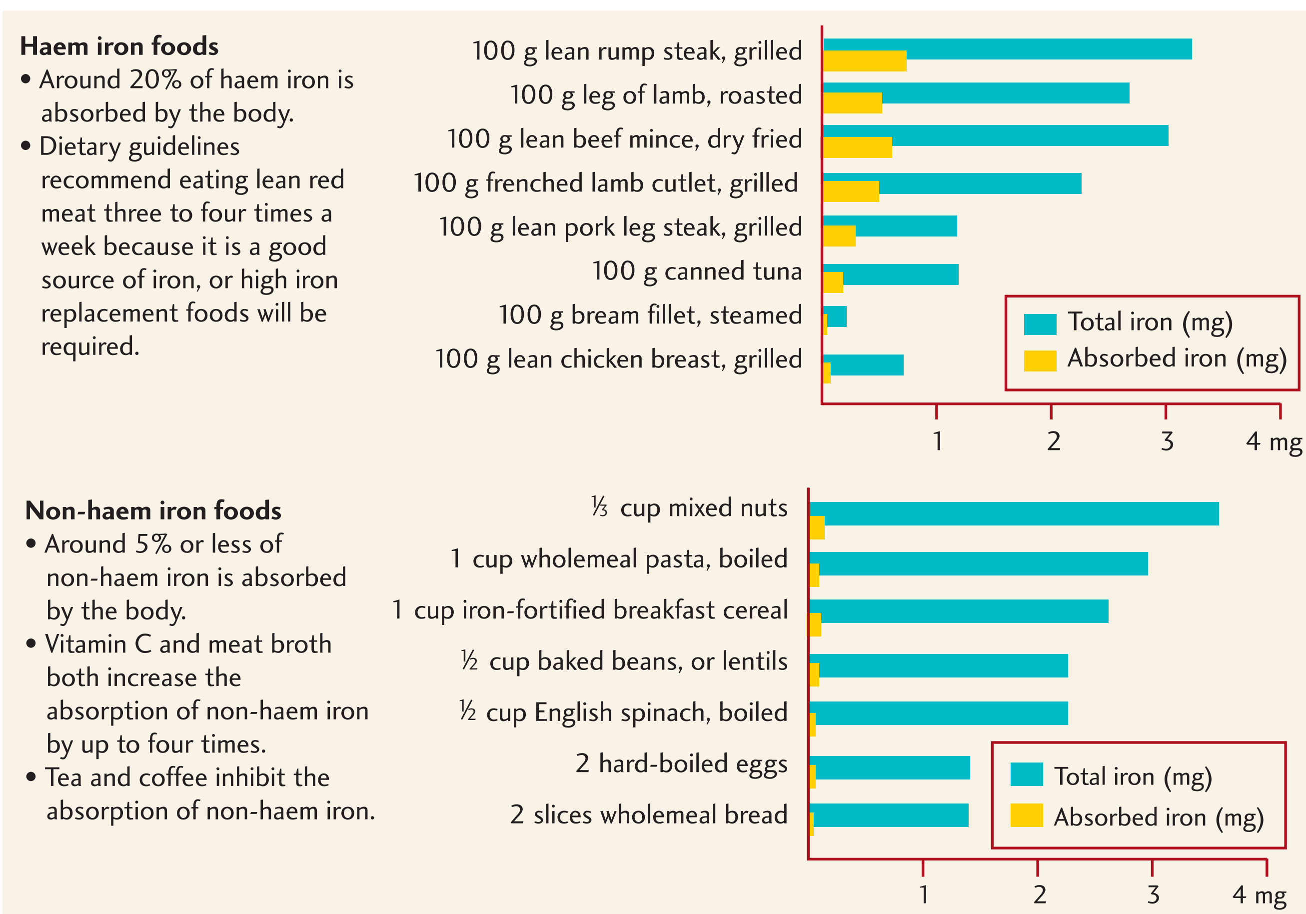
How much iron do we need?

The RDI for iron for adolescents is 10–13 mg per day. The amount varies slightly to allow for different body sizes and levels of activity. Women also need more iron than men because of their menstrual cycle.

What foods are the best sources?

Iron is found in a variety of plant and animal foods. However, not all of the iron in foods is absorbed by the body (see figure 7.2). There are two types of iron in food: haem iron, which is found in animal foods and is well absorbed (around 20 per cent), and non-haem iron, which is found in plant foods and is less well absorbed (around 5 per cent). The absorption of non-haem iron can be increased by consuming vitamin C and meat broth. This combination can increase the absorption rate by four times. Caffeine found in tea, coffee, soft drinks (especially cola drinks and some energy drinks) and chocolate decreases the absorption rate of iron. Therefore, it's recommended that these substances be consumed between meals rather than with a meal.

FIGURE 7.2: Sources of iron



Technobite

Kiwifruit, also known as Chinese gooseberries, are an excellent source of vitamin C and a moderate source of iron. The first Chinese gooseberry vines were introduced to New Zealand in 1906. By 1974, New Zealand was well known worldwide for producing Chinese gooseberries and the government officially renamed them kiwifruit.

Switch on

To find out more about iron, go to www.jaconline.com.au/switchedontech and click on the Main Meal weblink for this chapter.

Market research

One of the main aims of your market research will be to find out what foods teenagers will eat. Organise a survey. Make sure you give your survey participants some iron-rich alternatives to choose from in your questions, otherwise you may discover what you already know: that many teenagers like chips, cola drinks and chocolate! You need to establish not only what foods adolescents like to eat but also the way they like to eat. For example, many teenagers would rather have frequent snacks instead of a big meal. Don't forget to include questions that will assist you in promoting your product.

DESIGN PROCESS: MANAGEMENT

Managing resources

The main resources you need to consider are money, materials, time and equipment. You might be given a budget and you need to make sure your meal does not exceed it. Find out what foods are in season and explore cheaper alternatives when you are designing so that you don't spend too much.

The material you are working with — food — is a perishable item and you need to work within the time frame of your practical lesson. Therefore, you need to be organised. You can't work with most foods bit by bit and come back to them tomorrow.

You also need to manage your time and equipment so that you can produce your meal with a minimum of fuss. An action-management plan helps you to work efficiently and safely when you are producing food.

Action-management plan

An action-management plan is a list of all the steps you need to follow to produce your food product. It also includes a list of equipment needed and a time-management plan. This is very useful as not all recipes are written in a logical sequence. See figure 7.3 for a sample action-management plan. Make sure to allow plenty of time for cleaning up at the end of your practical lesson.

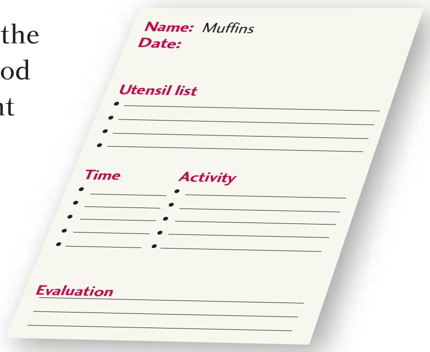


FIGURE 7.3: An action-management plan helps you to work efficiently.

DESIGN PROCESS: IDEAS GENERATION

Generating creative ideas

Write down all the foods you know of that are high in iron. Do any food combinations improve or inhibit the absorption of iron? From the research conducted on your peers, what meals are popular?

Try to think of an inventive way to make a healthy, iron-rich meal that tastes great and appeals to your market.

DESIGN PROCESS: COMMUNICATION

Communicating ideas

Record all your thoughts and ideas in your design folio. Even the ideas that you decide are no good should be acknowledged. Include all the recipes that you have collected and make a short note beside each one outlining what you liked and disliked about the recipe. For example, you may have found lots of recipes that were very high in iron but too high in fat to be called healthy.

Use a digital camera to take a photo of your design. Import this picture using graphics software. Collect samples of recipe cards to see what types of information you can include on yours. Try to use as many symbols as possible. Start sketching how you want your recipe card to look. Make sure all your sketches are annotated.

DESIGN PROCESS: SAFETY AND RISK MANAGEMENT

Risk management

In order to produce your meal safely, you must conduct a risk assessment. This involves identifying all hazards, assessing the risks arising from those hazards and eliminating the risks where possible or controlling them to a minimum. See below for the safety rules associated with food production.

During a practical lesson, your food technology room can be a dangerous place. You use a range of equipment and utensils that are potentially hazardous. Care needs to be taken to avoid accidents.

Look again at the rules for basic safety in chapter 2, pages 51–3, before beginning to work in the food technology room or at the computer. Note the information on occupational health and safety.

Safety

General rules for working with food

1. Keep calm at all times in the food-preparation area.
2. Know where the fire extinguisher is, how to use it and the evacuation procedure for your school.
3. Make sure you know how to light and use the oven and the stovetop.
4. On the stovetop, turn saucepan handles in so saucepans won't be knocked off or pulled down from the stove.
5. Always use a *dry* pot holder when getting food out of the oven.
6. Wipe up spills immediately.
7. Keep electrical appliances, such as food processors, away from water.
8. Switch off electrical appliances at the power point before unplugging them.
9. Take care with knives. Always carry knives with the point down, use a chopping board and hold the handle of the knife when washing up. Don't leave knives in the bottom of the sink.

You will find more safety rules that apply specifically to food technologies throughout this chapter in the places where they fit best. Observe them!

Hygiene

It's important to know how to work hygienically in the kitchen to prevent food contamination, spoilage and food poisoning. Hygiene can be divided up into three areas: personal, kitchen and food.

Personal hygiene

Even the cleanest bodies are covered in bacteria and some of these are pathogenic (disease-producing). Our aim is to work as hygienically as possible and prevent the bacteria being transferred onto the food.

Observe the following rules:

- Wash your hands properly with warm, soapy water before you cook.
- Wear a clean apron and tie it at the back.
- Do not wear jewellery or nail polish in the food technology room.
- Keep long hair tied back and do not touch it while preparing food.
- Cover all cuts with waterproof dressings.
- Do not sneeze or cough on food or cook when you are sick.
- Use a tasting spoon to taste food rather than licking your fingers or using stirring utensils.

Technobite

There are more than five million cases of food poisoning in Australia each year. The Food Safety Information Council campaigns to improve consumers' awareness of how to store, handle and cook food safely.

Kitchen hygiene

The environment where food is prepared can also transfer bacteria onto the food. This environment includes all the equipment and utensils that touch the food, as well as the floors, benchtops, dishcloths, tea towels and garbage bins. By law, food-preparation areas must be designed so they are easy to clean and have no porous surfaces on which bacteria can multiply. This is why most commercial kitchens have lots of stainless steel. There are several practices we need to follow to maintain a clean food-preparation environment. These include the following:

- Wash up in hot, soapy water in the correct sequence and rinse in even hotter clear water.
- Wipe down benchtops with a cleanser and a sanitising solution.
- Use bin liners and store garbage away from the food-preparation areas.
- Have adequate pest-control measures, such as flyscreens.
- Keep pets out of the kitchen.

Switch on

1. Do you know how to wash up properly and the order in which to wash the equipment? With a partner, rewrite the actions in table 7.1 in the correct order. Ask your teacher to check the order.

TABLE 7.1: Sequence for washing up

Incorrect order	Correct order
1. Wash in hot, soapy water (at least 45°C).	
2. Scrape food scraps into the bin.	
3. Rinse off excess food with cold water.	
4. Rinse off detergent in hot water (at least 70°C).	
5. Air dry or dry with a clean tea towel.	

2. It's also important to wash up utensils in the correct order. Number the objects in figure 7.4 in the order that you would wash them.

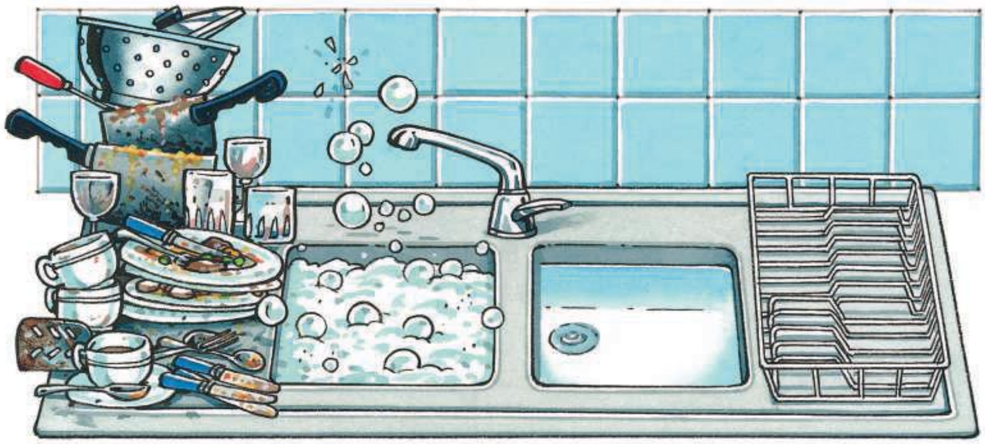


FIGURE 7.4: What should you wash first?

Technobite

Frenchman Louis Pasteur (1822–1895) discovered that most infectious diseases are caused by germs. His *germ theory of disease* was one of the most important breakthroughs in medical history. Pasteur developed *pasteurisation*, a process by which harmful microbes in perishable food products are destroyed using heat, without destroying the food.

Food hygiene

Many foods contain bacteria (micro-organisms) naturally, or foods can become contaminated through poor food-handling practices, lack of environmental hygiene or cross-contamination. Just as we need food, so do micro-organisms. Certain levels of bacteria are perfectly safe to eat. It is only when these micro-organisms are allowed to multiply to unsafe levels that the food becomes dangerous. Micro-organisms will multiply when they are given the right conditions, such as warmth, moisture, and the correct pH. We can't control the amount of bacteria that occurs naturally in food. We can, however, try to minimise the level of contamination and slow down the growth of micro-organisms by keeping food out of the *danger zone*.

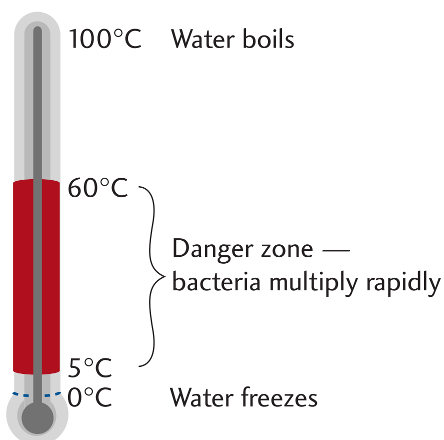


FIGURE 7.5: It's important to keep all potentially hazardous food out of the danger zone.

Switch on

1. Swab the room and grow bacteria on agar plates (ask your science teacher to incubate the agar and see what bacteria you find in the kitchen).
2. Use a computer to design a poster that illustrates a safety or personal hygiene rule. Make it without words so it can be understood by someone who doesn't speak English.
3. Make a list of *when* you should rewash your hands.

DESIGN PROCESS: EXPERIMENTATION AND TESTING

Experimenting and testing ideas

At this stage, you will need to trial some of your recipe ideas to see if they work. Make sure you write down the food quantities and cooking times so that you can make modifications if necessary. Ask your family and friends to try your experiments.

Switch on

Iron experiment. This is a simple test you can use to see how much iron is in the recipe you have designed. It might be fun to compare the results of everyone in the class. You need to make sure you use the same amount of food by weight so you can compare results accurately.

(a) Mash the food into slurry using a mortar and pestle. You may need to add a little water.

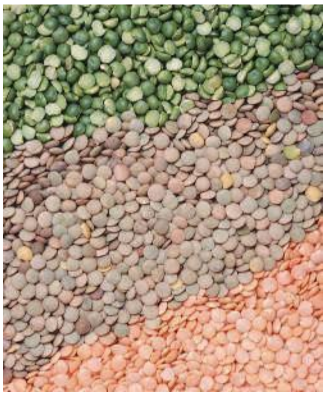
(b) Wrap a magnet in a piece of fabric or kitchen wipe.

(c) Move the magnet through the slurry. Make sure each food gets the same amount of exposure (time and movement) to the magnet.

(d) Rinse the magnet in a bowl of still water (not under the tap).

(e) Observe the magnet to see the amount of iron attached.

(f) Carefully remove the iron onto some scientific scales and weigh the amount of iron.



Technobite

In ancient Greece and Rome, poor people ate large amounts of lentils. The Romans imported huge quantities of them from the Egyptians. During these times, an obelisk (carved pillar of stone), made in Egypt, was shipped to St Peter's Square in Rome, Italy, snugly packed among 120 000 measures of lentils. The lentils were soon eaten; the obelisk still stands there today.

DESIGN PROCESS: PRODUCTION

Producing design solutions

This is the fun part where you get to cook your design in class or cook it at home and bring it in for everyone to try.

DESIGN PROCESS: FINAL EVALUATION

Throughout the design process, you have evaluated your ideas and made modifications to your designs. It is *essential* to evaluate your final product. It is also extremely important to think about the design process so that next time you are designing with food, you can make improvements to the process.

The product

When evaluating your product, you need to look back at your initial criteria for success. Even if the product meets all the criteria, there may still be room for improvement.

- Is the meal healthy, iron-rich and appealing to teenagers?
- Are you happy with the taste, texture and aroma?
- Does it have a good visual appeal or do you need to work on presentation?

Ask your peers and family to judge your product. In order to get meaningful feedback when conducting taste tests, you need to give your tasters some guidance, especially if they are not experienced critics. You can do this by providing tasting charts or star profiles for them to fill in (see figure 7.6. and table 7.2). A word bank of terms such as *salty*, *sweet* and *crispy* is also useful.

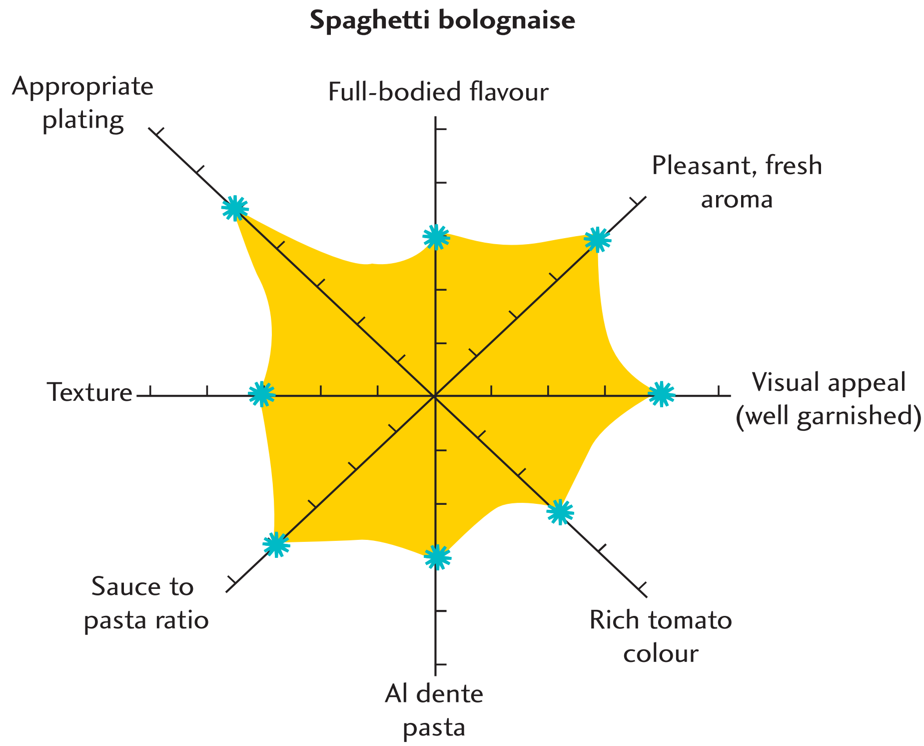


FIGURE 7.6: Star profiles can be useful for getting meaningful feedback.

TABLE 7.2: Example of a tasting chart for chocolate biscuits

Sample	1	2	3
Visual appeal	Dull Uniform shape	Dark and glossy Uniform shape	Smooth Irregular shape
Taste	Bitter	Rich and sweet	Sweet
Texture	Crumbly	Crunchy	Hard
Aroma	Chocolate and vanilla	Chocolate	Fragrant
Rating	5/10	8/10	7/10
Rank order	3/3	1/3	2/3

Switch on

1. Create a tasting chart and star profile to evaluate your meal.
2. Write a word bank of descriptive terms that could be used to describe your meal.

The process

Even if your product is fantastic, you need to think about what you would do differently if you had to do this project or a similar one again. When evaluating your process, it may be useful to ask yourself the following questions:

- Did I manage my time wisely? Was it all a mad rush at the end?
- Did I work though all the steps of the design process carefully or did I try to rush into making the product before I really knew what I was doing?
- Did I document my decisions well enough for my design folio?

7.2 Practical lesson 1

Safety

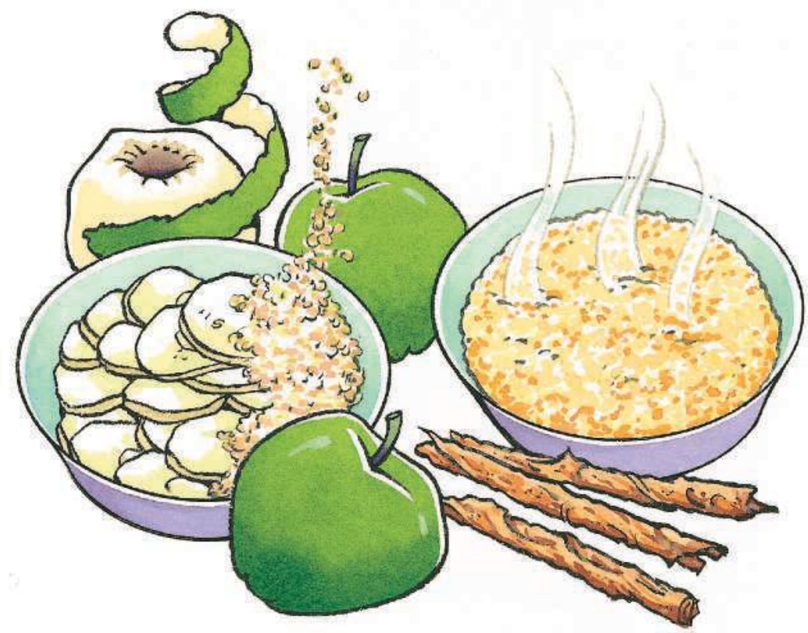
Focus on working safely and hygienically in the food technology rooms. By now you should know well all of the general safety rules for working with food. The same goes for the principles of hygiene. You should be able to work safely and hygienically in the food technology rooms as a part of your natural behaviour.

Select your ingredients carefully. Choose apples that are free from bruising and blemishes. Check the *use-by dates* on all the packaged ingredients.

Know the rules on pages 171–3.

Apple crumble

Serves 2



Ingredients: apple

2 Granny Smith apples
¼ t cinnamon
1 T water

Method

1. Peel and core the apples.
2. Slice the apples.
3. Place the apples in a small saucepan with water and cinnamon.
4. Simmer on medium heat until the apple is just soft.

See 'Accurate measuring' on page 178.

Ingredients: crumble

1½ T S.R. flour
2 T rolled oats
1 T grated coconut
1 T brown sugar
1 T margarine

Method

1. Pre-heat oven to 180°C.
2. Mix together the flour, oats, coconut, brown sugar and margarine.
3. Put the cooked apple into a greased ovenproof dish.
4. Sprinkle the flour mixture over the apple.
5. Bake for 15 minutes.

7.3 Tools and techniques

Equipment and utensils

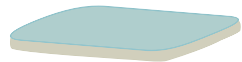
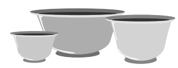
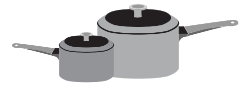
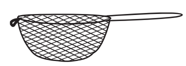
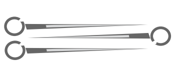
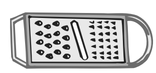
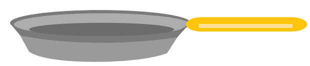
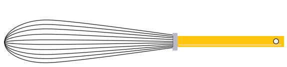
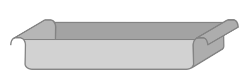
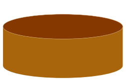
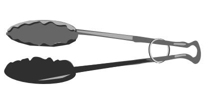
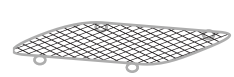
You need to know how to use the basic food-preparation equipment and utensils in order to follow recipes and prepare food.

Switch on

Complete table 7.3 below. For each of the items pictured, briefly describe:

1. what you use it for
2. where you would find it in the food technology room.

TABLE 7.3: Some utensils and equipment in the food technology room

 COOK'S KNIFE	1. ____________ 2. ____________	 CHOPPING BOARD	1. ____________ 2. ____________
 PARING KNIFE	1. ____________ 2. ____________	 MIXING BOWLS	1. ____________ 2. ____________
 WOODEN SPOON	1. ____________ 2. ____________	 SAUCEPANS	1. ____________ 2. ____________
 PASTRY BRUSH	1. ____________ 2. ____________	 SIEVE/STRAINER	1. ____________ 2. ____________
 SKEWERS	1. ____________ 2. ____________	 GRATER	1. ____________ 2. ____________
 VEGETABLE PEELER	1. ____________ 2. ____________	 FRYING PAN	1. ____________ 2. ____________
 WHISK	1. ____________ 2. ____________	 BAKING TRAY	1. ____________ 2. ____________
 EGG SLIDE	1. ____________ 2. ____________	 CAKE TIN	1. ____________ 2. ____________
 TONGS	1. ____________ 2. ____________	 COOLING RACK	1. ____________ 2. ____________

Safety

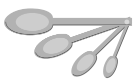
Ergonomic design

Equipment and utensils that have been designed with ergonomics in mind will be comfortable and easy to use. Many tasks in the food industry are very repetitive. If the equipment is not ergonomically designed, it will be uncomfortable to use and can lead to repetition strain injury (RSI). Utensils, such as vegetable peelers, are often designed with ergonomics in mind.

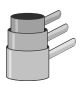
Switch on

1. List three kitchen utensils that are ergonomically designed.
2. Investigate the practices that can minimise RSI.

FIGURE 7.7: Measuring equipment



MEASURING SPOONS



MEASURING CUPS

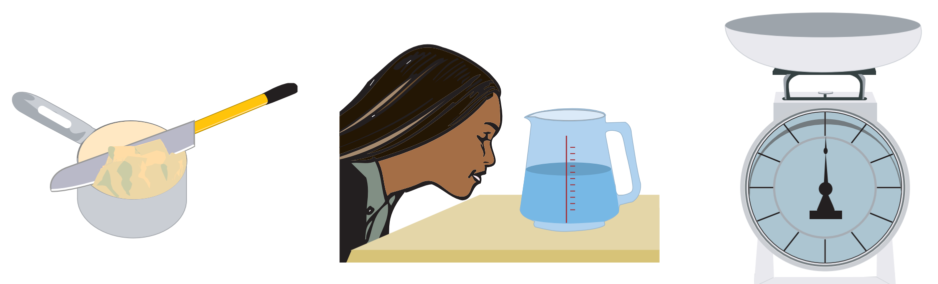
MEASURING JUG

Accurate measuring

For recipes to work, especially cakes, you must use exact amounts of ingredients. You need to know how to use your measuring equipment properly and learn how to be accurate. Wet and dry ingredients need different equipment.

- When measuring dry ingredients, such as sugar and flour, you can use cups, spoons or scales, depending on the quantity you need.
- When using cups and spoons, always overfill them, tap them gently to remove air pockets and level off with the flat edge of a knife.
- Remember to set the scales to zero and allow for the weight of the tray when weighing ingredients.
- Wet ingredients, such as oil or milk, need to be measured in a jug. It is important to put the jug on a level surface and read the measure at eye level.

FIGURE 7.8: Accurate measuring techniques



(a) Levelling off a cup

(b) Measuring a liquid

(c) Scales — stand on a level surface

Switch on

1. Ask your teacher to accurately measure one cup of flour, weigh it on the scales and record the weight. Then have a competition to see who can be as accurate as your teacher.
2. Write down the equipment you would use to measure the following ingredients.
   (a) $1\frac{3}{4}$ cups flour
   (b) 200 g butter
   (c) $\frac{1}{2}$ cup oil
   (d) 125 mL juice
   (e) $1\frac{1}{2}$ tablespoons sugar

Techniques

Now that you are familiar with some of the basic tools, you need to learn some simple techniques so you can follow recipes. Table 7.4 lists the meanings of some of the food-processing terms used in recipes.

Technobite

France and Italy are famous for good cooks, and we use French and Italian words for some of our dishes and cooking terms. For example, *crème brûlée*, which means 'burnt cream' in French, is a rich cream custard topped with caramelised sugar. *Al dente*, which means 'to the tooth' in Italian, is pasta cooked just enough to offer resistance to the teeth.

TABLE 7.4: Food-processing terms

Term	Meaning
Dice	Cut into small cubes.
Slice	Cut into rings or thin, even pieces.
Blend	Mix or combine ingredients with a spoon or processor.
Whisk	Beat to incorporate air using a fork or whisk.
Rub in	Mix fat into flour using your fingertips.
Knead	Massage dough with hands to shape or develop gluten strands.
Sauté	Toss or fry quickly in a small amount of fat.
Simmer	Cook gently, just below boiling point.

Switch on

1. As a class, search for recipes on the Internet and find as many unfamiliar cooking terms as you can. Look up their meanings.
2. Copy table 7.4 into your design folio and extend it with the new terms you have found and their definitions.

Methods of cookery

The methods of cookery can be divided into two main categories: wet and dry. The wet methods involve a liquid, usually water, juice or stock, and include boiling, steaming, poaching, braising and stewing. Dry methods of cookery use hot air, fat or a combination of these two to cook the food. Dry methods include baking, roasting, grilling and frying (deep-, shallow- and stir-frying). The method you use to cook the food will affect the end product.

Switch on

1. What are the characteristics of each method of cookery?
2. Give an example of a food you would commonly cook with each method.
3. Do any of the methods require special equipment? Give examples.
4. What is the difference between roasting and baking?
5. List methods of cookery that are healthy and explain why.
6. Outline the methods you will use to produce your food product.

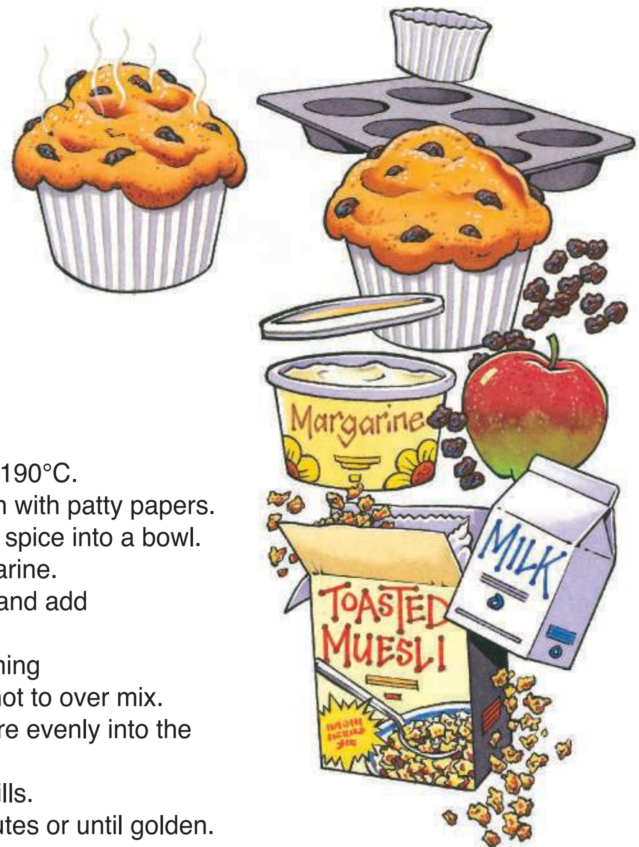
7.4 Practical lesson 2

Focus on measuring accurately and achieving muffins of a uniform consistency.

Look again at 'Accurate measuring' on page 178. Look also at table 7.5 on page 187 if your measuring jug does not have cup measurements marked.

Fruity muesli muffins

Serves 2



Ingredients

1½ C S.R. flour
1 t mixed spice
75 g margarine
1 small apple
½C brown sugar, firmly packed
¾C sultanas
¾C toasted muesli
¾C milk
12 muffin-size patty papers

Method

1. Preheat oven to 190°C.
2. Line a muffin pan with patty papers.
3. Sift the flour and spice into a bowl.
4. Rub in the margarine.
5. Grate the apple and add to the mixture.
6. Mix in the remaining ingredients; try not to over mix.
7. Spoon the mixture evenly into the muffin pans.
8. Clean up any spills.
9. Bake for 25 minutes or until golden.
10. Cool on a wire rack.

7.5 Nutrition

In order to design healthy recipes, meals, products or diets we need to have some understanding of nutrition. Unfortunately, no one food provides everything we need and everyone has slightly different nutritional requirements. Therefore, we must eat a variety of food to ensure we get all the nutrients our bodies need.

Nutrients

When we eat food, it is digested or broken down by the body and turned into nutrients. The nutrients include proteins, carbohydrates, fats, vitamins, minerals and water. These nutrients all have different functions in the body and we require them in different proportions for good health.

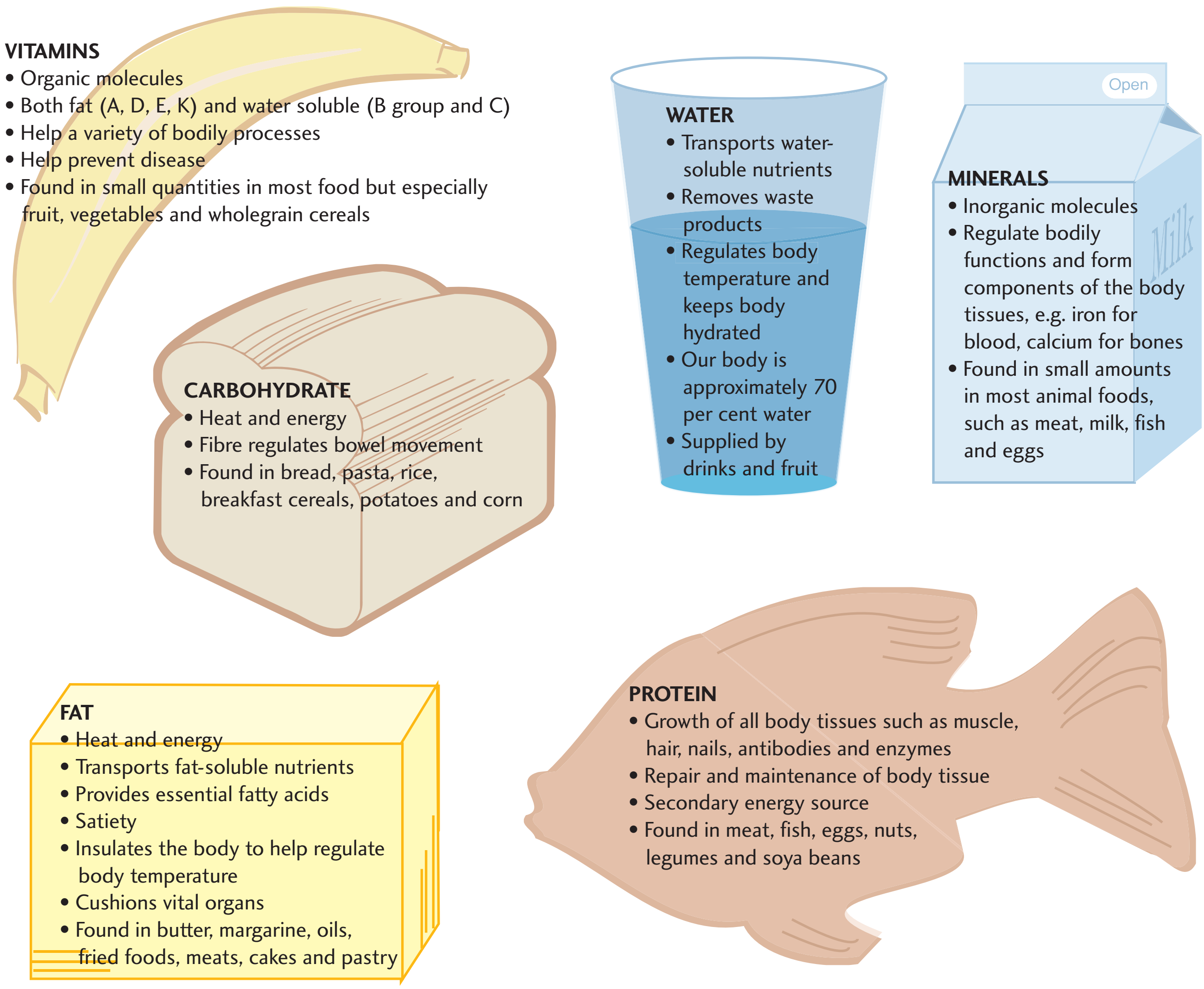


FIGURE 7.9: Nutrients: their functions and food sources

Now we know what the nutrients do, we need to figure out how to consume them in the correct proportions.

Healthy Living Pyramid

The *Healthy Living Pyramid* (a new version of the *Healthy Eating Pyramid*) is a nutritional tool, developed by Nutrition Australia, that is used to teach people what foods they should eat and in what proportions. The aim of the pyramid is to help us select food that provides a balanced diet and to emphasise the need for regular physical activity. The pyramid, shown in figure 7.10, is divided up into sections of those foods that we should eat most, those we should eat in moderation and those we should eat in small amounts. It groups foods together according to their energy content and according to the various nutrients that they can provide. The pyramid encourages variety, minimum fat, adequate fibre, limited salt and adequate water. The message is mainly visual so you don't need to be able to read or speak English to understand it. The pyramid shows basic foods only, enabling you to make choices about the ways these foods can be mixed to create pleasing flavours and textures.

FIGURE 7.10: *The Healthy Living Pyramid*, developed by Nutrition Australia

Other Australian guides to healthy eating

Another nutritional tool is *The Australian Guide to Healthy Eating* published by the Australian Government's Department of Health and Ageing. This tool is based on selecting foods from the five food groups: breads, cereals, pasta, rice and noodles; lean meat, fish, poultry, eggs, nuts and legumes; milk, yoghurt and cheese; fruit; and vegetables.

The nutritional needs of children and adolescents are different from those of adults because children are growing and developing. *Dietary Guidelines for Children and Adolescents in Australia* was written by the National Health and Medical Research Council in 1995 and revised in 2003. Each guideline deals with an issue that is important to optimal health, but the main aims of the guidelines are to reduce the incidence of chronic diet-related disease and, in particular, to reduce the rate of obesity.

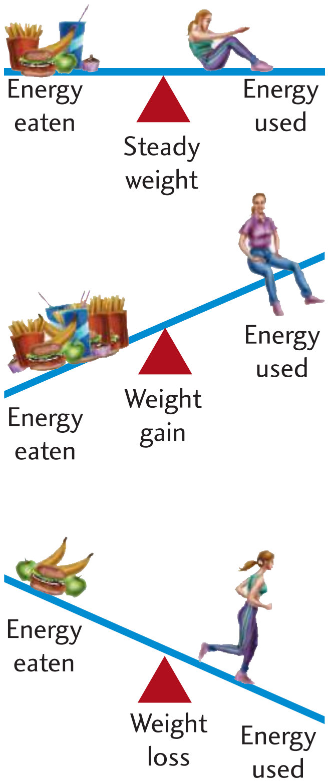


FIGURE 7.11: Energy balance

Switch on

1. Use the Internet to search for other food models that are used to teach good eating habits and study them carefully. To get started, go to www.jaconline.com.au/switchedontech and click on the following weblinks for this chapter:
   - *The Australian Guide to Healthy Eating*
   - *The Dietary Guidelines for Children and Adolescents in Australia* (2003).
2. As a class, discuss the good and bad points of the food models you find.
3. Design a model that suits the style of food you eat.

Energy balance

Food provides us with the fuel we need. Even when we're asleep, our body requires energy to perform its daily functions. The amount of energy needed to fulfil our body's involuntary functions such as breathing, growing and digestion is called our *basal metabolic rate*. In order to be healthy, we need to provide our bodies with the right amount of fuel to maintain a healthy body weight. Too much fuel and we will gain weight; not enough fuel and we will lose weight.

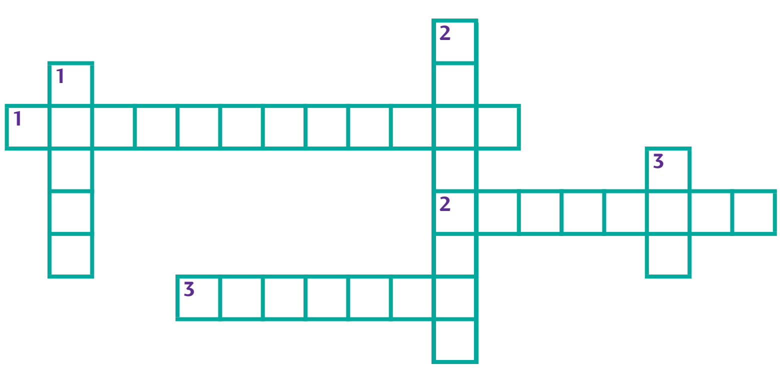
The energy from the food we eat is measured in kilojoules. If we consume more kilojoules than we expend, we will put on weight, and vice versa. We cannot do much to change our basal metabolic rate. It is determined by factors such as our age, gender, build (tall people usually have a higher basal metabolic rate) and even the climate we live in. We can, however, increase the level of energy required for voluntary processes by being more active. We can also try to avoid high-energy or energy-dense foods, particularly those that contain little nutritional value or empty kilojoules.

Recommended dietary intakes

The recommended dietary intakes (RDIs) are set by the National Health and Medical Research Council and are the essential amounts of each nutrient needed for optimum health. They are based on the needs of healthy individuals with a safety margin included to allow for slight differences between people. Gender and age are taken into consideration and different RDIs are set for each group of the population. Dieticians use RDIs when planning meals and food manufacturers show RDIs on their food labels to let consumers know the percentage of the RDI that the product contains.

Switch on

Nutrient crossword



Across

1. Bread and potatoes are good sources of this.
2. Form components of the body's tissues.
3. Needed for growth and repair.

Down

1. Regulates the body temperature.
2. Organic molecules found in fruits and vegetables.
3. Insulates the body and cushions vital organs.

Look again at 'Accurate measuring' on page 178.

7.6 Practical lesson 3

This recipe is low in fat and high in iron. It provides a great meal or snack for growing teenagers.

Fill-a-spud

Serves 4

Ingredients: potatoes

4 small–medium desiree (pink-skinned) potatoes

Method

1. Pre-heat oven to 220°C.
2. Prick potatoes and cook in the microwave on high for 5 minutes.
3. Use tongs to transfer the potatoes to a baking tray and bake for 30 minutes.

Ingredients: filling

½ small onion
1 clove of garlic
225 g lean beef mince
1 stick of celery
1 small carrot
1 T tomato paste
1 C peeled, diced tomatoes
½ t mixed herbs
½ t oregano
2 T fresh parsley
½ C grated cheese

Method

1. Finely chop the onion, celery, parsley and carrot and crush the garlic.
2. Fry the onion and garlic until the onion is transparent. Add the mince and cook until the meat is brown.
3. Add the celery and carrot to the mince and cook for a further 2 minutes.
4. Mix in the tomato paste, diced tomatoes, mixed herbs, oregano and half the parsley.
5. Simmer for 10 minutes on medium heat.
6. Remove the potatoes from the oven. Cut down the middle of each potato and scoop out some of the potato.
7. Fill with bolognaise sauce and top with the grated cheese.
8. Place on serving dishes and sprinkle with the remaining parsley.

7.7 Recipe modification and design

FIGURE 7.12: Recipes are available from many sources.

Why modify?

Writing a recipe from scratch can be very difficult, especially if you are not an experienced cook. You might need to find a recipe and modify or adapt it to suit the design brief. There are many reasons why people want to change or modify recipes, including:

- to alter the taste (it might be too bland or too sweet)
- to meet a special need (personal likes and dislikes, allergies)
- to make it cheaper or accommodate seasonal variations
- to improve its nutritional value.

In order to fulfil the design brief, you need to design something that has sound nutritional value, specifically, something iron-rich and healthy.

How to improve the nutritional value of recipes

- Leave the skin on fruit and vegetables. It provides fibre.
- Use foods to sweeten that also contain nutrients, such as fruit, rather than taking in the empty kilojoules of sugar.
- Use low-fat milks, yoghurts and cheeses.
- Use wholemeal varieties of flours and breads.
- Try to reduce the amount of saturated fat by using mono-unsaturated fats such as olive oil or canola oil instead of butter. Use cooking sprays and baking paper wherever possible.
- Avoid high-fat cooking methods like deep-frying and roasting. Dry bake, stir-fry or steam instead.

When changing recipes, make sure you leave the ratios of dry and wet ingredients the same and always test the recipe to make sure the changes you have made work in practice! It's also handy to know the properties that each ingredient brings to the basic recipe:

- Fat adds flavour, improves texture (by making foods either crispy or short and crumbly), increases shelf life, and holds air and moisture.
- Sugar sweetens and softens tart flavours, preserves, adds bulk and lightens foods. In food manufacture, it is used to lower the freezing point of water. Also, sugar is necessary for fermentation.
- Eggs hold air, help set and thicken food, emulsify fat and water, and are used for binding, coating and glazing. Eggs are also very nutritious and add protein, vitamins and minerals to a food product.
- Flour adds bulk, thickens liquids, forms a gluten structure that sets on heating, and provides flavour and texture. Flour can also provide dietary fibre if a wholemeal variety is used.

Technobite

'Cooking is like conducting an orchestra, and all the instruments must be in tune,' said Jean Delaveyne, French chef.

FIGURE 7.13: Common ingredients: fat (oil and butter), sugar, flour and eggs

Switch on

Find two recipes that include the ingredients discussed on page 185 and shown in figure 7.13. Make sure the recipes are quite different. Outline the function of the ingredients in each recipe.

What to put on your recipe card

Once you have decided on a recipe and you are ready to present it on a recipe card, you need to include the following information:

- name of the recipe or title
- number of serves
- list of ingredients
- exact quantities of each ingredient (use metric measurements)
- oven temperatures and cooking times
- method or step-by-step preparation instructions.

Recipe abbreviations and terminology

Tables 7.5, 7.6 and 7.7 will be useful for working out the quantities of each ingredient and for writing recipes.

Technobite

An eggtimer is a small, hourglass-shaped container holding a fixed amount of sand. When the timer is turned upside down, the sand moves from one half to the other in a three-minute period, during which time a medium-sized egg will cook to the soft-boiled stage.

TABLE 7.5: Useful measurements

Measure	Volume or weight
1 standard tablespoon	20 mL
1 standard teaspoon	5 mL
$\frac{1}{2}$ standard teaspoon	2.5 mL
$\frac{1}{4}$ standard teaspoon	1.25 mL
1 cup	250 mL
$\frac{1}{2}$ cup	125 mL
4 cups	1 L
1 kilogram	1000 g

TABLE 7.6: Common abbreviations

Word	Abbreviation	Word	Abbreviation
Gram	g, gm, gr	Cup	C
Kilogram	kg, Kg, Kilo	degrees Celsius	°C
Millilitre	mL, ml, mls	millimetre	mm
Litre	L, l	centimetre	cm
Teaspoon	tsp, tspn, ts, t, teas, Tsp	packet	pkt
Tablespoon	tbls, Tbls, T, tbs, tb, Tab	self-raising (as in flour)	S.R.

TABLE 7.7: Metric and imperial references

Weight/solids		Volume/liquids	
Metric	Imperial	Metric	Imperial
15 g	$\frac{1}{2}$ oz	15 mL	$\frac{1}{2}$ fl oz
25 g	1 oz	30 mL	1 fl oz
40 g	$1\frac{1}{2}$ oz	50 mL	2 fl oz
50 g	$1\frac{3}{4}$ oz	100 mL	$3\frac{1}{2}$ fl oz
75 g	$2\frac{3}{4}$ oz	125 mL	4 fl oz
100 g	$3\frac{1}{2}$ oz	150 mL	$\frac{1}{4}$ pint
125 g	$4\frac{1}{2}$ oz	200 mL	$\frac{1}{3}$ pint
150 g	$5\frac{1}{2}$ oz	300 mL	$\frac{1}{2}$ pint

Look again at 'Accurate measuring' on page 178. Look also at table 7.5 on page 187 if your measuring jug does not have cup measurements marked.

7.8 Practical lesson 4

Here is a modified recipe for you to try. The milk, flour and sugar have all been changed. Can you think of what was used originally?

Rock cakes

Serves 2

Ingredients

1 C white S.R. flour
1 C wholemeal S.R. flour
1 t mixed spice
⅓ C raw sugar
90 g mono-unsaturated margarine
½ C dried fruit
1 egg
½ C skim milk

Method

1. Pre-heat oven to 180°C.
2. Sift flours, sugar and mixed spice in a medium-size bowl.
3. Rub in margarine and stir in the dried fruit.
4. Beat the egg, add the milk and pour over the dry ingredients. Stir with a wooden spoon to a soft dough.
5. Place spoonfuls of dough onto a greased baking tray. Bake for 12 minutes.

7.9 Food display and photography

Food presentation

When food is presented well, it stimulates our senses and we want to eat it. Making food look good is also half the fun of food preparation. When trying to ensure food looks good, you need to consider certain factors, including:

- colour. Colour is an important indicator to tell us if food is fresh and cooked appropriately.
- serving dishes. These must not distract from the food and must be an appropriate size. White is the most popular choice.

- balance. This can be created with a mixture of soft and curved lines, heights and the ratio of food to plate.
- texture. Make sure the food is not overcooked and soggy, and looks how it should taste; for example, deep-fried food should look crispy.

Garnishes and decoration

A garnish is added to a dish to improve its visual appeal. We usually garnish savoury food, such as soups, and decorate sweet food, such as cakes. Garnishes are almost always edible and should complement the flavours of the dish as well as making it look good. A sprig of dill is often used to garnish fish and rosemary is used to garnish lamb.

Other simple garnishes include:

- fresh herbs, such as a sprig of basil, dill, coriander or parsley
- finely chopped parsley sprinkled over a dish
- a swirl of cream
- butter curls
- lemon wedges
- fresh fruit, such as berries.

Lemon wedge

Vandyked tomato

Chilli flower

FIGURE 7.14: Simple garnishes

Garnishes can also be quite intricate, such as:

- vandyked tomatoes, oranges or kiwifruit
- chilli flowers
- celery or shallot curls
- apple swans.

What we consider appealing is also influenced by fashion. Trends in food presentation and garnishing change, but the basic rule — to present food attractively — stays the same.

Switch on

1. Look through cookbooks or magazines to find examples of three of the garnishes listed above.
2. Find three other garnishing ideas.

Photography

Food styling and photography are used for product packaging, advertising for television and magazines, for cookbooks and for recipes in magazines and brochures. A food stylist and photographer work together to create and capture the best possible representation of the food. Sometimes, even lighting and art directors are involved.

Spotlight Profile of a food photographer

Do you need any formal qualifications to work as a photographer?
I completed two years of a four-year part-time diploma of photography at Sydney TAFE. This course included maths, light and optics, chemistry (photographic), composition and a practical component. In addition to TAFE training, candidates are also required to be working in the industry. I worked as a trainee wedding photographer.

What sorts of jobs are available for food photographers?
Shortly after I was accepted into the diploma, I left the job with the wedding photographer and started working at a black-and-white lab. I then got a job at the Australian Museum, in the photographic department, running the darkroom and assisting the photographer. I left TAFE to travel overseas. In London, I was assisting a food photographer who did advertising and packaging. That was my first experience working with food. It was also my first exposure to digital technology. After working with him for almost a year, I then started freelance assistance for other food photographers.

Upon returning to Sydney in 1997, I began assisting photographers in all areas but tried to concentrate on food. I met food stylists and started to do some test shots with them to build up my portfolio. At the moment, I'm working as a freelance photographer mainly doing editorial work (magazines). My work includes shooting gardens, food stories, produce farms, products and animals. I am also working on a proposal for a cookbook with a food stylist.

Describe a typical day.
If shooting food either on location or in the studio, the food stylist and I decide where to shoot and the style/feel we want the shot to have. I then set up the lighting and camera while the food stylist prepares the food. When the food is in front of the camera, I work quickly on getting the correct angle and finetuning the lighting; then I shoot a Polaroid. We both check the food and composition, and make any necessary changes. The food stylist freshens up the food and I shoot the film. How quickly all this happens depends on what we're shooting. With ice-cream you have to be really quick (no time for Polaroids). Overall, our aim is to make the food look so delicious that you want to eat it off the page! Or at least make it yourself.

Spotlight review

1. Summarise the difficulties of photographing food.
2. Does this job appeal to you? What training would you need to become a food photographer?

Tricks of the trade

In the past, food stylists were known for being a bit sneaky in order to make the food look appealing for photography. They used tricks, such as substituting plasticine for ice-cream and using hair spray on fruit to give it a shiny appearance. Now, it is against the law to be deceptive and food only must be the subject. There are, however, several hints to successful food styling and photography. These include:

- making sure the food is fresh and free of bruises, flaws and blemishes
- making sure the plate or serving platter is clean and not overcrowded
- making sure the garnish or decoration is appropriate to the dish
- spraying the food with water to give a moist appearance
- rubbing the food with oil to improve its shine and to make the food look warm

- using wet cotton balls that have been microwaved to create steam around the food
- undercooking the food to retain colour and texture
- combining food of contrasting colour and texture to create interest.

FIGURE 7.15: Some examples of well-presented food

Switch on

1. Use food magazines to find five pictures of well-presented dishes and five pictures of dishes you feel could be presented more attractively. Annotate what you like and dislike about each picture.
2. Look in old-fashioned cookbooks and analyse the trends in food presentation from those eras.
3. Read a range of current food magazines and identify trends in food presentation. Compare the different forms of presentation for different target markets. For example, are the foods in *Family Circle* magazine presented differently from those in *Gourmet Traveller*?

Techno**bite**

In 1519, Spanish explorer Hernán Cortés first tasted chocolate prepared by the Aztecs. After Cortés conquered Mexico in 1521, he brought the recipe back to Spain, where it remained a secret of the Spanish monks for nearly 100 years. Chocolate is made from the fruit of the cocoa tree.

Decorating with chocolate

Chocolate makes a great decoration for lots of different desserts. Chocolate curls, leaves and shavings are simple ways to use chocolate, but if you really want to impress, try making a piping bag and piping some patterns.

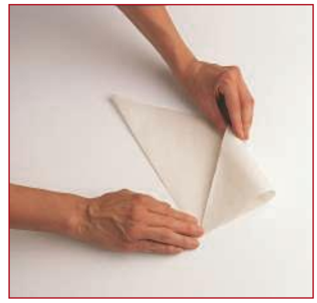
Making a piping bag

One way to decorate with chocolate is to pipe patterns onto baking paper. Once the piped patterns cool, they can be used to decorate desserts, cakes and ice-cream.

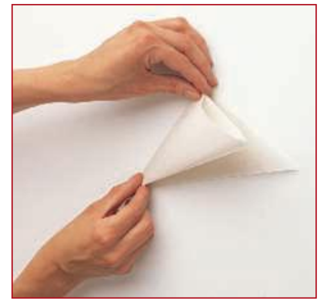
First you need to make a piping bag, as shown in figure 7.16.

FIGURE 7.16: Making a piping bag

(a) Unroll a length of greaseproof paper. Fold one corner of the paper across to meet the opposite corner of an imaginary square. Crease the fold and cut along it to remove a triangle of paper.

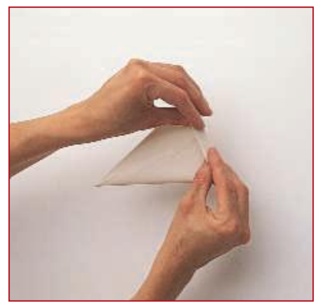


(b) Fold the triangle in half. Place on a flat surface, with its long side facing you. Bring the right-hand point up and across to meet the middle point.



(c) Now, fold the paper twice to the left to meet the left point. Squeeze the cone to open. Fold down the top edge of the cone above the seam to secure.

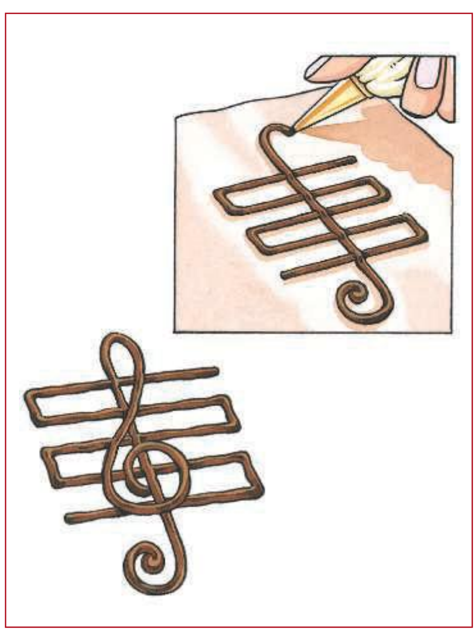
(d) Open the cone and gently spoon the icing into the finished bag. For best results, fill the bag just halfway.



(e) Fold over the top to seal. Snip off the tip when ready to use. The opening should be very small so that you can control the flow of the chocolate.

(f) Keep the cone upright to prevent the chocolate from running out.

FIGURE 7.17: Making patterns with piped chocolate



(a) Piping chocolate

(b) Feathering chocolate

7.10 Practical lesson 5

Look again at 'Accurate measuring' on page 178. Look also at table 7.5 on page 187 if your measuring jug does not have cup measurements marked.

Chocolate cup with ice-cream and raspberry coulis

Makes two chocolate cups (one to serve and one to practise on)
Makes enough raspberry coulis for 20–25 chocolate cups

Ingredients: chocolate cups

1 chocolate cup
1 scoop of ice-cream
50 ml of raspberry coulis
¼ C of fresh berries
70 g dark cooking chocolate

Method

1. Cut a 15 cm x 15 cm square of baking paper.
2. Break up the chocolate and melt in the microwave on medium/high for 2 minutes.
3. Stir well and spread a thin layer onto baking paper.
4. Put the baking paper into a shallow dish and refrigerate until the chocolate is set.

Ingredients: raspberry coulis

600 g frozen raspberries
1½ C of sugar syrup (1 C of sugar, 2 C of water — boil to reduce)

Method

1. Mix raspberries and sugar syrup well in a food processor or blender.
2. Pass through a sieve to remove the raspberry seeds.
3. Refrigerate until required (will last several days in the fridge).

Put it all together!

1. Carefully remove the baking paper from the chocolate cup and place the cup on a serving dish.
2. Fill the cup with a scoop of ice-cream.
3. Decorate with the coulis and fresh berries.

7.11 Special aspects of food technology

Occupational health and safety

FIGURE 7.18: Young workers are more likely to be injured at work.

Every second day, someone is killed as a result of a workplace accident in New South Wales. A study carried out by government agencies in 1999 found that more than 55 000 people suffered a workplace-related injury in New South Wales in the 1998–99 financial year. Young workers aged between 15 and 24 made up more than 8000 of the total number of cases.

Part-time and casual workers are more frequently injured than full-time employees, and workers are also most likely to be injured in the first few weeks of a new job. The hospitality industry has a significantly high injury rate. This is mainly due to the age of the staff and a high staff-turnover rate.

Switch on

As a group, brainstorm the reasons why young, part-time workers in a new job are more likely to hurt themselves.

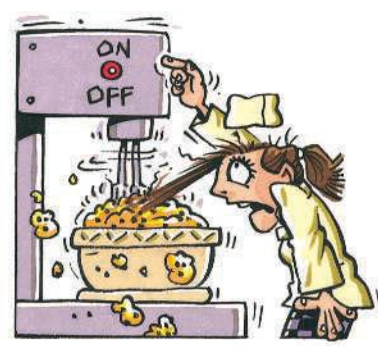
What are the hazards?

In the areas of food and the hospitality industry, you are at most risk of suffering an injury from the situations shown in figure 7.19.

FIGURE 7.19: Risk situations in the food and hospitality industry

(a) Manual handling — such as pushing and lifting

(b) Work environment — such as floor surfaces, noise, temperatures and ventilation



(c) Plant — the equipment you use, both powered and nonpowered

(d) Heat — burns and scalds

(e) Harassment or violence from coworkers or customers

(f) Coming into contact with hazardous substances — such as chemicals

Look again at the rules for basic safety in chapter 2, pages 51–3.

(g) Coming into contact with biological waste on napkins and from bathrooms

(h) Handling sharps — glass, knives and syringes

Switch on

1. Look at the hazards in figure 7.19. Make a list of the common accidents, for example, slips and falls, burns.
2. Using the safety rules for a food technology room on page 171, match each hazard in activity 1 with a rule to follow in order to prevent the accident from happening.
3. Make a list of personal protective equipment you might need when working in the hospitality industry. To find out more, go to www.jaconline.com.au/switchedontech and click on the Workcover and Youth Safe weblinks for this chapter.

Common injuries

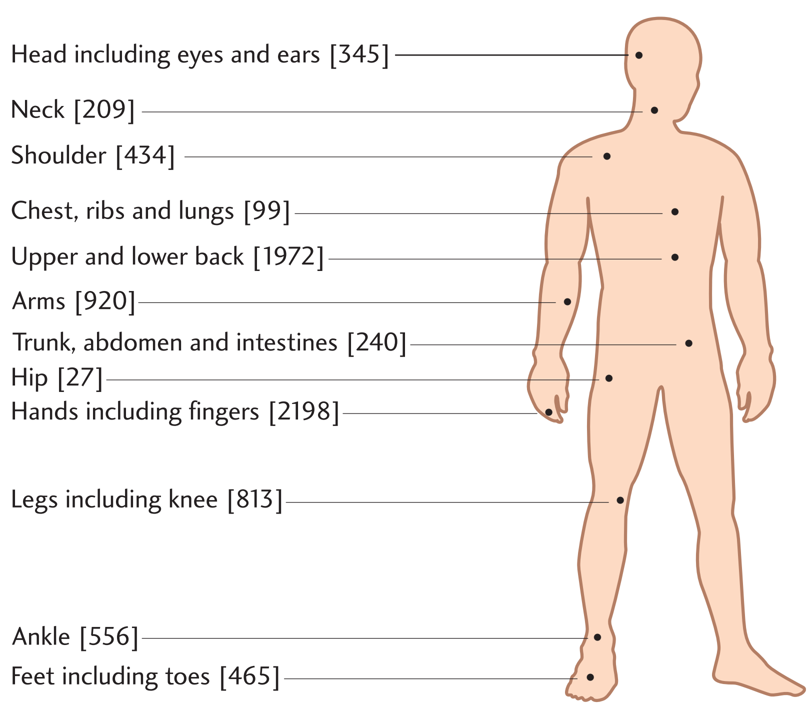


FIGURE 7.20: Injury analysis of workers between the ages of 15 and 24 during the 1997–98 financial year

Legislation

Look again at chapter 2, pages 52–3.

Laws concerning occupational health and safety have been designed to protect all workers from injury.

Employer's responsibilities

An employer has the primary responsibility for the health and safety of everyone in contact with the workplace. This includes both the employees (workers) and customers.

The employer's responsibilities include providing:

- safe working areas, machinery and equipment
- safe work processes
- protective equipment
- adequate training for staff, so that they are able to work safely.

Employee's responsibilities

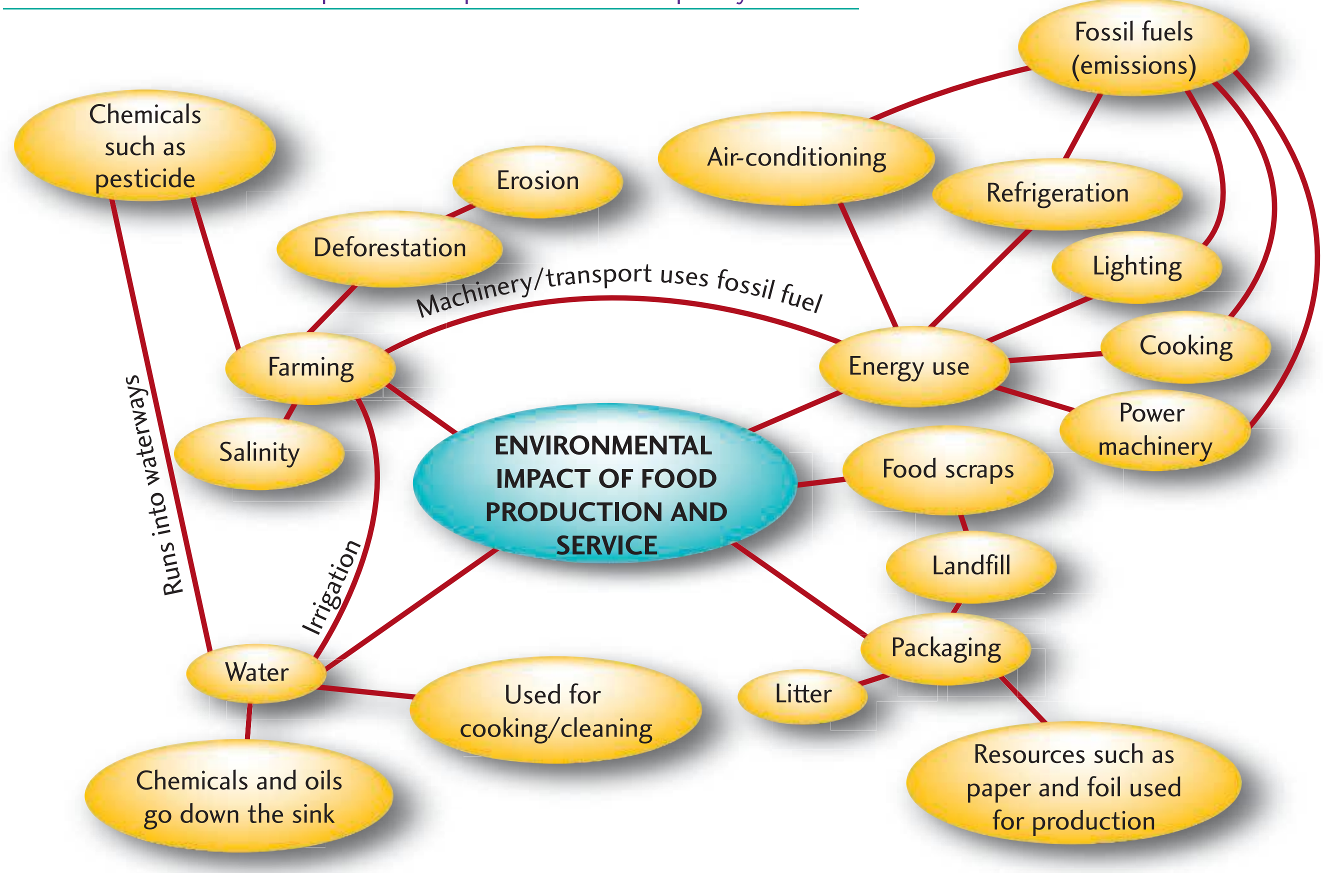
The law states that you must work safely and not put yourself or your fellow workers at risk of injury. In order to do this you need to:

- follow health and safety instructions
- use the personal protective equipment provided
- report all hazards and injuries to your employer immediately.

Environmental considerations

The production and processing of food and the hospitality industry can have a negative impact on our environment. We need to help minimise the impact. Figure 7.21 outlines some of the areas of the environment that are affected by food production and service.

FIGURE 7.21: Environmental impact of food production and hospitality industries



Technobite

In some parts of the world, people do not get enough to eat. The main causes of famine are drought, civil war and poor management of resources. Natural disasters, such as earthquakes and floods, often cause food shortages when communities are cut off from their food supplies.

ONLINE RESOURCE BANK

Switch on

1. Divide into four groups and select one of the main areas of environmental impact: farming, energy, water or packaging.
   As a group, research ways that businesses can reduce their impact on the environment. For example, to reduce the impact of food scraps, restaurants could compost their food waste or sell it to pig farmers.
2. List ten ways you could reduce the impact from your practical lessons on the environment.
3. Using graphics software, design an A4-sized poster that could be put above the sink to remind other students to save water.

Design process checklist

Go to the Online Resource Bank at www.jaconline.com.au/switchedontech and click on the Design Process Checklist. Use the checklist questions to self-evaluate your project and to help you finalise your design folio.

You can also find more ideas for design projects at the Online Resource Bank.

Plant production technologies

Plants not only enrich our lives with their beauty but also are vital to our continuing survival. They are essential for life on Earth, for without the oxygen they give off into the atmosphere, people and animals would die. Plants provide food, such as cereals, fruit and vegetables; and fibres, such as cotton, flax from which we make linen, and hemp from which we make rope. Some plants contribute to medicines and/or to dyes and perfumes.

Plants are suitable for making projects in all areas of study: Built Environments, Products, or Information and Communications. Chapter 8 provides detailed information to help you design and produce a landscape design for a garden. This chapter also includes general information about the materials, tools and techniques used in plant production technologies.

Focus

By the end of this chapter you will be able to:

- identify a variety of plants appropriate to the design project
- research and evaluate plant requirements in the development of a design project
- select, maintain and correctly use tools and equipment for specific purposes in design project development
- select and use techniques appropriate for the purposes of a design project.

Technobite

Plants contribute to alternative medicines and many mainstream medicines. The roots of the Mexican yam are used to make cortisone. The bark of the Cinchona tree yields quinine, mainly used for preventing and treating malaria. Digitalis, for heart disease, is made from dried foxglove leaves. Many plants used by indigenous peoples, particularly in rainforests, have not yet been scientifically tested. This is one of many important reasons why we should maintain plant diversity and protect wild areas.

Switch on

1. **List everything in your immediate surroundings that originates from plants. Don't forget fibre plants, such as cotton, and timber.**
2. **Go on a bushwalk and observe the plants you see. Make sketches to show their size, shape and colour. Make texture rubbings of bark and leaves. When you return, develop artwork from your impressions to use as a cover for your design folio.**
3. **Aboriginal and Torres Strait Islander peoples use native plants to provide food, medicine and other materials. Find out about Australian native plants used by Aboriginal peoples in your area. To get started, go to www.jaconline.com.au/switchedontech and click on the Bush Plants weblink for this chapter.**

8.1 Design process

Design project

Landscape designers create and manage designs for indoor and outdoor garden spaces that can be used for work, recreation and entertainment. Your design project for plant technologies is to create a garden design.

Area of study: Built Environments

Design specialisation: Landscape design

Techno**bite**

'No occupation is so delightful to me as the culture of the earth . . . and no culture comparable to that of the garden,' said Thomas Jefferson (1743–1826), third president of the United States.

Design situation

Many Australian gardens are boring. They contain a stretch of weedy lawn, a few shrubs, a clothes line and perhaps a lemon tree out the back. But a well-designed garden is a great asset to any house and adds monetary value to a property.

With some thoughtful landscaping, the grounds of any house can support the lifestyles of those who live there. Gardens can be living spaces in which we experience the great Australian outdoors.

FIGURE 8.1: A dull section of yard (left) is transformed by a garden makeover (right).

Design brief

Develop a special landscape design to improve a garden and carry out part of the plan yourself. The chosen site may be your home garden, or a site in the school or local community. The design brief describes and summarises what you will produce, but the look of the landscape design for the garden is up to you.

Project materials:

The plants and building materials will differ between sites, situations and budgets. Your teacher will give you a list of available materials.

Look again at the design process in chapter 2, pages 20–1.

Be flexible in your approach to this design process. The order of the steps is not set in concrete and you may not always follow them in the sequence presented here. Some steps go hand in hand with others throughout the design project. Other steps need to be completed before you can move on. You should concentrate on using the combined steps to form a process that guides the development of your design.

Design Folio **Production**

Your design folio is an important communication tool for design projects. It should tell the story of your design project's development, from your first rough ideas on paper to the final evaluation of your design brief solution.

Consider composing your design folio in electronic format for this technology.

DESIGN PROCESS: ONGOING EVALUATION

Essential for success

Techno**bite**

'He who plants a garden, plants happiness.' (Chinese proverb)

Remember that ongoing evaluation is central to the design process and should occur at every step. Regular evaluation helps to identify problems and challenges at the right time for you to deal with them. Putting evaluation off until later is asking for trouble. For example:

- wasted resources
- lost time
- failure to meet dealines
- increased costs.

DESIGN PROCESS: ANALYSIS

Design brief

Write the design brief in your design folio and then underline, circle or highlight words that give you specific information or instructions, as follows:

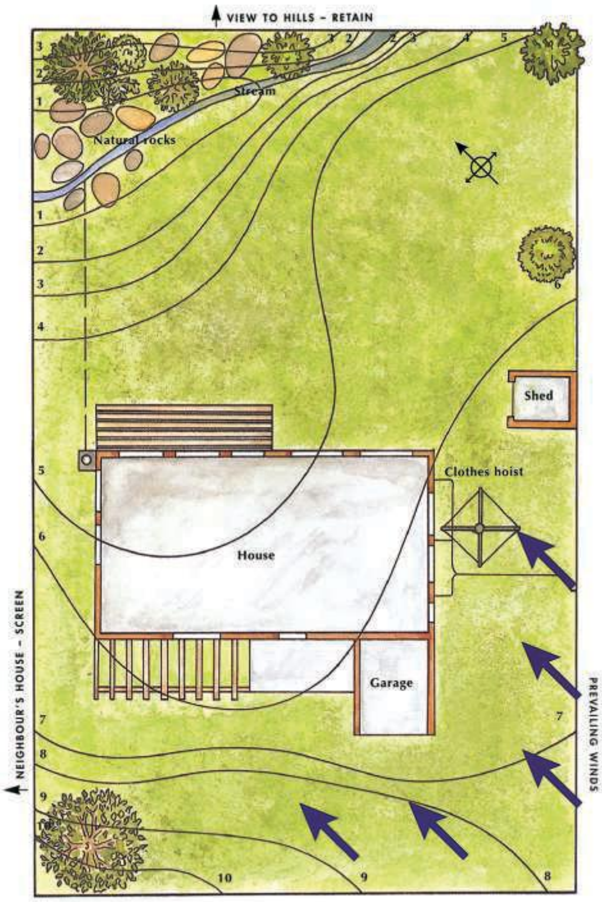
> Develop a special landscape design to improve a garden and implement part of the plan yourself. The chosen site may be your home garden, or a site in the school or local community. The design brief describes and summarises what you will produce, but the look of the landscape design for the garden is up to you.
>
> *Project materials:*
>
> The plants and building materials will differ between sites, situations and budgets. Your teacher will give you a list of available materials.

Analysing the design brief

First, you must critically analyse the current situation and develop an understanding of the client's needs. Second, you must develop a presentation design that could be used to redevelop the garden. This presentation will outline your new design and explain the reasons for your design decisions.

Waterlilies

FIGURE 8.2: Garden plans



(a) Basic site plan for a new garden

(b) Plan overlay showing final garden layout

Safety

Dial 1100 before you dig.

When digging, always check for underground services.

Daisy

Establishing aims

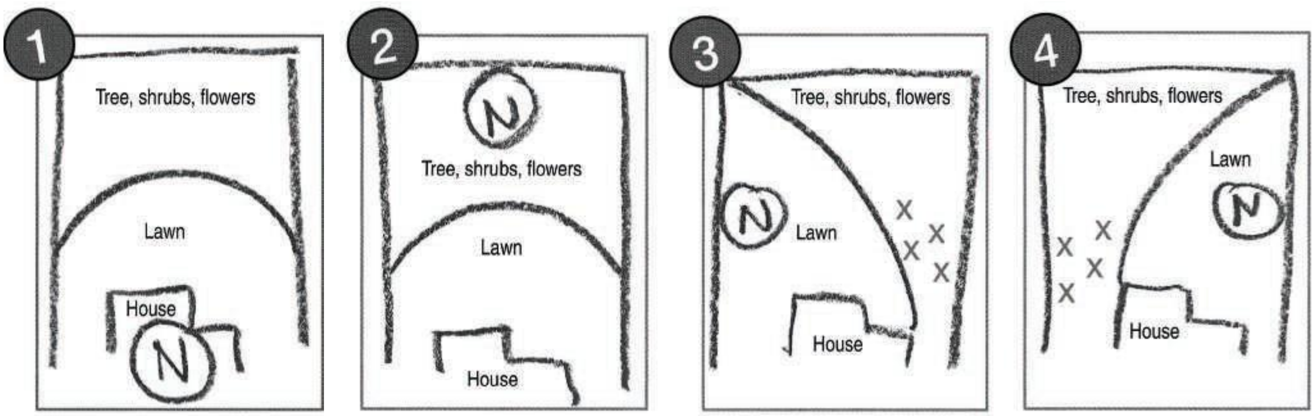
Develop a site survey. Begin with a site analysis plan that shows the important features of the existing site. Then, note the possibilities and limitations of the site. Next, obtain an accurate surveyor's map of the site. You may need to enlarge it to a useful size. Use grid paper with a faint grid to draw up the site dimensions more accurately. Use words, colours and symbols to add information to the map. Use plastic overlays for different types of information to help avoid confusion. Add the following to your site survey.

- *Climate or aspect.* Indicate north. Show areas that receive full sun and partial shade. Indicate the location of desirable or undesirable views outside of the garden. Consider views within the garden, for example, from doors or windows in the house.
- *Access points.* Show road access, doors and windows. This will guide the placement of paths and driveways and identify views from inside. Consider whether there might be better ways to move around the area.
- *Topography.* Decide which way the ground slopes. Think about whether slope and water run-off will be a problem.
- *Services.* Indicate underground gas pipes and water pipes and underground/overhead telephone and electricity wires — the location of these will affect where you can dig or plant trees that will grow very tall.

Tip
If you know the direction of north, you can predict the areas that will get full sun or shade. The position of the sun at midday (standard time) indicates where north is.

- *Service outlets.* Show outside taps and electricity outlets — irrigation systems, outdoor lighting and fountains will need to be connected.
- *Neighbours.* Consider noise or privacy issues that can arise from adjoining properties. Screens or screening plants might be needed.
- *Vegetation.* Map the existing vegetation. Some plants may be worth keeping. Symbols allow quick and easy addition of plants to the map; they can also show the size of the plant.
- *Soil.* You will need to conduct some tests on the soil to find out how good it is for growing different types of plants.
- *Atmosphere.* Think about the architectural style of the area, the existing plants and whether the site has any special historical character.

FIGURE 8.3: Which way is north? (*Source:* From *Gardens & Outdoor Living* magazine)



1. If north is behind you, shadows will tend to fall towards your back fence.

2. If you look north, shadows will fall towards the house so keep the tallest plantings to the back fence.

3. If north is to your left, a diagonal planting with tallest plantings at x will shade the house from hot morning sun in summer.

4. If north is to your right, tallest plants at x will shade the house from hot afternoon sun in summer.

Scale

A map is a scaled-down representation of an area, allowing you to get an idea of the real-life size. A scale can be shown with a bar or can be written as a ratio.

The ratio shows how one unit on the map represents many units in real life. For example, in a ratio of 1:100, 1 centimetre on the map equals 100 centimetres in real life. It's difficult to think how big 100 centimetres is, so change the units of the measurement into metres — 1 centimetre on the map will equal 1 metre in real life. The scale on landscape sketch designs and plans is commonly 1:100 or 1:500 and on landscape construction plans is 1:50, 1:100 or 1:200.

See chapter 1, page 6, for more information on scale.

Switch on

Work out the real-life measurement in metres for 1 cm on a map for each of the ratios: 1:50, 1:100, 1:200 and 1:500.

Criteria for success

Many physical constraints for this project can be identified from the site survey. Some may relate to location, for example, local climatic conditions. Most limitations can be overcome, for example, by buying good-quality soil from a landscape supplier to replace poor soil.

Dahlia

Switch on

1. List the physical limitations of the site in your design folio and outline ways you could overcome them.
2. Interview family members or clients to investigate their needs, wants and wishes. Record their answers in your design folio as a mind map (see figure 8.4) or as a table (see table 8.1).

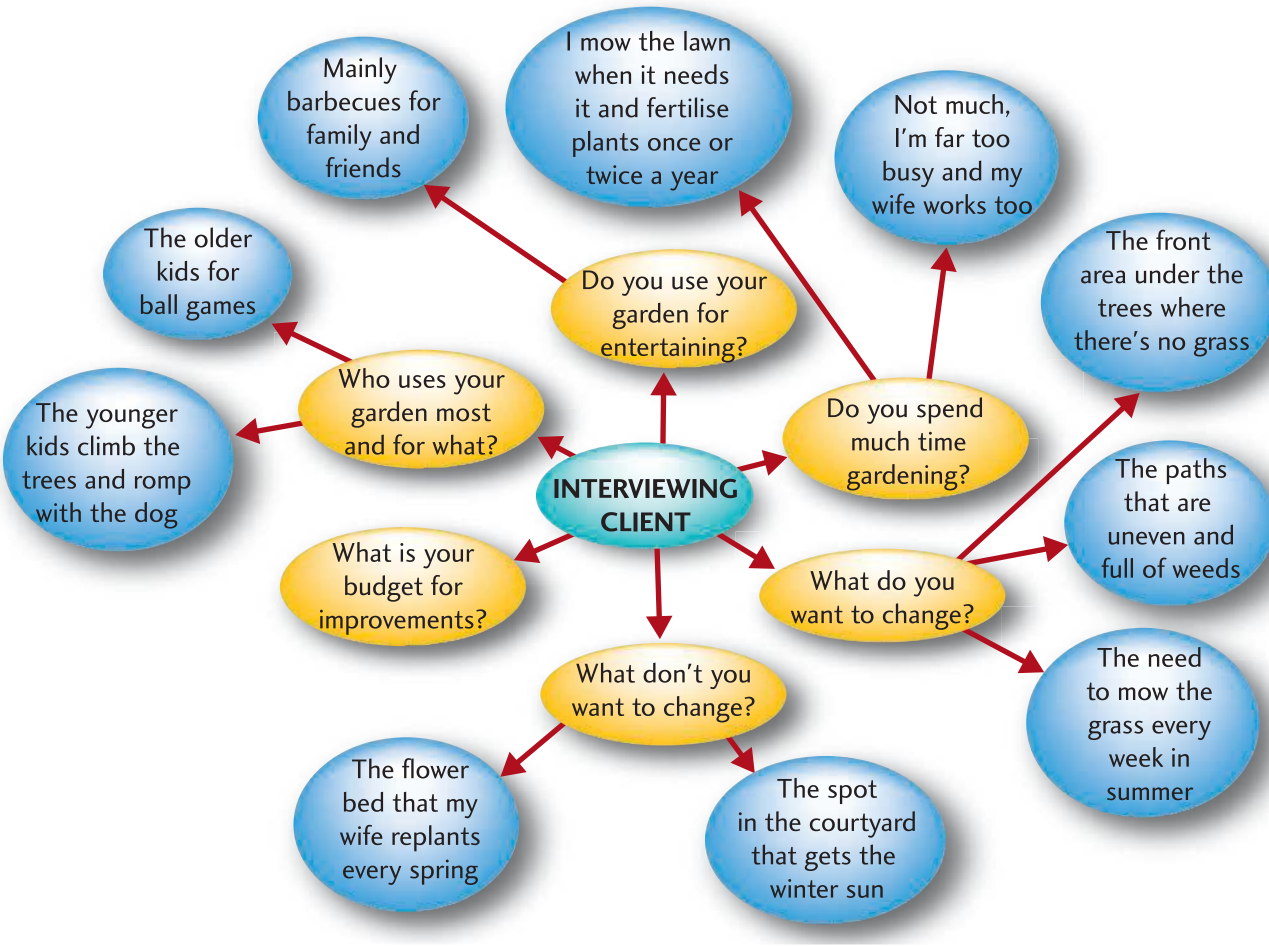


FIGURE 8.4: You could draw a mind map after interviewing your client.

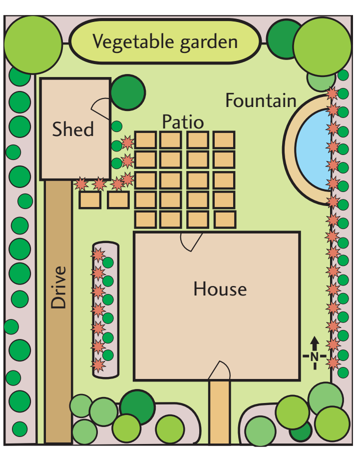


FIGURE 8.5: A simple garden plan

TABLE 8.1: Aspects to consider

Need. This is so important. I must have …	Want. If there's room, I would like …	Wish. If money, time and space were no problem …

3. Develop a checklist in your design folio that the client could use to evaluate the garden design.
4. Draw a garden plan for your design (see figure 8.5).


Tulips

DESIGN PROCESS: MANAGEMENT

Getting organised

Management is a step that must be considered alongside other steps throughout your project and needs constant reviewing as you progress with your work.

- Develop action-management, time-management and budget-management plans.
- Evaluate and justify any changes to your management plans, outlining impacts on the design project's development. This will mean re-evaluating your management plans regularly during the making of your design project.
- Plan and manage available resources effectively and efficiently.
- Evaluate the appropriateness of available resources as they relate to your design brief and developed criteria for success.

Developing a budget

Use a spreadsheet to develop a budget for the project. Set up columns for:

- item description
- number of units
- unit cost
- total cost.

For each type of plant you will use in your garden, enter the name and specify the size needed. Bigger pots mean more mature, more expensive plants. Enter the number you will use of each plant type. Visit a nursery or use a price list from a supermarket,
mail-order catalogue or the Internet to find out how much each plant will cost.

Find out prices for the other materials you will need, for example, pavers and a barbecue, and enter these on the spreadsheet as well. Use the spreadsheet to multiply the number of units for each item by the unit costs to arrive at a total cost for the project.


Aster daisies

DESIGN PROCESS: RESEARCH

Using the Internet

Go to www.jaconline.com.au/switchedontech and research the following topics.

- What landscape designers do:
  - Click on the Landscape Designers weblink for this chapter.
- Landscaping as a career:
  - Click on the Landscaping Careers weblink for this chapter.
- Landscaping (tips, hints, etc.) and environmental concerns:
  - Click on the Landscape Tips weblink for this chapter.
- Italian renaissance gardens:
  - Click on the Italian Renaissance Gardens weblink for this chapter.
- Landscape design shareware:
  - Click on the Shareware weblink for this chapter.

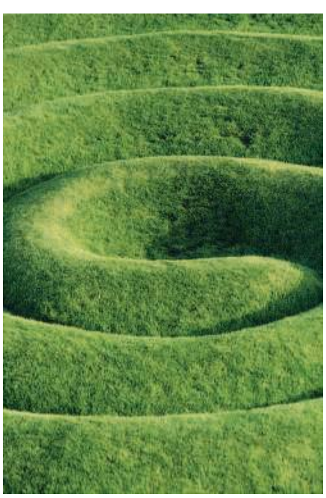


FIGURE 8.6: Formal hedge garden

Investigating the site

Soil

Different plants prefer different soil conditions. Soil tests are simple.

- A *pH test* will show how acidic or alkaline the soil is. The pH can be altered with soil additives, such as lime.
- A *soil texture analysis* measures the amount of sand, silt and clay in a soil. This influences aspects of a soil such as the rate of water infiltration, how much water the soil will hold, the nutrient level of the soil and the susceptibility of the soil to erosion.

Sometimes landscapers use a ready-made potting mix. These mixes have a moderate pH and a sandy texture.

See page 213 for further information about pH tests and soil texture.

Climate

The particular climatic conditions in an area will influence the plants you can grow there.

Switch on

1. Go to www.jaconline.com.au/switchedontech and click on the Bureau of Meteorology weblink for this chapter to find out about the long-term climatic conditions in your area. Find the weather station that is closest to your site and locate data on temperature, rainfall and evaporation.
2. Use climatic data to create graphs that show how average temperature, rainfall and evaporation levels change during the year.

Technobite

'Earth laughs in flowers,' said Ralph Waldo Emerson (1803–1882), American poet.

Technobite

Swedish botanist and explorer Carolus Linnaeus (1707–1778) developed a system for assigning names to plants and animals. He introduced a standard hierarchy of classification of *class, order, genus* and *species*.

Investigating plants in landscaping

Plants form a major part of garden design and there are thousands of species available. In Australia, we are particularly lucky to have a huge range of native plants, peculiarly suited to the range of climatic conditions across the continent. In addition, we have *exotic* species — plants imported from other lands that grow here very successfully. Almost all the cereals, fruits and vegetables we eat and many of our garden flowers were not here before Europeans arrived in 1788.

Different plants are desirable in particular situations for their combination of special features. Garden designers can select plants for:

- *sensual qualities.* These include smell, feel or taste of leaves, flowers, seeds or bark.
- *appearance.* This includes colour, shape, size of leaves, flowers, seeds or bark.
- *screening.* Some plants provide privacy screens for movement or noise.
- *function.* Some plants provide useful products, for example, fruit. Some are low-maintenance or hard-wearing, and some cope with difficult conditions, for example, salty conditions, wind or low soil pH.
- *thematic reasons.* Some plants are associated with particular garden types or themes, for example, Australian native, European formal, Japanese, cottage garden or colour compatibility.

FIGURE 8.7: Ornamental Cherry Sundae cabbages planted for effect

Tip
To attract birds to your garden, you must supply their basic requirements — food, water, shelter, a safe place to roost and nesting sites.

FIGURE 8.8: Blue-breasted fairy wren

Plants change as they grow. Annuals last for only a year so they will need to be replaced regularly to maintain the integrity of the design. Landscape design software is available that allows you to see both the short- and long-term consequences of planting particular plants.

Investigating landscaping materials

In a landscape design, you will often use materials other than plants to help make the area more accessible or useful for people. Some types of landscaping materials include:

- paths, drives, entertainment areas, decks
- pools, ponds, fountains, irrigation
- pergolas, sheds, cubbyhouses, swing sets
- steps, retaining walls
- outdoor lighting
- shadecloths
- mulches.

Switch on

1. Some of the landscaping materials in the above list are used only in particular types of gardens. Discuss the circumstances where these materials would be used. Can you think of other landscape materials you could use?
2. Outline the likely needs for clients with the following garden design situations:
   (a) inner-city terrace
   (b) new-release block of land
   (c) established house in suburbs with existing lawn and three teenagers.
3. Explore your school or neighbourhood for examples of landscape design. Take photographs and annotate them to describe the design elements used.
4. Research some famous garden designs and designers. Begin with Edna Walling, Australia's most influential landscape designer — go to www.jaconline.com.au/switchedontech and click on the Edna Walling weblink for this chapter. Also investigate Capability Brown, an eighteenth century English landscaper, and others.
5. Develop a database of plants that could be used in your design. Include the following information:
   - common name
   - scientific name
   - mature height
   - mature width
   - colour of flowers (if the plant produces any)
   - time of flowering
   - soil requirements
   - water requirements
   - fertiliser requirements
   - preferred pH range
   - special features of plant (such as bird-attracting).

Technobite

Eggplant

Deadly nightshade

Tomato

Chilli

Potato

Capsicum

Plants that are related to each other are classified into families. When edible plants such as tomatoes, potatoes, eggplant and capsicum were first introduced into Europe, people were concerned about getting poisoned because these plants are in the same family as deadly nightshade.

FIGURE 8.9: Garden water feature

FIGURE 8.10: Most herbs are easy to grow and thrive side by side in small areas of soil.

DESIGN PROCESS: IDEAS GENERATION

Brainstorming

Remember that the purpose of brainstorming is to generate as many ideas as possible in a short period of time. It's important not to judge the suitability of an idea at this stage — often the craziest thoughts spark the most creative and original ideas!

Preliminary sketches and plans for the solution

In your design folio, develop a series of rough sketches for a garden design that incorporates the needs, wants and wishes of the client.

Classic garden designs

Research garden designs and list the special features that are present in particular styles of garden, for example, cottage, formal, Japanese, Australian native, colour-themed.

In your design folio collect images of different gardens from magazines, the Internet or books. Use arrows to point to different features in the pictures and comment on the design elements they use. Try to identify the dominant style or theme in each garden.

Switch on

Make photocopies of your basic site plan — see figure 8.2(a) — and develop a number of garden designs in different styles for your site.

DESIGN PROCESS: COMMUNICATION

Final sketches and working drawings

Use a computer-aided design (CAD) package for the finished design — a specialised landscape design package if possible. Different versions range from very inexpensive to expensive and from amateur to professional. CAD packages make generating the plan easier as they contain templates for different plants and landscape materials, and they show slope, soil type, climate and aspect. Other useful features may include different viewpoints, simulations of shaded areas, suggestion of alternative plants, generation of materials lists and budgets, and the ability to view the garden over time.

- Carefully plot the garden boundary and put in the features you have retained from the existing site.
- Add the hard landscaping features, such as paving and lighting.
- Block in lawn areas, then the large feature plants, and finally the smaller filler plants. If you are using a CAD package with a time-simulation feature, you can check how the plants will change the appearance of the garden as they age, and adjust your design if necessary. Plant types should be indicated using a key.
- Some features of the plan will need annotated additional information.

See chapter 2, page 46 for more information about annotation.

Illustrated report and oral presentation

Outline your available garden design options and how you will make your plan work for your family or clients. Develop an illustrated report that will display your new design and explain reasons for your design decisions. Present your report to the class.

Geranium

See pages 218–21 for more information about plant propagation.

Technobite

When you propagate plants using cuttings, you are making clones of the original plant.

Technobite

People have given meaning to many plants and flowers. In *Hamlet* by William Shakespeare (1564–1616), sad, mad Ophelia speaks of rosemary for remembrance and pansies for thoughts. The language of flowers was very popular in Victorian times (1819–1901) for sending messages and expressing feelings. Clover meant good luck — a cloverleaf with four parts instead of three still does today. Lavender showed devotion. Sweet peas said, 'Farewell! Thank you for a lovely time!'

DESIGN PROCESS: EXPERIMENTATION AND TESTING

Evaluate the model

- Test the plan against your criteria for success. Use your design folio's checklist of client's needs, wants and wishes. For example, 'Mum loves white roses, so I've put white roses in a row down each side of the new front path.'
- Check whether the project is within the original budget constraints. You may be able to alter your budget by reducing some of the pot sizes of the plants so they are cheaper, or by propagating some plants yourself.
- Present your plan to your client(s) and consider any feedback they offer.
- Consider the time and resources available. You might choose to work alone and carry out a small part of your garden design.
- If everyone in your class has developed plans for the same site, you could look at the designs of other class members, and together select the best plan to develop the garden as a group.

Obtaining plants

Plant propagation

The cheapest method of obtaining new plants is to propagate them yourself. With some basic supplies, including plant material and seeds, pots and potting mix, you can easily grow many plants for your garden.

Plant a variety of cuttings and seeds. Experiment to find the best propagation techniques for different plants. Your new plants will need sunlight, water and fertiliser.

FIGURE 8.11: A cutting can be the tip of a plant stem or a section of a plant stem.

Nursery plants

It may take some time for propagated plants to develop in size. An alternative is to buy plants from a nursery. Selecting good quality plants is important. Think particularly about whether you are getting value for money.

- Older plants will generally be larger, but they will also cost more, whereas younger plants will be cheaper, but may take some time to look good.
- Plants that are mature and flowering or fruiting look good, but may not react well to transplanting, and you will probably have to prune them anyway.
- Compare the pot size to the size of the plant. It's important to have a well-developed root system, but the plant should not be root-bound, which is when roots grow around the inside of the pot and occupy the whole pot space. Turn the plant over and knock it out of the pot — the potting mix should not fall away from the roots, the roots should not fill the entire pot and the root tips should be white.
- Pests or diseases can limit plant growth, and you don't want to bring new ones into your garden. What signs would indicate pests or diseases?
- Garden plants are chosen for appearance and must have a pleasing balance or symmetry. Turn the pot and examine the plant from different angles to see if it looks good.

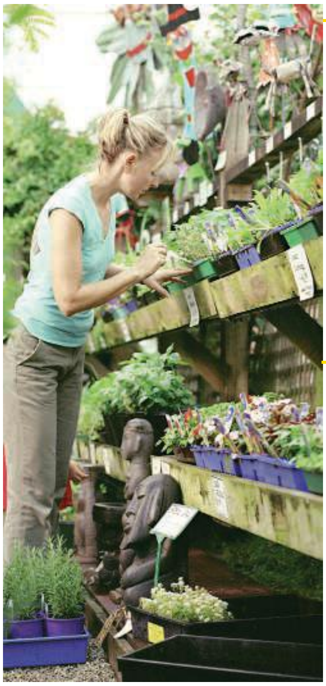


FIGURE 8.12: Be careful to choose healthy plants at a nursery.

Switch on

Develop a checklist in your design folio of things that you would look for to help you select the best nursery plant. Look at a group of plants, perhaps on a visit to a nursery, and practise using your checklist to find the best ones.

Fertiliser

Your plants will need to be provided with the correct nutrients to grow properly.

Switch on

1. In gardens, we can supply nutrients in different forms. Research the range of nutrients that plants need, and find out which ones are important for the different parts of a plant.
2. Compare several different fertilisers, for example, soluble fertilisers, chicken manure, different chemical fertilisers and native plant fertilisers. Draw up a table in your design folio that shows the nutrients contained in each type of fertiliser, their relative solubility, whether they affect soil pH and any safety aspects. Draw some conclusions about the best use of these fertilisers.

Landscape materials

Mulch

Mulch can reduce moisture loss from the soil and decrease weed germination. Many different materials make good mulch, for example, bark, pebbles, straw, newspapers and weed mat. These materials vary in appearance, price, efficiency and replacement time.

Switch on

1. *Mulch.* Evaluate different mulches. Compile information in your design folio about appearance and price, and test how well the mulches retain water and prevent weed growth. Use this information to give star ratings to each of your test mulches.
2. *Building materials.* Analyse different building materials for your landscape design; for example, a path could be constructed from concrete, pavers or gravel, and a retaining wall from timber, brick or architectural blocks. A garden is also a great place to use recycled building materials.
3. *Irrigation systems.* Obtain catalogues from irrigation equipment manufacturers, go to websites or visit a supplier to survey the wide range of irrigation fittings that are available. Put together a system with different water delivery fittings, including sprayer (spray, mist and directional), dripper (variable and fixed) and weeping hose. Measure the water output from each delivery fitting in millilitres per hour. Look at the water requirements per annum of the plants you have researched. Generally, vegetables and smaller bedding plants will have greater water needs. Match the delivery fittings to the different plant requirements.

Daffodils

FIGURE 8.13: Paths can be constructed from different materials.

(a) New bricks in a herringbone pattern (b) Flower-bordered path of recycled stones

Look again at the rules for basic safety in chapter 2, pages 51–3, before beginning to work on your project.

DESIGN PROCESS: SAFETY AND RISK MANAGEMENT

You will find safety rules that apply specifically to plant production technologies throughout this chapter in the places where they fit best. Observe them!

General rules for working with plants

- Wear gloves and a face mask when working with potting mix and fertiliser, as they can have health risks.
- Wash your hands well after handling commercial seed, as it may be coated with fungicide.
- Take care when using sharp cutting implements to take cuttings or when pruning.
- Find out as much as you can about the materials, tools and techniques that you use. For example, always read any information provided on potting mix and fertiliser package labelling. You can also refer to *Chemical Safety in Schools* (ask your teacher to show you *Vol. 1* and *Vol. 2*).

DESIGN PROCESS: PRODUCTION

Summary of the production process

1. Take a 'before' photograph of the site, and continue taking photographs to document the evolution of the site as you work.
2. Use your action-management plan to order the right amount of materials at the right time.
3. Put the hard landscaping materials in place. You may need to ask a tradesperson to assist you. Make sure you budget for this.
4. Carefully select and purchase the best nursery plants.
5. Dig and plant.
6. Install irrigation.
7. Finish the site with mulch and/or decorative features.
8. Tidy the site.

Flowering cherry

DESIGN PROCESS: FINAL EVALUATION

Test the product

1. Spend some time in the garden and consider how well the garden has achieved your aims.

Sunflower

2. Take photos of the special features of the site and match them to your garden plan.

Peer, self- and professional evaluations

1. Hold a grand-opening ceremony for the garden. Design an invitation. Invite the client to cut a ribbon.
2. Collect feedback from the client and from your classmates about the features they like and do not like about the garden. Add these comments to your design folio.
3. Did you use the most suitable materials, tools and techniques?
4. What could you do to improve the process?
5. Did you enjoy this unit of work? Why or why not?

FIGURE 8.14: Open your garden with a ceremony.

8.2 Materials

Now you can use some or all of the stages of the design process to start a design project of your own.

Look again at chapter 2, pages 20–1, for the stages of the design process.

Characteristics of plants

Knowing a little more about plants will contribute to the success of your plant production technologies project.

Plant types

Trees and shrubs are probably the most common plants that we notice around us, but we also grow ground covers, flowering annuals, fruits and vegetables, and palms and ferns. Enthusiasts and collectors sometimes raise special plants, such as succulents, cacti or orchids. Some people practise the art of bonsai — growing very small examples of trees and shrubs by carefully cutting back their roots and branches.

FIGURE 8.15: These are just a few of the Australian native plants available.

(a) Downy wattle (b) Australian violet (c) Cooktown orchid (d) Red-flowering gum (e) Macadamia

Function

Plants fulfil a function in the landscape. Grass lawns provide open spaces where people may enjoy physical activities, such as ball games, or quieter pastimes, such as sitting, thinking or reading a book.

Screening plants, such as photinias, ensure privacy. Certain types of trees and tall shrubs, for example, conifers and casuarina species, make effective windbreaks. Some trees with spreading branches provide shade from the hot sun, for example, eucalypts. Plants can reduce noise from roads, or mark a garden edge to show people where to walk.

Technobite

New plants are being discovered every year. Scientists believe there are more than 260 000 species of plants — some so small they are hard to see, others much taller than a giraffe. Plants become extinct when the conditions for their growth are no longer available.

Aesthetics

The beauty of plants can soften a built environment. When designing a garden, the plants you select need to complement or blend with the buildings and provide interesting colours, shapes, sizes and fragrances.

Many famous garden designers have used themes to guide their design choices. Some popular ones are Australian native, European formal, Japanese, cottage garden, colour-themed and Mediterranean.

FIGURE 8.16: Tranquillity in a bustling city — Chinese Garden, Darling Harbour, Sydney

Lotus

Characteristics of soil

pH test

Different plants are suited to soils of different pH levels, some thriving in acidic soils, others doing best in alkaline soils.

Garden lime can be used to alter soil pH. Retest a soil sample after lime has been added to see the result.

Switch on

An inexpensive pH kit, which can be used for hundreds of pH tests, can be obtained from most garden shops or supermarkets. Collect a small soil sample and add a few drops of universal indicator. Then sprinkle lightly with white barium sulfate powder. After a few minutes, the powder will change colour. Compare this colour to the kit's colour chart to work out the soil pH.

Soil texture

Become a soil texture detective. First, you will need to gather clues. Have water, soap and a towel ready, because you are going to get dirty.

Switch on

Collect a handful of soil and moisten it to a workable consistency. Try to mould the soil into a ball. How well does it form a ball? Is it sticky and easily moulded, or does it fall apart? Rub the soil sample between your fingers and note its grittiness and smoothness. Press the sample out between your fingers into a hanging ribbon and note how well it sticks together. Put down the sample and notice how dirty your hands are.

The soil texture detective looks for three families:

- *sandy soil.* A sandy soil will be rough and gritty, and will not roll into a ball or ribbon. It does not leave your hands very dirty.
- *silty soil.* A silty soil will be silky smooth and slippery. It will roll into a ball, but will not ribbon. It will stick to your hands and leave them dirty.
- *clayey soil:* A clayey soil feels sticky and slippery and can easily be rolled into a ball and ribboned. It sticks to itself so it will leave your hands relatively clean.

FIGURE 8.17: Testing soil texture is a great hands-on experience.

Technobite

There are organic and non-organic methods of plant production. Organic gardeners don't use any poisonous sprays or chemical fertilisers. They improve soil fertility and control pests and diseases by safe, natural methods.

Most soil textures contain varying amounts of these three families. For example, a soil sample that feels gritty, can just be moulded into a ball but not ribboned and leaves a dirty mark on your hands contains a lot of sand and a small percentage of clay and silt. This soil texture is called *sandy loam*.

Soil drainage

Texture affects how water drains through the soil.

Switch on

Analyse a number of soil samples of different textures. Include sand and clay samples.

(a) Collect soil samples and label them.

(b) Dry samples in an oven on a medium heat (100–120°C).

FIGURE 8.18: Set up your equipment for each soil sample.

(c) For each soil sample, you will need a 100 mL measuring cylinder with a funnel resting on the top. Line each funnel with a piece of folded filter paper and add the soil, pressing gently so the soil sample is firm and finishes 2 cm below the top of the paper.

(d) Measure 50 mL of water for each soil sample. *Simultaneously* pour the water onto the top of each soil sample, and start a timer. You will need more than two hands to do this, so, depending on where you are, ask for help from other students, your family or friends.

(e) Carefully observe the experiment. Rank the soil samples according to the speed at which they let water pass through the filter paper.

(f) Measure the amount of water that passed into the cylinders. Rank the soil samples on the amount of water they retained.

(g) Write up the experiment, with an *aim*, *method* and *result*. Draw some conclusions on the effect of soil texture on drainage and water-holding capacity.

See chapter 2, pages 49–50, for more information about writing up reports of experiments.

8.3 Tools

Safety

Protect your hands with a pair of gardening gloves when you are using tools or pulling weeds.

You need very few tools to grow plants. A potted plant might need only to be watered. You can make an effective recycled watering-can from a plastic or tin container, perhaps modified with punched holes.

Some other tools can make work easier, particularly as the garden size increases. Store tools carefully so they do not go rusty or splinter.

Planting

Cultivation

New plants need certain conditions to grow to their best. Before planting seeds or seedlings, remove all weeds so the seedlings will not compete for resources. Loosen the soil and break up any big clods of earth. This process is called *cultivation*. If you are using potting mix, it will already be a loose, weed-free mix.

HOE, GARDEN FORK, GARDEN RAKE: A hoe or garden fork helps to break up the soil and create a weed-free environment. A garden rake helps to smooth the bed.

FIGURE 8.19: Cultivation tools

(a) Garden fork (b) Garden rake (c) Hoe

Safety

Observe the following safety guidelines.

- With large sharp-edged implements, such as hoes, you must remain in control and avoid wild actions, as these tools can present a danger to yourself and others. Work calmly with the end of the hoe below knee height.
- Protect yourself from back strain by using heavy tools correctly.

ROTARY HOE, PLOUGH, HARROW: Using a hoe to break up the soil in a large garden would take a lot of time and energy. Machines can be used instead; for example, rotary hoes have paddle-like blades that churn through weeds and break up the soil. Various designs of plough are used to cultivate large areas of land. Often the soil is smoothed down afterwards with other machines, such as harrows, that act like a rake in your garden.

Tip

No-dig gardens can be made without all the work of cultivation. This is a good way to start a garden bed where you have previously had a lawn. Stop the growth of grass and weeds by laying down thick overlapping layers of newspaper and adding repeating layers of materials, such as straw, hay, organic fertiliser and compost, to build up the bed. Raised garden beds using no-dig principles are great for elderly gardeners or gardeners with a disability.

Switch on

Obtain a farm machinery catalogue or look at a farm machinery website. To get started, go to www.jaconline.com.au/switchedontech and click on the Kubota Machinery weblink for this chapter. Classify cultivation machinery into primary cultivation (where the machines act like a hoe, breaking up the soil) and secondary cultivation (where the machines act like a rake, smoothing the soil).

Measuring

When planting, space seeds or seedlings correctly so that the growing plants don't compete with each other. This is even more important in a formal garden where the placement of plants is very precise.

MEASURING TOOLS: A measuring device is useful for accurately placing plants. Some methods of measuring are very low-tech, such as using your hand width or pacing out a distance. Others are very high-tech, such as global positioning systems (GPS), which use satellite technology.

Some commercial nurseries use a special plate that sucks seeds into position with a vacuum, and then releases the seeds over the potting mix for perfect accuracy. Mechanised planters called seed drills can be used to plant a large-scale crop. The delivery mechanisms can be adjusted to alter the spacing and depth of planting. Some combine drills can cultivate, drill the seeds, deliver measured amounts of fertiliser and cover the seeds.

Tip

You can buy seed tapes where the vegetable seeds are attached to a paper tape at their correct spacing. All you need to do is tear off the tape at the length you want your row and plant it at the correct depth to get a straight, perfectly spaced row of vegetables.

Switch on

1. How will you measure in your garden? You could use a ruler or a piece of string with knots in it. Design and produce your own measuring tool for seed planting using recycled or inexpensive materials. Your measuring tool could incorporate other useful planting features, such as providing a straight edge for sowing straight rows, or a part that helps you form a furrow.
2. Identify three situations where different measuring systems would be appropriate.

Rose

Other tools

HAND TROWEL: Transplanted seedlings are planted in small holes. A hand trowel is ideal for this task.

Safety

If you are caring for your secateurs properly, the blades will be very sharp. Be careful not to cut yourself!

SECATEURS: You will need a sharp pair of secateurs to take cuttings. Good quality secateurs are expensive; care for them properly and make sure you keep them sharp and clean. Dip secateurs into a bleach solution between uses to help stop the spread of diseases between plants.

FIGURE 8.20: Hand trowel

FIGURE 8.21: Secateurs

Tip

We know we should be cautious when dealing with blood from other people because blood can carry diseases. Plants can carry diseases in their sap in the same way. If we perform 'surgery' on plants, we need to be careful that we keep their wounds clean and use clean operating equipment.

Managing weeds

In a garden, people make the decisions about what plants will go where. *Weeds are plants growing in the wrong spots*. Unfortunately, weeds often grow faster and spread better than chosen plants. This means people spend a lot of time and effort weeding. In large-scale plant production, cultivation machinery with accurate width settings is used for weed control where cultivation occurs between the rows of plants. You can use your hands to pull out many weeds, but some are more stubborn with deep roots or stings (for example, stinging nettles), and a tool may be needed to remove them.

Some weeds can have unexpected useful qualities. For example, chickweed (*Stellaria media*) can be eaten as a green vegetable.

HOE: A hoe is a useful tool for removing weeds. Spacing your plant rows the same width as your hoe makes weeding easier without risking your plants.

HAND FORK, HAND CULTIVATOR: A hoe is really too big for taking out weeds when there are delicate small plants nearby. Something smaller is required, such as a hand fork or a hand cultivator, which you can easily control.

WHEELBARROW: A wheelbarrow helps move heavy or bulky materials, for example, weeds and mulch.

FIGURE 8.22: Hand fork

FIGURE 8.23: A sturdy wheelbarrow saves you work.

FIGURE 8.24: Spade (left) and shovel (right)

SPADE: A spade is used to dig holes, for example, when planting shrubs or trees.

SHOVEL: A shovel is used to move loose material, for example, soil or manure.

Switch on

In groups, use a word processing program to produce a series of A4-sized fact sheets on weeds.

(a) Collect examples of the most common weeds in your area.

(b) Use reference books or websites to help you identify and find out about the weeds. Sometimes understanding the weed properly can help you to come up with ways to control it better. A weed such as a dandelion (*Taraxacum officinale*) uses the wind to spread its seeds widely. It's a good idea to control the weed before its seeds are produced.

Safety

Be careful with weeds:

- Some weeds are poisonous and you must wash your hands carefully after handling them.
- If you decide to eat your weeds, first check with an expert to ensure you have the correct plant, as many edible weeds are very similar in appearance to inedible weeds; for example, edible dandelion (*Taraxacum officinale*) looks very similar to inedible rough cat's ear (*Hypochoeris radicata*).

Tip

A spade is often called a shovel and vice versa. A *spade* has a flattened square shape and a sharp lower edge. There is a flattened section next to where the blade is attached to the handle so you can push down on it with your foot. A spade usually has a shorter handle than a shovel. A *shovel* has a rounded shape that can be flat or curved at the lower end and a long handle so you can use it with your hands spaced apart.

FIGURE 8.25: Rough cat's ear (left) is inedible. Dandelion (right) is edible.

FIGURE 8.26: Commercial crops are mostly harvested by specialised machinery.

Harvesting

Sharp secateurs (see figure 8.21) are best for harvesting flowers, fruits and many vegetables. Some vegetables are easier to harvest with a **SERRATED KNIFE**.

Switch on

(a) Select a crop and research how the problems associated with mechanically harvesting that particular crop have been overcome.

(b) Construct a display model to show how the machinery works.

8.4 Techniques

Dahlia

Planting

Seeds

It's important to plant seeds in the correct way or they won't germinate and you will never see your plants emerge. You first need to find out your seeds' *vital statistics*:

- *when* to plant
- *how deep* to plant
- *how far apart* to plant — between rows and within rows
- *time to germination* — when you can expect to see them.

This information may be found on the back of a seed packet, in a gardening book or on the Internet.

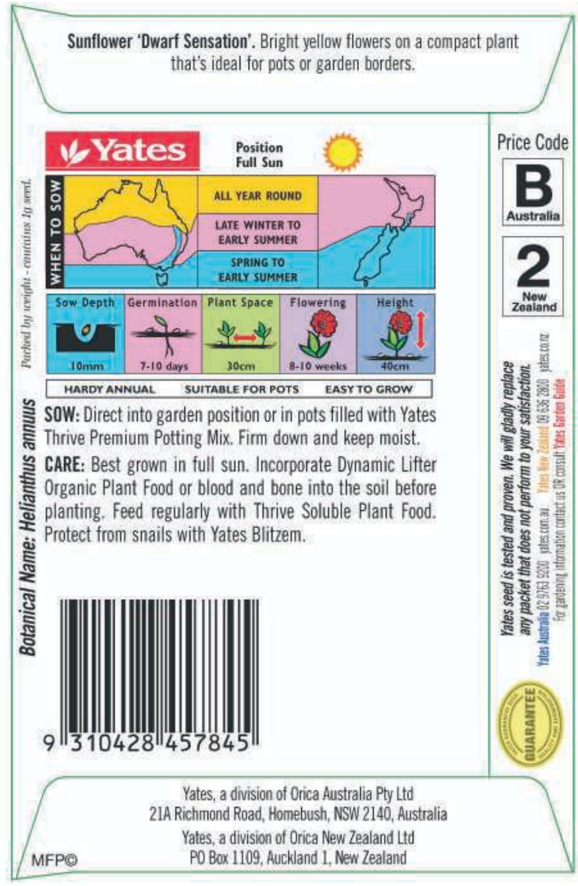


FIGURE 8.27: Sunflower seed packet

Switch on

Use the information in figure 8.27 to list the vital statistics of sunflowers.

Planting depth

Seeds contain an energy store for the emerging plant to use before it reaches the surface and can produce food of its own from the sun. Large seeds contain more energy than small seeds, so the bigger the seed the deeper it can be planted. Sow large seeds (for example, beans, peas and sweet peas) 25–50 mm deep. Sow medium seeds 12 mm deep. Tiny seeds have almost no energy, so they must be sprinkled on the surface or the plant will never make it.

Switch on

(a) Develop a table in a word processing or spreadsheet program that summarises the vital statistics of seeds you want to plant.

(b) Print out the table and put it in a protective plastic sleeve to keep it clean and dry.

(c) Take the table with you when you are gardening to use as a planting reference guide.

Sowing seed

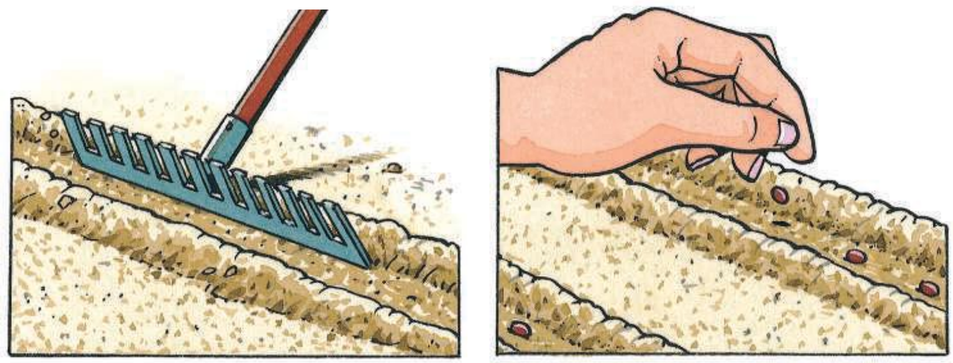
- You will need a weed-free seedbed with fine soil. When your plants begin to emerge they will need nutrients, so add some fertiliser. A high level of phosphorus (P) will help young seedlings grow quickly.

Technobite

Some Australian native species have special coatings on the seeds that resist germination and they require special treatment, such as fire, to stimulate growth. Australia's first inhabitants, the Aboriginal peoples, used to set fire to the bush to promote new growth in the natural vegetation.

- Make a furrow of the depth required for the seeds and water it. Space the seeds along it. Some gardeners put extra seeds in each place to be sure they will get a plant there; then they remove extra plants later. Cover the seeds with fine soil. In heavier textured soils, such as clay, you will have better results if you cover the seeds with a light textured material, such as potting mix.
- Water newly planted seeds well so the seeds will absorb moisture and begin to germinate.

FIGURE 8.28: Planting seeds



(a) Make a furrow with the back of a rake.

(b) Sow the seeds at recommended spacing. Cover the seeds with fine soil or potting mix and water thoroughly.

Marking rows

If you are planting seeds in a row, it's a good idea to mark the ends of your row so when the tiny plants begin to emerge, you do not mistake them for weeds. You can then pull out any plants that come up that are not in the row.

Switch on

Row markers can be as simple as sticks or stones, or elaborate, such as those made from brass or ceramics. Design some row markers for your garden using available materials. Remember your markers need to be weatherproof, so paper and water-based inks will not be effective. You also need to select materials that will not blow away or degrade in the sun. If you are planting different types of seed, you may want plant names on the markers. If many students are planting in the same area, your markers may need your name or a special symbol. Make your row markers and test them in the garden.

Hibiscus

FIGURE 8.29: Ideas for row markers

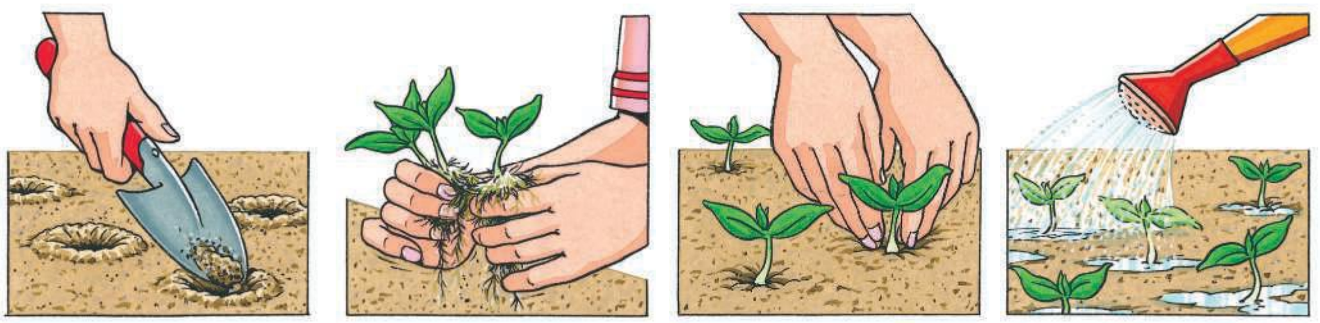
Bearded iris

Seedlings

Very small seeds dry out and die if they are sown directly into a garden bed. It is also difficult to space them properly. Small seeds are sometimes planted in trays of seed-raising mix and then transplanted into the garden as seedlings.

Transplanting should be done when it's cool, as the operation damages the root system and makes the plant more likely to die from drying out.

FIGURE 8.30: Transplanting seedlings



(a) Dig a hole a little larger than the seedling's root-base.

(b) Gently pull seedlings apart or tip them out of the pots.

(c) Place seedlings in hole. Fill in soil around roots and firm down carefully so the seedling is in a shallow depression.

(d) Water seedlings.

Tip
Cuttings don't work well for everything — annual plants are better grown from seed.

Cuttings

The best way to reproduce some plants is by vegetative propagation. The easiest way to do this is to take a cutting. A cutting is a piece of the plant that is cut off and then grown into a new plant. Experiment with different types of plants to find the best method. Geraniums are a good choice for a first attempt.

Switch on

The trick with a cutting is to make it produce roots before the rest of it dies off.

(a) Use your sharp secateurs to cut a piece about 15 cm long off the parent plant. Prepare the cutting by making an angled cut just below a node (a lump on the stem where the leaf attaches). Remove a sliver of rind. Remove all the leaves on the lower two-thirds. Too many leaves will make the cutting lose water faster and your cutting will dry out and die.

(b) Dip the end of the cutting in *cutting powder*, if you have some.

(c) In a pot filled with seed-raising mix, use the end of a pen or a stick to make a hole and insert the cutting. Firm the seed-raising mix around the cutting and water it.

(d) Keep the pot moist and out of direct sun until the plant develops roots. You can provide extra protection by covering it with a plastic bag supported by a wire loop.

FIGURE 8.31: Propagating cuttings

(a) Cut a piece from the parent plant.

(b) Remove a sliver of rind, dip in cutting powder.

(c) Plant the cuttings and water them.

(d) Cover with a plastic bag and keep out of direct sunlight.

Tip
Cutting powder contains a plant hormone that helps promote root growth. It can be inexpensively purchased at many supermarkets and gardening stores.

Managing plants

To keep your plants healthy and growing, you need to meet their needs.

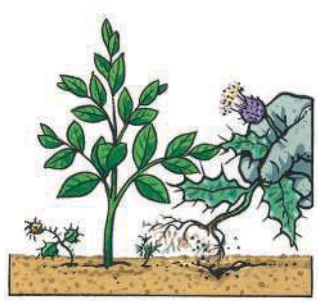
Switch on

For each of the needs of growing plants, identify the things you can do to help. Prepare a poster to communicate these needs. Before you begin, look carefully at figure 8.32. The figure omits at least one need — re-read page 208 'Nursery plants' to find out what it is.

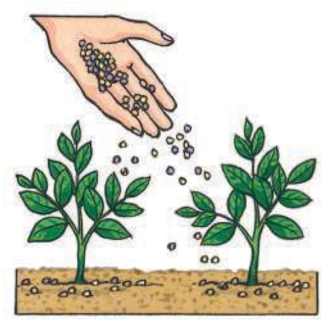
FIGURE 8.32: The needs of growing plants

(a) Sunshine

(b) Regular watering



(c) Weed-free environment



(d) Fertiliser

(e) Protecting with mulch

(f) Pruning or cutting back (perennials, shrubs and trees)

(g) Deadheading (flowers)

Harvesting

Harvesting produce is best carried out in the coolest part of the day. This will keep the produce fresh for longer.

Switch on

To find out about the ideal conditions for storing different fruits and vegetables, go to www.jaconline.com.au/switchedontech and click on the Sydney Postharvest Laboratory weblink for this chapter.

Cut flowers

FIGURE 8.33: Cut flowers

Some harvesting tips to make cut flowers last longer include:

- cut the flowers when it is cooler — in the morning or evening
- cut the stem at an angle
- immediately place the stems in a bucket of tepid water to avoid air bubbles forming in the stem
- add a drop of household bleach to every 500 mL of water to help prevent disease
- remove leaves and flowers that will be below the water
- never leave cut flowers in the sun.

8.5 Plant production technologies at work

Technobite

'In Australia is to be found the Grotesque, the Weird, the strange scribblings of Nature learning how to write,' said Australian writer, Marcus Clarke (1846–1881).

Spotlight Legend stays at the cutting edge

The Victa motor mower has been a real legend for more than 50 years … Last year, the Victa company introduced its new and much advanced Razor model for domestic use. Next month, it introduces its more robust Tornado line (see figure 8.34).

The earlier models have been earning international market share for decades, with current exports to more than 30 nations. Last year's launch of the Razor model produced the equivalent of one year's orders in less than two months, with large exports for Europe.

The forthcoming Tornado is pretty much like the Razor except that its steel baseplate is better able to resist rock damage than the alloy breastplate beneath the Razor.

How do you improve on a lawnmower? The new models have a wider cut and inset wheels to allow edge cutting on both sides. A shorter wheelbase gives easier turns. A choice of motors includes one, claimed to be the only one of its kind, that actually throttles up under load when power is most needed. Ergonomic changes include a cushion-grip handle, a redesigned grass catcher that simplifies removal and replacement, and an overall streamlined appearance that makes it clear that cosmetic change is a factor in modern business successes.

Source: 'Forty years of Australian invention', *The Australian*, 12 August 2004, p. 7.

FIGURE 8.34: Tornado Victa mower

Tulips

Spotlight review

1. What ergonomic changes have been made to the lawnmower? What parts of the body are they designed to protect?
2. Research the work of Mervyn Victor Richardson (1894–1973), who founded the Victa company. To get started, go to www.jaconline.com.au/switchedontech and click on the Victa and Powerhouse weblinks for this chapter.
3. Victa mowers of various ages are exhibited in the Powerhouse Museum, Sydney, and they featured prominently in the opening ceremony of the 2000 Olympic Games. They are an Australian icon. Identify another Australian icon. Research its history and produce a poster to display in your classroom.

Popular garden design

In recent times, garden design has been popularised by television programs. *Gardening Australia*, *Backyard Blitz* and *Burke's Backyard* all have featured *garden makeovers* that demonstrate how to transform a garden. Frequently, these are thematic gardens that are intended to match the personality or interests of the home owner. These shows often publish their garden designs, including the budget for the featured garden, in a magazine or on the Internet.

Switch on

Find a garden design from a television show and look at it critically.

(a) Think about good design features and decide if they have been adequately considered.

(b) Have the designers thought about how the garden will be used? Have they considered changing needs, for example, the addition of children or pets to a family?

(c) Will the garden still work in different weather conditions? For example, cushions in an open arbour will get wet in the rain.

(d) Will the garden require a lot of maintenance to keep it looking good, for example, pruning or replanting annuals?

(e) Will the garden still look good over time, or have plants been planted too close together creating an instant effect?

Design process checklist

ONLINE RESOURCE BANK

Go to the Online Resource Bank at www.jaconline.com.au/switchedontech and click on the Design Process Checklist. Use the checklist questions to self-evaluate your project and to help you finalise your design folio.

You can also find more ideas for design projects at the Online Resource Bank.

Graphics technologies

Graphics increasingly dominate our environment. They appear on billboards and banners beside railways and highways, on road signs, in shopping centres, on posters, stickers and pamphlets, and scattered throughout magazine and textbook pages. We immediately recognise many companies and institutions by their graphic logos and understand many messages, such as safety precautions and recommended 'healthy heart' foods, from graphic symbols.

It's possible to use graphics to design and produce projects in any of the three areas of study: Built Environments, Products, or Information and Communications.

Business cards are popular in the business and social worlds for identification and exchanging contact details. Although you may have no need for business cards yet, chapter 9 provides detailed information to help you design an equivalent card: your own personal introduction card. This chapter also includes general information about the materials, tools and techniques used in graphics technologies.

Univers Light 45
Univers Light Oblique
Univers 55
Univers Oblique
Univers Bold 65
Univers Bold Oblique
Univers Black 75
Univers Black Oblique

Focus

By the end of this chapter you will be able to:
- select and use appropriate materials, resources and data types for particular purposes
- select and use correct graphic formats appropriate for a design project
- select and correctly use the appropriate tools of graphics
- use computer-aided drawing (CAD) in the development of the design project
- view and interpret a 3-D model
- select and use techniques appropriate for the purposes of a design project.

Technobite

In March 2004, it was calculated that personal computers throughout the world were being sold at the rate of more than four a second, around 400 000 a day, or 140 million a year.

Switch on

1. **From memory, sketch three advertising billboards you have seen recently. Name three aims of advertisements.**
2. **From a library or the Internet, find out as much as you can about changes to the work of graphic designers since computers were introduced.**
3. **Why is colour important in design?**

9.1 Design process

Design project

Your design project for graphics technologies is to make your own personal introduction card.

Examples of graphics editing software are Adobe® Photoshop®, Adobe® Illustrator®, Corel PHOTO-PAINT®, CorelDRAW® and Microsoft® Paint and Photo Editor.

Area of study: Products. The focus of this area of study is on objects, systems and artifacts.

Design specialisation: Promotional design — packaging, presentation, brochures, advertisements and branding

Design specialisation: Communication systems design — signage

Design situation

When businesspeople meet, they often exchange business cards. These small cards usually contain a person's name, the name of their business, a brief description of the work they do and their contact details: phone number, fax, email and/or address.

Instead of a business card, you are going to produce a personal introduction card to help others know and remember you. It should convey a sense of you (for example, the only boy in a family of six girls), what you do and your interests (for example, music, athletics, history, the outdoors, reading).

FIGURE 9.1: Business cards and their holders come in many designs.

Design brief

Produce a personal introduction card (90 mm × 50 mm) for just one aspect of your school life or interests outside school. The look of the personal introduction card is up to you.

Project materials:

- computer
- computer graphics program, such as Adobe Photoshop, CorelDRAW, Corel PHOTO-PAINT, Microsoft Paint, Microsoft Publisher or Adobe Illustrator
- examples of other business cards to evaluate
- images, symbols, logos available to you to manipulate and change your card
- sketching paper to sketch out your ideas.

Look again at the design process in chapter 2, pages 20–1.

Be flexible in your approach to this design process. The order of the steps is not set in concrete and you may not always follow them in the sequence presented here. Some steps go hand in hand with others throughout the design project.

Other steps need to be completed before you can move on. You should concentrate on using the combined steps to form a process that guides the development of your design.

Design Folio **Production**

Your design folio is an important communication tool for design projects. It should tell the story of your design project's development, from your first rough ideas on paper to the final evaluation of your design brief solution.

Consider composing your design folio in electronic format for this technology.

Design process: ONGOING EVALUATION

Essential for success

Remember that ongoing evaluation is central to the design process and should occur at every step. Regular evaluation helps to identify problems and challenges at the right time for you to deal with them. Putting evaluation off until later is asking for trouble, for example:

- wasted resources
- lost time
- failure to meet deadlines
- increased costs.

San Marco

Tekton Black

Helvetica Black

Courier Medium

Colossalis

STENCIL

IRONWOOD

Helvetica Black

Biffo MT

Times Roman

FIGURE 9.2: The names and styles of some typefaces

See also pages 235–6.

Design process: ANALYSIS

Thinking about the design situation

When you answer the following questions, you have already started to research and create design ideas. These analysis questions could help you plan your personal introduction card.

- What do you want your card to communicate to others: your skills as a poet, perhaps, or that you came tenth in the cross-country? List everything about you and then pick one aspect as a focus. Write a description of that part of your life. Think of a title for yourself.
- Is your card going to be serious and formal or light-hearted and informal?
- Is there going to be an emphasis on your school name and/or logo (crest)?
- Is there going to be an emphasis on a particular part of the contact information (phone, address, email)?
- Will your layout be horizontal (landscape) or vertical (portrait)?
- What size will your logos or other graphics be: large (dominant) or small?
- How many colours will you use?
- How much white space will there be?
- Will you use a conservative typeface or a fun, informal typeface (such as crooked letters, funny shapes, odd sizes) or a mix? Experiment with your typefaces — remember that readability is a priority.

FIGURE 9.3: Try out different colour combinations.

Switch on

Thinking about the design brief

Write the brief in your design folio then underline, circle or highlight words that give you specific information or instructions. For example:

Produce a personal introduction card (90 mm × 50 mm) for just one aspect of your school life or interests outside school. The look of the personal introduction card is up to you.

Project materials:

- computer
- computer graphics program, such as Adobe Photoshop, CorelDRAW, Corel PHOTO-PAINT, Microsoft Paint, Microsoft Publisher or Adobe Illustrator
- examples of other business cards to evaluate
- images, symbols, logos available to you to manipulate and change your card
- sketching paper to sketch out your ideas.

Think about the main points and keywords and ask what, where, why, how and when. Record your analysis ideas in your design folio.

Choose facts about yourself that you would like others to know. Table 9.1 suggests some options.

TABLE 9.1: Information you could include on business/personal introduction cards

Information	
• Your name • Name of school • School address • Phone number • Fax number • Email address	• Web page address • School motto • Logo • Graphic image(s) (including purely decorative elements) • Favourite activities

Limitations to the design brief

There are always limitations to designing a product or solving a problem. Identify constraints for the development of your project:

- *Time available.* When does the project need to be completed?
- *Function.* What are the purpose and main features of the project?
- *Aesthetics.* What does the project need to look like?
- *Cost.* Do you have enough money to complete the project?
- *Materials and tools available.* What materials and tools are required? Are they available at school?
- *Expertise.* Do you have the skills required to complete the project?
- *Environmental considerations.* Will any production waste harm the environment?

In your design folio, list the factors that might limit your production of the personal introduction card. What will be the biggest limitation? Why?

Criteria to evaluate success

Criteria to evaluate success spell out exactly what the design must achieve, while taking into account the design limits that could affect the final solution. Copy figure 9.4 into your design folio and add four more criteria to the diagram.

Tip

Computer language is full of abbreviations (or shortened forms), generally made up of the first letters of a multi-word name, for example, PC for personal computer and www for World Wide Web. Try to memorise shortened forms as soon as you come across them.

Tip

Use short words in place of long ones so you can fit more on this small card. Use a single word in place of two or three. Try out abbreviations, but remember that the reader must be able to recognise any that you invent.

FIGURE 9.4: Criteria to evaluate success

Technobite

'The business card … is a kind of an extension of yourself. It's a little bit of giving yourself to someone else,' said Ken Erdman, founder of the Business Card Museum, US.

Design process: MANAGEMENT

Getting organised

Management is a step that must be considered alongside other steps throughout your project and needs constant reviewing as you progress with your work.

- Develop action-management, time-management and budget-management plans.
- Evaluate and justify any changes to your management plans, outlining impacts on the design project's development. This will mean re-evaluating your management plans regularly during your design project.
- Plan and manage available resources effectively and efficiently (for example, hours available to use a computer, computer facilities at home).
- Evaluate the appropriateness of available resources as they relate to your design brief and developed criteria for success.

Design process: RESEARCH

Investigating the design brief

Find information to help you design a range of options from which you will make your final choice. You can use various primary research techniques to do this, such as questionnaires and interviews.

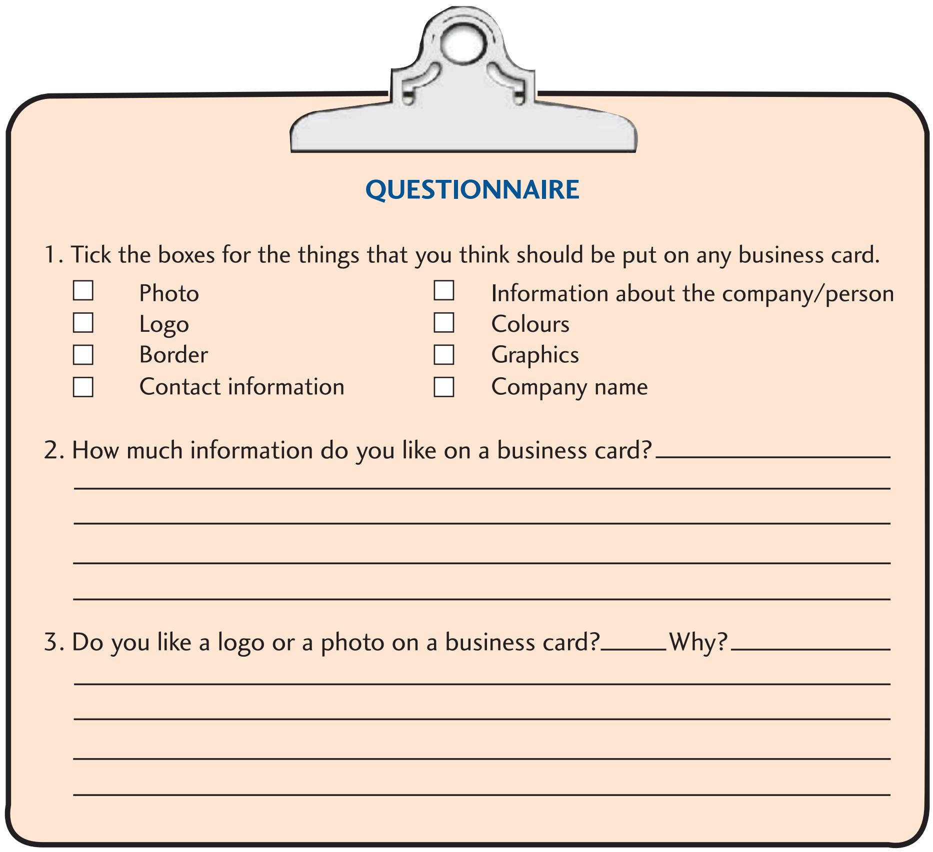
Look again at chapter 2, pages 36–7.

Questionnaires

Think about giving a questionnaire to your parents or friends.

1. Check the questionnaire to make sure that it matches your aim, is clear, makes sense and uses a variety of questions.

2. Approach a variety of people willing to complete the questionnaire.
3. Gather the information and sort it into fact or opinion.
4. Group the data and present it in an appropriate form, for example, as a report, a table or a graph.



QUESTIONNAIRE

1. Tick the boxes for the things that you think should be put on any business card.

☐ Photo ☐ Information about the company/person
☐ Logo ☐ Colours
☐ Border ☐ Graphics
☐ Contact information ☐ Company name

2. How much information do you like on a business card? ____________

3. Do you like a logo or a photo on a business card? ______ Why? ______

FIGURE 9.5: Questionnaires are useful tools for gathering data and ideas.

Business card environment

Look at hairdressers', doctors' and dentists' appointment cards, ask in offices and shops, and search through magazines and on the Internet to gather information on business cards.

Switch on

1. *Market*. Research in as many books, catalogues, brochures and pieces of junk mail as you can find, and in libraries, shops and on Internet sites to find out about business cards. Complete two A4 pages for your design folio recording your market research.
2. *Materials*. Find out as much as you can about the graphics software that you will use to produce your cards. Write an A4 page for your design folio on your findings.
3. *Tools*. Research the tools in the software program that could be used to make the personal introduction card: for example, cut, paste, mask, draw, import and insert.
4. *Techniques:* Research the techniques for the software tools. How and what will you use to cut, paste, mask, draw, import and insert?

Techno**bite**

The layout of the QWERTY keyboard, which is standard for many typewriters, word processors and computers, was invented in 1867 by an American, Christopher Latham Sholes. He positioned the keys to ensure that commonly used pairs of letters were far enough apart on the keyboard to stop the mechanism from jamming.

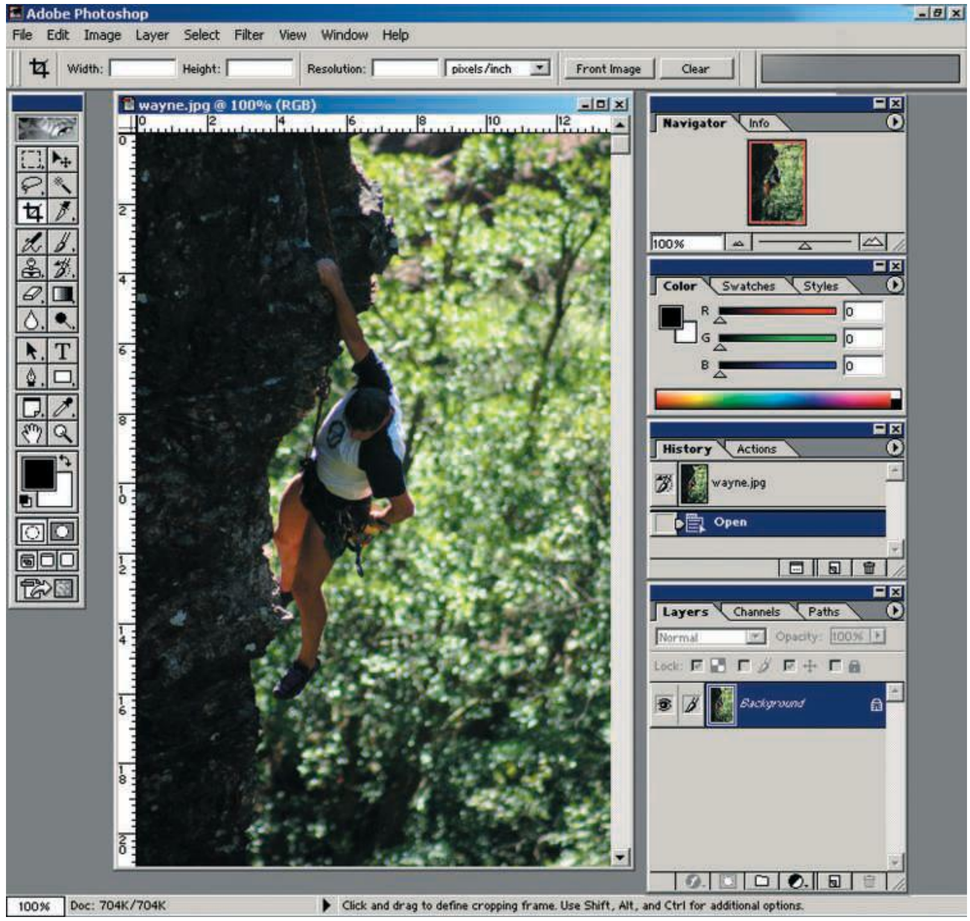


FIGURE 9.6: Adobe Photoshop and its toolbars

Technobite

'A computer is like a pencil. It is a really amazing pencil. [But] computers don't create computer animation any more than a pencil would create a drawing,' says John Lasseter, Executive Vice President, Creative at Pixar.

5. Business cards are just one way to promote yourself or a business. What other ways could you do this? What marketing strategies would you use?
6. Use the Internet to search for more information about business cards and their use in the promotion of business and individuals — for example, the differences between the impact and emphasis of using images on business cards and using only text.

DESIGN PROCESS: IDEAS GENERATION

Computers and graphic design software will never replace your imagination, but they will give great support to your ideas and make working with text and images much easier.

Look again at chapter 2, pages 39–40, for more information on brainstorming and mind maps.

Brainstorming

Brainstorming with others or on your own generates lots of ideas. Write them down. At the end of the session, group similar ideas together. Work through each group of ideas and decide which ones you would like to use.

Mind maps

Mind maps help connect our ideas together. Sketch the mind map shown in figure 9.7 and add your own ideas and information. After completing the mind map, select and prioritise your ideas.

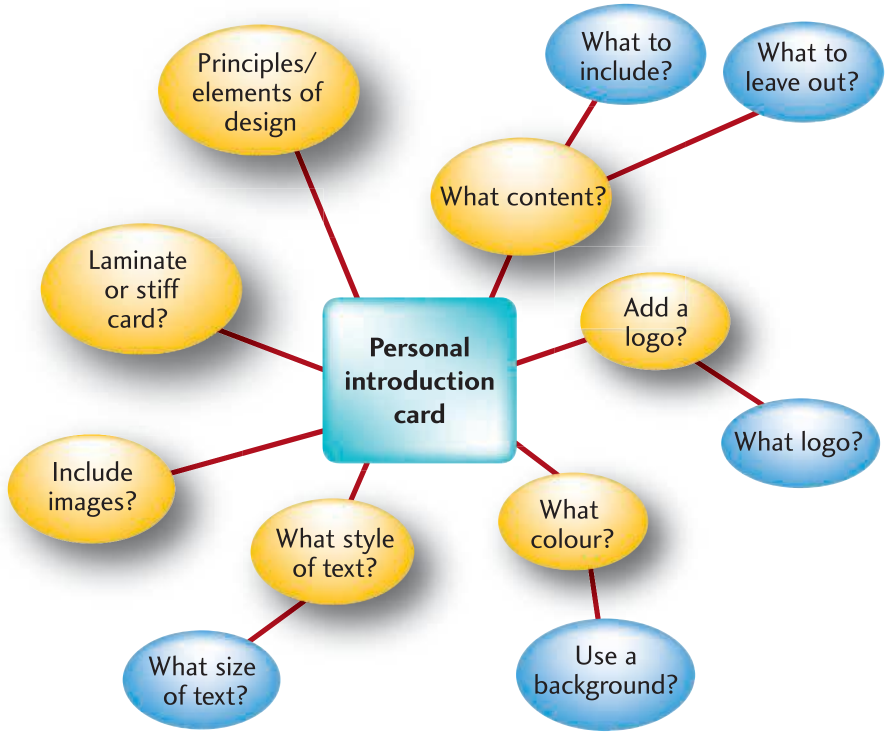


FIGURE 9.7: Mind map showing ideas for your personal introduction card

Preliminary sketches and plans for the solution

Now brainstorm your own card in graphic form. Draw five to six thumbnail sketches, showing font styles, colours, content and organisation of text balanced with graphics, logos and pictures. Think about materials, tools and techniques for all the designs. Then choose your three favourite designs and label them with materials, tools and techniques.

Review your time-management plan for completing your project.

Material
- Thick cardboard

Techniques
- Inserting graphics
- Inserting text
- Inserting logo
- Inserting effects

FIGURE 9.8: Card labelled with materials, tools and techniques

Tools
- Adobe Photoshop
  - Effects tool
  - Drop shadow on image and main text
  - Colour paint bucket used to colour the background
  - Marquee tool for inserting the logo or name background

Look again at chapter 2, page 44.

DESIGN PROCESS: COMMUNICATION

Final sketches and working drawings

When designing your personal introduction card, produce concept sketches and working drawings. These will help you plan in your mind and on paper what the card will look like and any problems that may arise. Often an excellent design idea cannot be made because resources or specific tools are unavailable.

Promotion

1. Design a promotional package for your card. Consider the four Ps: *price, place, promotion* and *product*. What did the package include?
2. Design and make an A4-sized pamphlet to present and promote yourself.

Technobite

'Typography has one plain duty before it and that is to convey information in writing. No argument or consideration can absolve typography from this duty,' said Emil Ruder (1914–1970), Swiss teacher of typography.

DESIGN PROCESS: EXPERIMENTATION AND TESTING

Exploring space

An important aspect of this project is to show that you can manipulate text and images to fit into a space. It's not easy to condense a description of yourself to the size of a business card, but doing so may help you to focus on the most important aspects of your personality. It might also help to develop your vocabulary as you search for new words to describe yourself. But, of course, it isn't possible to tell everything there is about a person from such a card.

FIGURE 9.9: The use of space is an important element in business card design.

(a) Good use of space

(b) Bad use of space

Evaluating a prototype

When designing and making, it helps to construct a template or model (prototype) to let you see what your product will look like. For a business or personal introduction card, this could be done on a piece of paper, on computer in a CAD (computer-aided design/drawing) or graphics program, or with cardboard.

When experimenting and testing, you need to:

- test material properties (see 9.2 Materials)
- test techniques (see 9.3 Tools and techniques).

See chapter 2, pages 51–5.

Safety

DESIGN PROCESS: SAFETY AND RISK MANAGEMENT

Look again at the rules for your basic safety in chapter 2, especially the section on ergonomics in the computer room.

General rules for working with computer equipment

- Make sure your hands are clean before touching the keyboard.
- Do not eat or drink in the computer area.
- Keep the whole area and especially the monitor free from dust.
- Wipe marks off the screen with a soft cloth.

DESIGN PROCESS: PRODUCTION

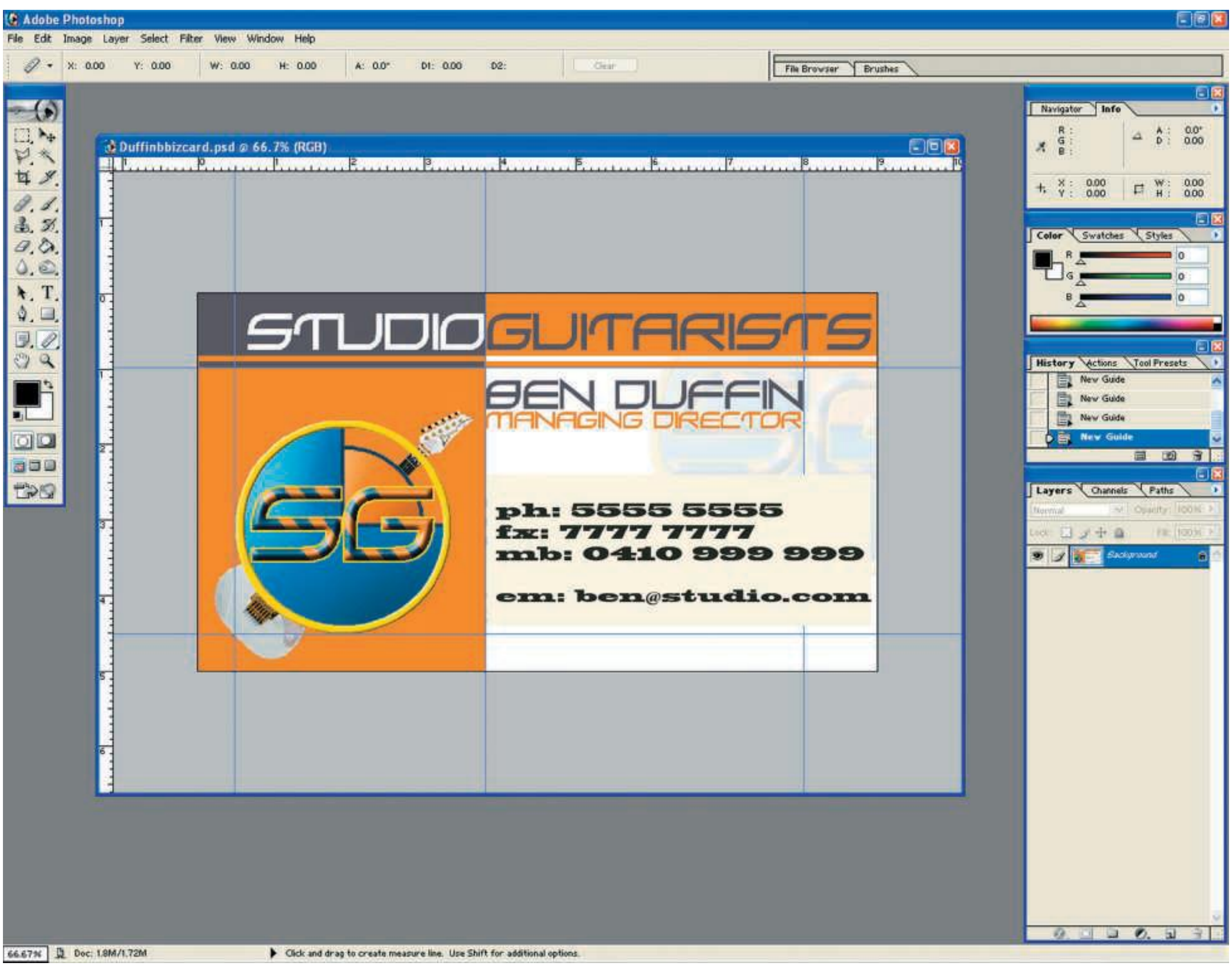
Getting started

You are now ready to produce your cards from your working drawing labelled with materials, tools and techniques. Make sure you work to your time-management plan.

The information you need to go on with your project is contained in:

- 9.2 Materials (pages 235–8)
- 9.3 Tools and techniques (pages 239–47).

FIGURE 9.10: Using a grid system for marking-out and measuring on a personal introduction card



Technobite

The National Heart Foundation of Australia's Tick symbol, designed to help people select healthier foods, is an excellent example of symbol + lettering + space = an instant message — *this is a healthier choice among foods of the same type*. In general, Tick-approved foods are relatively lower in saturated fat, sodium and, where appropriate, kilojoules. Some are also higher in fibre.

When you are marking out and measuring your card, make sure that you use a grid system to work out where your text, graphics and space should go. Each of these elements is very important; they need to be clear and well defined. Look at the ratios of each and see whether they look right.

Production steps

Use the following steps as a guide to completing a successful project.

1. Using your graphics software, enter the card size — 90 mm × 50 mm.
2. Using your working drawings as a guide, insert the text. Position the text on the card in the appropriate places — top, bottom, centre, right, left.
3. Complete the logo (if you have one) that will identify you. Insert the logo in the place that best suits the text.
4. Select photos or background images and insert them on the card.
5. Use elements and principles of design, such as colour, tone, unity and balance.
6. Print a black and white draft first and then print a low-quality colour draft.
7. When you are happy with your card, see how many you can fit on an A4 page in portrait or landscape format. Set up your card for tile printing so you can print more than one at a time.
8. Print on high-quality paper.
9. Use a guillotine to cut your sheet into individual cards.
10. Laminate individually and then use a guillotine to trim the laminated overlap.

Design process: FINAL EVALUATION

Testing the product

After making several evaluations of your product during the production process, the finished card is now ready for the final test. This means making sure that information on your personal introduction card is clear and easily understood.

Professional, peer and self-evaluations

Ask your teacher and your peers to evaluate your personal introduction card by answering the following questions.

1. What is the focal point of this personal introduction card; that is, what catches your eye first — graphic, name, colour or other?
2. What is the cardholder's main role, activity or job?
3. Is this a formal (serious) or informal (casual) personal introduction card?
4. Is the card easy to read?
5. Is the type large enough?
6. Is the amount of information on the card just right/too much/not enough?
7. Do you like this card? Why or why not?

Then answer the questions yourself as an honest evaluation of your card. Your teacher will use checklists like the one above to help evaluate the effectiveness of your personal introduction card. Be fair and truthful when evaluating your classmates' cards.

FIGURE 9.11: Sample personal introduction card

Switch on

Working with a partner or in a group, prepare a presentation on how to make a business card — it should be presented as a flow chart. The purpose of your presentation is to teach other students the skills you have learned.

9.2 Materials

Paper

TABLE 9.2: Common paper sizes

Size	Width (mm)	Height (mm)
A0	841	1189
A1	594	841
A2	420	594
A3	297	420
A4	210	297
A5	148	210
A6	105	148
A7	74	105
Letter (USA)	215.9	279.4

Paper is made from cellulose (plant) fibre, usually from timber or cotton, but other plant fibres such as linen (from flax) or rice are sometimes used. Paper is produced in thin sheets on which we can write, draw, paint or print.

Table 9.2 shows the metric measurements for paper sizes A0 to A7, as set by the ISO (International Standards Organization). The last entry is an American standard measurement called *letter*, normally measured in inches but converted here to millimetres so you can compare it with the ISO standard.

As well as measuring paper by its dimensions, paper is also measured in grams per square metre (gsm). Grammage is always based on the same sheet size — one square metre — regardless of the paper grade.

Technobite

We write and print English and many other European languages in an adapted version of the alphabet once used by the Romans to write Latin. Frenchman Claude Garamond (1499–1561) was a famous founder of types, and the roman fonts he made remained popular well into the eighteenth century. The modern Garamond typefaces are named after him but are not based directly on his designs.

Fonts

The selection of the *font* is one of the most important decisions you will have to make in graphic design. Firstly, there are dozens of different *typefaces* to choose from. A typeface is a full set of characters in the same style: capital letters, lowercase letters, numerals, symbols and punctuation marks. Two of the most popular typefaces for everyday documents are Times New Roman and Helvetica. The text in this book is set in Charlotte.

Secondly, each typeface can be varied in:

- size — height is measured in points, almost always abbreviated to pt. A point is 1/72nd of an inch, which in metric measurement is about 0.35 millimetres.
- posture — the tilt of the lines, such as roman = upright, *italic* = slanting
- stroke weight — the thickness of the lines, such as **bold**.

Each of these variations of the typeface is a separate font. The term 'font family' is sometimes used instead of typeface.

Italic, **bold**, underline and size (20 pts) can be used to vary a typeface.

Antique Olive	Hiroshige
Dom Casual	Rockwell
ITC Bookman LT	Belwe
Futura	Helvetica
New York	OCRA

FIGURE 9.12: Examples of typefaces, all in 12 pt

ITC Bookman LT (18 pts)
Helvetica (22 pts)
Courier (30 pts)

FIGURE 9.13: Examples of typefaces in different pt sizes

Serif or sans serif

Typefaces are either *serif* (with serifs) or *sans serif* (without serifs). A *serif* is the extra stroke at the end of the main vertical and horizontal strokes of letters. Some serifs are subtle; others are more pronounced. Serifs may make a typeface easier to read.

Serif

(a) Times New Roman — The quick brown fox jumped over the lazy dog.
New York — The quick brown fox jumped over the lazy dog.

Serif

(b) Futura — The quick brown fox jumped over the lazy dog.
Lucida Sans — The quick brown fox jumped over the lazy dog.

FIGURE 9.14: (a) Examples of serif typefaces, (b) examples of sans serif typefaces

Pixels

The *pixel* — the word comes from picture *(pix)* element *(el)* — is the basic unit and smallest coloured picture element of a computer image. All digital pictures are composed of pixels — tiny points or dots that make up a picture on the computer screen. The higher the number of pixels, the higher the screen resolution will be, making the picture look more sharply defined to our eyes.

A bit-map is a large number of data bits that represent a graphic. Data, such as the colour and brightness of every pixel, are stored on the bit-map.

Graphic data types

There are three common bit-map image formats used on the World Wide Web. They are known by the short words formed by their initials rather than by their full names. The three formats are GIFs, JPEGs (pronounced 'jaypegs') and PNGs (pronounced 'pings').

GIF (Graphic Interchange Format)

GIF is a bit-map image format popular for:

- images with areas of high contrast
- images with large blocks of colour
- low-quality photographs and images with up to 256 colours, the maximum number of colours GIFs can support.

FIGURE 9.15: Example of a GIF

PNG (Portable Network Graphics)

PNG saves 24-bit images with 16.7 million colours and is a good choice for high-quality photographs and artwork. Unlike JPEG, PNG images do not lose any quality when they are saved. However, PNG image files are considerably larger than the same images saved using JPEG. This, and the fact that not all web browsers will show PNG images, makes PNG less popular than JPEG for use in web pages.

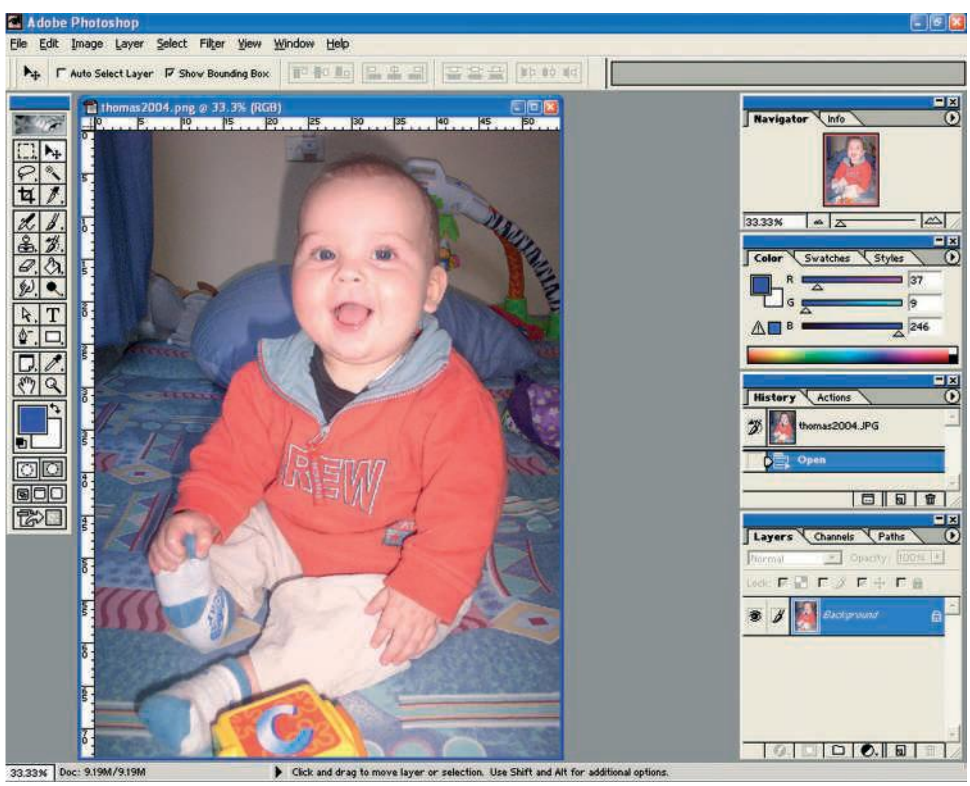


FIGURE 9.16: Example of a PNG

JPEG or JPG (Joint Photographic Experts Group)

JPEG is a bit-map image format popular for:

- making high-resolution graphic images as computer files for storage and transmission
- compressing (reducing the storage size of image files) photographs and detailed artwork. JPEG allows you to create smaller files, but there is a resulting loss in image quality. Larger file size results in higher quality; smaller file size results in lower quality.

A JPEG with up to 24-bit (16.7 million colours) handles subtle shades more efficiently than an image in GIF format, but is not suitable for line art, cartoons, screenshots and other high-contrast images. JPEG is used for still images but is not suitable for moving images, such as video.

JPEG uses a method of compressing images that can reduce their quality every time they are saved. So it's not a good idea to use JPEG for images that you will be constantly reloading, editing and resaving.

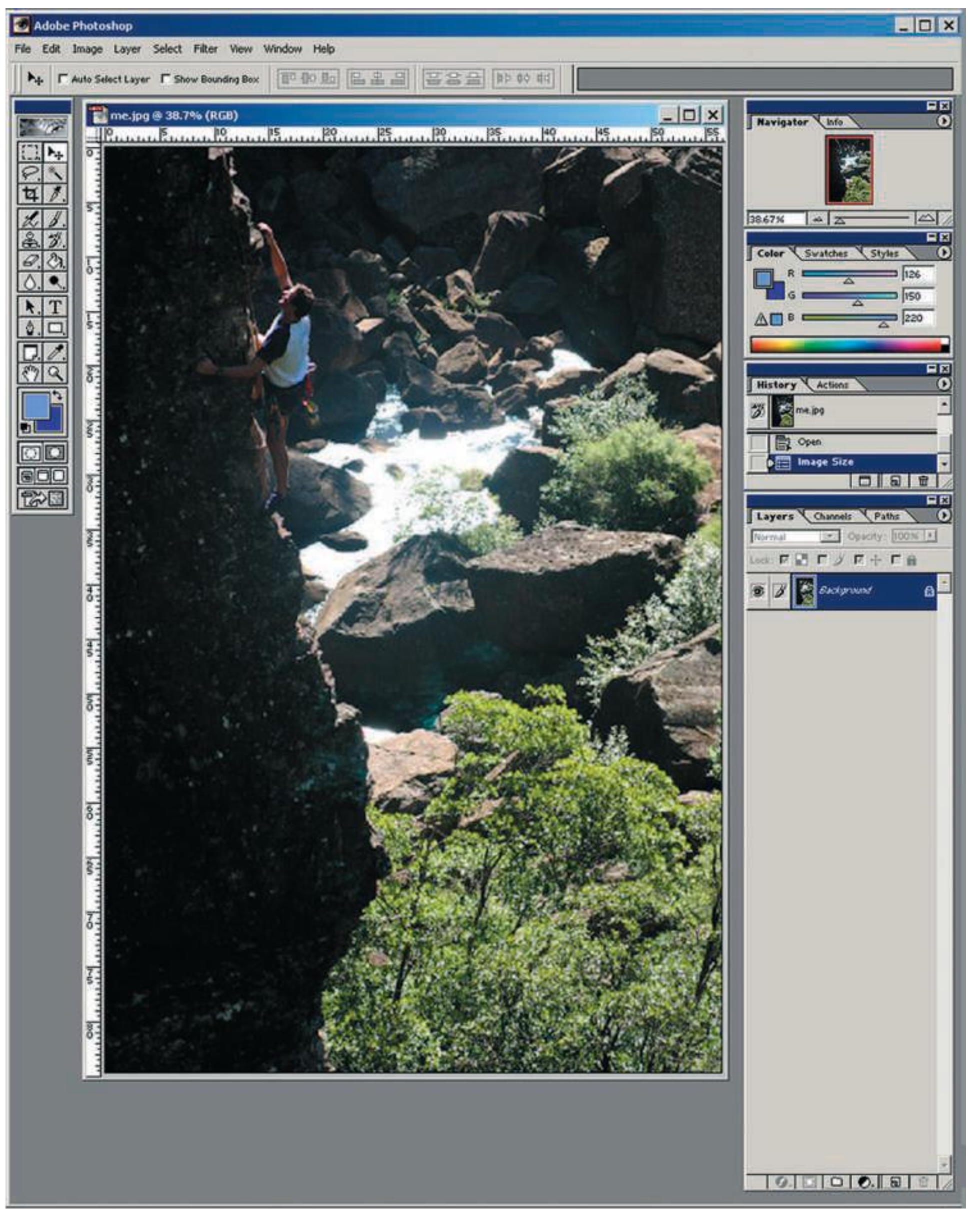


FIGURE 9.17: Example of a JPEG

Switch on

1. Describe paper and give examples of how we use it every day. What does ISO stand for and what relevance does the ISO have to the paper that we use?
2. What would you use an A0 piece of paper for compared to an A7 piece of paper? Discuss the differences.
3. What are typefaces? Give two examples of a serif and a sans serif typeface. Name two of your favourite word processing typefaces.
4. What are two differences between a GIF and a JPEG?
5. As well as the graphics file formats you have learned about, what others can be used? For example, .doc stands for document and is used in Microsoft Word. Complete table 9.3.

TABLE 9.3: File formats

File format	Stands for ...	Program used in ...
.doc	Document	Microsoft Word
.jpg	Joint Photographic Experts Group	Any graphics program
.avi		
.mp3		
	Portable Network Graphic	
		Adobe PhotoShop

9.3 Tools and techniques

Computer tools can be divided into two groups: hardware and software. The distinction between hardware and software is sometimes confusing because they are so integrally linked. Clearly, when you purchase a program, you are buying software. But to buy the software, you need to buy the disk (hardware) on which the software is recorded. The terms *software* and *hardware* are used as both nouns and adjectives. For example, you can say: 'The problem lies in the software (noun),' meaning that there is a problem with the program or data, not with the compuer itself. You can also say: 'It's a software (adjective) problem.'

Computer technology is one of the fastest growing technologies in the world. No sooner is new hardware developed or a software program launched than improvements are being made.

FIGURE 9.18: Flatbed scanner — the scanner creates a bit-map copy of a document or photograph, which is sent to the computer to be used as part of the output immediately or at a later date.

HARDWARE: Computer components, disks, keyboards, scanners, digitising tablets, printers, digital cameras and other such equipment are called hardware. Each piece of hardware, such as a mouse, has different capabilities and limitations. You will learn what these are as you work with different pieces of hardware and develop new techniques.

SOFTWARE: Software packages enable you to carry out functions such as desktop publishing, graphics and photo editing, web authoring (for Information Technologies) and multimedia presentations.

Marking-out and measuring

MARKING-OUT AND MEASURING TOOLS: Found in desktop publishing programs, but are more common in computer-aided design (CAD) programs. The three main educational versions of CAD used in schools are:

- Bentley MicroStation®
- Autodesk® AutoCAD®
- IMSI® TurboCAD®.

Dimensioning tools can also be used to measure a line on an object. The package will work out exactly how long the line is and type it for you on the dimension line.

Construction tools and adhesives

CONSTRUCTION TOOLS: These can be found in graphics, 3-D animation and CAD packages. Three common examples of software packages used in schools are:

- Adobe Photoshop (graphics)
- Autodesk 3ds Max® (3-D animation)
- Bentley MicroStation (CAD).

Figure 9.19 shows the construction tools for Adobe Photoshop — tools for constructing shapes, objects and text. Figure 9.20 shows the construction tools in 3ds Max. They are 2-D and 3-D solid construction tools, used to create splines, spheres, wire meshes, cubes, pyramids, planes, cones etc.

ADHESIVES: Adhesive tools in computer software are used for 'welding' together two solids or lines, either 2-D or 3-D. The two common programs are 3ds Max and Bentley MicroStation. The terms used in software such as this are attach, fuse, group, union or weld (see figure 9.21).

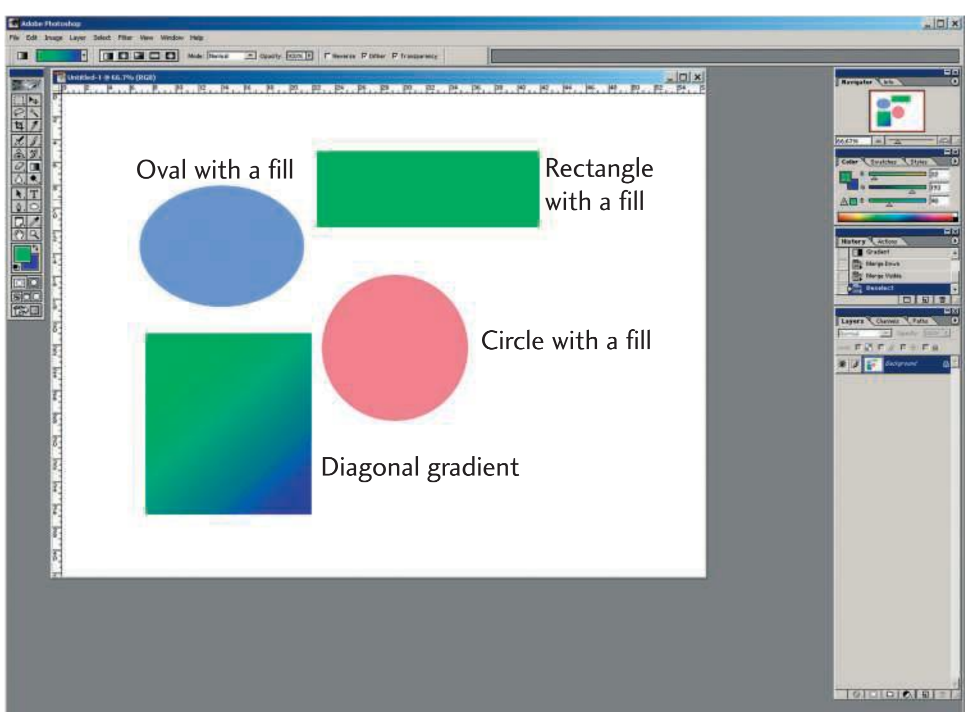


FIGURE 9.19: Tools in Adobe Photoshop: oval, rectangle, circle, diagonal gradient and fill tools

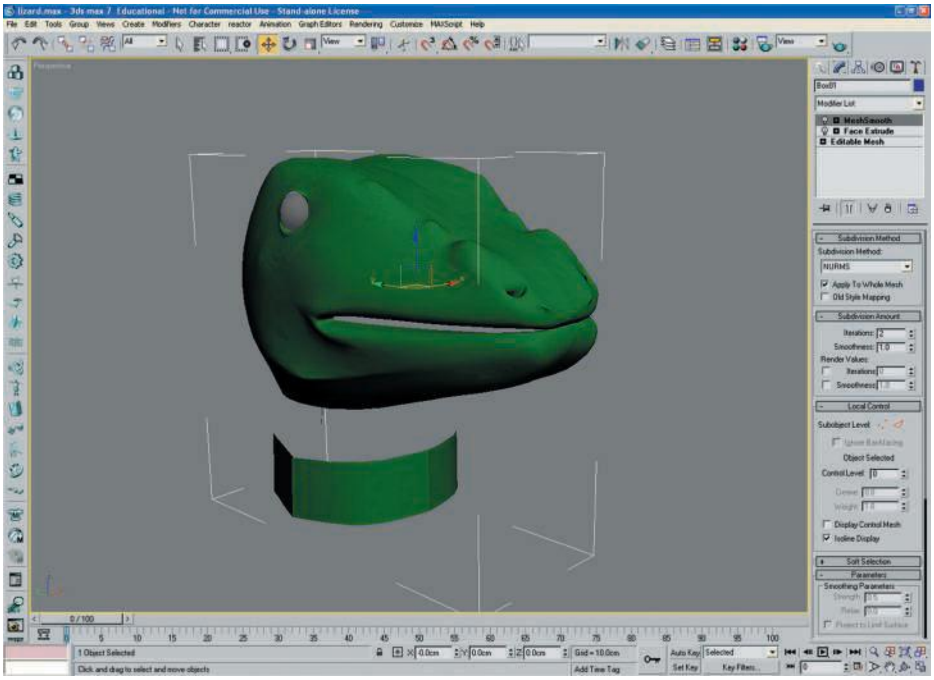


FIGURE 9.20: Tools in 3ds Max to weld and fuse parts. In this example, the neck is to be fused to the head.

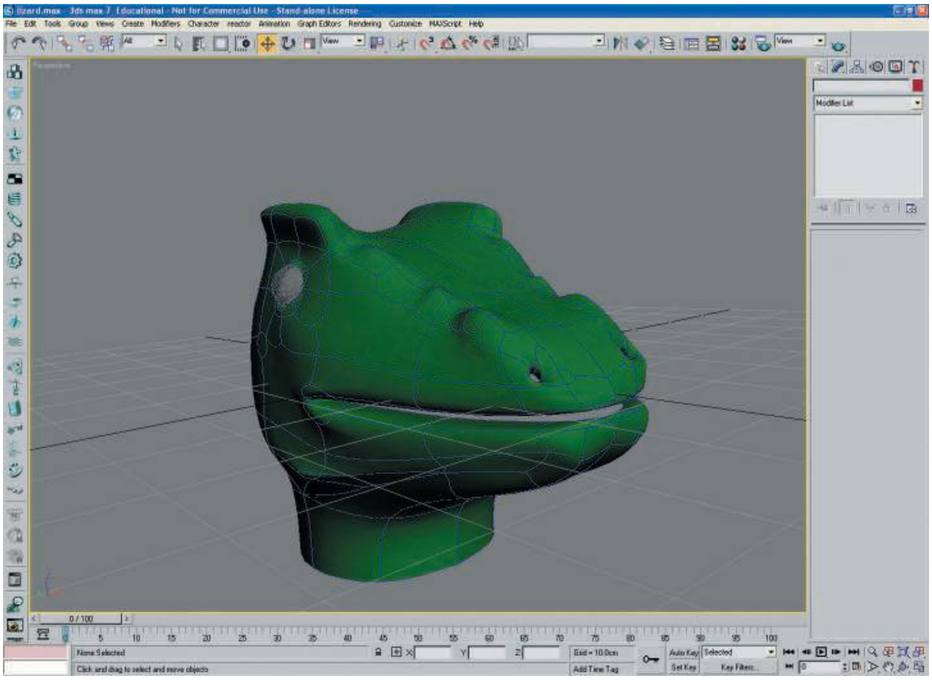


FIGURE 9.21: The two solids (neck and head) have been welded together with an adhesive.

FIGURE 9.22: Drafting a design

Simple drafting

Drafting is the process of using *mechanical drawing* to represent topography (the detailed geographical features of an area), engineering works, buildings and pieces of machinery. These drawings use a universal language that is understood worldwide by specialists working on such projects, for example, architects, builders and engineers.

AS 1100 is a series of booklets, published by Standards Australia, which set out standards for working drawings. Talk to your teacher if you would like to know more about Standards Australia or these documents.

CAD

CAD (COMPUTER-AIDED DESIGN): This is software used by artists, designers, draftspersons, architects and engineers to produce precision and technical drawings. CAD software is an aid to creating 2-D drawings and 3-D models. CAD programs simplify making changes that are very difficult to do on flat drawing sheets.

Technobite

Florentine artist Leonardo da Vinci (1452–1519) was one of the great masters of the Renaissance. He was celebrated as a painter, sculptor, inventor and architect. He was also a famous draftsperson.

Multi-view drawing

All CAD programs use *multi-view working drawings*, which show the top, bottom, side (left and right), front and back views of an object. These allow the user to see the object being designed from various angles and are helpful to designers of cars, computers, buildings and bridges, among many other things.

The problem with drafting is that the paper is flat, while the object being drawn is not. To get around this, we can develop a number of working views:

(a) front view

(b) top view (plan view)

(c) right-side view

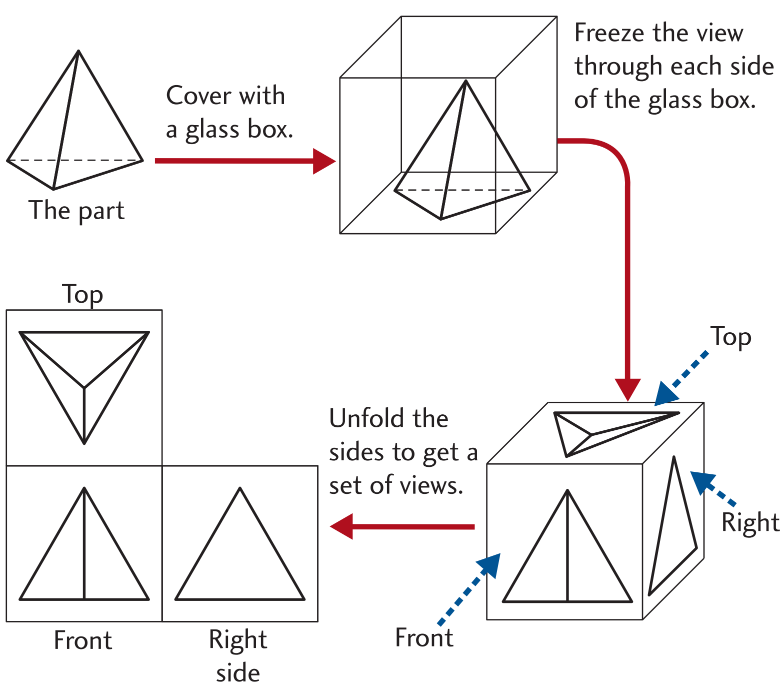
(d) left-side view.

This method of developing views, known as *orthogonal projection*, makes it easier for the viewer to look at the object. Figure 9.23(a) shows a tetrahedron (a triangular pyramid) that has been changed from a three-dimensional object to a set of views of a two-dimensional object — see figure 9.23(b). The views are developed as if a glass box were placed over the object, which is a different way of developing them from the method of doing it by hand described in chapter 2.

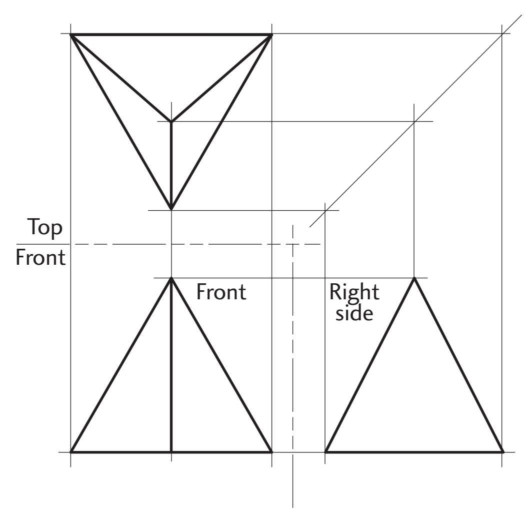
See chapter 2, page 45, figure 2.24.

FIGURE 9.23: Views of a tetrahedron

(a) Tetrahedron changed from a 3-D to a 2-D object



(b) Tetrahedron — top, front and right-side views



> **Tip**
> Remember, the closer and smaller the pixels, the better the resolution, which means the image is clearer. You can edit the image by adding or erasing pixels.

Paint and draw

PAINT SOFTWARE: Painting software is generally used to create manually drawn bit-mapped graphics, which are formed by a series of dots called pixels.

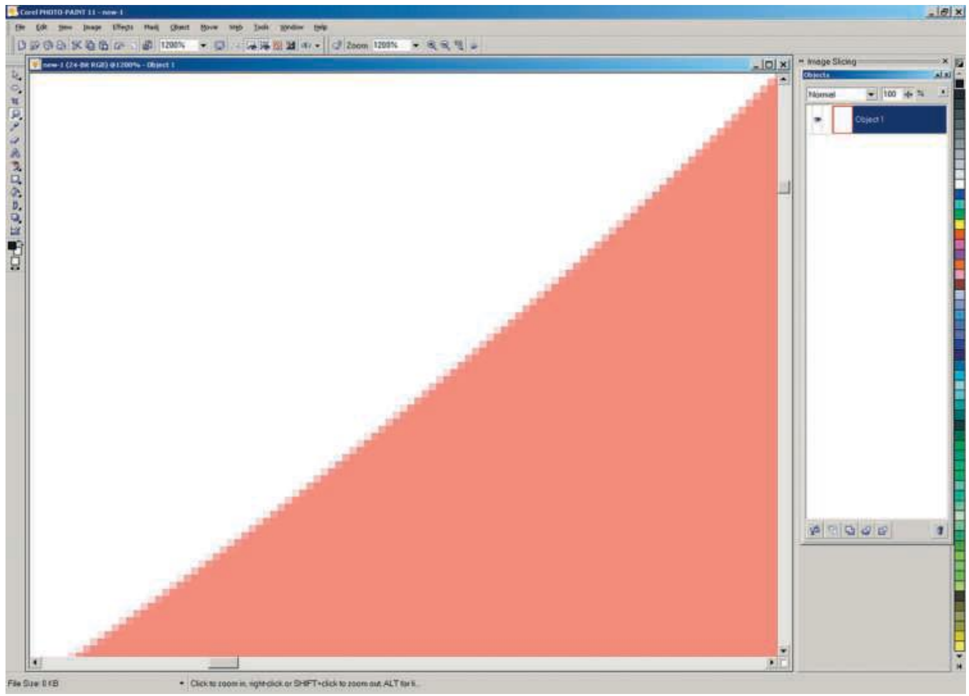


FIGURE 9.24: Paint tool (Corel PHOTO-PAINT 11). Close up of curve shows individual pixels in bit-mapped software package.

DRAW SOFTWARE: Drawing programs allow freehand drawing and object manipulation. The program allows you to highlight the drawn object and modify it as required. You can change the dimensions, colour and angle of the object by using the mouse and menu options and other input devices such as a light pen and graphics tablet.

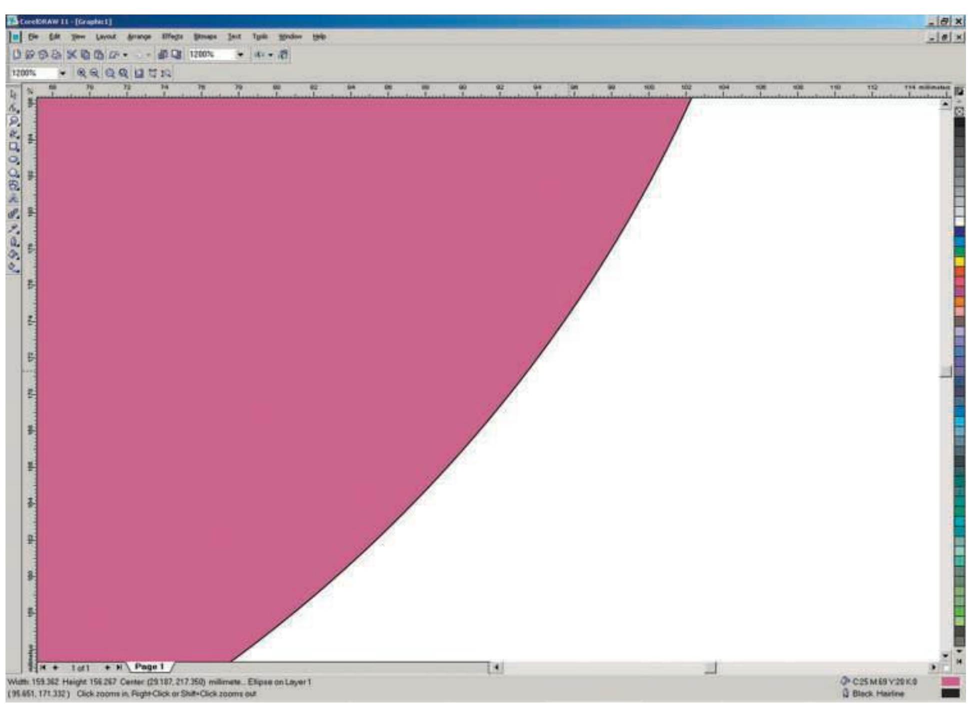


FIGURE 9.25: Draw tool (CorelDRAW 11). Close up of curve shows a smooth line in a drawing software package.

Technobite

In 1982, *Time* magazine's Man of the Year award wasn't given to a man. The award went to a machine — the computer!

Editing graphics

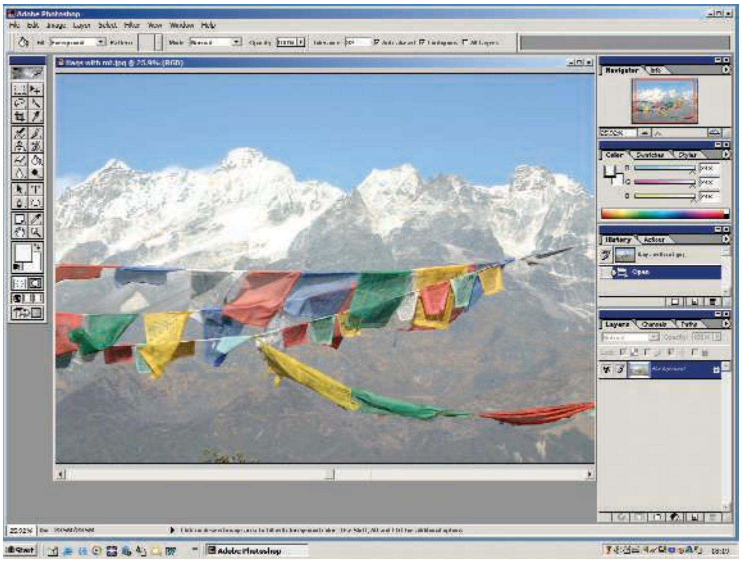
Cutting tools: In the graphics/computer room, you can use cutting tools from photo editing packages to *cut, mask, manipulate* and *edit* an image.

Photo editing software allows image manipulation at a very sophisticated level. Two images can be combined to form one, for example, you could place a person's head on someone else's body. Photographs can be feathered, faded or morphed (where the shape of one thing is transformed into another). Sections can be 'cloned' or deleted.

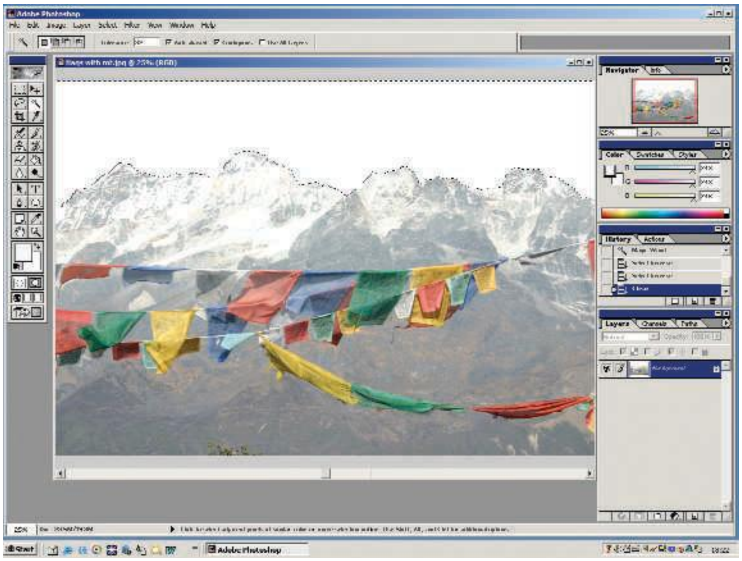
One of the most common uses of this software is to remove imperfections or change the colour of objects. In fashion magazines, for example, models' faces are often enhanced by deleting blemishes and intensifying colours.

FIGURE 9.26: Editing a section of an image

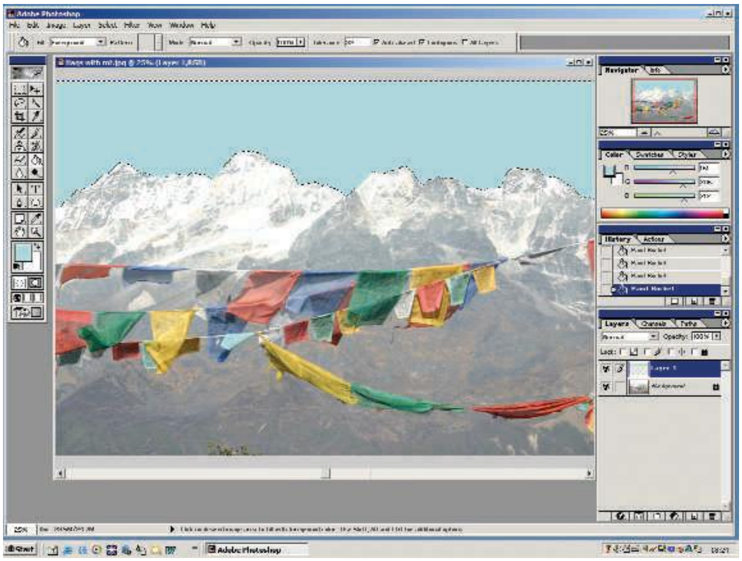
(a) You want to replace the dark-blue sky.



(b) Remove the sky by editing.



(c) Insert a light-blue sky.



Rendering

Rendering gives any two-dimensional object a rounder appearance or shading and shadow. Figure 9.27 shows a computer-drawn object that has not been rendered (*left*) and the same object after rendering (*right*). Note the difference.

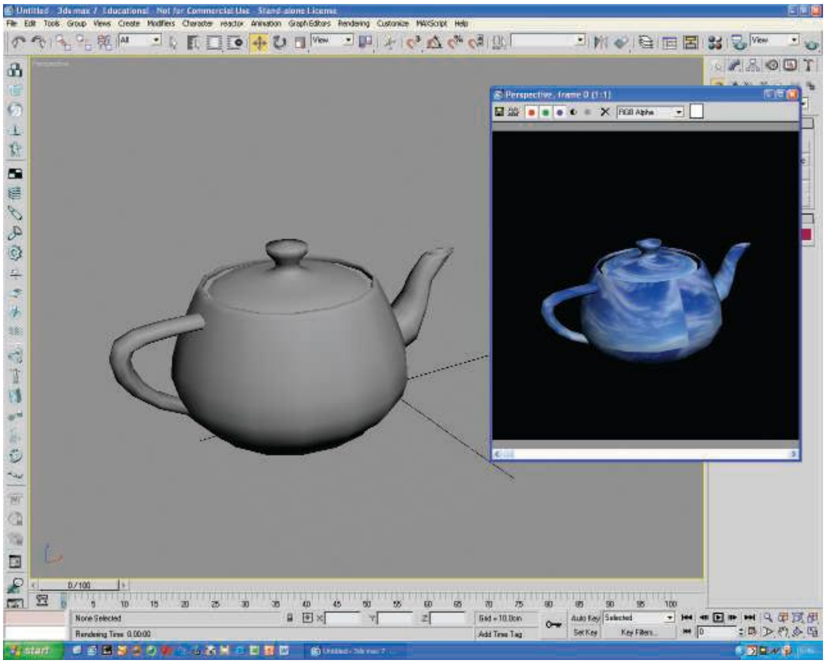


FIGURE 9.27: Teapot — before rendering (left) and after rendering (right)

Printing technologies

Computer printouts are in dpi (dots per inch — an inch is 25 millimetres). Generally, the higher the *resolution* of your printer, the better your output looks. Printers with 600 dpi print 600 tiny little dots across (horizontally) one inch and 600 dots down (vertically) one inch. A high resolution gives a better quality print when printing by inkjet printer on glossy paper.

Safety

A guillotine has a sharp blade. When you position your sheet, make sure your steadying hand is well clear of the blade's arc.

See page 234.

You will need to use matte paper, inkjet printer paper or glossy paper for printing your cards. Print the cards in colour on a laser printer or an inkjet printer.

Discuss with your class how to mass-produce the personal introduction cards, so instead of just printing one card you could print as many as possible on an A4 page — ten in portrait format and nine in landscape format. This process is called tiling. If you print a sheet of cards, you will have to use a guillotine to cut the sheet into individual cards. Position your card carefully on the guillotine's guide grid.

The cards can be laminated after cutting to give them a glossy surface. After laminating, they will need to be trimmed again.

Don't forget the last step in the design process: final evaluation of your personal introduction card.

(a) Portrait

(b) Landscape

FIGURE 9.28: Tiling cards for printing

Technobite

Johannes Gutenberg of Germany is credited with inventing the printing press in 1438. Before that, there were only about 30 000 books in Europe, nearly all Bibles or biblical commentary. They were hand copied and very valuable. Libraries throughout the world now store well over 100 million original books. Iceland publishes more books per head of population than any other country.

Switch on

1. What can a construction tool do in a computer graphics program? Experiment on an image with two construction tools and print out that experiment.
2. What is a dimensioning tool? Sketch how you would dimension an object.
3. What is orthogonal projection?
4. Choose an object with different top, side and front views. Hand-draw the views roughly. Now, with a ruler and a sharp HB pencil, draw the different views as in the example in figure 9.23.
5. What is the plan view and why is it used?
6. What does a draftsperson do and how is this different/similar to what you do in the classroom for graphics technology?
7. What is a cutting tool in reference to computer graphics? What is the difference between a cutting tool for timber and one in the computer graphics classroom?
8. What is masking or editing an image?
9. Take an image and create a mask that selects a block of colour. Replace that block of colour with another colour.

9.4 Graphics technologies at work

FIGURE 9.29: Industrial printing process

Industrial production methods

Printing processes in the graphics industry are on a much larger scale than in the classroom. The products (for example, personalised stationery, newspapers, magazines, books) are mass-produced. The complexity of industrial processes means that specialists attend to each stage of the process.

In the classroom, students must be multi-skilled, do all the tasks themselves and produce small numbers of copies of the projects.

As well as CAD, in industry CAM (computer-aided manufacture), CIM (computer-integrated manufacture) and CNC (computer numerically controlled) systems are widely used.

Renewing and recycling

Every recycled item saves energy to be used elsewhere, for example, in mining, harvesting, manufacturing and transporting. The use of paper and the way it's recycled is everyone's responsibility. Every tonne of paper recycled saves almost 13 trees, 2.5 barrels of oil, 4100 kilowatt hours of electricity, 4 cubic metres of landfill and 31 780 litres of water. Paper sent to landfill rots down into methane — a harmful greenhouse gas. So recycling paper helps to reduce the amount of methane in our atmosphere.

Trees are a valuable *carbon sink*. They absorb carbon dioxide, lock it into the wood and release oxygen back into the air.

Techno**bite**

It's estimated that Australia now has 20 billion fewer trees than when the Europeans first settled in 1788. Trees provide timber for many products and woodchips for making paper. Vast areas of land have been cleared for buildings, crops, grazing, sports fields, roads and airports. But trees help regulate the temperature, keep our air clean, and give homes to animals, birds and insects — all vital reasons to conserve them.

Spotlight Adrian Frutiger

On 18 June 1998, as the sun was setting, a party began at Heidelberg Castle in Germany to celebrate a man's seventieth birthday. There were 100 European and American guests, all connected with typography in some way. The guest of honour was Adrian Frutiger.

Swiss-born Adrian Frutiger was apprenticed to a printing firm in Interlaken for four years and studied at the Zurich School of Arts. He writes about symbols and forms, and is a wood engraver as well as a typographer who has understood graphics technology in a successful career that spans the eras of hot metal, phototypesetting and digital typesetting. He went to Paris, France, in 1952.

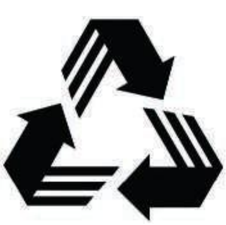
Adrian Frutiger has created many outstanding sans serif fonts, in particular Univers (see page 224) which looks as fresh and modern today as it did when first released more than fifty years ago. In the late 1960s, he was commissioned to design the signage for Paris's new Charles de Gaulle Airport. He created Frutiger, a font of outstanding clarity, suitable for being read by people who are often stressed and in a hurry.

At his Heidelberg Castle birthday party, Frutiger said, 'If we actually notice type and design, they are not doing their job, because they are detracting from the content.'

Spotlight review

1. 'If we actually notice type and design, they are not doing their job, because they are detracting from the content.' Do you agree with Frutiger's words? Discuss as a class.
2. Go to www.jaconline.com.au/switchedontech and click on the Adrian Frutiger weblink to read 'Traces', an article about Adrian Frutiger. Here, you can also see examples of the fonts he designed.
3. From libraries and the Internet, find out as much as you can about hot metal, phototypesetting and digital typesetting. Prepare a PowerPoint presentation on 'Typesetting in the twentieth century'.

Techno**bite**



The basic recycling symbol or mobius loop consists of three twisted arrows chasing each other in a triangle. Under regulation ISO 14021, the mobius loop can be used only in relation to products or packaging that have recyclable or recycled content.

Switch on

1. Construct a flow chart of the steps you would take to produce a poster, from the ideas generation part of the process to the final printing.
2. Repeat the previous activity for an example of a poster, pamphlet or brochure in an industry of your choice. Write down the people that would be involved in this process and their jobs. You may need to do some research and ring, email or visit some businesses.
3. Why recycle paper? Propose three points for your argument and explain what is saved by recycling a tonne of paper.
4. Imagine you have been appointed signage designer for a new shopping complex. Make some working drawings of the types of signage that will be required.
5. From a library or the Internet, find out as much as you can about CAM (computer-aided manufacture), CIM (computer-integrated manufacture) and CNC (computer numerically controlled) systems.

Design process checklist

ONLINE RESOURCE BANK

Go to the Online Resource Bank at www.jaconline.com.au/switchedontech and click on the Design Process Checklist. Use the checklist questions to self-evaluate your project and to help you finalise your design folio.

You can also find more ideas for design projects at the Online Resource Bank.

Information technologies

Our world relies on technology for information and communication. The 'digital age' or 'information revolution' enables us to access and process information speedily, anytime and almost anywhere. There are computer systems in homes, schools, hospitals and the travel industry, at major sporting events, in the entertainment business, in banks and supermarkets, and in many other places.

Information technologies (IT) consist of computer hardware and software. Together, they allow us to acquire, process, modify, store, present, retrieve and communicate information.

Chapter 10 provides detailed information to help you to design and produce your own interactive Microsoft® Word document (interactive Word document). This chapter also includes general information about the materials, tools and techniques used in information technologies. Reading sections 9.2 and 9.3 of chapter 9, Graphics technologies, is useful preparation for work on this chapter.

Focus

By the end of this chapter you will be able to:

- select and use appropriate data types for particular purposes
- select and justify the use of correct file formats in a design project
- select and use software for specific purposes in a design project
- select and correctly use the appropriate tools of information technology for a design project
- select and use techniques appropriate for the purposes of a design project.

Switch on

1. **Write the steps for turning on and logging into your school computers in a flow chart or as step-by-step instructions. Swap these instructions with your classmates and see whose is easiest to follow.**
2. **List three things that computers are used for in your school.**
3. **List five places outside your home and school where you see computers being used.**

Techno**bite**

'Almost everybody today believes that nothing … has ever moved as fast as, or had a greater impact than, the information revolution. But the industrial revolution moved at least as fast in the same time span, and had probably an equal impact if not a greater one,' said Professor Peter Drucker, Viennese writer, teacher and management consultant. What can you find out about the technology of the industrial revolution, which began in Britain in the late eighteenth century?

10.1 Design process

Design project

Your design project for information technologies is to make your own interactive Word document.

Area of study: Information and Communications. The focus of this area of study is on various types of data and information — text, images, audio, video and numbers for the purposes of conveying a message.

Design specialisation: Information systems design. Information systems designers design databases, information management systems and information kiosks.

Design specialisation: Software design. Software designers design data management and analysis systems.

Design situation

In school, at home and in business, word processing is a popular way to create and edit text-based material that can be distributed electronically and in print. A single A4 page can be a rich source of information with the help of hypertext links.

Design brief

Produce an interactive Word document. The document's content must teach the viewer about a specific sport. The design brief describes the product you will design and make, but the look of the interactive Word document and the particular materials and tools used are up to you.

The document must be a word processed A4 page (210 mm × 297 mm) containing:

- a hyperlink to a spreadsheet document
- a hyperlink to a database document
- a variety of images
- content of a specific sport
- text in a variety of fonts
- hyperlinks to a variety of URLs (uniform resource locator — a World Wide Web address)
- some formatting such as bullet points, tables, borders, colours, columns.

Project materials:

- a computer with word processing, database and spreadsheet programs and an Internet browser
- examples of other interactive Word documents to look at and evaluate
- examples of database and spreadsheet documents
- images, symbols and logos for you to manipulate and change.

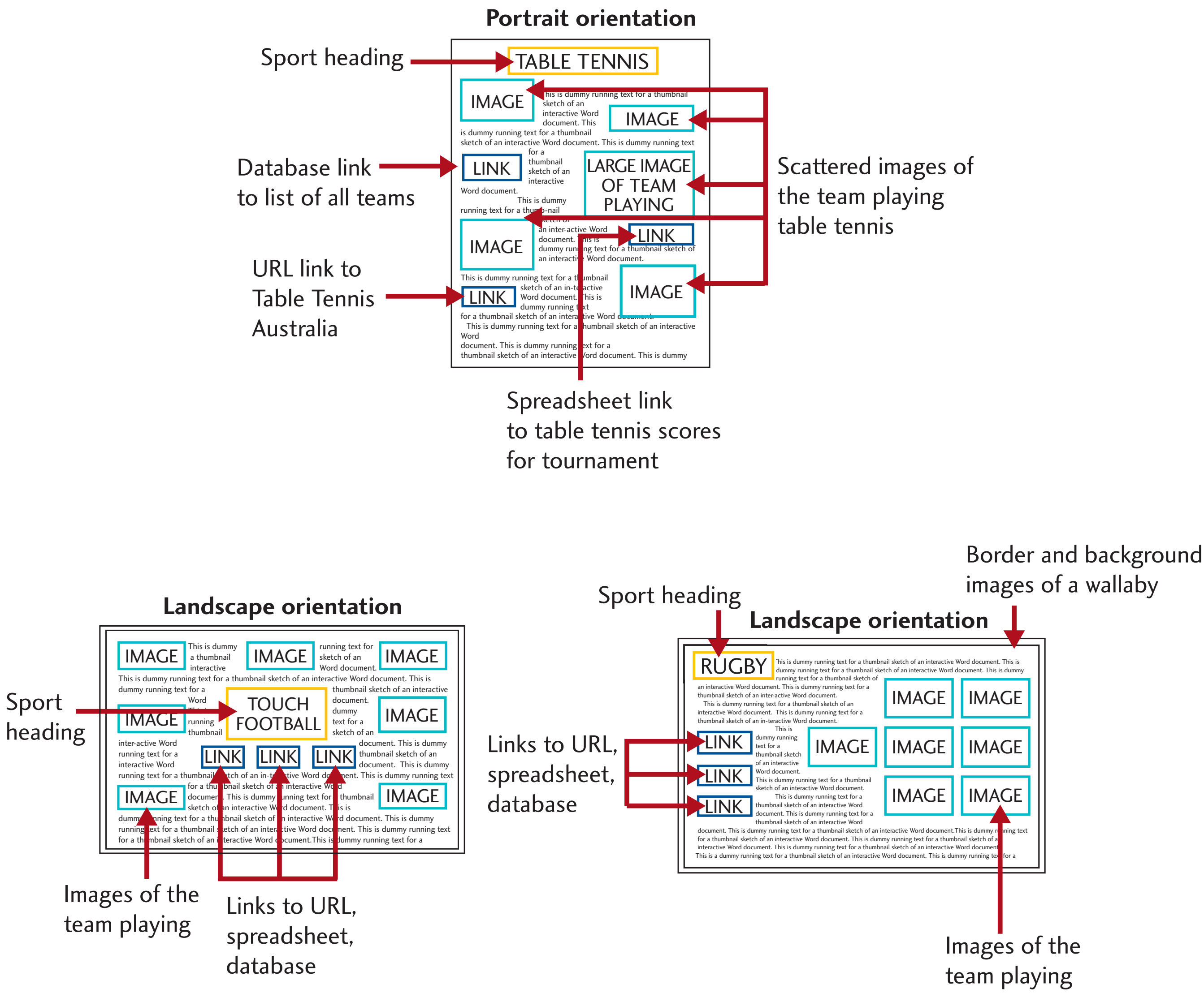


FIGURE 10.1: Some thumbnail examples of interactive Word documents

Look again at the design process in chapter 2, pages 20–1.

Be flexible in your approach to the design process. The order of the steps is not set in concrete and you may not always follow them in the sequence presented here. Some steps go hand in hand with others throughout the design project. Other steps need to be completed before you can move on. You should concentrate on using the combined steps to form a process that guides the development of your design.

Design Folio **Production**

Your design folio is an important communication tool for design projects. It should tell the story of your design project's development, from your first rough ideas on paper to the final evaluation of your design brief solution.

Consider composing your design folio in electronic format for this technology.

Design process: ONGOING EVALUATION

Essential for success

Remember that ongoing evaluation is central to the design process and should occur at every step. Regular evaluation helps to identify problems and challenges at the right time for you to deal with them. Putting evaluation off until later is asking for trouble, for example:

- wasted resources
- lost time
- failure to meet deadlines
- increased costs.

Design process: ANALYSIS

Thinking about the design situation

When you answer the following questions, you have already started to research and create design ideas. These analysis questions could help you plan your interactive Word document.

- What sport will you choose? What are its rules? What skills do you need to play this sport? What are you trying to teach the viewer?
- Will you emphasise an individual sportsperson? You could choose George Gregan's performance in rugby union, Michael Clarke's career in test cricket, Jodie Henry's swimming successes — it depends on the sport you choose and there are lots of possibilities.
- How will you use the principles and elements of good design?
- How much can you fit onto an A4 page? You might need to think of briefer ways to say things and tighter layouts, if you want to fit everything in.
- Will you use a horizontal (landscape) or vertical (portrait) layout?
- What size will your logos and other design elements be? Are they large (dominant) or small?
- How many photographs or diagrams do you need?
- Where are the hypertext links going to take the viewer?
- What information will your database contain? For example, you could have a sporting team with all the members' statistics listed.
- What information will your spreadsheet contain? For example, you could have the scores of the Rugby World Cup, the Australian Open or the Davis Cup.
- What URLs will the hypertext links go to? For example, you could link to the website of your favourite local or overseas sporting team or to a website showing the rules of how to play your specific sport.
- What type of formatting will you have? Will you use tables or columns?
- How big will your text be? How much text will you have?
- Will you use a conservative typeface or a fun, informal one (such as crooked letters, funny shapes, odd sizes or type that looks like handwriting), or a mix of typefaces?
- How many colours will you use?
- How much white (blank) space will your document have? How will you distribute the white space around the page?

Technobite

The first Internet link outside the US was a temporary one — to a computing conference in Brighton, England, in 1973. The UK was permanently connected to the Internet in 1989.

Technobite

'The current reliance on fonts stems in part from the fact that few designers remain who possess the skills to actually draw fonts.' *Practical Web Design*, Issue 15.

FIGURE 10.2: Draw a spidergram to help you choose your topic.

Switch on

Thinking about the design brief

Write the design brief in your design folio, then underline, circle or highlight words that give you specific information or instructions.

For example:

Produce an interactive Word document. The document's content must teach the viewer about a specific sport. The design brief describes the product you will design and make, but the look of the interactive Word document and the particular materials and tools used are up to you. The document must be a word processed A4 page (210 mm × 297 mm) containing:

- a hyperlink to a spreadsheet document
- a hyperlink to a database document
- a variety of images
- content on a specific sport
- text in a variety of fonts
- hyperlinks to a variety of URLs
- some formatting such as bullet points, tables, borders, colours, columns.

Project materials:

- a computer with word processing, database and spreadsheet programs and an Internet browser
- examples of other interactive Word documents to look at and evaluate
- examples of database and spreadsheet documents
- images, symbols and logos for you to manipulate and change.

Limitations to the design brief

There are always limitations to designing a product or solving a problem. Identify constraints for the development of this project:

- *Time available.* When does the project need to be completed?
- *Function.* What are the purpose and main features of the project?
- *Aesthetics.* What does the project need to look like?
- *Cost.* Do you have enough money to complete the project?
- *Materials and tools available.* What materials and tools are required? Are they available at school?
- *Expertise.* Do you have the skills required to complete the project?
- *Environmental considerations.* Will any production waste harm the environment?
- *Safety rules and regulations.* Will the product meet all legislative requirements?

List the factors that will limit you when making your interactive Word document. What is going to be the biggest limitation to overcome? Why?

Criteria for success

Criteria for success describe exactly what the design must achieve and set the design limits that could affect your final solution. For example, the product must:

- have hypertext links to the Internet, a spreadsheet and a database
- contain information about a specific sport
- use a professional layout and be clear and concise.

Think of another five criteria and copy all eight criteria into your design folio.

Technobite

Chairman and Chief Software Architect of the Microsoft Corporation Bill Gates, born in Seattle, USA, in 1955, began programming computers at the age of thirteen. He believes that 'personal computers have become the most empowering tool we've ever created. They're tools of communication, they're tools of creativity, and they can be shaped by their user.'

Design process: MANAGEMENT

Getting organised

Management is a step that must be considered alongside other steps throughout your project and needs constant reviewing as you progress with your work.

- Develop action-management, time-management and budget-management plans.
- Evaluate and justify any changes to your management plans, outlining impacts on the design project's development. This will mean re-evaluating your management plans regularly during the making of your design project.
- Plan and manage available resources effectively and efficiently (for example, hours available to use a computer, computer facilities at home).
- Evaluate the appropriateness of available resources as they relate to your design brief and developed criteria for success.

Design process: RESEARCH

Investigating the design brief

Find information to help you design a range of possible options from which you will make your final choice. Look in local and school libraries, magazines, catalogues, local shops, on CD-ROMS or DVDs, in databases and on the Internet to gather information on sports.

Look again at chapter 2, pages 36–7.

Questionnaires and interviews

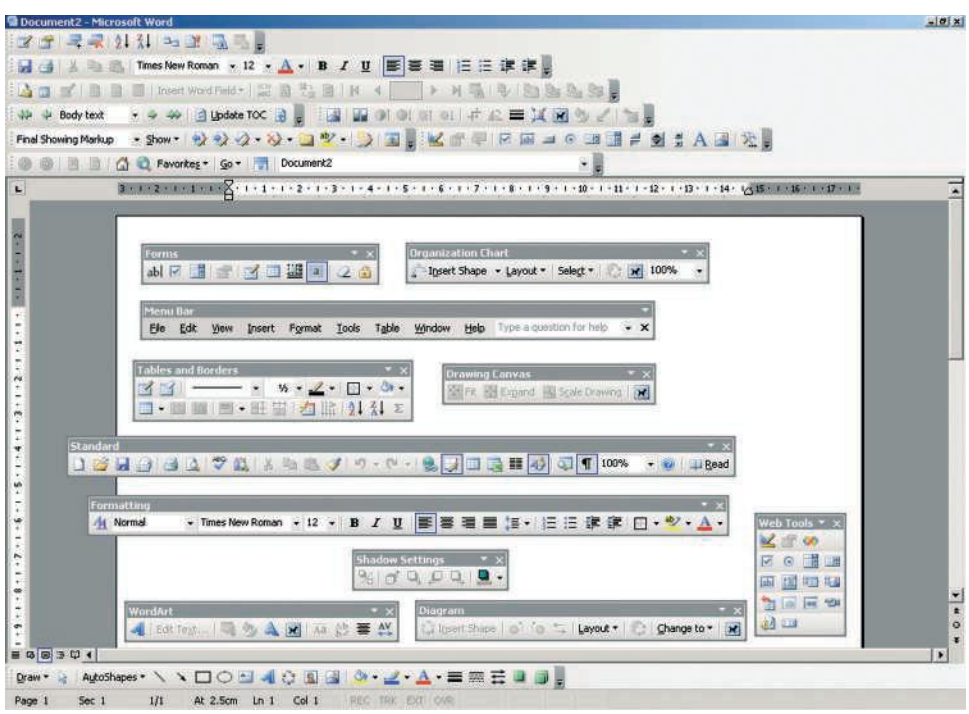
Think about setting a questionnaire or conducting an interview with your parents or friends.

1. Check the questionnaire to make sure that it matches your aim, is clear, makes sense and uses a variety of questions.
2. Approach a variety of people willing to complete the questionnaire.
3. Gather the information and sort it into fact or opinion. Then group the data and present it in an appropriate form, for example, as a report, a table or a graph.

Switch on

1. Find out about interactive Word documents. Why and how are they used? Complete two A4 pages of market research.
2. What are two uses for an interactive Word document in industry or commerce?
3. Name two ways of gathering information (apart from questionnaires and interviews) and give examples of them.
4. Find out as much as you can about the software you will use to produce the interactive Word document.
5. Write an A4 page analysing available word processing, spreadsheet and database software and add it to your design folio.
6. Research the tools, for example, cut, paste, hypertext, draw, import and insert, that could be used to produce the interactive Word document. Research the techniques for these software tools.

FIGURE 10.3: Screenshot of Microsoft Word and its toolbars



Design process: IDEAS GENERATION

Brainstorming

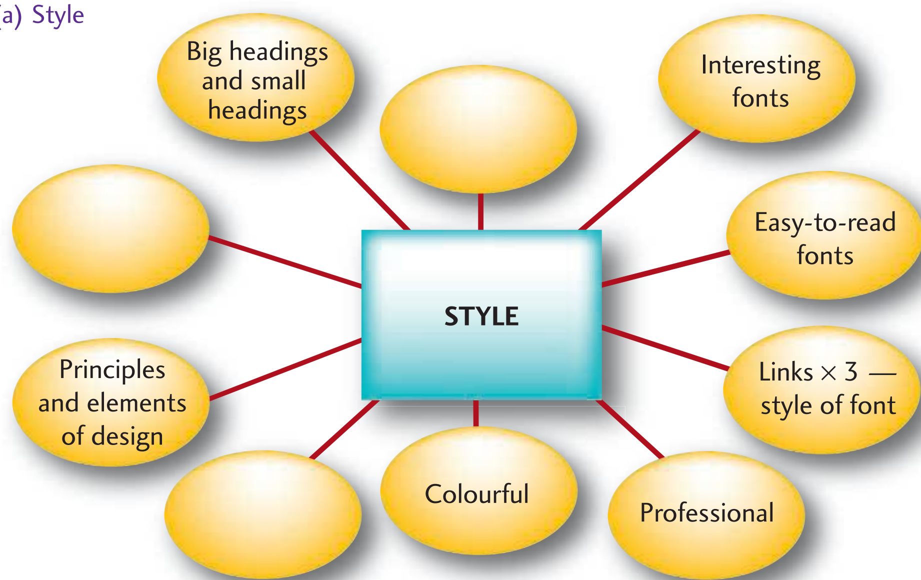
See chapter 2, pages 39–40.

In small groups of four to five, brainstorm ideas on sporting themes for your interactive Word document. At the end of the session, group similar ideas together and work through them to decide which ones you would like to use.

Mind maps

Copy the incomplete mind maps (figure 10.4) into your design folio and add your own ideas and information. Consider pictures, text, spreadsheets, databases and Internet hyperlinks. After completing the mind maps, select and rank your ideas.

(a) Style



(b) Layout

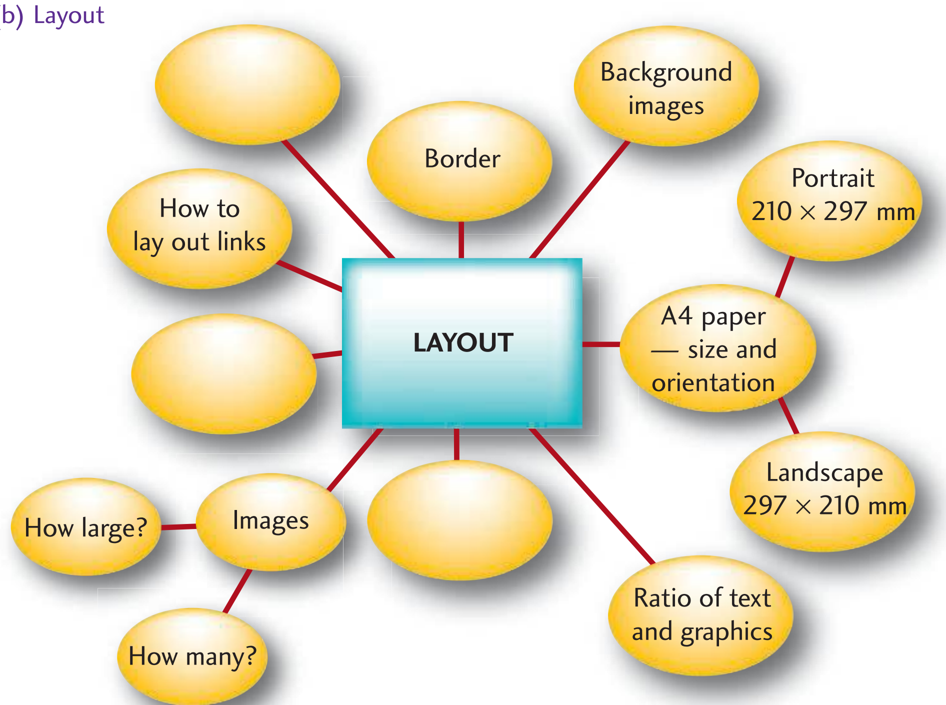


FIGURE 10.4: Mind maps

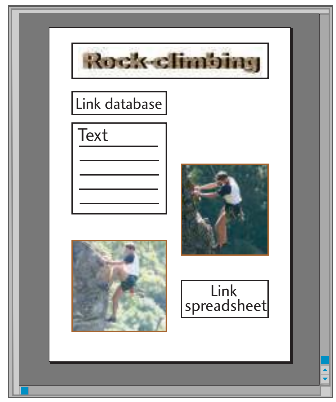
Preliminary sketches and plans for the solution

Brainstorm again but this time in graphic form. Draw five to six thumbnail sketches, showing sport, hyperlinks, style, colour, logos, images, and content and organisation of text. Think about materials, tools and techniques for all the designs. Then choose your three favourite designs and label them with materials, tools and techniques.

Review your time-management plan for completing your project.

Materials
- Microsoft Word
- Microsoft Access
- Microsoft Excel
- Microsoft Paint

Tools
- Insert graphic
- Font change
- Insert WordArt
- Format
- Edit tools
- Drawing tools



Techniques
- Cut
- Paste
- Copy
- Import
- Export
- Insert
- Manipulate
- Edit

FIGURE 10.5: An idea for an interactive Word document labelled with materials, tools and techniques

See chapter 2, page 44.
See page 254 to remind you what the design brief requires.

Design process: COMMUNICATION

Final sketches and working drawings

Produce concept sketches and working drawings. These will help you to plan the look of your interactive Word document and identify any problems that may arise. Often an excellent design idea cannot be made because resources or specific tools are unavailable.

Ways of communicating

Your interactive Word document is communicating information about a sport or a professional sportsperson. People respond in different ways to communication. Some learn from visual stimuli such as diagrams, photographs and graphics; others may prefer looking at a spreadsheet.

By including both visual and other forms of information, your presentation should satisfy:

- organised people who like information sorted in a database
- visual people who rely on images and diagrams
- systematic people who like to view things in columns and rows
- inquisitive people who follow the hyperlinks and surf for the information on search engines.

Design process: EXPERIMENTATION AND TESTING

Construct a prototype and evaluate the model

When designing and making your interactive Word document, it helps to construct a prototype to give you an idea of what the document will look like. This could be done by hand or on a computer.

When experimenting and testing, you need to:

- test material properties (see 10.2 Materials)
- test tools and construction techniques (see 10.3 Tools and techniques).

See chapter 2, pages 51–5.

Safety

Design process: SAFETY AND RISK MANAGEMENT

Look again at the rules for your basic safety in chapter 2. You particularly need to take notice of the section on ergonomics in the computer room.

General rules for working with computer equipment

- Make sure your hands are clean before touching the keyboard.
- Do not eat or drink in the computer area.
- Keep the whole area and especially the monitor free from dust.
- Wipe marks off the screen with a soft cloth.

FIGURE 10.6: A computer mouse for left-hand use

Design process: PRODUCTION

Getting started

You will make the product from your working drawing labelled with materials, tools and techniques. When you are making your product, make sure that you are working to your time-management plan.

To make your interactive Word document you will need to use different types of materials, several tools and a variety of techniques. The information you need to go on with your project is contained in:

- 10.2 Materials (pages 261–3)
- 10.3 Tools and techniques (pages 264–73).

Production steps

1. Finalise your choice of sport or sportsperson from your working drawings.
2. Open a new A4 page (210 mm × 297 mm) in Microsoft Word.
3. Use your working drawings to plan the layout of the page. Decide where you are going to put the graphics, images, text and hyperlinks to the Internet, spreadsheet and database. Adjust your layout to make it look good.
4. Make a small database of information about your chosen sport, for example, the weeks it is being played.
5. Make a spreadsheet about the sport, for example, scores of the last season's games.
6. In the Word document, make headings for the database link and the spreadsheet link. To create a link to your spreadsheet, highlight your spreadsheet heading, then click on the **INSERT** menu on the Word menu bar. Select the **HYPERLINK** option from the drop-down menu. Locate the spreadsheet file and click OK. Repeat this process for the database file.

7. Insert the images and graphics into the Word document. Arrange them around the page, using the elements of design.
8. Create text in an easy to read font. Use different fonts and sizes for the main title and subheadings.
9. Insert two links to the Internet — URLs about the sport. Insert in the same way as you did for the database and the spreadsheet — go to the **INSERT** drop-down menu and then click on **HYPERLINK**. Use the full address such as http://www. ? .com.au.
10. Submit your interactive document to your teacher as an electronic version, not a printout.

Design process: FINAL EVALUATION

Evaluating the interactive Word document

When your interactive Word document is complete, you must evaluate it to see whether it has satisfied the criteria for success you identified at the start of the project. You will need to check each of the criteria — the three given to you and the five that you added. The first three criteria are listed below, with some examples of questions you may ask yourself.

- *Have hypertext links to the Internet, a spreadsheet and a database.* Did I include these? Have they been tested and do they work?
- *Contain information about a specific chosen sport.* Does my document do this? Is it easy to understand?
- *Use a professional layout and be clear and concise.* Does my document look professional? Is it clear and concise?

You do not need to do all the evaluating yourself. You can ask your teacher, parents, brothers, sisters and peers, professionals from shops (for example, Snap Printing or Officeworks) and graphics designers.

Professional, peer and self-evaluations

Electronically exchange interactive Word documents with your classmates and teacher for their objective evaluations. Then self-evaluate your project by asking the following questions:

1. What is the focal point of this interactive Word document? That is, what part is supposed to catch the reader's eye first?
2. What job, role or activity does this interactive Word document describe?
3. Is this supposed to be a formal (serious) or informal (casual) interactive Word document?

An important aspect of this project is to be able to show your teacher that you can:

- insert hyperlinks
- use a professional layout with colour
- teach the viewer about your chosen sport
- use skills in desktop publishing.

Technobite

Junk mail is one of today's pollution problems. There is junk email, too — it's called *spam*. Although programs to block spam exist, they are unable to prevent all junk mail from being delivered to your email address.

10.2 Materials

Data types

Also refer to graphic data types in chapter 9, pages 236–8.

Table 10.1 sets out some of the many types of file extensions that can be used when looking at databases, spreadsheets and word processing. Computer technology is developing so quickly that a table such as this can never cover the complete range of data types or be truly up to date.

TABLE 10.1: Data types

Data type	File extension	How and where used?
Databases	.mdb	Microsoft Access — database file format
	.fp(version number)	FileMaker® Pro — database file format
	.txt	Tab separated text — transfers data between word processors and databases
	.csv	Comma separated values — transfers data between word processors and databases
Spreadsheets	.xls	Microsoft Excel
	.123	Lotus 123®
	.wq	Corel Quattro Pro®
Word processing	.doc	Microsoft Word
	.wp	Corel WordPerfect®
	.txt	Microsoft Notepad — txt file
	.cwk	AppleWorks (was ClarisWorks)

Hypertext

Text is what you are reading at this moment, written in the roman alphabet of 26 characters. The meaning of text is extended by numbers and symbols, such as punctuation marks. The text in this book was initially created as a Word document and is supported by pictorial material: photos, drawings, diagrams and icons to highlight safety issues or refer you to other pages.

Text exists as normal text on web pages just as it exists in Word documents. *Hypertext* is text formatted in a specific way so that, when selected (for example, when you put the cursor on a *hyperlink* and click with the *mouse*), it allows you to link to other information. *Hyperlinks* link words or phrases in the text to another web page, either on the same site or on another World Wide Web site. When the document is printed out in colour, the hypertext links usually appear as underlined text in another colour (most frequently blue).

http://www.jaconline.com.au/ is made a hyperlink automatically because it is a URL web address. The World Wide Web address will appear in the status bar — click on this hyperlink and the computer will take you there.

A hyperlink to a document is created differently. The word or phrase that will become the hyperlink is highlighted and the **HYPERLINK** option is chosen in the **INSERT** drop-down menu. The correct file for the link is then selected. When you move your mouse over the finished hyperlink, as shown in figure 10.8 (on page 262), a 'pop-up' message shows the address of the file. Hold down one of the control keys (Ctrl) and click the mouse to open the hyperlink.

Techno**bite**

'The new information technology — Internet and email — have practically eliminated the physical costs of communications,' said Professor Peter Drucker. As a class, discuss whether you think he is right.

Navigation buttons
The navigation buttons in your browser help you with common tasks like going back or forward and refreshing or stopping the loading of the current page.

Menu bar
The menu bar allows you to access the available functions of your browser.

Web address (URL)
This is the location of the website currently being displayed.

Browser window
The browser window is the area of your browser where a web page is displayed.

Graphics
Graphics are pictures used in a web page. Sometimes text is actually created as a graphic to get exactly the look required.

Hyperlink
A hyperlink or hotspot takes you to another page when you click on it. A hyperlink can be text or a graphic.

Status bar
The status bar has a number of functions. It shows the amount left to load when a page is loading and it shows the address that a link will take you to when clicked.

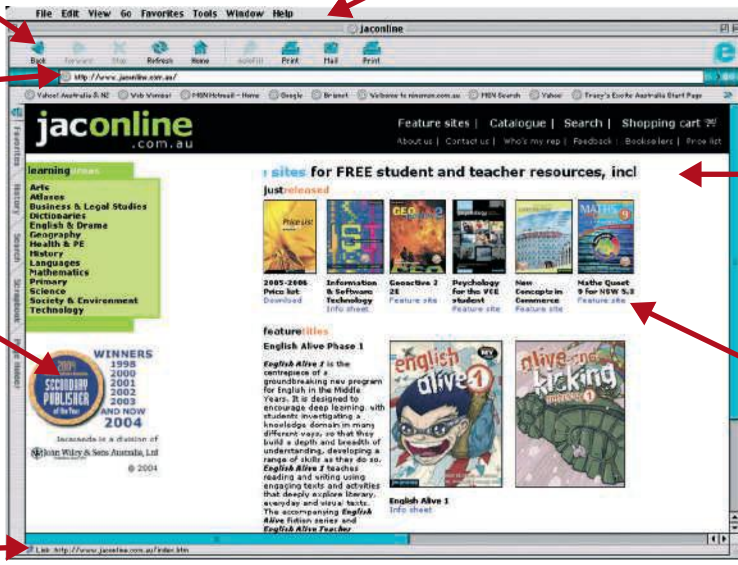


FIGURE 10.7: A World Wide Web website

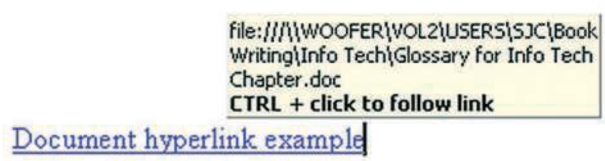


FIGURE 10.8: Document hyperlink showing the mouse-over information

Internet information

The Internet is a collection of computer networks around the world that are connected to each other via high-speed telecommunications links.

The World Wide Web (WWW) is a graphic representation of the millions of documents and resources that are available on the Internet. When you think of the Internet and the WWW, think of them as two parts of the same object, the Internet is the physical structure of millions of computers cabled together worldwide — the hardware, topology and technical part. The WWW is the content of the Internet — the graphics, text and hyperlinked structure.

There are excellent sites on the WWW for obtaining information on almost any subject, from flash games to homework for history. The WWW contains primary and secondary sources of information. Unlike other research tools, however, information from WWW websites should be carefully assessed for accuracy and trustworthiness. Judging the reliability of sources has become a vital thinking skill. Use table 10.2 to check your website sources.

Technobite

No one owns the Internet and no one person or organisation controls it. The Internet relies on an infrastructure that connects networks. Many organisations, corporations, governments, schools, private citizens and service providers own pieces of the World Wide Web infrastructure, but there is no single body that owns it all.

TABLE 10.2: Testing a website

Area	Ask yourself these questions
1. Scope	• What is the subject of the website? • How detailed is the website? • Is everything on the topic covered? • Is there missing information?
2. Audience/ end-user	• For whom is the website written, for example, children or adults? • Is the content appropriate for the audience it's aimed at?
3. Authority	• Who wrote the website? • What are the author's or authors' credentials/qualifications? • Are the authors experts?
4. Currency	• Is the information up to date? • Is the website consistently being updated? • Is timeliness important to the subject area?
5. Accuracy	• Is the information correct? • Is there a personal opinion or bias present? • What is the source of this information?
6. Purpose	• What is the purpose of the website? To entertain? To inform? To teach? • Does the website fulfil its purpose?
7. Organisation, structure and design	• Is the website easy to use and understand? • Is the website organised in a way appropriate to the content and purpose? • Are there too many images, making the pages slow to load?

Remember, just as you would acknowledge book or magazine article sources if you quoted them in your work, you must acknowledge website sources. Plagiarism (taking other people's work without their permission and passing it off as your own) is stealing and against the law.

Switch on

1. You have learned about file formats — for example, .doc stands for document and this is the file format used by Microsoft Word. Copy table 10.3, complete the unfinished rows and list another five file formats and complete the information for them.

TABLE 10.3: File formats

File format	Stands for …	Program
.doc	Document	Microsoft Word
.jpg	Joint Photographic Experts Group	Any graphics program
.xls		
.pdf		

2. What is the World Wide Web? How can it be used? Write half a page in your design folio on the history of the World Wide Web.

10.3 Tools and techniques

Making an interactive Word document will introduce you to a number of the tools and techniques suitable for working with information technologies. This section also introduces options you might choose for other projects and may mention only some of the equipment you have in your school.

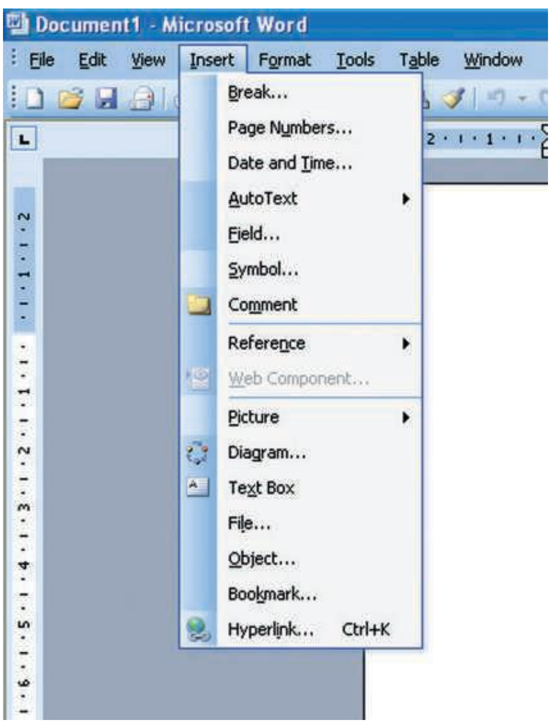
Inserting and formatting tools

INSERT TOOLS: Used to insert text, graphics and other media into the Word document.

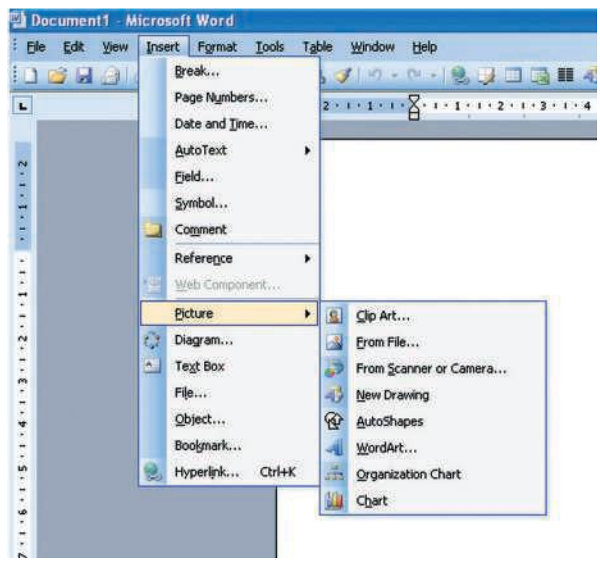
FORMAT TOOLS: Used to format text and layout a Word document and to add colour and other background effects.

FIGURE 10.9: Microsoft Word's insert and format tools

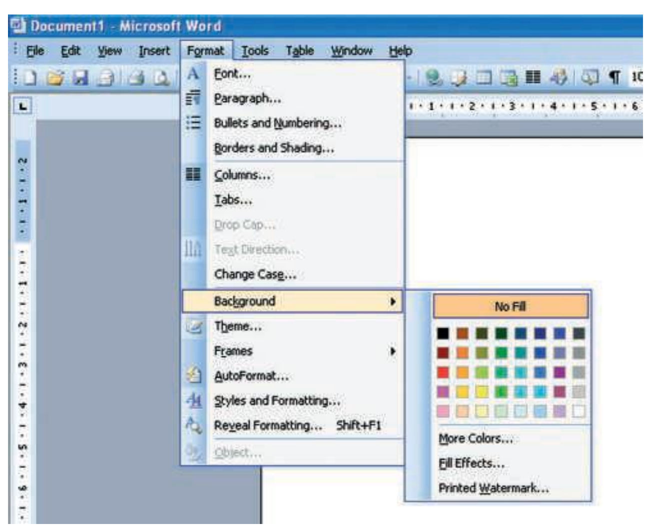
(a) INSERT drop-down toolbar



(b) INSERT picture toolbar



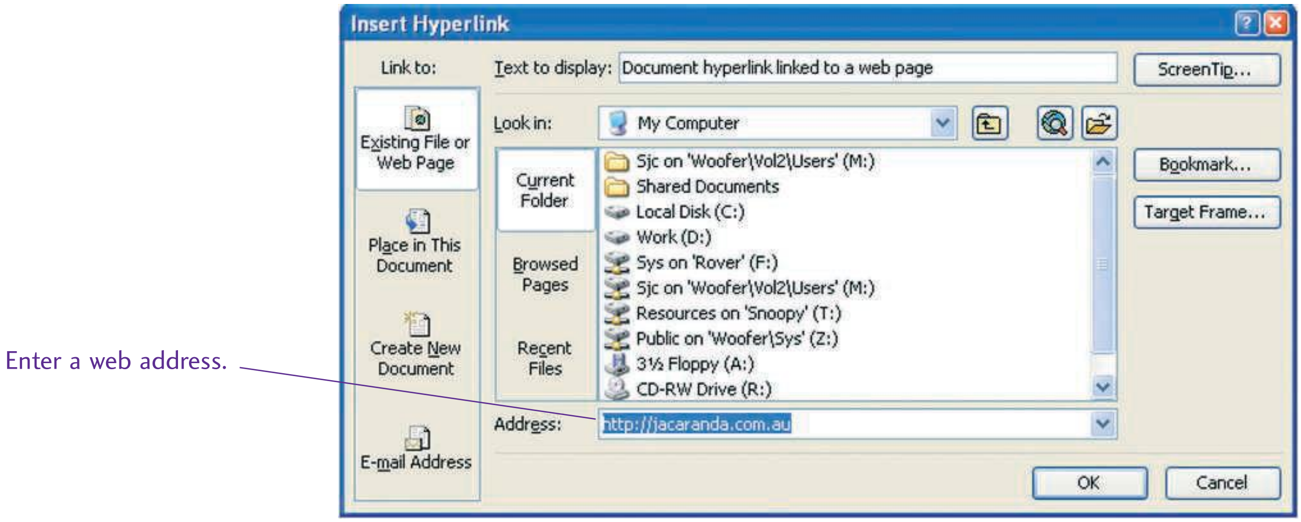
(c) FORMAT background toolbar (to insert colour)



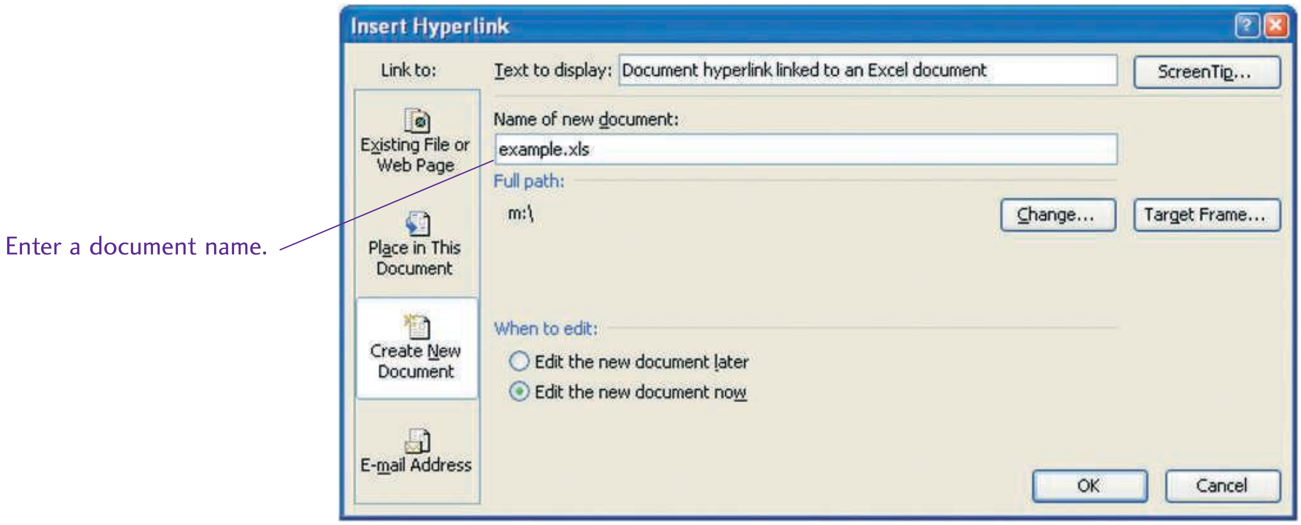
HYPERLINK TOOL: This tool allows you to insert hyperlinks into web pages and other files, such as database and spreadsheet files.

FIGURE 10.10: Using Microsoft Word's **INSERT HYPERLINK** tool

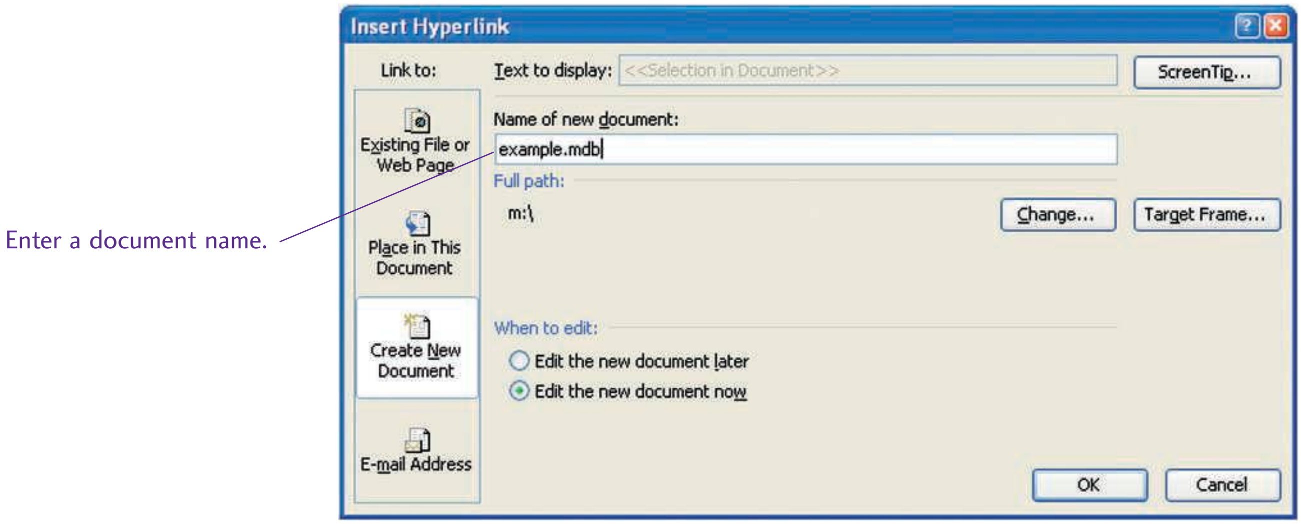
(a) To link to a web page



(b) To link to a Microsoft Excel file (.xls)



(c) To link to a Microsoft Access file (.mdb)



Switch on

1. What does the **INSERT HYPERLINK** tool do? State some examples.
2. Working with a partner or in a group, prepare a presentation that uses flow charts on how to make an interactive Word document. The purpose of your presentation is to teach other students the skills you have learned.
3. What type of environment do you work in when working on a computer at home and school? Complete table 10.4.

TABLE 10.4: Your computer environment

Home	What and where?	School	What and where?
Furniture		Furniture	
Desks		Desks	
Chairs		Chairs	
Lighting		Lighting	
Workspace		Workspace	

4. Conduct an interview with someone at home and ask them if they use interactive Word documents at work. Think of other places that could use this type of communication.

Software

SOFTWARE: The software tools used for your design project are Microsoft Word, Microsoft Access, Microsoft Excel, Microsoft Internet Explorer® and a graphics program. You will use these tools for different purposes:

- *Presentation.* Present information in different forms of communication: written, oral and graphic.
- *Draw and paint.* Create and edit graphics.
- *Word processing.* Create, edit and format a document, using menus, buttons, bars, keyboard shortcuts, help commands and document management tools.
- *Databases and spreadsheets.* Database software collects and stores data (records sounds, images, facts and figures about places, people and events). A database can be searched and organised. Examples of databases are books in a library or a telephone directory. Spreadsheet software allows users to organise numeric data.

Techno**bite**

'No matter how well it's been designed, a site without worthwhile content is like fancy icing without a cake.' *Web Pages Made Easy*, Issue 48.

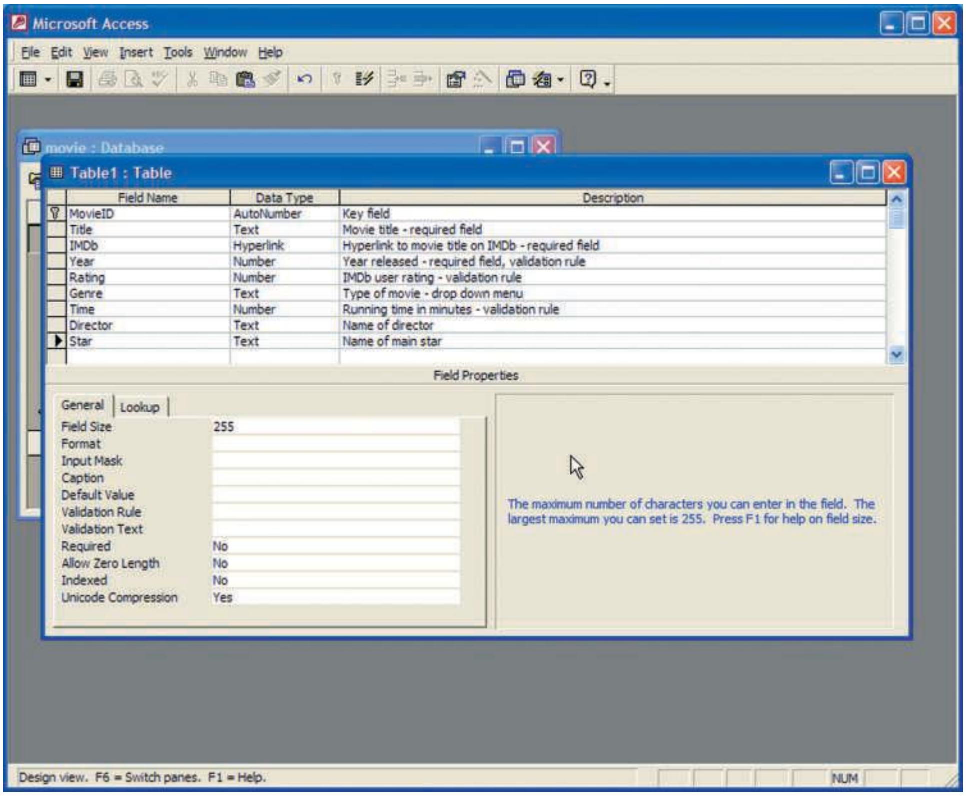
Table 10.5, showing software programs and their purposes, lists:

- some of the tasks that users might undertake
- examples of software that could be used
- features of the software that make them suitable for each task.

TABLE 10.5: Software programs and their purposes

Example task	Example software	Features suited to the task
Create text/write a letter	Microsoft Word	Word processing features including document creation and editing
Create a logo	Paint Shop Pro®	Manipulation of graphic images
Develop a website	Macromedia® Dreamweaver®	HTML editor
Create a flyer	Adobe PageMaker®	Creation and editing of high-quality documents
Develop a multimedia presentation	Macromedia Flash®	Animation and sound
Develop a presentation for a client	Microsoft PowerPoint	Presentation features
Manage a project	Microsoft Project	Gantt chart production
Make a budget	Microsoft Excel	Spreadsheet facilities including functions, calculations and graphing
Make a list of friends	FileMaker Pro	Database facilities including data storage, retrieval and search
Send a message to a friend	Hotmail®	Internet-based software for sending, receiving and managing email
Search for information	Netscape® Navigator	Web browsers for viewing websites

FIGURE 10.11: Creating a database in Microsoft Access

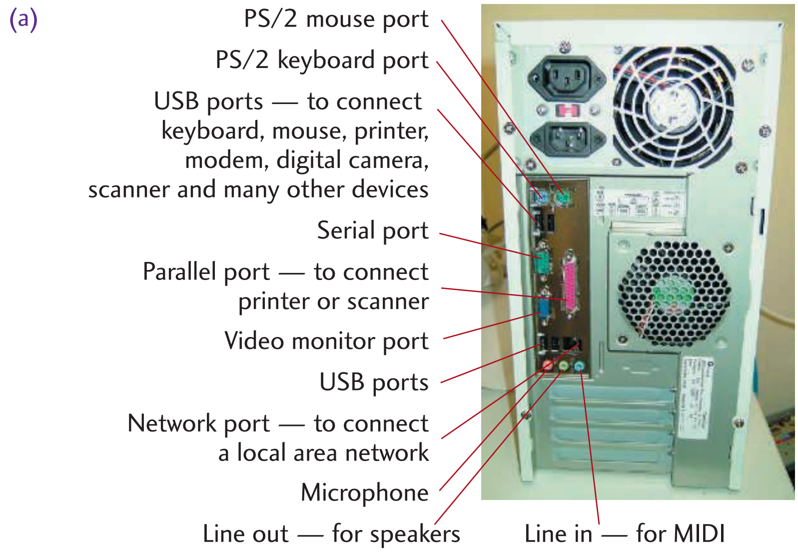


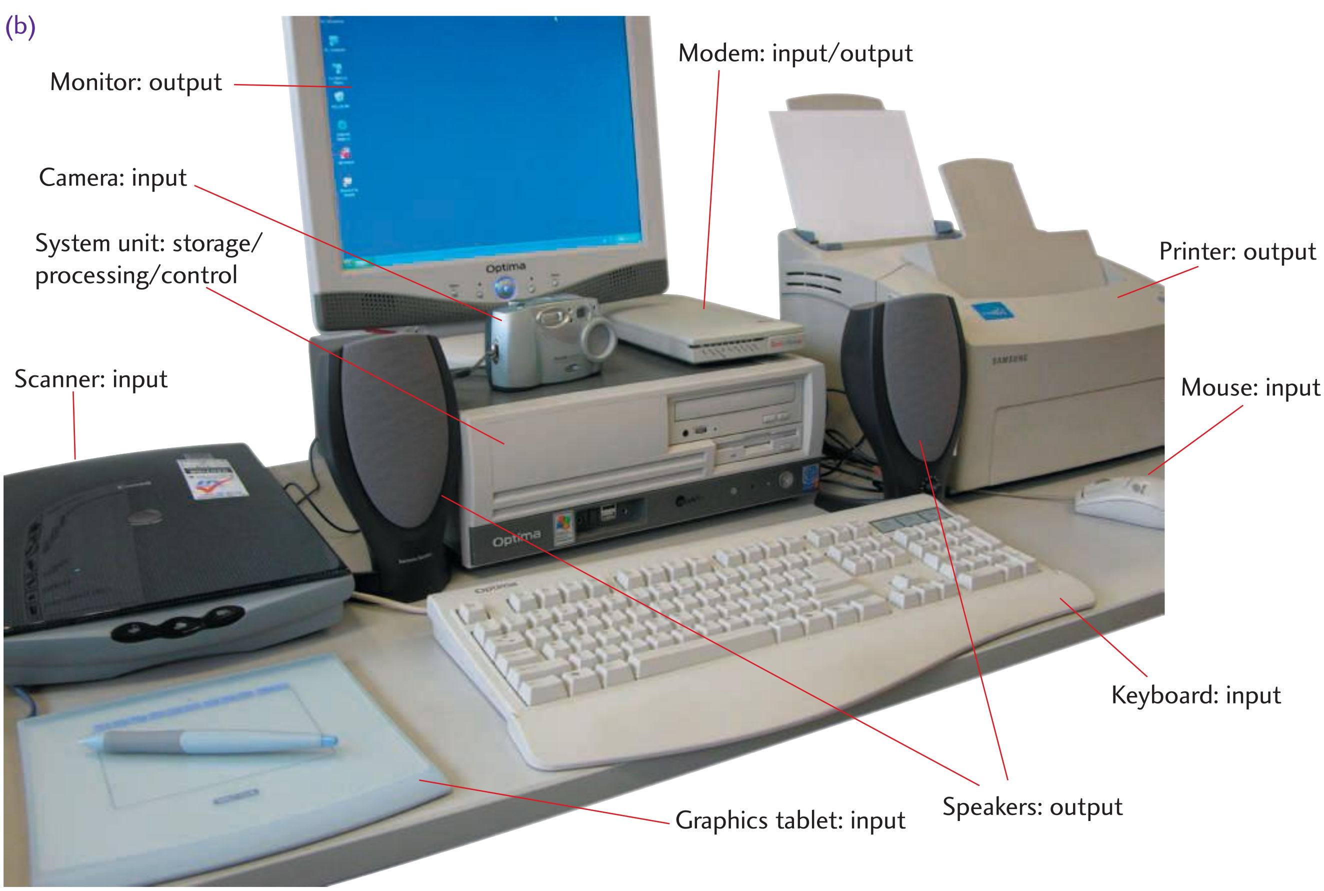
Input and output tools

An *input device* is used to transfer data into a computer, for example, a scanner, a microphone or a mouse.

An *output device* is used to present data from a computer, for example, a printer, speakers or a monitor.

FIGURE 10.12: (a) Input/output ports on a personal computer, (b) inputs and outputs





Capturing images

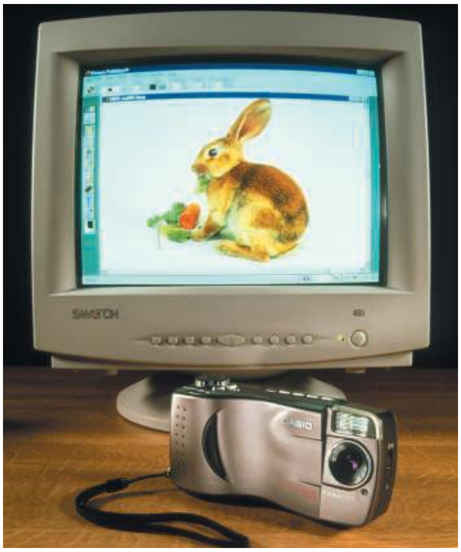
Data from the natural world are *analogue* and have an infinite number of possible values.

Computers store data as *digits*, which are whole numbers. The process of turning analogue input into *digital* data is called *digitising*.

DIGITAL CAMERA: A digital camera captures still images, although some also have the ability to take short movies. Once you transfer the images to your computer, you can use graphics software to edit the images, such as removing the background of an image as shown in figure 10.13.

FIGURE 10.13: Capturing images

(a) A digital camera converts continuous analogue data into digital data.



(b) A photograph from a digital camera has been transferred to a computer.

DIGITAL VIDEO CAMERA: A digital video camera captures moving images, but can also capture still images. Once you transfer the movies to your computer, you can use video editing software to edit the movies, add a soundtrack and create effects.

SCANNER: A scanner uses a strong light to create a digitised image of a document or a photograph. There are three main types of scanners: *drum, flatbed* and *sheet-fed*. Drum scanners are large machines that scan many large images at once. They are used in newspaper and industrial situations. Flatbed and sheet-fed scanners are small enough to be used in schools and offices and at home.

FIGURE 10.14: Creating graphics for a website in a flatbed scanner

Storage devices

A number of devices can be used to store information. Each storage device can hold a different amount of information. Some external drives can store 1 terabyte (1000 gigabytes or 1 000 000 megabytes) of data!

FLOPPY DISK. Size of storage: 1.44 megabytes (MB)

CD-ROM R (READ) and **RW (READ AND WRITE).** Size of storage: 600–800 MB

DVD R AND **RW.** Size of storage: 4.7 gigabytes (GB)

ZIP DISK. Size of storage: 100–750 MB

FLASH CARD. Size of storage: 10 MB–2 GB

FIGURE 10.15: A CD-ROM can store more data than a floppy disk.

Printing

PRINTER: Used to print text and graphics that have been created by a computer. The type of printer selected is determined by:

- the required quality of the print
- the speed of the printer
- whether or not there are graphics
- whether or not there is colour.

Printed images are made up of thousands of little dots. The sharpness of the printed image is called the *resolution* and is measured in dots per inch (dpi). The smaller the dots, the more dots per inch and the sharper the image.

There are two common types of printers: *inkjet* and *laser*.

An inkjet printer makes pictures by spraying tiny droplets of liquid ink onto the paper. Most inkjet printers can print at 600 dpi with some going as high as 2400 dpi.

A laser printer uses a fine powder called toner, which is heated to fuse or melt it into the paper. Laser printers print at a resolution of 300–600 dpi. Laser printers print a lot faster than inkjet printers but they are a lot more expensive to purchase.

Both inkjet and laser printers are available to print in colour or black and white.

Technobite

'By the year 2010, all computers will have a minimum of computer memory of 1 terabyte (1000 gigabytes or 1 000 000 megabytes).' *PC User*, August 2004.

FIGURE 10.16: Desktop printer

Switch on

1. Analyse five types of digital storage device.
2. Compare the output of laser and inkjet printers. List their advantages and disadvantages.
3. Explain in your own words what digitising means.
4. What is a scanner used for? Give examples.
5. Define word processing. How is it different from desktop publishing?

Information processes

Processing data and information involves various computer hardware, software and techniques. The techniques or processes used in information processing are collecting, organising, analysing, storing and retrieving, transmitting and receiving, processing, and displaying.

Collecting information

Table 10.6 shows that information can be collected from a variety of sources.

TABLE 10.6: Sources of information

Sources		
• Libraries	• Media outlets, e.g. radio and television	• Promotional pamphlets
• CD-ROMs/DVDs	• Statistics	• Billboards
• The Internet	• Reports	• Junk mail
• Professionals	• Journals	• Movies and theatre
• Shops		• Catalogues

Technobite

Web servers use cookies (not the edible sort!) to keep track of a user's activity on a specific website. Cookies are small text files that a web server transmits to a web browser. The information in these files is entered into the memory of the browser. The browser, in turn, stores the cookie on the hard drive, so when the browser is closed, then re-opened at a later date, the information stored in the cookie is still available.

Organising information

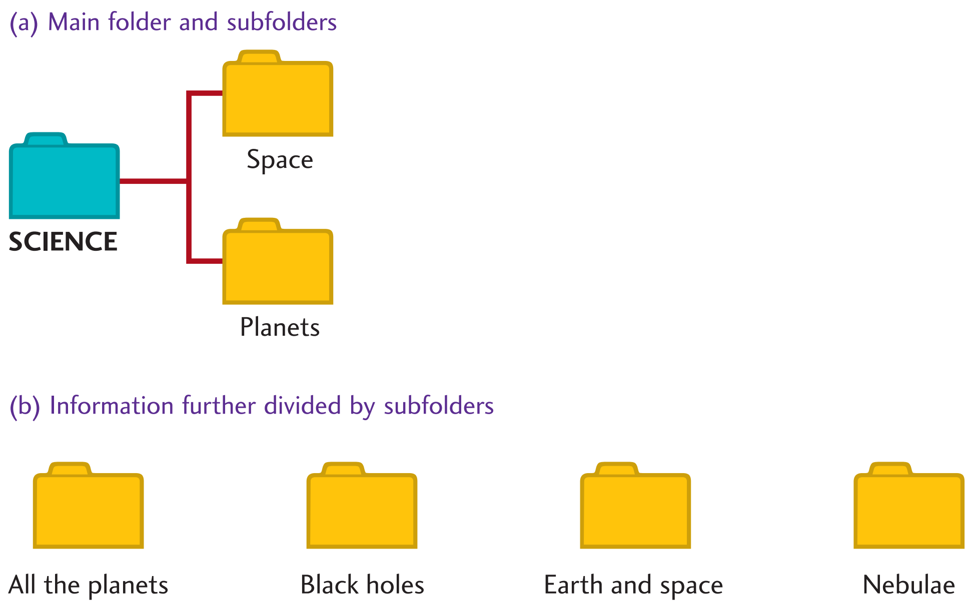
It's important to keep your desk at home and your locker at school organised or you may lose pages, folders, textbooks and other vital information. It's just as important to keep computer material organised.

When starting a unit at school, you would normally begin with a fresh notebook or a different section in your folder. Do the same on the computer: start new folders and new files for new projects. It's very important to organise your files, folders and *archives* well, as single files can be easily lost.

For example, if you were studying the topics of space and planets in science, you could create a folder with the name 'Science'. In this 'Science' folder, you could create two subfolders, one called 'Space' and the other 'Planets'. You could then store all of your files for these topics in those folders.

You could then create more subfolders that keep you organised within those folders.

FIGURE 10.17: Organising information in folders



Backing-up helps you to organise your files and folders. This process involves making another copy of the folders and files that you want to keep. For example, you could save the interactive Word document on your computer's hard disk and on a floppy disk. You could then label the floppy disk and safely store it in a place separate from the computer.

Analysing information

Analysis is the process of critically examining information. There are three parts to analysing information:

1. checking the validity of the data
2. manipulating the data
3. correlating the data.

The analysed data can be stored and displayed, for example, as a graph or chart.

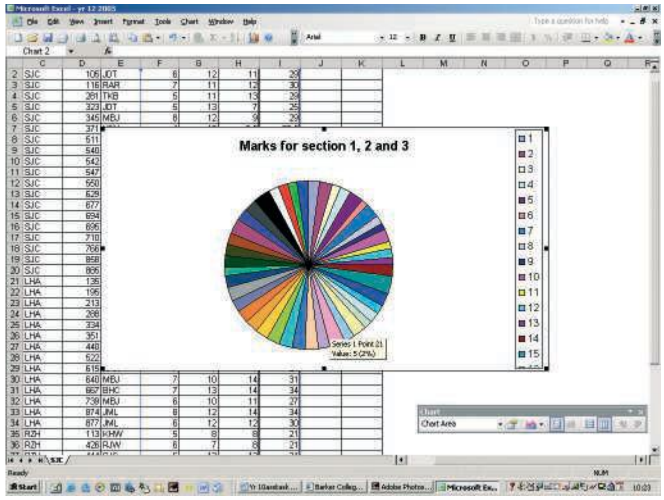


FIGURE 10.18: Analysing information — data stored in a spreadsheet and displayed as a pie chart

Storing and retrieving information

Data are stored and retrieved from different types of disks.

See page 269.

Transmitting and receiving information

Transmitting and receiving information is the process responsible for moving data between computers, for example over the Internet and between a computer and its input/output devices, for example, to a printer.

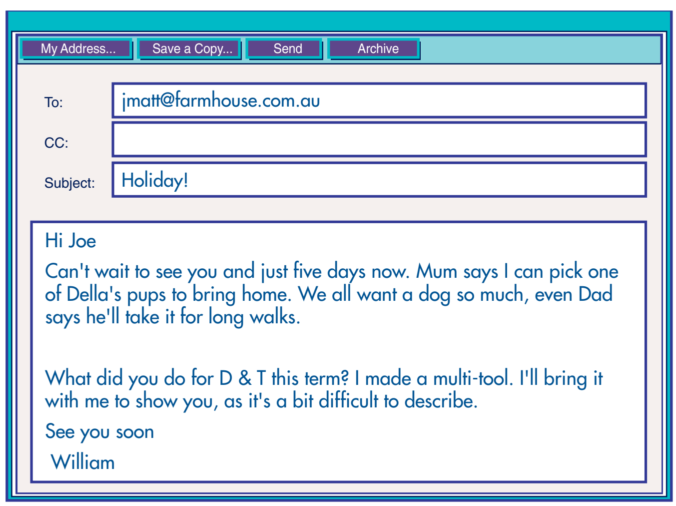


FIGURE 10.19: Transmitting and receiving information controls email and the Web.

Processing information

Central processing unit (CPU): The chip or CPU controls and executes the instructions that make up the computer program that is running.

CPUs are capable of running instructions one after the other. A CPU, in conjunction with the operating system, can enable *multi-tasking*, that is, one user running more than one task at a time. It does this by sharing its time between the processes and generally the user doesn't notice any lowering of performance.

CPUs are capable of executing a large number of instructions per second. Their speed of operation is increasing further as technology continues to improve.

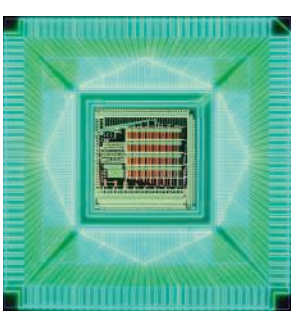


FIGURE 10.20: A central processing unit (CPU)

Displaying information

There's really no point in spending time and money on a design project if you don't think ahead about how the project will be presented and displayed.

How will your audience receive your interactive Word document? Were you lucky enough to produce it using the latest version of Microsoft Internet Explorer and a broadband Internet connection? If so, think of the people who have no access to broadband services and are restricted to very slow dial-up services.

Your main alternatives for delivery of the product are via the Web or on a CD or DVD. Look at table 10.7 and consult your teacher to consider your options.

TABLE 10.7: Choosing between distributing on CD/DVD or the Web

Distribution medium	Advantages	Disadvantages
CD/DVD 	• Highest possible quality for all types of data • No download delays or problems • Better control over copyright	• High distribution costs • CDs/DVDs will not be readable on all systems. • Quick updates are not possible.
Web 	• Fast distribution • Quick updates are possible. • Lower distribution costs	• Video and audio data will be limited and not playable on all systems. • Image quality must be reduced to improve download time. • Slow Internet connection will cause major problems.

Switch on

1. You can collect information in many places in addition to the ones mentioned in this section. List an additional five sources.
2. Describe how you would process raw data, for example, data you have collected in a survey, and present it as a graph.
3. Find out the limitations of CPUs.
4. Explain how you would display information that you have gathered in a design project.

10.4 Information technologies at work

The world of work

All processes that are carried out in the classroom are carried out in industry but on a much larger scale. Information technologies are transforming the workplace and forcing changes to trade practices and the government regulations that control them.

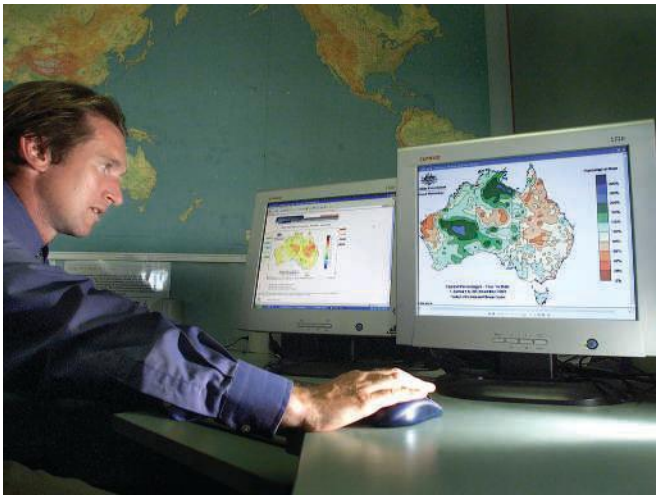
Information technologies is an industry in its own right with a huge number of workers committed to research, programming, manufacturing, advertising, selling, after-sales service and maintenance. There are even people working on the problem of computer equipment disposal. Almost every bit of a computer system is recyclable, yet discarded hardware clogs tips and landfills and is dumped in natural habitats.

Technobite

Delia Smith is a popular English cookery expert. She has a website: www.Deliaonline.com. A recent analysis confirmed that the site is accessed close to three million times a month, with more than 600 000 visitors spending 15 minutes on the site per visit.

Computers have taken over many tasks in the world of work that were formerly performed by people. The quest continues to program computers to perform more tasks automatically. Information technologies scientists and engineers cooperate in the search for *artificial intelligence*, studying the ways in which organisations and individuals use information and how computers could support them without the need for human intervention.

FIGURE 10.21: Computers at work



(a) Australian forecasters are able to choose and display massive amounts of weather data on specialised terminals.

(b) Computer lab in a school

FIGURE 10.22: Book designers like Ruby use graphics and information technologies as part of their day-to-day work.

Spotlight

Working with graphics and information technologies

Interview with Ruby McCallum

What is your title at work?
Book designer

What do you do during a standard working day?
There is always a lot of emailing, both to answer queries about a project and to send PDFs (portable document format) of roughs to people for feedback. Most of the elements used in book production, that is, photos, text and illustrations, are sent to me electronically. If I am working on a cover or internal design, I spend time mocking up ideas on paper and collecting anything I find inspiring. This could be colour swatches or something to be scanned for texture or type ideas from typography magazines. An equivalent amount of time would then be spent using the computer to create the design. If I am doing layouts, I can go for months at a time doing the same job — styling text, putting in pictures and keeping notes on problems that arise. The schedules are always tight, so I work out how much I have to produce each day to meet the deadline and then try to stick to it.

What hardware do you use most often?
Computer, scanner, printer, CD burner and digital camera

What particular software do you use?
QuarkXPress®, Adobe Illustrator, Adobe Photoshop, Adobe Acrobat®, Microsoft Word

Why is design important in your area of work?
It's very important on many different levels. Good type design is easy to read while badly designed typography makes a book impossible to concentrate on. It really works that way. If the typography is not done carefully, a person is more likely to put a book back on the shelf in a bookshop, thinking the book is boring but often it is just difficult for the eye to read. The cover also has to entice the reader. A cookbook, for example, should have a cover that makes someone want to cook. A touring book should make someone want to hit the road. A large reference book should look serious and information packed. It is the combination of different design elements that achieves this.

What is fun to do in your work place?
I really like choosing pictures, both on my own and in a group. We always have a laugh and I like to see how different photographers treat the same subject.

How different do you think your work place is from the classroom?
Creating books is a team effort, which requires many different skills. This means that you get to meet a lot of different people, authors, photographers, editors, illustrators etc. With so many creative people involved, the challenge is to work well within a team and realise that your ideas will not always be accepted. One big difference is that there is a lot of money at stake if you don't meet your deadlines.

Spotlight review

1. After reading this spotlight, list at least three different ways that Ruby uses graphics or information technologies in her work.
2. According to Ruby, what are two of the most important design considerations when producing a book?
3. Describe how making your own design project was similar to or different from the type of work done by a book designer.
4. Interview a professional such as an engineer, nurse, doctor, dentist, vet, teacher, accountant or lawyer and prepare an interactive Word document about why information technologies are important in their area of work.

Switch on

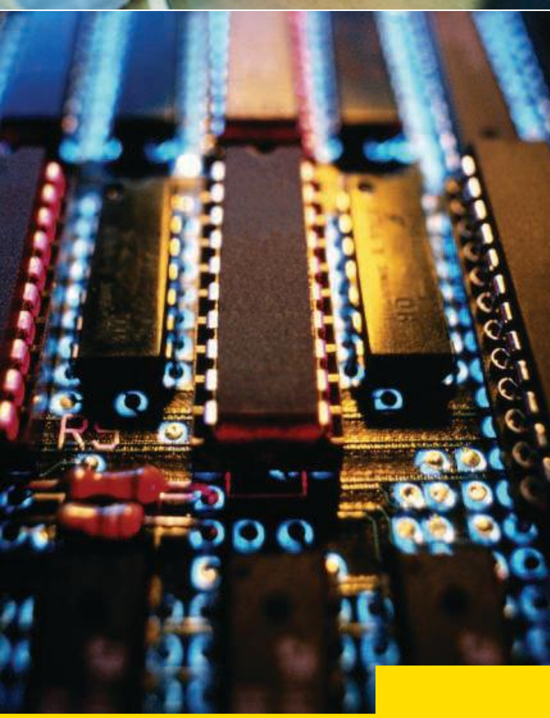
1. Create a timeline showing the major changes and trends over the last 20 years in the IT industry.
2. Create an A4 poster, pamphlet or brochure about the IT industry. Write down some of the jobs that are found in this industry. You may need to do some research and call, email or visit some companies or businesses.
3. Explain why it is important for a person working in IT to keep up with developments in computing.

Design process checklist

ONLINE RESOURCE BANK

Go to the Online Resource Bank at www.jaconline.com.au/switchedontech and click on the Design Process Checklist. Use the checklist questions to self-evaluate your project and to help you finalise your design folio.

You can also find more ideas for design projects at the Online Resource Bank.



Technobite

Electronic components help to improve and even to save lives. Their reliability and size allows them to be used successfully in modern surgical techniques and medical supplies, such as hearing aids and heart pacemakers.

CHAPTER **Eleven**

Electronics technologies

How many different forms of electronics do you depend on daily? Do you wake to the sound of an alarm clock, make toast in a toaster, punch your ticket in the machine on the bus to school or listen to the stereo in your parents' car? Electronics play a big part in our lives. We know that a light comes on when we press a switch and that sound gets louder when we turn up the volume control on the TV or stereo, but we may not fully understand *how* this happens. Each electronic application is a *system*: a series of steps in the correct order that give a required response.

Electronics involves the use of electric circuits. Circuits are made up of common electronic components such as switches, batteries, resistors and connecting wires. Electronic components are excellent materials for design projects because they are suitable for making projects in any of the three areas of study: Built Environments, Products, or Information and Communications. Chapter 11 provides detailed information to help you design and produce an electronic skill tester. This chapter also contains general information about the materials, tools and techniques used in electronics technologies.

Focus

By the end of this chapter you will be able to:

- identify and categorise common electronic components
- select and use electronic components for a design project
- select and correctly use tools of electronics technology for a design project
- solder efficiently
- set out and construct simple circuits for a design project.

Switch on

1. **List 20 electrical products in your home. Organise a class discussion to share your findings.**
2. **List five occupations that depend on knowledge about electronics.**
3. **Choose one electronic product and consider its development over your lifetime, for example, digital cameras (what has happened to the price?) or mobile phones (what has happened to the size?).**

11.1 Materials

> **Tip**
> Imagine that electricity is like water flowing through a circuit made of pipes. If there is a break or a hole in the pipes, the water can escape and the flow will stop.

Electronics is a huge area to study. *Electronic systems* operate the most powerful computer and the simplest torch. Understanding the basics of electronic systems will enable you to construct simple projects using electronic components such as switches, batteries, resistors, diodes, capacitors and connecting wires. There must be a continual flow of electric current around an electronic system to keep it operating. This pathway is called an *electric circuit*. If there is a break in the circuit, the system fails and the operation stops.

Using electronic technologies to design and make a product usually requires:

- thinking about the required function of an electric circuit
- choosing electronic components
- drawing a circuit diagram
- testing a circuit using actual components
- producing the solution.

This design process is like the one used for working with other materials.

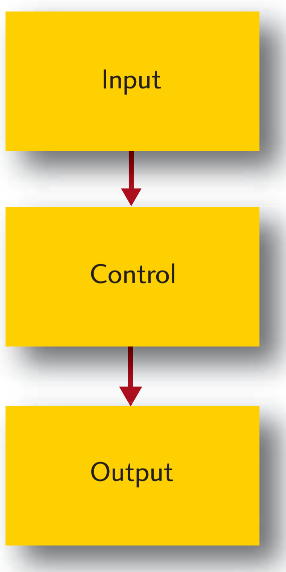


FIGURE 11.1: A system must have an input, a control and an output.

Electronic systems

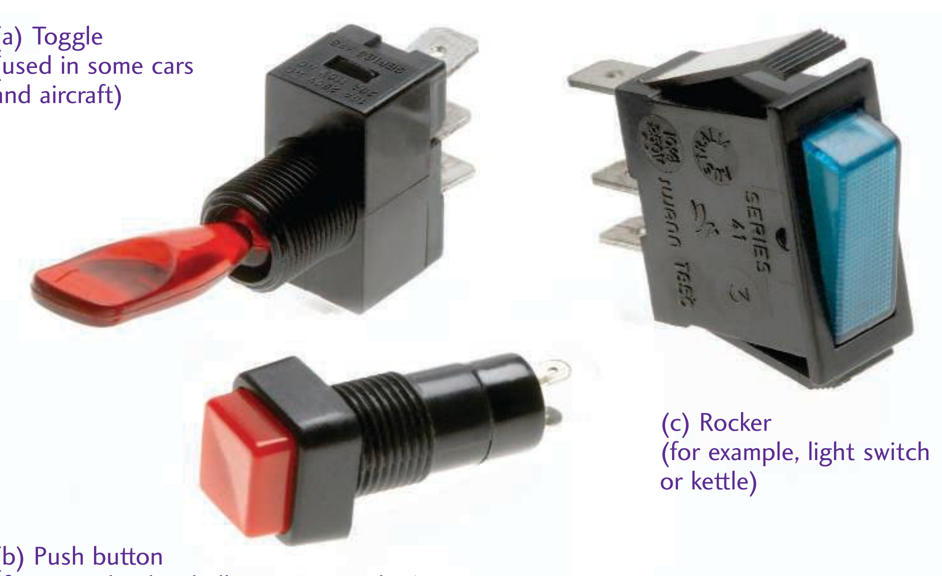
The building blocks of an electronic system are *inputs*, *outputs* and *controls*. Though each would be unable to work independently, together they work in harmony.

Inputs

Input commands are the start of the system. The most common forms of input commands are simple *switches*. We use switches every day without really thinking about it, for example, in lights and appliances, lifts and doorbells.

Push switches, slide switches, toggle switches and rocker switches all do the same thing. They *make* the connection or *break* the connection in a circuit. So an on/off switch simply makes or breaks a circuit. Being able to control these commands gives the system a use or function.

FIGURE 11.2: Some of the types of switches



(a) Toggle (used in some cars and aircraft)

(b) Push button (for example, doorbell or computer key)

(c) Rocker (for example, light switch or kettle)

Technobite

The clicking sound from a car's indicators is a switch opening and closing.

Input signals

Inputs can also come from other electric circuits. For example, the signals picked up by your television come from the electric circuits in the transmitter at the television station. When you are viewing a web page on your computer, the signals that created the page on your screen have come from the electric circuits in another computer on the Internet.

FIGURE 11.3: Electronics inside a computer mouse

Outputs

If you put a command into a system, you would expect a response — an *output*. And it is often the output that makes a product useful. Light, heat, movement and sound are all outputs, given out by components, such as light globes, heating elements, motors or speakers. Outputs usually draw or use up power from a source: the brighter, hotter, faster or louder the output, the more power required.

Controls

Controls are sometimes harder to locate in a system. They control what happens in the system from the input command to the output response. The control components direct the flow of electric current and regulate its level — reducing or increasing this level. If you look at a circuit, for example, the type used in a TV or a computer mouse, the control components are the small coloured pieces or the small black boxes called *microchips*.

Powering an electronic system

Technobite

The physical size of batteries has no relation to their overall power level. The physical size simply determines how long the battery will last.

An electrical power source is needed to operate an electronic system. Electricity is a form of energy that involves the movement of electric charge from one place to another. The movement of the electric charge is called electric current. This electrical energy can be converted to other forms of energy such as heat, light and sound. In your home, most of the electrical energy you use is obtained by plugging a lead into a power point.

Electrical energy can also be stored in batteries. An electronic system such as a torch or a portable CD player is powered by batteries. Batteries are suitable for your design projects because they are safe and easy to use.

The size of an electric current can be measured by determining the amount of electric charge passing a particular point in the circuit every second. An ammeter measures electric current in amperes (A).

Voltage is the force that pushes current through an electric circuit. A voltmeter is used to measure the voltage gain across the terminals of a power supply (such as a battery) or voltage drop across parts of a circuit. Voltage is measured in volts (V). Your design projects will probably use 1.5 or 9 volt batteries.

In a circuit like a torch that operates using a steady voltage source, such as a battery, current flow is always in the same direction. We call this *direct current* (DC). In a circuit like a desk lamp that is connected to mains electricity, the current continuously reverses or alternates its direction. We call this *alternating current* (AC).

FIGURE 11.4: Batteries

Electronic components

Resistance in electronics is mainly concerned with controlling the current — making it easier or harder for the current to flow. The current flows easily through a component that has *low resistance*. Low resistance gives high current levels.

Technobite

Electronic components have had a huge influence over the actual design of products. Early components and batteries were big and bulky, so early electrical products were big and bulky too. Modern components are much smaller, allowing miniaturisation in products. Entire circuits and systems can now be stored in a component no bigger than a grain of rice.

The opposite of this is a component with *high resistance*, making it difficult for the current to flow through. High resistance gives low current levels. *Resistors* are one of the most common components used in electric circuits. They can have a fixed resistance or can be variable like those in volume controls.

The highest level of resistance is reached where the current cannot flow at all. A component that blocks the current is known as an *insulator*. Materials, such as plastic and wood, are insulators. The outer coating on electrical wires is made of plastic so that the current stays within the system.

The opposite of an insulator is a *conductor*. Conductors allow the current to flow freely through them. Most metals are conductors, so they are used to make many electronic components and connecting wires. Copper has one of the highest conductive levels; it is the most common conducting material used in electrical products in your home.

Other common electronic components include *diodes* and *capacitors*.

Diodes allow electric current to travel through them in only one direction. They look like resistors but have a single coloured band at one end. This end of the diode is the negative end and should be connected closer to the negative terminal of the power supply than the positive terminal.

Capacitors store electric charge for a short time before allowing it to flow to other parts of a circuit. The amount of charge that can be stored for each volt across a capacitor is called its capacitance.

Positioning components in circuits

Technobite

Copper is widely used as a conductor in connecting wires and in other components. Gold is actually a better conductor of electricity but it is too expensive.

Because some outputs require more power than others, it's important to place components in the most useful positions within circuits.

If you place three identical light globes in a *series circuit* (directly one after another), they will all shine but with a dim light because the voltage supplied by the battery has to push the current through all three globes. This reduces the total current that flows through the circuit so the globes produce less light. Placing components in a series circuit gives each component the same current but reduces the overall current that flows.

Placing the same three light globes in a *parallel circuit* will make them shine brighter because the voltage supplied by the battery has to push the current through only a single globe in each parallel branch. So each globe receives more current and produces more light. Placing components in a parallel circuit gives each component the same voltage.

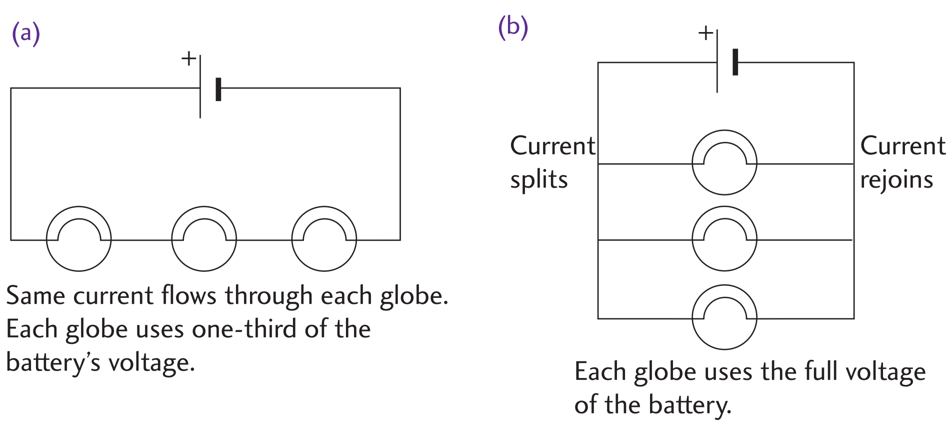
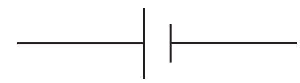
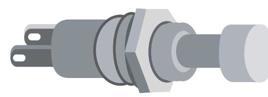
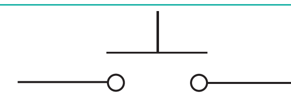
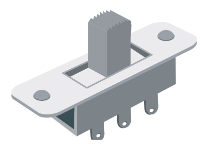
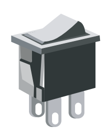
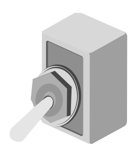
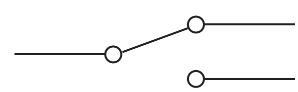
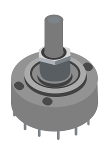
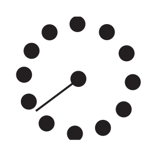
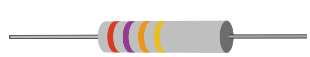
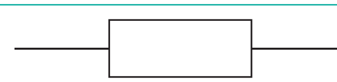
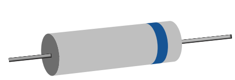
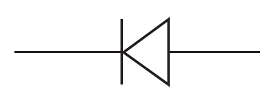
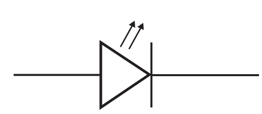


FIGURE 11.5: (a) Series circuit, (b) parallel circuit.

Circuit diagrams

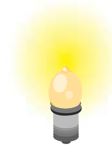
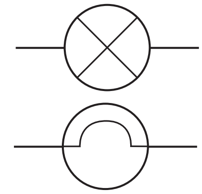
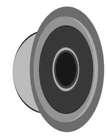
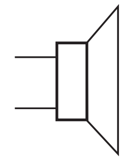
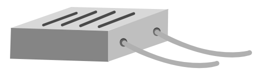
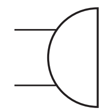
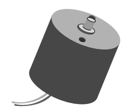
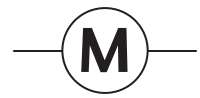
Maps of electric circuits, as shown in figure 11.5 (on page 279), are called circuit diagrams. These diagrams need to be drawn so that people all over the world can read them. Circuit diagrams use straight lines for connecting wires and symbols for other parts of circuits.

TABLE 11.1: Electronic components — type, appearance and circuit symbols

Type	Appearance	Circuit symbol
Battery		
1.5 volt battery		 1.5 V
9 volt battery		 9 V
Inputs		
Push switch		
Slide switch		
Rocker switch		
Toggle switch		
Rotary switch		
Controls		
Resistors		
Diodes		
Outputs		
Light emitting diode (LED)		

Technobite

A new LED named 'Luxeon' is one of today's brightest light sources, producing 10–20 times the output of a standard LED.

Light globe		
Speaker		
Buzzer		
Motor		

Switch on

1. Look at some commonly used batteries.
   (a) Sketch some examples.
   (b) Note the voltages of each.
2. Design a symbol/logo that could represent 'low voltage'.
3. Using the idea of water in pipes (see tip on page 277):
   (a) show how a circuit could look
   (b) show a break in the circuit.
4. Draw and label a range of switches/buttons that control electronic systems in your home/classroom. What do each control?
5. Draw and label some electrical outputs from a range of electrical products.
6. Go to www.jaconline.com.au/switchedontech and click on the How Stuff Works weblink for this chapter. Select Batteries from *Top Subjects* and research them. Prepare two A4 pages summarising your information and including diagrams and pictures. You might like to add these pages to your design folio.

11.2 Tools and techniques

See the information about using a drill press in chapter 3, page 80.

Many of the tools you will use when working with electronic components are hand tools but you will also use some machine tools, including a drill press. Soldering is a particularly important technique. You must also know how to produce circuits and circuit boards.

Tools

There are a number of cutting tools and other tools for working with electronic components. Knowing which tool to use in a particular situation will help you achieve the best results. Some of the components are small and you will need to practise with the tools to develop your manipulative skills.

FIGURE 11.6: Tools used for electronics technologies

(a) **Combination wire strippers and cutters:** Use to strip the outer cover of plastic insulation off wires and to cut connecting wires and components.

(b) **Tweezers:** Use to hold or pick up small components.

(c) **Pliers:** Use to hold small components and for twisting or bending wires.

(d) **Wire cutters:** Use to cut connecting wires and components.

(e) **Screwdrivers:** Use to alter or attach some components.

(f) **Long nose pliers:** Use to hold small components and for twisting or bending wires in difficult to reach places.

Joining techniques

There are two ways of joining connecting wires: mechanical fastening and soldering. In each case, strip the ends of the wires to be joined with wire strippers to make them conductive.

See pages 298–9 for information on mechanical fastening.

Soldering in electronics

Good *soldering technique* is essential for building circuits. Poor soldering can mean the circuit won't function at all or will cease working after a short time. The process of soldering is similar to gluing, but molten metal instead of adhesive is used to join wires or to attach components to a circuit board. Twisting the wires together before soldering makes a stronger connection. Use electrical tape to hold the wires in place and protect the soldered joint.

Safety

This type of joinery will need your teacher's supervision

FIGURE 11.7: **SOLDERING IRON:** Use to melt solder to attach components to the circuit board.

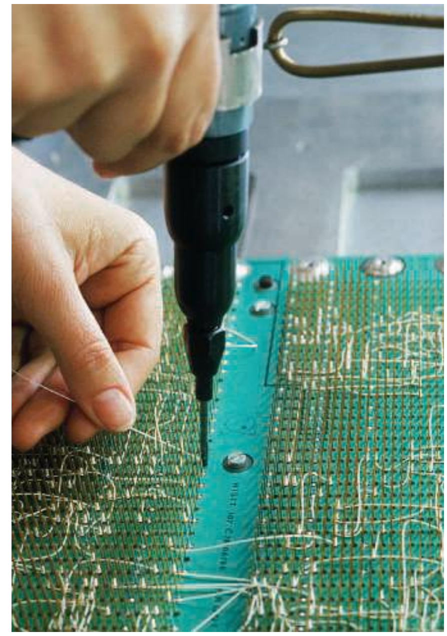


FIGURE 11.8: Soldering is a key joining skill in electronic projects.

Safety

Safe soldering

- Always wear personal protective equipment, such as an apron and eye goggles, when soldering.
- Always point a soldering iron towards the bench. Do not wave it around in the air.
- Remember that solder fumes can be dangerous and should not be inhaled.
- Soldering irons get extremely hot. Keep them in the soldering iron stand.
- Wash your hands thoroughly after using solder.
- Always report faulty equipment and accidents to your teacher.

Tip

The process of soldering will become easier with practice and increased confidence.

Soldering technique

1. Plug in the soldering iron and allow it to heat up.
2. Wipe the tip of the soldering iron on a damp sponge to clean it.
3. Cover (tin) the tip with solder by touching the solder and iron together.
4. Place the length of solder on one side of the component or wire to be joined. Touch the soldering iron on the other side of the component or wire for about a second. The molten solder will flow into the joint.
5. Remove the soldering iron and solder. The joint will cool and harden very quickly.
6. Inspect the joint after it is cooled. It should feel firm and be shiny in appearance.
7. Re-solder if necessary.

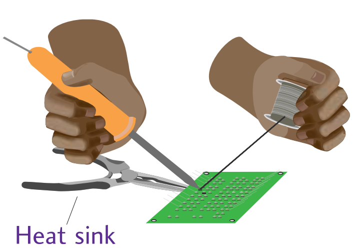


FIGURE 11.9: Heat sinks are used to protect components.

When soldering delicate components, such as LEDs, it is best to use a *heat sink* to take the heat away from the component. A pair of long nose pliers held on the component while soldering acts as a heat sink (see figure 11.9).

TABLE 11.2: Common faults in soldering

Fault	Reason	Remedy
Solder forms a ball	Not enough heat	Reheat and add more solder if needed
Joint looks cracked	Too much heat	Reheat after cooling and add more solder
Solder is bridging components where it isn't needed	Too much solder	Reheat and remove excess solder with soldering iron or solder sucker
Solder will not take to component	Wire or component is greasy or unclean	Clean area and re-try

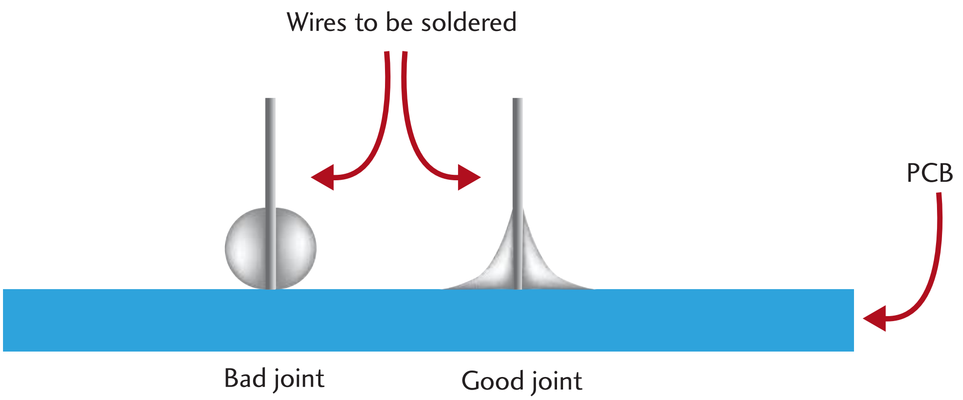


FIGURE 11.10: A badly soldered joint looks dull and forms a ball. A well-soldered joint looks shiny and holds firmly.

Switch on

1. Draw a flow chart of the soldering process.
2. Design a poster that shows how to use a soldering iron safely.
3. Describe a good soldering technique.
4. Design a simple organiser to hold electronic components and tools.

Prototyping in electronics

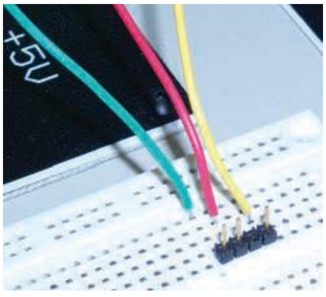


FIGURE 11.11: Breadboards are used for quick electronic prototyping.

When designing a circuit with a specific function, what works on paper doesn't always work in reality. This is because components can act differently when placed together in a circuit. You need to make a model (*prototype*) to test whether circuits will work. There are various ways to create a prototype of a circuit, some more basic than others.

In industry, prototypes can be produced by using a computer program that simulates the circuit's components in use. Improvements to the design can be made on screen, which saves time and money. In a school workshop, however, such computer programs are not always available or practical.

One of the most convenient ways to build a temporary circuit for testing or to try out an idea is to use a prototype board or *breadboard*. The surface of the board has many rows of tiny sockets. Strips of metal run underneath the board connecting the sockets. Components can be plugged into the sockets and a circuit can be formed using the metal strips, instead of wires, as conducting pathways. No soldering is required. Components can be changed or moved, giving a realistic simulation of how the circuit functions.

A hard plastic mesh called Veroboard can also be used for prototyping. The components and wires are soldered in place. Veroboard can be used in your project as your circuit board, although it can look messy and is not very strong.

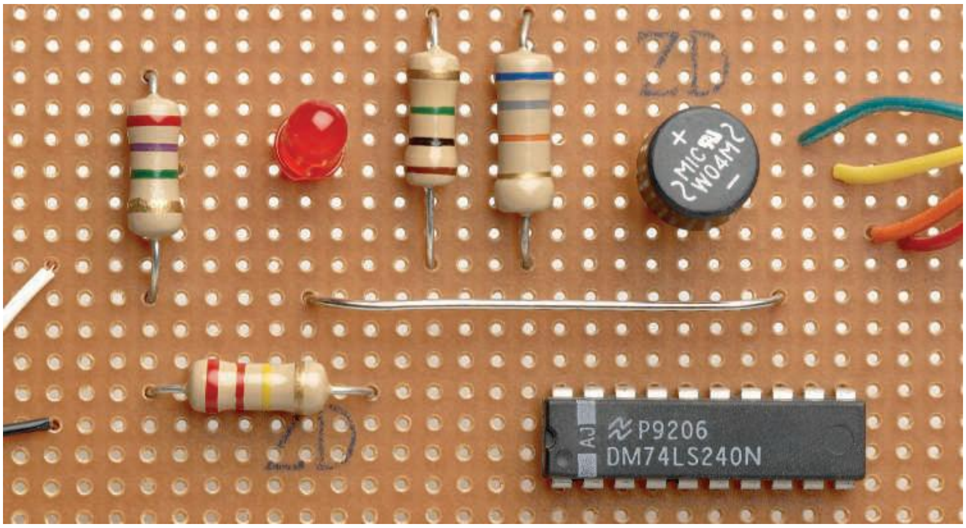


FIGURE 11.12: Veroboard is also used for electronic prototyping.

Building electric circuits

A *printed circuit board* (PCB) can be designed and manufactured from a final prototype. The board used for a PCB is a hard plastic sheet with a thin layer of copper covering it. The copper layer is photosensitive and is covered by a protective plastic layer. Acid is used to etch copper lines or pathways, which act as the connecting wires for the circuit. Holes are drilled at the positions where the components are to be placed in the circuit. The components are placed in these holes and soldered into position. Once a PCB has been designed, it can be reproduced time and time again.

The skill of designing a PCB is in using the available space on the board. These boards can become very complex, with some boards even becoming double-sided for maximum use of space.

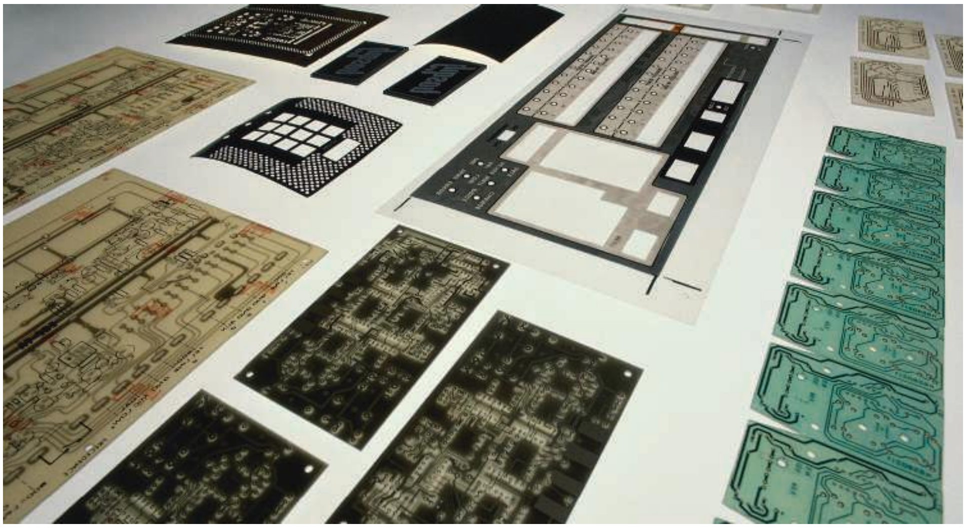


FIGURE 11.13: Printed circuit boards (PCBs)

Tip
PCBs can be printed on both sides to maximise the use of space.

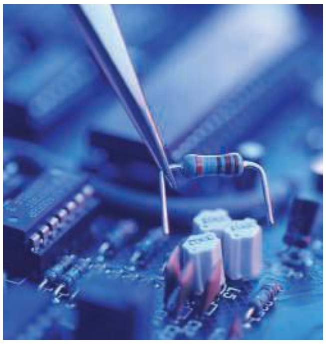


FIGURE 11.14: Using tweezers to position a resistor on a PCB

Look at chapter 12, page 313, for information on fault finding.

Manufacturing a PCB

Step 1: Design the PCB on paper, using a prototype board as a model. Carefully draw this design onto thin clear plastic (overhead projector sheets), using a permanent marker. Rub-on transfers or a printout from a computer program can also be used. This is called the PCB mask.
Step 2: Cut the new PCB board to the required size and remove the protective backing from the photosensitive layer.
Step 3: Place the PCB mask on the photosensitive layer. Put both in an ultraviolet light box. Areas covered by the PCB mask are not exposed to the UV rays, thus transferring the mask design onto the PCB.
Step 4: Place the exposed board in a developing solution to fix the design onto the board.
Step 5: Rinse the PCB in water.
Step 6: Place the PCB in an etching tank. The tank contains a concentrated acid solution that eats away the exposed copper, leaving only the required copper pathways.
Step 7: Rinse the PCB again in water. The copper pathways are now clearly visible.
Step 8: Place the PCB in a zinc bath to coat the pathways and protect them from damage.
Step 9: Rinse the PCB in water a third time.
Step 10: Drill holes for components using a small PCB drill.
Step 11: Position the components and solder them into place.
Step 12: Test the PCB. Use a fault-finding system to identify problems.

PCB manufacturing safety

Safety

- Never look directly into the UV light box. It will damage your eyes.
- Always wear personal protective equipment when using chemicals.
- The acid solution can be extremely dangerous. Take care when using it.
- When finished, wash all equipment and your hands.

Switch on

1. Draw a flow chart of the PCB process.
2. List the safety rules you should observe when manufacturing a PCB.
3. Go to www.jaconline.com.au/switchedontech and click on the PCB Design weblink to access links to a range of free PCB design and circuit simulation software.

11.3 Electronics technologies at work

Industrial production methods

All processes carried out in the classroom apply to industry but they occur on a much larger scale. Some industrial machines would take up the whole space of your classroom.

Four common processes are used when manufacturing electronics.

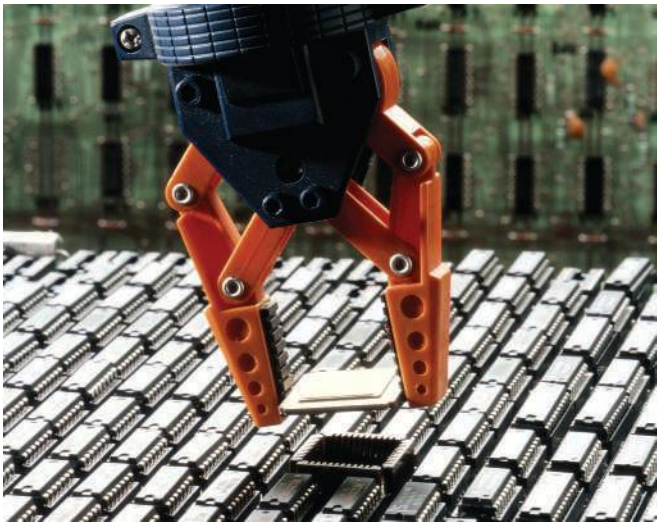
1. Design and manufacture of PCBs by computer. Computer-aided design (CAD) is used to determine the best way to place components. CAD ensures that every available space is used in the most cost-effective way. Unused space would make the overall product bigger than it needs to be.
2. Sorting and placing components. As electronic components are becoming smaller, workers are finding them increasingly difficult to sort and place in a PCB. Automated systems can do this quicker and more precisely than people. Automated systems can also work around the clock.
3. Automated wave soldering. Instead of soldering components one by one, components can be soldered in one motion. PCBs with placed components are held just above a bath of molten solder. A wave in the bath is created, which coats the components' wires. As the wave passes, the joints cool.
4. Quality control and assurance. The quality of electronics is checked to ensure overall solder quality and PCB functioning. This is much quicker and more reliable than checking by human eye.

Technobite

One of the first computers ever made was kept in Manchester, UK. It was the size of an entire room, capable only of adding simple figures.

FIGURE 11.15: Industrial applications

(a) Computer-aided design in electronics



(b) A robot placing a chip in a circuit board

Spotlight 1 Bright idea:

A new class of sensors fashioned from LEDs

Already glowing away on thousands of consumer electronics products, the light-emitting diode (LED) is proving to be a remarkably versatile material.

The same technology behind the glowing lights reminding people to turn off VCRs and stereos is being applied to new treatments for hard-to-heal wounds and new super-efficient traffic lights. Now a group of scientists at the University of Wisconsin-Madison have shed light on a valuable new use for LEDs by demonstrating their usefulness as chemical sensors. The resulting light change can be put to use in simple, highly sensitive systems that warn of chemicals in the air or water.

FIGURE 11.16: Lettuces growing under red light-emitting diodes (LEDs) at a vegetable factory in Japan. The lettuces grow three to four times faster than the same species grown outdoors.

The finding may have a big impact on the national campaign to develop 'laboratories on a chip' by offering an accurate, inexpensive and mass-producible method to integrate sensors on to computer chips. They could be used at work and home in safety systems used to detect smoke, radon or carbon monoxide. They are also used to monitor air and water pollution, both indoors and outdoors, and monitor problems in car engine performance.

One ultimate goal of the 'lab on a chip' research effort is to create a real-time response to environmental dangers, whether it be a chemical spill in a river or the threat of chemical warfare or bioterrorism. The current technology is nowhere near meeting that challenge, but industry has shown early interest in the technology. In the next step, researchers will try to better understand the basic chemical reactions that are taking place on the surface of LEDs in order to optimise the process.

Source: Adapted from an article by the University of Wisconsin-Madison in *Science Daily*, 28 February 2001.

Spotlight review

1. If sensors like these could be used to detect smoke, pollution and problems in car engines, suggest some other products that could be improved with this kind of technology.
2. How could environmental pollution detection benefit from this technology?
3. Design a handheld product that could be used by asthmatics to detect high levels of pollution.

FIGURE 11.17: This is the Japanese 'Q-car 7' — a one-seat electric vehicle. A new TAU battery may accelerate the development of more economical and efficient electric cars.

Spotlight 2 New non-toxic, environmentally friendly electric car battey gives electric-powered car a boost

The economic, environmental and health benefits of practical, electric-powered cars can be enormous. However, the lack of suitable light, efficient, cost-effective rechargeable batteries has limited most efforts to date.

Using a radical new design, a team of scientists from Tel Aviv University (TAU) have developed rechargeable batteries, thinner than a razor blade, which work well at temperatures not much hotter than a cup of coffee. Sheets of these batteries can be stacked or rolled, so their combined voltage will deliver considerable power output. For example, a 2 cm stack of 135 such thin batteries, each 0.15 mm thick, could deliver high power at 200 volts.

The TAU battery's materials are non-toxic, environmentally friendly and inexpensive.

On the basis of their data, the researchers expect that a practical electric car version should be feasible.

Technobite

A recent study has shown that 10–15 per cent of all household power is consumed by devices, such as TVs, being left in 'standby' mode.

Spotlight review

1. What are the benefits of battery-powered vehicles?
2. Why is it important that the battery is light in weight?
3. What other products that currently run off an engine or mains electricity could be improved by this sort of technology?

Switch on

1. What do you think are the positive and negative effects of electronics being mass-produced by computers? How might this affect a local community?
2. What are your ideas about electronics production in the future? Do you think it will continue to develop?
3. Complete your own case study. Choose a professional person such as an engineer, nurse, doctor, dentist, vet, teacher, accountant or lawyer and prepare a questionnaire with 10 questions about why electronics are important in their area of work. Present your findings about the importance of electronics to the class.

See chapter 2, pages 36–7, for more information on how to prepare a questionnaire.

11.4 Design process

Design project

Your design project for electronics technologies is to make an electronic skill tester.

Area of study: Products. The focus of this area of study is on objects, systems and artifacts.

Design specialisation: Industrial design. Industrial designers create products such as toys, mechanisms, furniture, leisure products and production systems.

Design situation

An electronic skill tester is a simple, but effective, electronic puzzle — sometimes known as a *steady hand game* or a *wacky wire game* — and is fun to try out on friends and family, young and old. The aim is to pass a small steel hoop around a steel wire course without setting off a buzzer. The basic principle is straightforward but, like any design project, *how* you implement this idea in your own design is the creative part. By adding a specific theme to the project, you can customise each part of the product. Your choice of target market will determine the complexity of the skill tester.

FIGURE 11.18: Wacky wire game 1: A game for patient players — the aim is to move a wand up the twisting, coiling wire without touching it.

Design brief

Design and construct an electronic skill tester for a specific hobby or personal interest and decide on a target market. For this task, you must choose the theme first, then design the electronic skill tester to suit that target market. Along with the electronic components, you are to use plywood, perspex, steel wire, wooden dowel and washers and nuts. The design brief describes and summarises the product you will design and make, but the look of the electronic skill tester is up to you.

Project materials:

- electronic components
  - 9 volt (V) battery
  - battery clip
  - buzzer
  - electrical wire
- 3 sheets of 12 mm plywood, 250 mm × 250 mm
- 1 sheet of perspex, 250 mm × 250 mm
- steel wire, 3 mm diameter
- wooden dowel, 25 mm diameter
- washers and nuts, 3 mm thread.

Look again at the design process in chapter 2, pages 20–1.

Designing and making your electronic skill tester will involve several stages. Be flexible in your approach to this design process. The order of the steps is not set in concrete and you may not always follow them in the sequence presented here. Some steps go hand in hand with others throughout the design project. Other steps need to be completed before you can move on. You should concentrate on using the combined steps to form a process that guides the development of your design.

Design Folio **Production**

Your design folio is an important communication tool for design projects. It should tell the story of your design project's development, from your first rough ideas on paper to the final evaluation of your design brief solution.

Consider composing your design folio in electronic format for this technology.

Design process: ONGOING EVALUATION

Essential for success

Remember that ongoing evaluation is central to the design process and should occur at every step. Regular evaluation helps to identify problems and challenges at the right time for you to deal with them. Putting evaluation off until later is asking for trouble, for example:

- wasted resources
- lost time
- failure to meet deadlines
- increased costs.

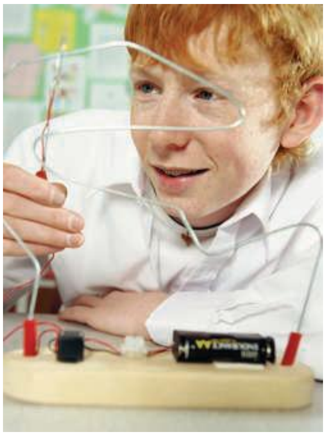


FIGURE 11.19: Wacky wire game 2: A buzzer sounds if the wand touches the wire.

Design process: ANALYSIS

Analysing the design situation

When you answer the following questions, you have already started to research and create design ideas. These analysis questions could help you plan your electronic skill tester's theme, placement, size, shape and design.

1. Who is the intended user of this electronic skill tester?
2. What hobby or interest would make a good theme? What visual images could be developed from this theme?
3. Can these ideas be made into simple outline shapes for the base and wire designs in the electronic skill tester?
4. How could you add colour and interest to the plywood base?
5. Which tools could you use to cut and finish each material?
6. What are the weight, shape and size of the electronic skill tester?
7. How will you fit in the electronics components? Which ones need to be seen from the outside?
8. How can you change the battery?

Switch on

Analysing the design brief

Design briefs contain specific information and instructions. When starting with a design brief, it's a good idea to write the brief in your design folio then underline, highlight or circle the words that give you specific information or instructions as indicated. The design brief describes and summarises the product you will design and make, but the look of the electronic skill tester is up to you.

Design and construct an electronic skill tester for a specific hobby or personal interest and decide on a target market. For this task, you must choose the theme first, then design the electronic skill tester to suit that target market. Along with the electronic components, you are to use plywood, perspex, steel wire, wooden dowel and washers and nuts.

Project materials:

- electronic components
  - 9 volt (V) battery
  - battery clip
  - buzzer
  - electrical wire
- 3 sheets of 12 mm plywood, 250 mm × 250 mm
- 1 sheet of perspex, 250 mm × 250 mm
- steel wire, 3 mm diameter
- wooden dowel, 25 mm diameter
- washers and nuts, 3 mm thread.

Think about the main points and the keywords and ask what, where, why, how and when. Record your analysis ideas in your design folio.

Technobite

Electronics are now used to create artificial intelligence, taking the place of human intelligence. This artificial intelligence can think and react in a similar way to a human, for example, move and pick up an object.

Limitations to the design brief

Think about the resources you have available. Resources could include:

- *Time:* When does the project need to be completed?
- *Function:* What are the purpose and main features of the project?
- *Aesthetics:* What does the project need to look like?
- *Cost:* Do you have enough money to complete the project?
- *Materials and tools:* What materials and tools are required? Are they available at school?
- *Expertise:* Do you have the skills required to complete the project?
- *Environmental considerations:* Will any production waste harm the environment?
- *Safety rules and regulations:* Will the product be safe? Will it meet all legislative requirements?

In your design folio, list the factors that will limit you when making the skill tester. What is going to be the biggest limitation that you will need to overcome? Why?

Criteria for success

Criteria to evaluate success spell out exactly what the design must achieve, while taking into account the design limits that could affect the final solution. For example, the product must:

1. be designed for a hobby or personal interest theme
2. be challenging enough for the target market (also see research)
3. include the given non-electronic components: plywood, perspex, steel wire, wooden dowel and washers and nuts.

Think of another five criteria. Write your criteria and the ones above in your design folio.

Design process: MANAGEMENT

Getting organised

Management must be considered alongside other steps throughout your project. It needs constant reviewing as you progress with your work.

- Develop action-management, time-management and budget-management plans.
- Evaluate and justify any changes to management plans, outlining impacts on the design project's development. This will mean re-evaluating your management plans regularly during the making of your design project.
- Plan and manage available resources effectively and efficiently.
- Evaluate the appropriateness of available resources as they relate to your design brief and developed criteria for success.

Design process: RESEARCH

Hitting the target

The success or failure of a game of skill often has to do with how well the game matches the abilities of the age group for which it is designed.

Many toys for pre-school children are designed to develop their hand–eye coordination and young children love bright playthings that buzz and/or light up. Don't forget to investigate other things pre-school children play with, if your project is going to be simple enough for them.

A more advanced skill tester will certainly amuse as well as try the patience of an adult.

Switch on

1. *Market:* Research your market in books, catalogues, brochures, junk mail, libraries, shops and on the Internet to find out about electronic skill testers (steady hand or wacky wire games). Complete two A4 pages of market research.
2. *Materials:* Find out as much as you can about the materials and components that you have been given and any other materials you can use with this project. For example, write an A4 page on plywood and its properties, the use of electronic components (switches, batteries, LED, motors) and so on.
3. *Tools:* Research the tools that could be used to make the electronic skill tester. You will need tools to cut, shape, bend, join and finish the available materials.
4. *Techniques:* Research the techniques for making an electronic skill tester. How are electronic components joined? How are threads made on steel wire?

Design process: IDEAS GENERATION

Brainstorming

Use brainstorming techniques to begin generating a range of ideas for the electronic skill tester. Begin with the heading *Hobbies and interests* and write your ideas around it. From these words, create simple outline images that are associated with the theme.

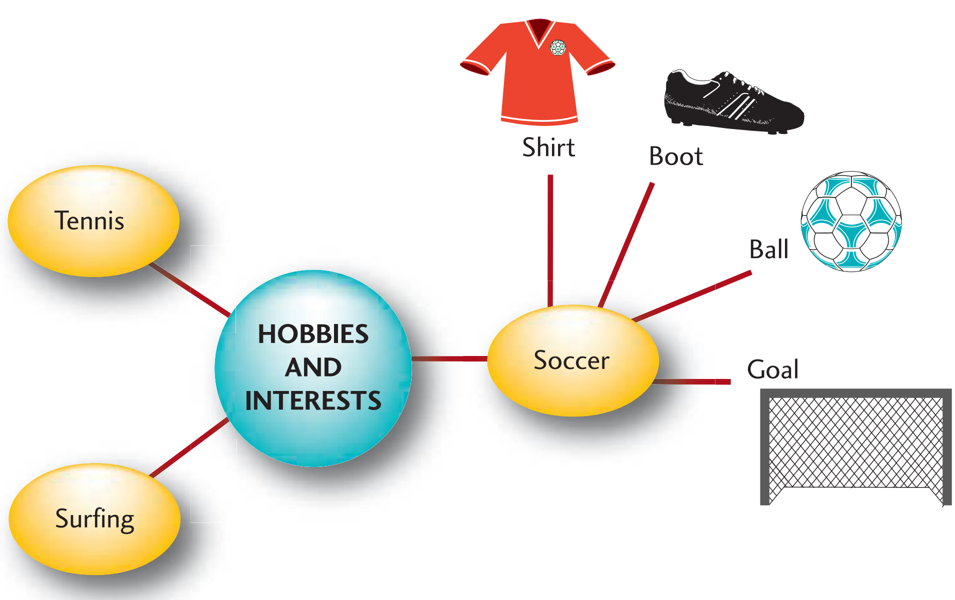


FIGURE 11.20: Use mind mapping in your brainstorming session.

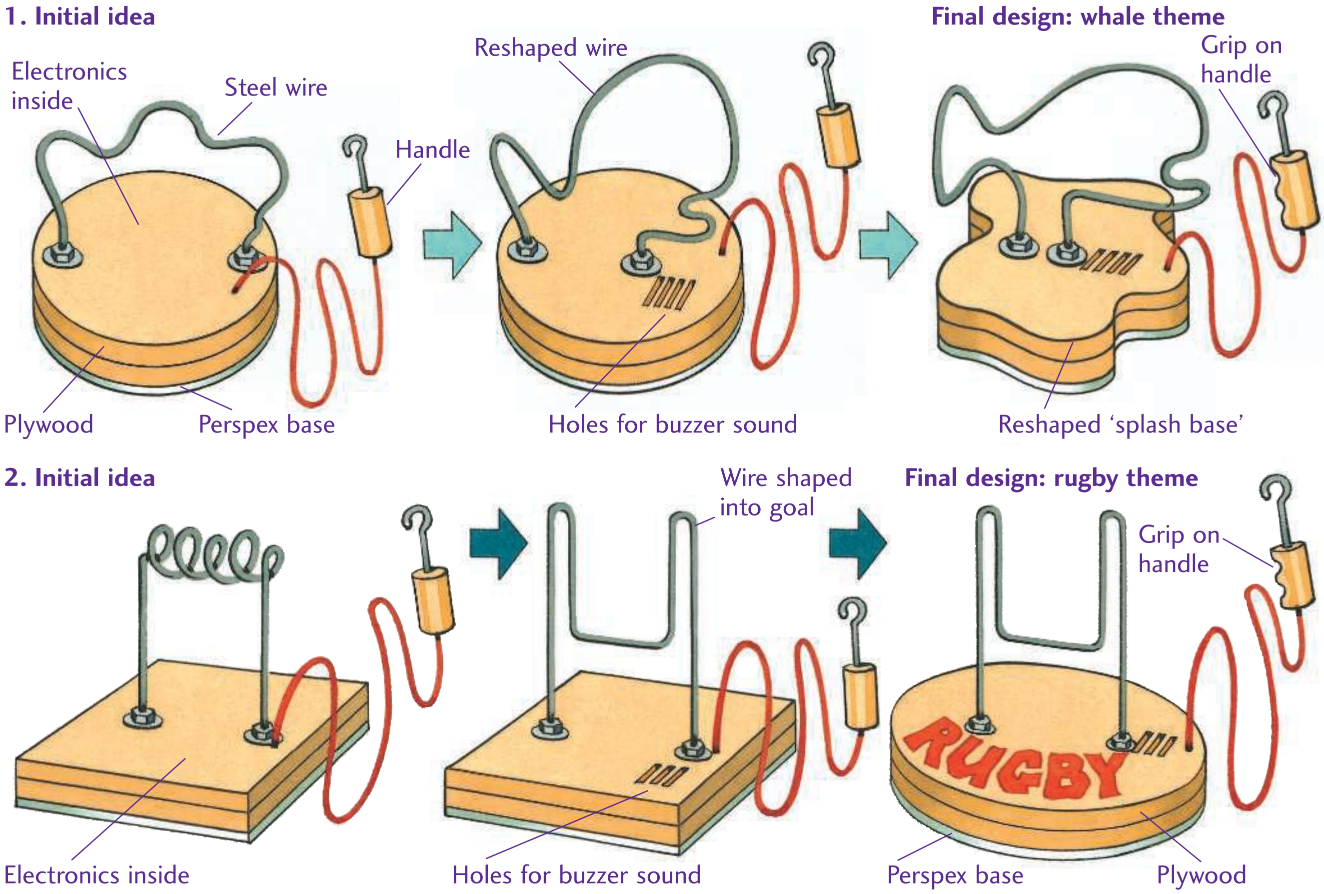


FIGURE 11.21: Ideas for electronic skill testers

Preliminary sketches and plans for the solution

This section of the design process requires you to develop ideas in a graphic form. Draw six thumbnail sketches showing shape, style and colour for the base, wire and handle of the electronic skill tester. Think about materials, tools and techniques for all the designs. After you have finished, choose your three favourite designs. Label these designs with materials, tools and techniques.

Review your time plan for completing your project.

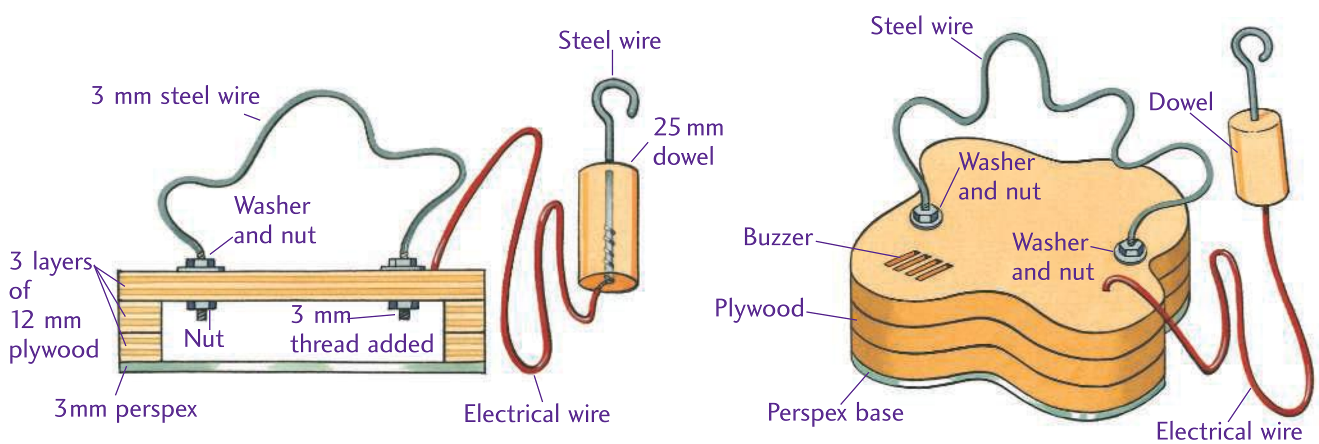


FIGURE 11.22: Electronic skill tester labelled with materials

Switch on

In your design folio, complete a cutting list for your electronic skill tester using table 11.3 as a guide.

TABLE 11.3: Sample cutting list for an electronic skill tester

No of parts	Material	Width × length × thickness	Hardware/decoration
3	Plywood	250 mm × 250 mm × 12 mm	Washers and nuts (3 mm)
1	Perspex	250 mm × 250 mm × 3 mm	9 V battery
1	Dowel	25 mm × 60 mm	Battery clip
1	Steel wire	400 mm (length) × 3 mm	Buzzer
			Electrical wire

An exploded drawing shows how the different components go together. They are often used to show how a system is put together (see figure 11.23).

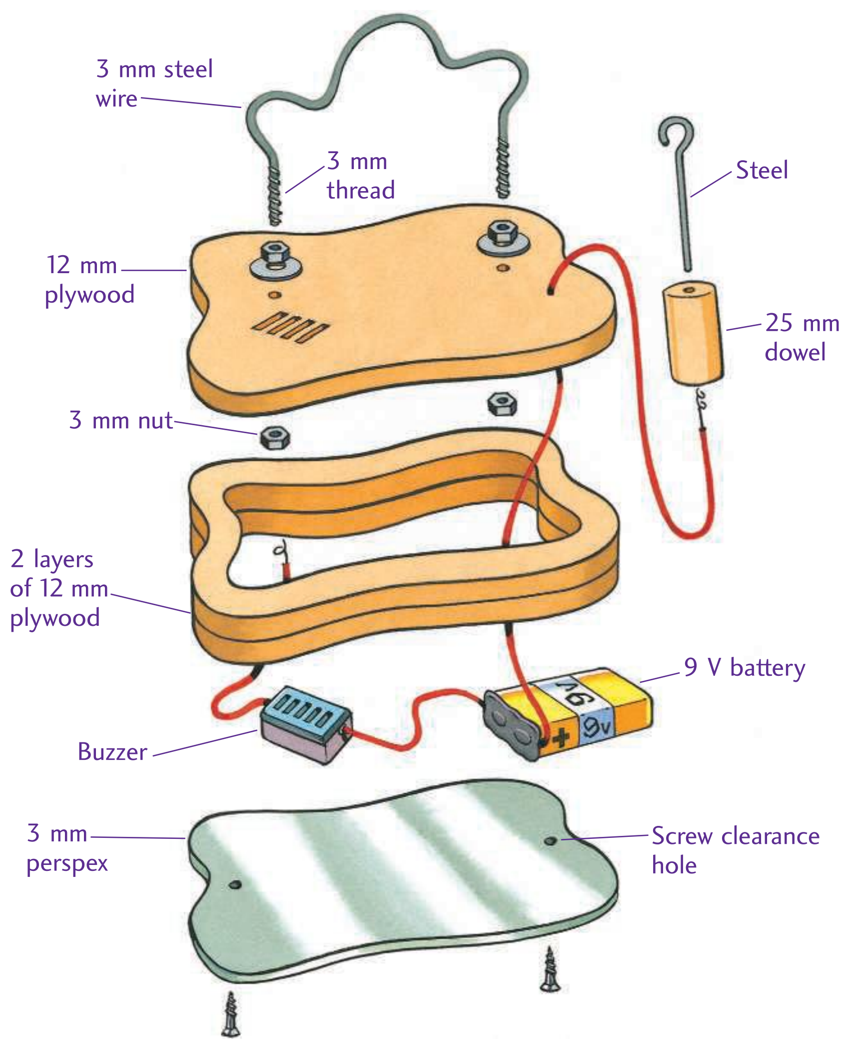


FIGURE 11.23: Exploded view of the skill tester

See chapter 2, pages 44–6.

Design process: COMMUNICATION

Final sketches and working drawings

When designing the electronic skill tester, produce concept sketches and working drawings. These will help you to plan in your mind and on paper what the electronic skill tester will look like and to identify any problems that may arise. Often an excellent design idea cannot be made due to unavailable resources or because the electronic systems don't function as required.

Oral/aural presentation

Devise a radio advertisement for your skill tester complete with punchy text, sound effects and music.

Present your advertisement to the class and listen to the ads made by other class members. Apart from your own product, select three products that appeal to you. Do you think you will make any changes to your product now that you have heard others' ideas?

See the information on model making and digital communication in chapter 2, pages 46–7.

Design process: EXPERIMENTATION AND TESTING

Construct a prototype

When designing and making your project, it helps if you construct a model to let you see what your electronic skill tester will look like. This could be done by hand on paper or on computer in a computer-aided design (CAD) or paint program.

When experimenting and testing, you need to:

- test material properties (refer to 11.1 Materials)
- test construction techniques (refer to 11.2 Tools and techniques).

Look again at the rules for basic safety in chapter 2, pages 51–5.

Design process: SAFETY AND RISK MANAGEMENT

Some safety rules that apply specifically to electronics technology are stated in this chapter in the places where they are most applicable. Observe them!

Design process: PRODUCTION

Making the product

This project uses a basic switch circuit, where the output, in this case sound, is produced when the circuit is *made*. A *break* in the circuit stops the sound. A *printed circuit board* (PCB) is not required for this project.

The aim of the skill tester is to pass a steel hoop around a winding course without letting the hoop touch the course. You need a steady hand for this. When the steel hoop touches the course it *makes* the circuit and sounds the buzzer.

You should label your working drawings with materials, tools and techniques. When you are making your product, make sure that you are working to your time plan.

To make your electronic skill tester you will need to use different types of materials specified in the design brief, several specific tools and techniques for working with electronic components (see pages 277–86) and some general tools and techniques that are described on the following pages.

COPING SAW: See chapter 3, pages 73–4.
SCROLL-SAW: See chapter 3, page 79.
WIRE CUTTERS: See page 282.

Cutting tools

COPING SAW: Use this hand tool and the template to cut the plywood and perspex into shape. It can also cut holes and curves and cut dowel.
SCROLL-SAW: Use to cut curved and straight lines.
WIRE CUTTERS: Use wire cutters like scissors to cut thicker steel wire. The steel wire can be bent into shape with your hands or with pliers.
DIE: Once bent into shape, you need to cut a thread at both ends of the steel wire to allow two nuts to be fastened on. You use a die to do this.

- Place the end of the steel wire pointing upward in a vice.
- Holding the 3 mm die in its holder on the end of the wire, add slight pressure and begin to turn in a clockwise motion.
- After three turns clockwise, do half a turn back to help remove waste. The thread should be made to about 30 mm in length.

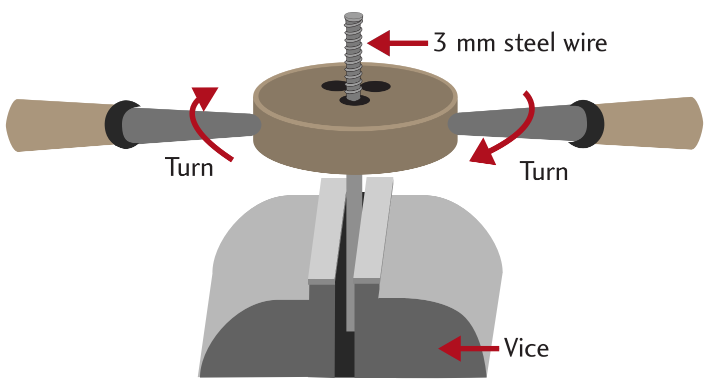


FIGURE 11.24: Making the thread on the steel wire

CORDLESS DRILL: See chapter 3, page 76.

CORDLESS DRILL: Once cut to size, the wooden dowel needs a hole drilled through the centre of it to take the steel wire handle. Use a cordless drill to do this, holding the dowel in a vice.

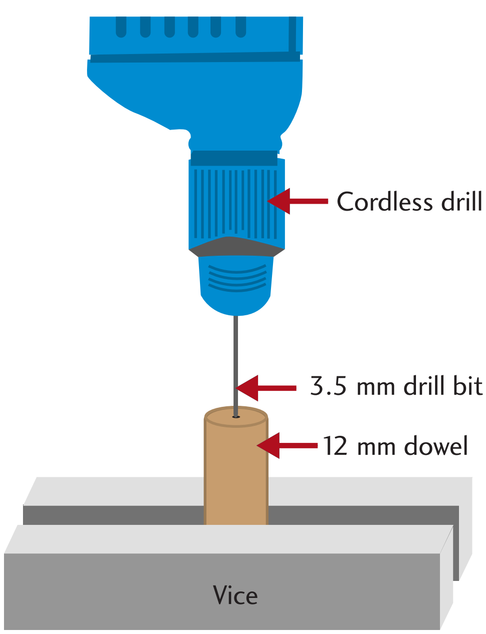


FIGURE 11.25: Drilling the dowel handle in a wood vice

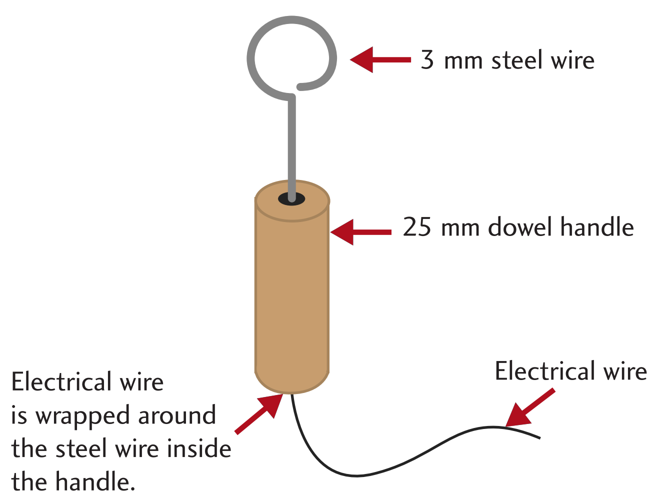


FIGURE 11.26: Completed handle

See also chapter 3, pages 77–9 and chapter 5, pages 121–3.

Finishing tools

When the base for the electronic skill tester has been cut out and all the parts are ready, you must finish the edges before you go on. Follow these easy steps:

Filing: Use a square, half round, flat or round fine file for smoothing and finishing. Place the perspex in a vice and pull the file towards you in a firm sweeping movement at 45˚ to the perspex.

Abrasive paper: To remove the scratches after filing, start with a coarse abrasive paper and finish with a fine abrasive paper.

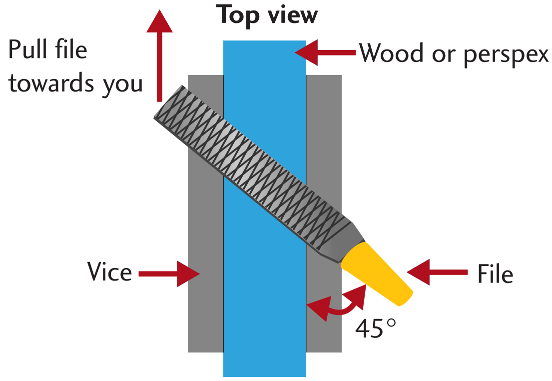


FIGURE 11.27: Hold the file at an angle of 45˚ to the material being filed.

Joining methods

There are two ways to join woods, plastics and metals together: mechanical fastening with screws and nuts, or gluing with adhesives.

TABLE 11.4: Joining methods for different materials

Project parts to be joined	Method of joining
Layers of plywood for base	PVA (polyvinyl acetate) glue
Perspex to plywood base	Small screws (drill clearance holes for the screws through the perspex to avoid cracking)
Steel wire to plywood base	3 mm nuts lock the wire in place through a drilled hole
Steel wire to wooden dowel handle	The wire is pushed into the hole in the dowel handle

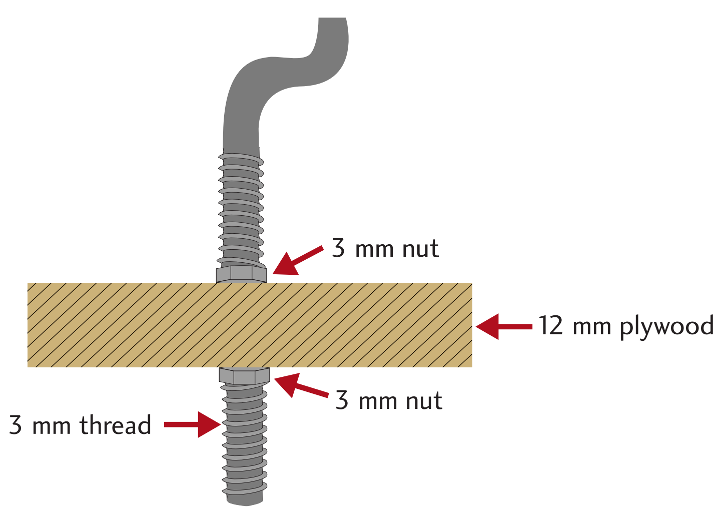


FIGURE 11.28: The two nuts on either side of the base are tightened against each other.

Safety

Observe the following safety rules.

- Extreme care should be taken when dealing with solvents and adhesives.
- Wash your hands after using PVA glue.
- When putting in screws, make sure the work is securely held in a vice.

Some ways of joining the other components are outlined in table 11.5.

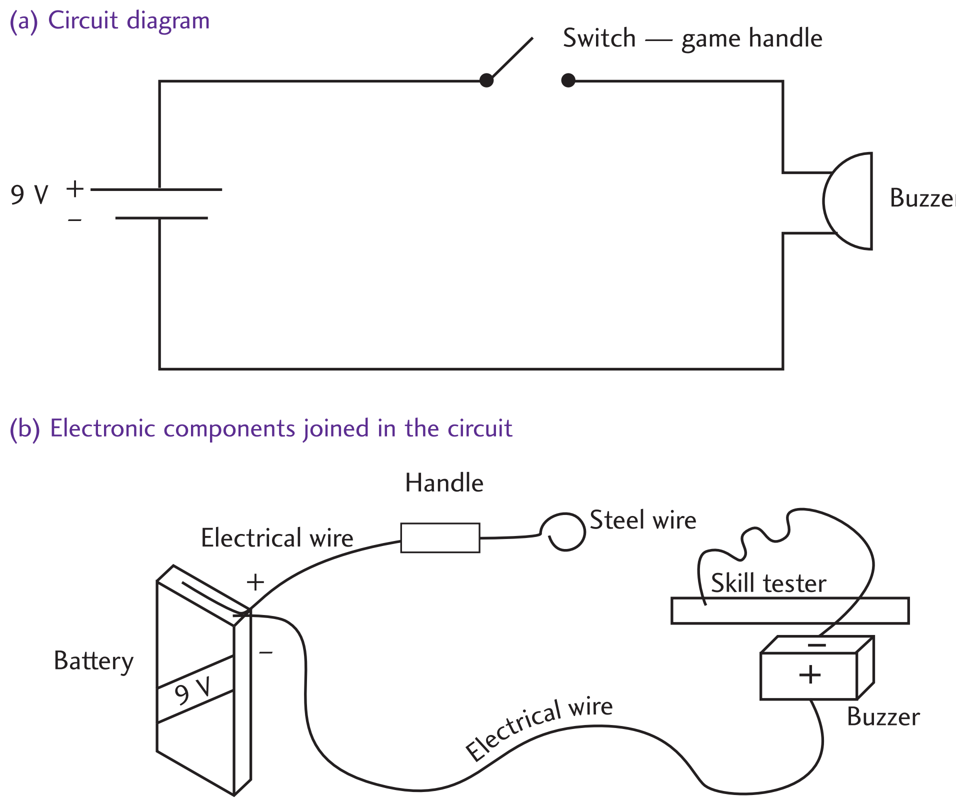


FIGURE 11.29: Joining components

TABLE 11.5: Joining methods for other components

Components to be joined	Method of joining
Steel wire to electrical wire	Wrap electrical wire around steel wire and secure in place with electrical tape or glue.
Electrical wire to battery clip	Connect two ends by twisting, then solder together. Cover with electrical tape.
Battery clip to buzzer	Connect two ends by twisting then solder together. Cover with electrical tape.
Buzzer to skill tester base	Loosen the nut inside the skill tester, wrap around the positive buzzer wire and tighten up the nut.

See pages 282–4 for information on soldering.

Switch on

1. Investigate other simple, electronic, puzzle-type games. Identify the inputs and outputs.
2. Design an advertisement for your skill tester.
3. How could you package your skill tester?

FIGURE 11.30: Completed electronic skill tester

4. Investigate other types of mechanical fastenings. Which could be used on the project and where?
5. How else could you develop the function and look of your skill tester? Explain how you would attempt one of the following ideas:
   (a) On/off switch for a game. This can be connected to the positive (red) battery clip. It connects or cuts the power to the circuit.
   (b) Light-emitting diode (LED) indicator. This can be used instead of or as well as the buzzer to indicate a connection. If the LED is placed after the buzzer in the circuit (in series), no resistor is required. If an LED only is used, a 330 ohms resistor must be placed before it to protect it from too much current.
   (c) Motor. Instead of an additional sound output, the motor itself could be used as the single output component. For example, a ribbon could be attached to the motor so that the ribbon spins when the motor is activated.

Design process: FINAL EVALUATION

Test the product

Evaluate your product several times during the production process. When it is finished, you are ready for the final evaluation. This means making sure that the electronic skill tester works, the tester is challenging to the user and the battery can be changed easily.

Professional, peer and self-evaluations

Ask your teacher and your classmates for objective evaluations of your skill tester. Then self-evaluate your project by asking the following questions:

1. Does the skill tester keep the user interested and challenged?
2. Did you like this unit of work? Why or why not?
3. If you were to make your electronic skill tester again, what changes would you make?
4. Is the design safe to use?
5. Did you use the most appropriate theme?

Design process checklist

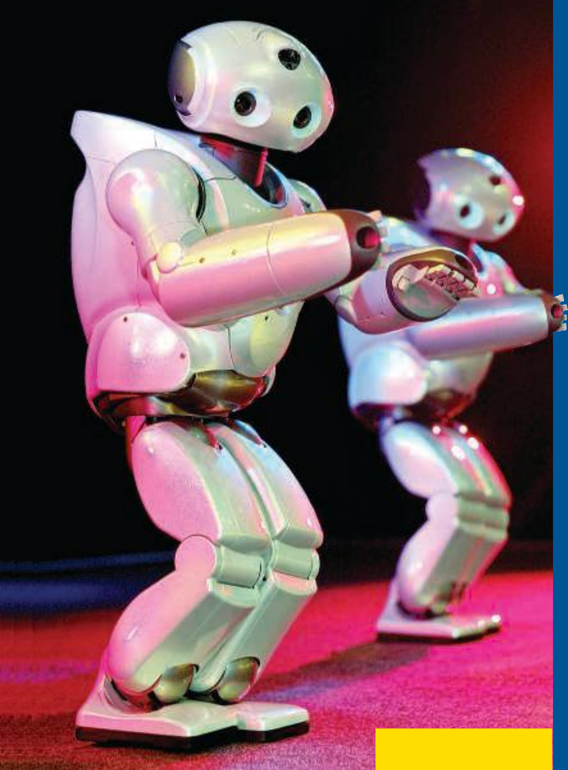
ONLINE RESOURCE BANK

Go to the Online Resource Bank at www.jaconline.com.au/switchedontech and click on the Design Process Checklist. Use the checklist questions to self-evaluate your project and to help you finalise your design folio.

You can also find more ideas for design projects at the Online Resource Bank.

CHAPTER Twelve

Control technologies



How does the air-conditioning unit in your school or home know when to turn on or off? Why does the alarm activate when a car is being stolen? How do automatic gearing systems in cars know when to change gear? The logical reason for these events and many more is found in control technologies.

Control technologies are suitable for making projects in any of the three areas of study: Built Environments, Products, or Information and Communications. This chapter provides detailed information to help you design and make your own moisture sensor, but before you can start, you need to know about the materials, tools and techniques used in control technologies.

Read chapter 11 on electronics technologies before beginning this chapter. Like electronics technologies, control technologies involve systems. The study of these systems helps you to understand control technologies.

Focus

By the end of this chapter you will be able to:

- identify and select appropriate data for use in a design project
- recognise, connect and use input and output devices to construct systems including sensors, switches, wiring, lights and motors for a design project
- select and correctly use tools appropriate for the construction, maintenance and management of systems for a design project
- connect interdependent devices for the purposes of a design solution
- troubleshoot problems with systems
- test function of solutions for a design project.

Switch on

1. Recall the contact you have had with automatic systems or computers today. Share your list with the class.
2. Find some images of computer-aided manufacturing in industry.
3. Draw a flow chart of the steps of a simple process, such as putting on your socks and shoes, or cleaning your teeth.

Technobite

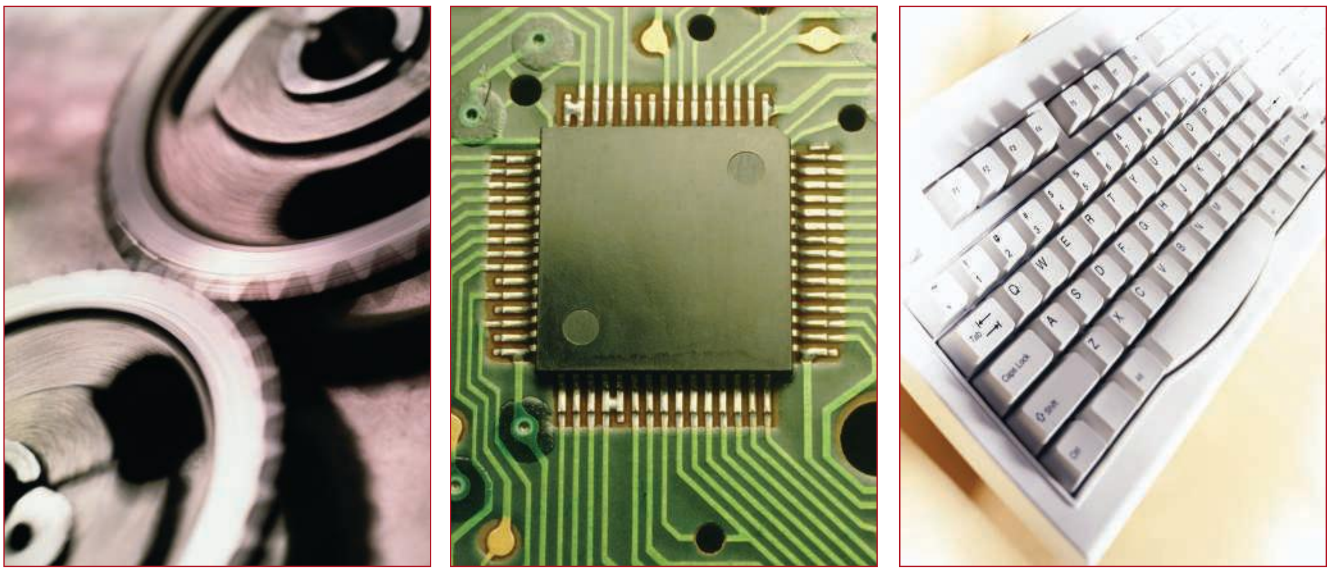
When this millennium began, people feared that the moment 1999 became 2000, huge shutdowns in computer control systems would occur caused by the 'millennium bug' (also known as the 'Y2K computer bug'). In fact, there was far less trouble than 'experts' predicted. Planes did not fall from the sky, lifts in tall buildings did not drop from top floor to basement, and data banks of government records were not destroyed.

12.1 Materials

See chapter 11, pages 277–8.

A system is a series of steps in the correct order that give a required response. An electronic system has an input, a control and an output. Without the control element, the system would fail. The control links the input to the output, telling the output what to do. This is not only true for electronic systems, but also for computer systems, mechanical systems, pneumatic systems and hydraulic systems.

FIGURE 12.1: Control technologies in everyday life



(a) Mechanical control (b) Electronic control (c) Computer control

Technobite

Pneumatic (air-powered) systems are used in pit lanes in motor sports because of the much lower risk of producing sparks, which are a potential fire hazard when combined with engine fuels.

Control technologies in electronic systems

Unlike an electronic device that has to be switched on by hand, the control element in an *automated system* senses a change and responds to it without human intervention. Changes in temperature, movement, sound, humidity, radiation and infra-red light can all be picked up by certain components within an automated system.

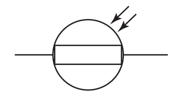
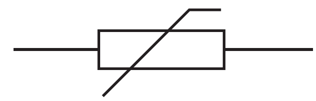
Input components

The input components in an automated electronic system often consist of *sensors*, such as moisture sensors, movement sensors, light sensors and temperature sensors. A sensor is any device that produces or alters a signal when it detects a change in its environment. Table 12.1 shows some common input sensors.

For example, in a sensor that uses a resistor that is sensitive to light, the resistance is low when there is abundant light. When the light level drops, lack of light creates high resistance in the light-dependent resistor (LDR).

A thermistor set up to detect a cooler temperature has high resistance in warm temperatures. As soon as the temperature cools, the resistance in the thermistor drops, creating a low resistance.

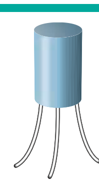
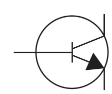
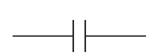
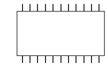
TABLE 12.1: Input sensors

Input sensor	Use	Appearance	Circuit symbol
Light-dependent resistor (LDR)	Detects changes in light levels. Used in some security systems, night-lights and streetlights.		
Thermistor	Detects changes in temperature. Used in thermostats to control heating and cooling devices: refrigerators and some air-conditioning units.		
Moisture sensor	Detects changes in water and moisture levels. Used in automated watering systems.		

Control components

The control component detects the change in resistance and then activates the output component. Several different components can be linked up to give a variety of responses. Table 12.2 shows the main control components.

TABLE 12.2: Control components

Control component	Appearance	Circuit symbol
Transistor		
Capacitor		
Microchip		

Transistors

Transistors are used as amplifiers (to increase the strength of electric currents) and as switches (to turn electric currents on and off). This makes them useful in all sorts of devices, from radios to computers. The microprocessor chip or CPU found in home computers has over a million transistors packed into a few square centimetres.

A single transistor has three legs: the base, emitter and collector. A small current going into the base is used to control the much larger current that enters the collector and leaves through the emitter. There are no moving parts and the change in the output current at the emitter can occur almost instantly.

When used as an amplifier, a small change in the current at the base produces a much larger change in the current flowing from the collector to the emitter. In a radio this effect turns a weak signal from an antenna into a signal strong enough to power a set of speakers.

When used as a switch, a weak current or no current at the base will block the current from the collector — thus turning the transistor off. A stronger current at the base will let the current flow from the collector to the emitter — thus turning the transistor on. In a computer LCD display, this effect is used to control the colour of the individual screen 'dots' or pixels.

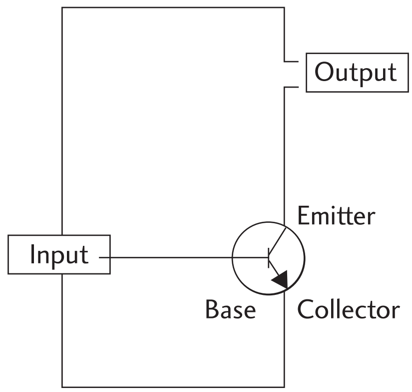


FIGURE 12.2: Transistor in a circuit

In an automated electronic system that detects moisture, water probes could be used as the input sensor, a transistor could be used as the control component and a buzzer could function as the output.

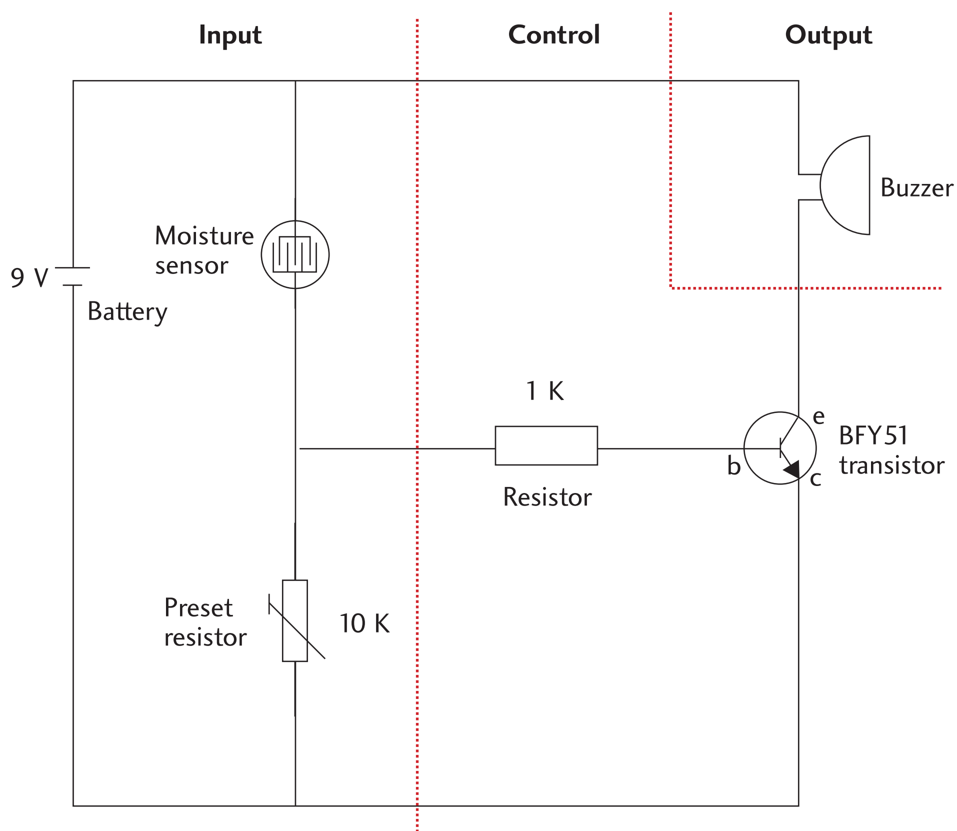


FIGURE 12.3: A moisture sensor circuit

Techno**bite**

Konrad Zuse, a German engineer, completed the first general-purpose programmable calculator in 1941.

When the moisture sensor is dry, it has a very high resistance. So very little current will flow through the sensor to reach the base connection of the transistor. The low base current will switch the transistor off. The only other path that the current can take is to go through the buzzer to the transistor and then back to the battery. But because the transistor is switched off, this path is blocked. The result is that no current flows through the buzzer and it stays silent.

When the moisture sensor is wet, it has a low resistance so a larger current reaches the base connection on the transistor. This turns the transistor on and allows a current to flow through the buzzer to produce a noise.

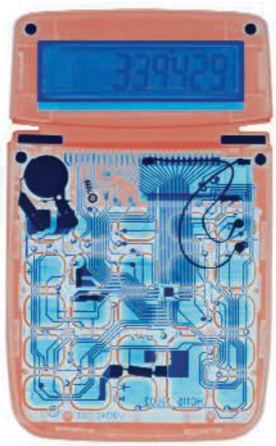


FIGURE 12.4: Thousands of tiny components make up the integrated circuit of an everyday calculator.

Microchips

Microchips are usually very small pieces of silicon that contain microscopic circuits called *integrated circuits*. These circuits can perform a range of tasks and each one can be connected to a series of outputs. The size and complexity of microchips has revolutionised electronics and electronic products. At first microchips, in products such as calculators and home computers, were relatively big and could handle only small pieces of data.

In early computer games, the graphics contained simply dots and dashes or combinations of these. As microchips developed, their complexity and uses also developed. They became more and more powerful, smaller in physical size and cheaper to manufacture. They are now widely used in most electronic products to control, process and output information. They are able to carry out numerous tasks at the same time at an incredible speed.

PC computer chips are commonly known as *processors*. Their power or ability to carry out tasks is shown by the number of *bytes* they can load and process.

An 8-bit programmable controller chip can be used for a simple control circuit in design projects, for example, to flash a series of light-emitting diodes (LEDs). It can be instructed to switch a series of outputs on or off in a sequence or order. Other types of microchips can be used to switch on an output after a specified period of time. The chip merely controls the timing circuit — a *capacitor* actually carries out the timing process.

FIGURE 12.5: Some of the many microchips used in electronic systems

Capacitors

FIGURE 12.6: Capacitors

Capacitors collect and store electric current until it reaches a specified level. When the current reaches this level, the capacitor releases the current in one go. The collecting and storing of current acts as a timer or delaying component. This simple principle has many useful applications. A capacitor's ability to store current is measured in *microFarads*.

In *microelectronics*, the combinations of control circuits and processors can be extremely complex. If you have ever helped build up a computer, you will have seen that microelectronics are contained on the many boards within a computer.

Technobite

A timing system in products has no real connection to time or a clock. It is actually the 'length of time' it takes for a component, such as a capacitor, to store up enough current and then release it.

Output components

Inputs can sense or be activated by human contact. Control is monitored and carried out by systems using simple components in many combinations. The output is usually the most noticeable feature in any kind of system. In electronic systems, outputs could be motors, lights, buzzers or LEDs. These outputs are sometimes referred to as *actuators* because they are the components that are actually carrying out the task.

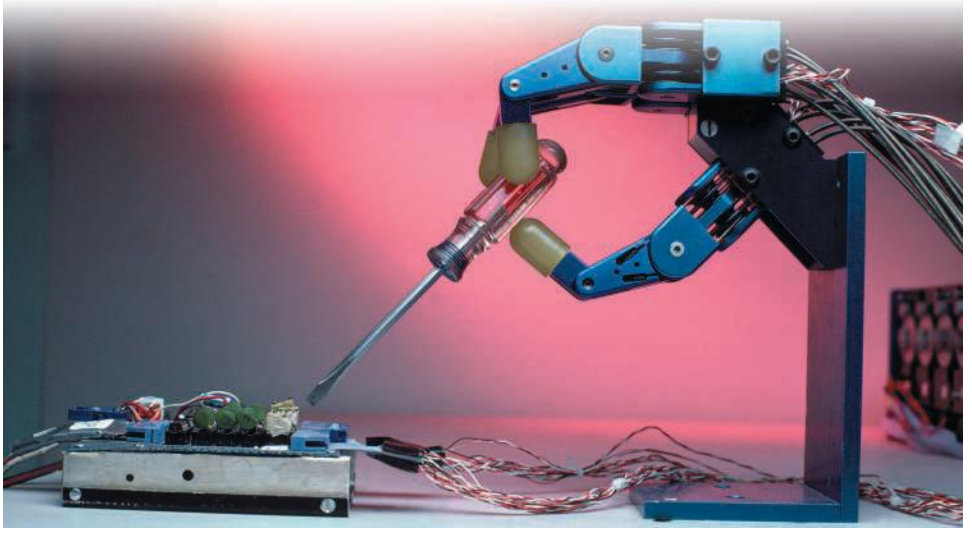


FIGURE 12.7: Actuator used in control technology. The gripper on an industrial robot can be designed for a variety of tasks and can be replaced with different tools for specialised work.

For example, take a temperature monitor in a greenhouse that opens the windows at a specified temperature. Once the temperature reaches a certain level, the control system detects this temperature and turns on a motor (the actuator). This, in turn, is connected to a mechanism that opens the window.

Actuators can also be a light indicator, a cut-out switch, a robotic arm to move an item, a lift to move the item, or an electronic switch (relay switch). Whatever the task that needs to be done, a system can be devised to do it. Actuators may:

- physically carry out a task
- switch on another system
- indicate something to the user.

FIGURE 12.8: A relay switch and its internal workings. Relay switches are automatic switches.

Operating electronic systems

How does a user know whether a task has been carried out or whether a system is operating effectively? There is always a need for *feedback* in a system.

Open-loop systems

Open-loop systems have no feedback. They are 'open' to failure. Look at figure 12.9. How does the control component know whether the output is functioning? Without feedback, there is no way of checking.

Closed-loop systems

Closed-loop systems have feedback. The control system is told whether or not the output is functioning (see figure 12.10). In a closed-loop system, the control system can check the output and make changes if necessary.

In the example of the temperature monitor in the greenhouse, the windows are opened at a specific temperature.

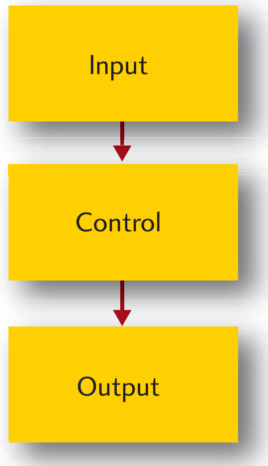


FIGURE 12.9: Open-loop system

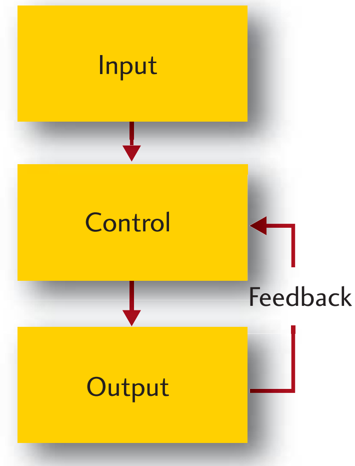


FIGURE 12.10: A closed-loop system with feedback

TABLE 12.3: Greenhouse system

Input	Thermistor (temperature sensor)
Control system	Monitoring input, ready to switch on output
Output	Actuator (motor and window-opening mechanism)
Feedback system	Sensor in window detecting position of window

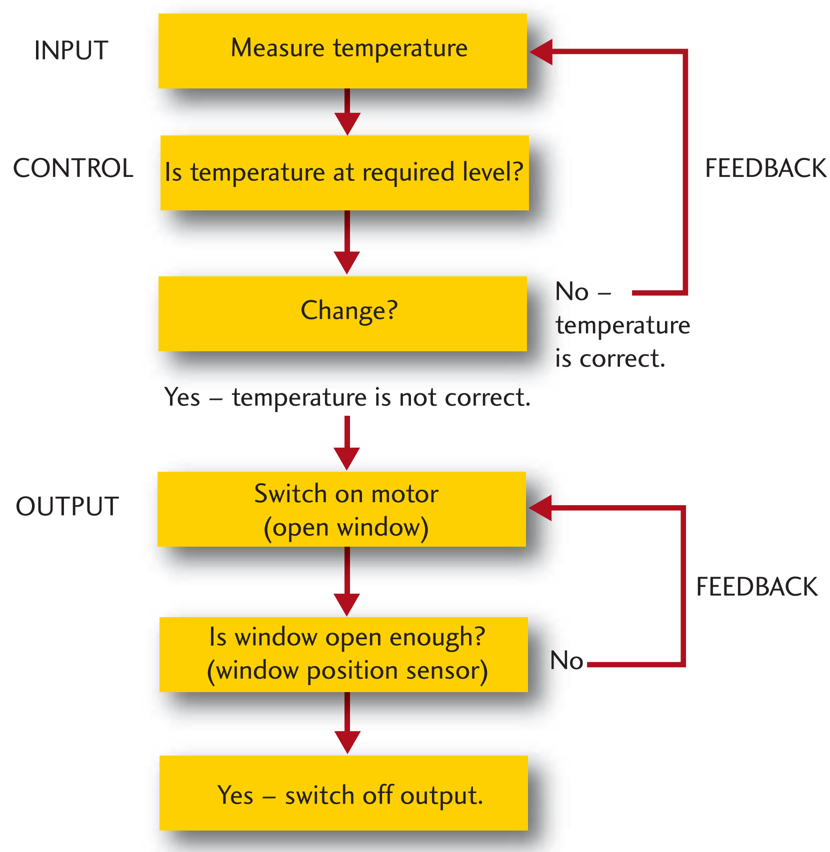


FIGURE 12.11: Greenhouse closed-loop system

Without these two crucial pieces of feedback, the closed-loop system for the greenhouse would fail to operate.

Technobite

In 1843, a mathematician, Ada Byron, published the first computer programs. She based them on a punch-card idea. Her programs were for the first general-purpose mechanical computer, invented by Charles Babbage at the same time.

Switch on

1. What other products have you seen that incorporate an LDR?
2. What sort of sensor is used to trigger the alarm on a fire detection system you have seen? Name the input sensor and state where it is located.
3. Design circuit symbols for humidity sensors, radiation sensors and infra-red sensors.

Control technologies in computer systems

Systems that are controlled by computer obviously have an element of electronics in them. The electronic circuit boards within them control the system. There are three control areas, though, that are directly related to computer control. These are interfaces, programmable logic chips and, more importantly, computer programming.

Technobite

The Apple Macintosh was introduced in 1984. It featured a simple, graphical interface, used the 8-MHz, 32-bit central processing unit (CPU) and had a built-in 9-inch black and white screen.

Interfaces

An interface is an external device attached to a computer to carry out extra functions. These extra functions (too numerous to list here) include monitoring weather or counting the number of cars on a road. Specialist interfaces are designed to carry out specific purposes. The interface may be a small additional circuit board or card, such as a sound or extra memory card. Alternatively, it could be a complex monitoring station, far away from the computer, in an environment unsuitable for humans.

Technobite

Interfaces used to be restricted by the long connecting wires that attached them to their computer system. Now some are wireless — opening up many more possible opportunities and uses

Programming

Programming is the process that tells the computer to carry out a series of steps in a particular order so that a particular task will be completed. Computers use digital information to run systems. There are only two states in digital information: one extreme or the opposite of that extreme. These could be yes/no, on/off, or, as in computers, a type of binary number system using 0 and 1. There is no 'in between', no 'maybe' or 'in the middle'. These direct instructions or *data* allow programs to be formed.

The opposite of digital information is analogue information. Unlike digital, analogue can have an 'in between', somewhere between 0 and 1. Because of all the 'in between' values they can have, analogue instruments are not as easy to read as digital instruments.

FIGURE 12.12: A temperature sensor and data logger can store data for later downloading to a computer.

FIGURE 12.13: Digital displays (right) are easier to read than analogue displays (left).

Switch on

Examine a digital watch and an analogue watch (with hands). If the digital watch gives a clearer display of hours, minutes and seconds, suggest why analogue watches are still so popular.

Using programs

A program (a written set of directions) is the control aspect of the system but, as with electronic systems, there needs to be an input, control and output.

Computer inputs: These put information into the computer system. Some examples of inputs are:

- typing on a keyboard
- mouse
- tracker ball
- light pen
- voice activation
- scanner
- camera
- external sensors, such as moisture or temperature sensors.

Computer outputs: These display or relay information. Some examples of outputs are:

- printers
- plotters
- speakers
- monitors
- external machines, such as in CAD (computer-aided drawing)
- external devices, such as water controllers, heaters or lights.

These inputs and outputs are called the system hardware. The program is a set of rules and decisions that operates the control part of the system. The decisions that the program makes will be affected by the data it receives — for example, is the temperature too high or too low?

Flow charts

By using standard symbols and flow charts, we can represent what a program is doing with the data. Basic symbols for flow charts are shown below.

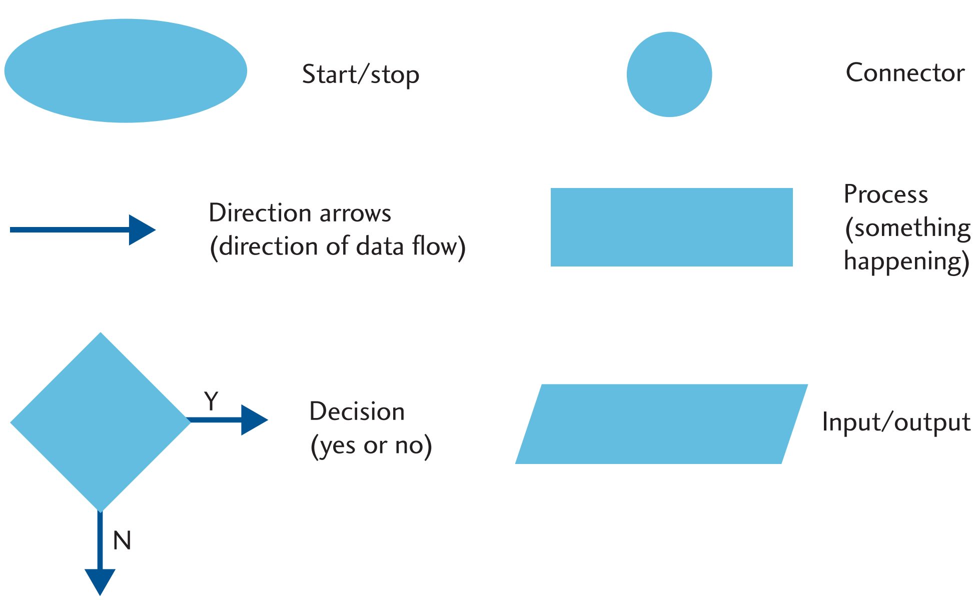


FIGURE 12.14: Basic symbols for flow charts

Technobite

The *computer system* concept can be traced back to 3000 BC with the use of the abacus — a device for calculating that consists of beads strung on rods and set in a frame.

Figure 12.15 shows a clear example of a closed-loop system where feedback is used to control the air temperature.

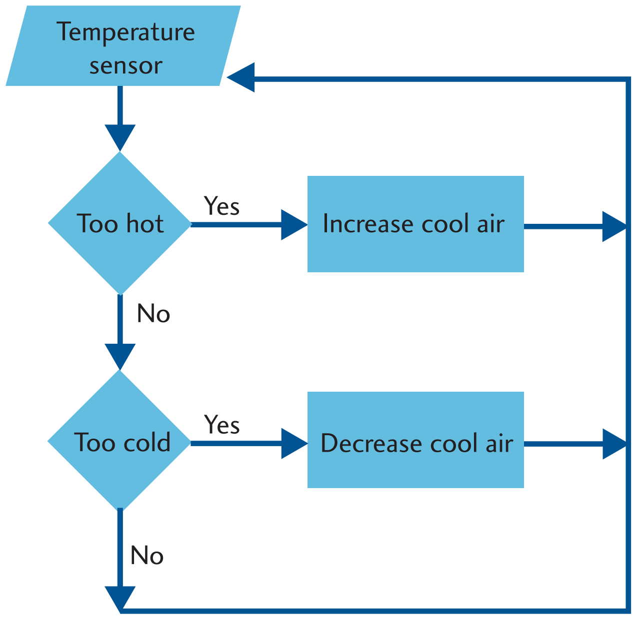


FIGURE 12.15: This is a flow chart for an automatic air-conditioning unit.

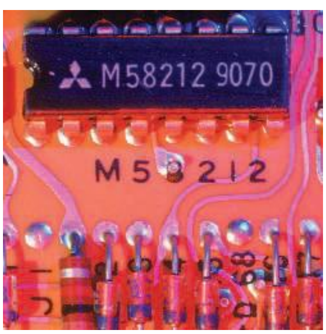


FIGURE 12.16: Programmable logic chip (black rectangle at top) on a printed circuit board

Programmable logic chips (PLCs)

These small microchips can be pre-programmed to carry out simple functions. Again, by using decisions from the program data, they can be connected to outputs. They are really mini-programs that have no need for an external computer. For a simple control circuit in design projects — for example, to flash a series of LEDs — an 8-bit programmable controller chip can be used. It can be instructed to switch a series of outputs on or off in a sequence or order.

Control technologies in mechanical systems

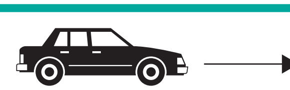
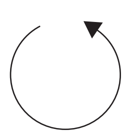
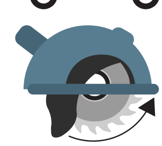
A bicycle is controlled through movement. The physical movement of components, such as wheels, gears and levers, enables complex machines to be manoeuvred around with ease. As with all control systems, there needs to be an input, control and output.

FIGURE 12.17: Mechanical control in everyday use — gear system on a bicycle

Types of movement

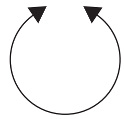
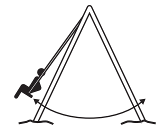
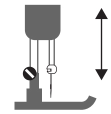
Inputs and outputs for a bicycle are usually actual movements: turning the handlebars or pulling the brake lever. Table 12.4 shows a number of common movements or motions.

TABLE 12.4: Common movements or motions

Movement/motion and symbol	Description of movement	Diagrammatic representation
Linear →	Movement in a straight line in any direction	
Rotary 	Movement in a circular motion, usually around the same central point	

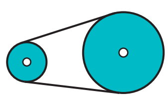
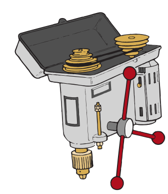
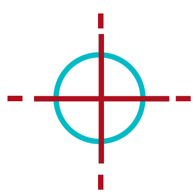
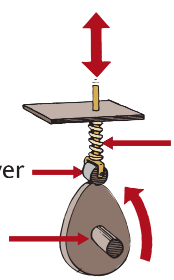
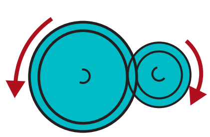
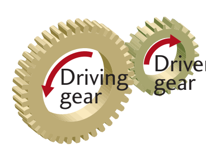
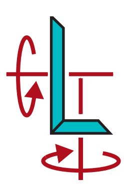
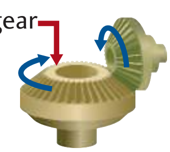
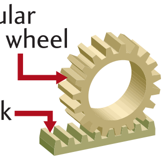
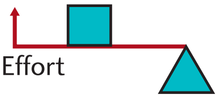
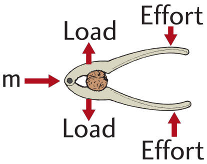
Technobite

In mechanical systems, energy is lost due to heat loss caused by friction. This creates the need to lubricate or oil the system components, which improves the components' life spans as well as the overall efficiency.

Oscillating 	Circular motion in a clockwise then an anticlockwise motion	
Reciprocating 	Linear movement back and forth in a straight line	

Input motion can be the same as the output motion or changed to a different type of motion. The conversion from what happens from the input motion to the output motion is called the *mechanical control* or *mechanism*.

TABLE 12.5: Types of mechanisms

Type of mechanism and symbol		Input motion	Output motion	Appearance	Use
Pulley system		Rotary	Rotary		Lifting systems
Rotary cam		Rotary	Linear/ reciprocating		Movement in toys
Spur gears		Rotary	Rotary		Clock movement
Bevel		Rotary	Rotary		Windmill
Rack and pinion		Rotary	Linear		Steering systems
Lever system		Linear	Linear		Scissors, nutcrackers and other tools

12.2 Tools and techniques

The tools for electronic control projects are the same as those for electronic projects. They include **WIRE CUTTERS**, **WIRE STRIPPERS**, **LONG NOSE PLIERS**, **TWEEZERS**, **SCREWDRIVERS** and **SOLDERING IRONS** (with solder and flux).

See chapter 11, pages 281–3.

Measuring levels within circuits

Control components detect the varying levels of current and voltage within circuits. The tool used to measure and test these levels is called a *multimeter*.

MULTIMETER: A multimeter is a measuring instrument and can be analogue or digital. Recent models have a digital display, giving a reading in numbers. The multimeter has three main measuring features:

- an *ammeter* measures current (*amps*)
- a *voltmeter* measures voltage between two points (*volts*)
- an *ohmmeter* measures resistance (*ohms*).

The features are selected by setting the rotary switch in the centre of the instrument.

FIGURE 12.18: Digital multimeter

Using the multimeter

Select the nearest measurement position on the rotary switch to the units you are using. For example, as your projects will be using 9 volts, you would select the 20 volts position.

The probes are connected at the front of the multimeter (see figure 12.18). The black lead always goes in the COM socket, short for *common*. The red lead connects to the VΩmA socket. (Ω stands for ohms.)

The multimeter also includes a sounder. The sound signals that there is a connection and can be used for testing soldered joints. Place the probes before and after the component; the beeping sound will indicate a connection. If there is no beeping, there is a problem with the connection.

The multimeter has a built-in fuse in case too much current is passed through it, but random testing on circuits in random ranges will break the multimeter. Choose the correct range on the rotary switch before measuring a value.

Safety

- **Never** connect a multimeter to mains electricity.
- **Never** take measurements off mains-powered products, such as the TV.
- If unsure of the level of a voltage, ask for help before testing.

Measuring current

To measure current, a break must be made in the circuit to allow the current to run through the multimeter instead of simply running through the circuit. It must be connected in series, that is, after a resistor. A multimeter won't significantly change the behaviour of the circuit.

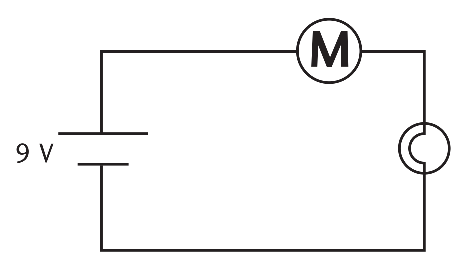


FIGURE 12.19: Measuring current must be done in series. (*Note:* M = multimeter)

Measuring voltage

To measure voltage, no break in the circuit is necessary. The multimeter has to be added in parallel, that is, before and after a resistor. Due to this fact, voltage measurements are used more frequently than current measurements.

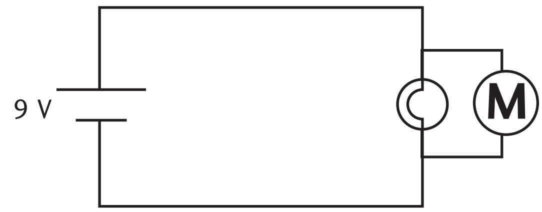


FIGURE 12.20: Measuring voltage must be done in parallel.

Measuring resistance

An ohmmeter is not used with a circuit connected to a power source. To test the resistance levels of a component, you must take the component out of the circuit and test it separately. An ohmmeter works by passing a current through the component and measuring the resistance. The multimeter has a power source (such as a built-in battery) to supply the current needed to measure the resistance. The battery should be tested before the ohmmeter function is used.

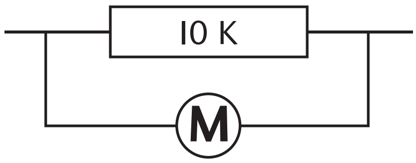


FIGURE 12.21: Measuring resistance is done separately on the component.

Fault-finding procedures

A very small fault, such as a badly soldered joint or a damaged component, could cause the whole circuit to stop functioning. To avoid frustration and loss of time, it's best to use a troubleshooting systematic approach to find the fault (see table 12.6).

TABLE 12.6: Systematic approach to fault finding in a non-functioning circuit

Step	Tick
1. Check power source is functioning at correct level, usually 9 V for small projects. 2. Check components are in correct position and the correct way round using the original printed circuit board (PCB) design. 3. Check soldered joints are clear and secure. 4. Place a multimeter, set to 20 amps, to check current is running through components. Alternatively, use the 'sounder' function on the multimeter to check the connections between components. If there is no sound or amp reading, the connection or component is faulty. 5. Use the same approach as in 4 to check there are no breaks in the PCB copper tracks (connecting wires). 6. After checking any suspect components, start at the positive connection from the power source. Go round the circuit in a systematic manner checking each part of the circuit until you reach the negative connection of power source. 7. Components can be easily damaged by the soldering iron's heat. Replace any components to which you may have applied too much heat. 8. You may have to go back to your original circuit design, prototype board and PCB design and re-evaluate its success.	

If you've followed a correct process of design and manufacturing, you will rarely need this fault-finding procedure and can usually stop at step 2 or step 3.

Switch on

1. Briefly explain why a systematic fault-finding approach is better than random checking.
2. Why do the ranges on the multimeter go beyond those you use in design projects? In what occupations do you think people use a multimeter?
3. Design a safety sign for a multimeter safety rule.
4. Design a wrist-worn multimeter.

12.3 Control technologies at work

Ahead!

New developments in control technologies are happening every day. Just think how quickly computers or MP3s have developed over the past few years. Increased technology has improved product use and, as a result of more demand, the price of such products has decreased. The Spotlight focuses on one of the tiny building blocks of electronic control, a new development in transistor technology.

Spotlight Engineers create world's first transparent transistor

Engineers at Oregon State University have created the world's first transparent transistor, a see-through electronics component that could open the door to many new products. The university is already consulting with major electronics companies about the findings and their potential applications. …

'This is a significant new advance in basic electronics and material science,' said John Wager, a professor of electrical and computer engineering at OSU. …

'It's a little bit like lasers when they were first developed in the 1960s — people at first thought they were an interesting novelty, but no one was quite sure what they could be used for,' he said. 'Later on, lasers became the foundation of dozens of products and multi-billion dollar industries. Right now we're just beginning to think about what you could do with a transistor you can see through.'

The basis of a potential new industry is a compound that's cheap, safe and easy to work with, a good electrical conductor, transparent, can be deposited in thin layers at low temperatures, and is environmentally benign.

Among the possible applications:

- Transparent transistors might improve the quality of liquid crystal displays, which are a \$10 billion to \$15 billion industry, making the displays more clear and bright.
- Electronic devices might be built into window glass or the windshield of a vehicle, allowing a range of new functions or the transmission of visual information.

- Many electronic devices such as flat panel displays have glass that now serves no electronic purpose, but could accommodate new circuits or functions.

There should eventually be a range of applications in consumer electronics, transportation, business and even the military, Wager said.

Transparent materials that conduct electricity have been around since the 1940s, Wager said, and have found their way into many applications — flat panel displays, solar cells, car windshields that can defrost themselves. But the advent of transparent transistors, he said, opens up the much broader potential of electronic devices that require control, logic, switching and the other transistor functions that are essential to modern information systems.

Source: Adapted from an article by David Stauth, oregonstate.edu/research/TechTran/transistor.html.

Spotlight review

1. What consumer electronic product could use the transparent component technology?
2. How could it be incorporated into a house window?
3. Where are lasers now used in everyday life and in industry?
4. Design a circuit symbol for the transparent transistor.
5. What could be the possible safety hazards of this 'invisible' technology?

12.4 Design process

Design project

Your design project for control technologies is to make a moisture sensor.
Area of study: Products. The focus of this area of study is on objects, systems and artifacts.
Design specialisation: Industrial design. Industrial designers create toys, everyday products and production systems.

FIGURE 12.22: Some of the many moisture sensor designs available today

(a) Soil moisture sensor

(b) Liquid level indicator — an aid for the visually impaired. A buzzer goes off when the liquid reaches a certain level.

(c) Sensor to determine the level of moisture in the skin

Design situation

In many situations we are able to sense a lack or excess of moisture through touch, taste and sight. But that's not easy to do inside a machine or an industrial process. In such cases, we can use an electronic system to monitor the moisture level. By incorporating this monitoring system into an easy-to-make product, we can solve problems, such as being alerted when an indoor plant has dried out or being called when the bath is about to overflow. Your design brief concentrates on this latter situation. The principle is similar to the sensors used by people with a vision impairment when they are filling a container with liquid and are unable to sense when it is nearly full.

Designing and making your moisture sensor will involve several stages.

Design brief

Design and produce a moisture sensor to detect the level of water in a bath or water container. For this task, you must investigate the user of the product and the environment your product will be used in. The product must be easy to use and have an output that you can hear. The design brief describes the product you will design and produce, but the look of the moisture sensor is up to you.

Project materials:

- perspex sheet
- electronic components
  - printed circuit board (PCB)/Veroboard
  - battery clip
  - 9 V battery
  - 10 K preset resistor
  - 1 K resistor
  - BFY51 transistor
  - buzzer
  - electrical wire
- copper tracking (connecting wire)
- small nuts and bolts.

Look again at the design process in chapter 2, pages 20–1.

Be flexible in your approach to this design process. The order of the steps is not set in concrete and you may not always follow them in the sequence presented here. Some steps go hand in hand with others throughout the design project. Other steps need to be completed before you can move on. You should concentrate on using the combined steps to form a process that guides the development of your design.

Design Folio **Production**

Your design folio is an important communication tool for design projects. It should tell the story of your design project's development, from your first rough ideas on paper to the final evaluation of your design brief solution.

Consider composing your design folio in electronic format for this technology.

Design process: ONGOING EVALUATION

Essential for success

Remember that ongoing evaluation is central to the design process and should occur at every step. Regular evaluation helps to identify problems and challenges at the right time for you to deal with them. Putting evaluation off until later is asking for trouble, for example:

- wasted resources
- lost time
- failure to meet deadlines
- increased costs.

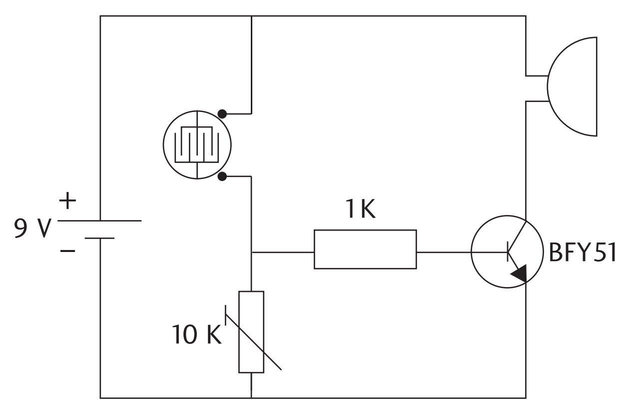
Design process: ANALYSIS

Understanding the project

This project is more complex than the one in chapter 11. It requires a PCB or Veroboard prototype to produce the circuit. The circuit is based on using a transistor as a very sensitive switch to detect a change in the circuit. The change, in this case, is caused by the detection of water. When the transistor detects a higher electric current, due to the conductivity of water, it switches on another part of the circuit. When the liquid reaches the required level, a buzzer will sound.

See figure 12.23(a) for what the circuit will look like. See figure 12.23(b) for what your moisture sensor's PCB will look like.

(a) Circuit diagram



(b) PCB

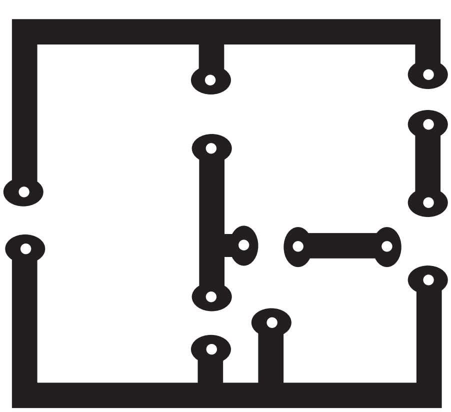


FIGURE 12.23: Diagrams for moisture sensor

Thinking about the design situation

When you answer the following questions, you have already started to research and create design ideas. These analysis questions could help you plan your moisture sensor's size, shape and design.

1. How will the moisture sensor be attached to the bath or container?
2. How will you keep the circuit away from water? How will you use the pieces of perspex? How can you join perspex?
3. What measurements will you need to investigate from the environment, for example, the size of the bath?
4. Will the moisture sensor be easy to use?
5. What other rooms in your house, school or community could use moisture sensors?
6. Where are you going to research the materials and tools that you could use for the moisture sensor?
7. Are the weight, shape and size of the moisture sensor important?
8. Is the look (aesthetics) or the function of the moisture sensor more important? Why and how?
9. Where will you position the PCB? How big will the plastic casing have to be to fit the PCB and battery?

Switch on

Thinking about the design brief

Write the design brief in your design folio and then underline, circle or highlight words that give you specific information or instructions as indicated.

> Design and produce a moisture sensor to detect the level of water in a bath or water container. For this task, you must investigate the user of the product and the environment your product will be used in. The product must be easy to use and have an output that you can hear. The design brief describes the product you will design and produce, but the look of the moisture sensor is up to you.
>
> *Project materials:*
>
> - perspex sheet
> - electronic components
>   - PCB/Veroboard
>   - battery clip
>   - 9 V battery
>   - 10 K preset resistor
>   - 1 K resistor
>   - BFY51 transistor
>   - buzzer
>   - electrical wire
> - copper tracking (connecting wire)
> - small nuts and bolts.

Think about the main points and the keywords and ask what, where, why, how and when. Record your analysis ideas in your design folio.

Limitations to the design brief

When designing a product or solving a problem there are always limitations. Identify constraints for the development of the project.

- *Time available:* When does the project need to be completed?
- *Function:* What are the purpose and main features of the project?
- *Aesthetics:* What does the project need to look like?
- *Cost:* Do you have enough money to complete the project?
- *Materials and tools available:* What materials and tools are required? Are they available at school?
- *Expertise:* Do you have the skills required to complete the project?
- *Environmental considerations:* Will any production waste harm the environment?
- *Safety rules and regulations:* Will the product be safe? Will it meet all legislative requirements?

List factors that might limit you when making the moisture sensor. What is going to be the biggest limitation? Why?

Technobite

The need to upgrade computers every few years is now an environmental problem. Millions of computer cases and their parts are dumped in landfills or burned. Compunote, a Dutch company, recycles computer circuit boards, making them into such things as clipboards, mousepads, address book covers, business card and CD holders and key rings.

Criteria for success

Criteria to evaluate success spell out what the design must achieve, while taking into account design limits that could affect the final solution. For example, the product must:

1. detect a specific level of moisture/water
2. have an audible output such as a buzzer
3. keep the PCB and electronic components dry.

Think of another five criteria and write these and the ones above in your design folio.

Design process: MANAGEMENT

Getting organised

- Develop action-management, time-management and budget-management plans.
- Evaluate and justify any changes to management plans, outlining impacts on the design project's development. This will mean re-evaluating your management plans regularly during the making of your design project.
- Plan and manage available resources effectively and efficiently.
- Evaluate the appropriateness of available resources as they relate to your design brief and developed criteria for success.

Design process: RESEARCH

Find information to help you design a range of options from which you will make your final choice.

Investigating existing ideas is crucial. Look at moisture sensors already available. What materials are they made of and what special features do they have?

Choosing your information

Printed catalogues, brochures and magazines make it fairly easy to find pictures of existing ideas. The Internet is also a good source.

- Find good-quality clear images, preferably in colour.
- Find a range of similar ideas, for example, a range of moisture sensors.
- Don't repeat ideas just to fill space.
- Search for images using a search engine on the Internet. Note where you retrieved the information from.

Analysing your images

Visual references are useful, but setting some criteria for analysing the information will allow you to discover more. Criteria could include:

- materials used
- finish
- special features
- retail cost
- size.

Decide whether the results of your analysis for each of the criteria are *advantages* or *disadvantages*.

See chapter 2, pages 35–6.

Evaluation technique

Identify the strengths, weaknesses and interesting aspects to analyse images.

Material: *Plastics*
Finish: *Grey colour*
Features: *Small, interesting shape, includes phone, video camera and MP3 player*
Size: *87 mm × 78 mm × 18.6 mm*

FIGURE 12.24: Analysing visual images can give you even more ideas.

Strengths:
Pocket size, large screen
Weaknesses:
Not comfortable in pocket
Interesting aspects:
Earphones in same style

FIGURE 12.25: Identifying strengths, weaknesses and interesting aspects — a quick but very useful technique

FIGURE 12.26: Electronic components

Switch on

1. *Market:* Research the market for your product in books, catalogues, brochures, junk mail, libraries, shops and on the Internet to find out about moisture sensors in various situations. Complete two A4 pages of market research for your design folio.
2. *Materials:* Find out as much as you can about the materials and components that you have been given and any other materials you can use with this project. For example, complete an A4 page for your design folio on the components and how they work. Investigate ways of bending perspex and using it to make a PCB package or holder. Investigate the transistor as a frequently used component.

3. *Tools:* Research the tools that could be used to produce the moisture sensor. You will need tools to cut, shape, bend, join, finish and heat the perspex. You will also need to use a variety of electronic tools.
4. *Techniques:* Research the techniques for making a moisture sensor: bending, joining and finishing.
5. Collect images of existing ideas for a product of your choice, for example, an MP3 player. Note the following:
   - the sources that are easiest to collect
   - the criteria you could use to analyse them.

   How else could you collect images of this product?
6. Using a list of criteria, analyse three examples of the product. Identify their strengths, weaknesses and anything interesting about them. State their advantages and disadvantages and decide which product is the most useful.

See chapter 5 for the tools to use with perspex. See chapter 11, pages 281–3, for electronic tools.

Design process: IDEAS GENERATION

There are various techniques you can use for generating creative ideas, such as brainstorming, drawing mind maps and research.

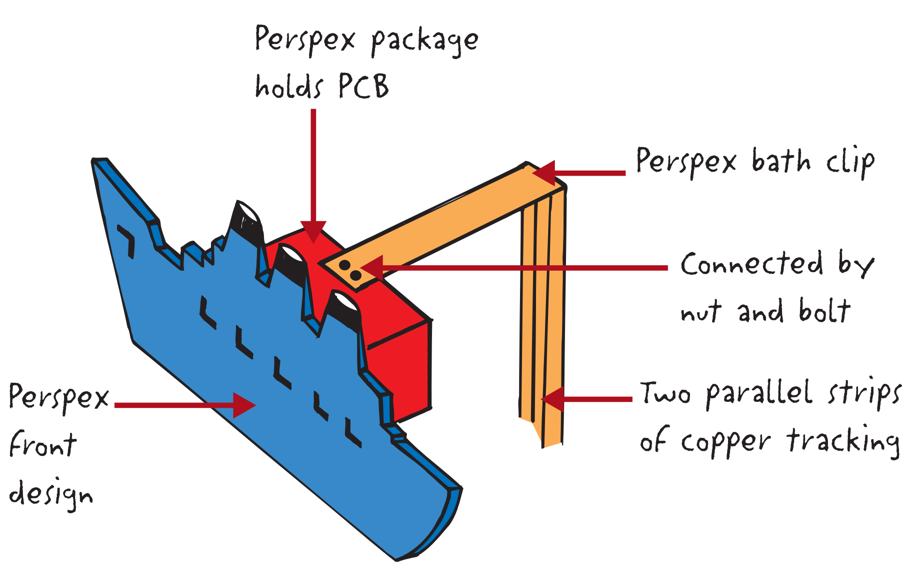
See chapter 2, pages 39–41.

Preliminary sketches and plans for the solution

This section of the design process requires you to brainstorm, but this time in a graphical form. Draw six to ten thumbnail sketches, showing the style, colour and method of construction for several moisture sensor designs. Think about materials, tools and techniques for all your designs. Then choose your three favourite designs and label each one with the materials, tools and techniques that you would require to construct them.

Review your time-management plan for completing your project.

FIGURE 12.27: An example of a design for a moisture sensor that clips over the side of the bath, labelled with materials



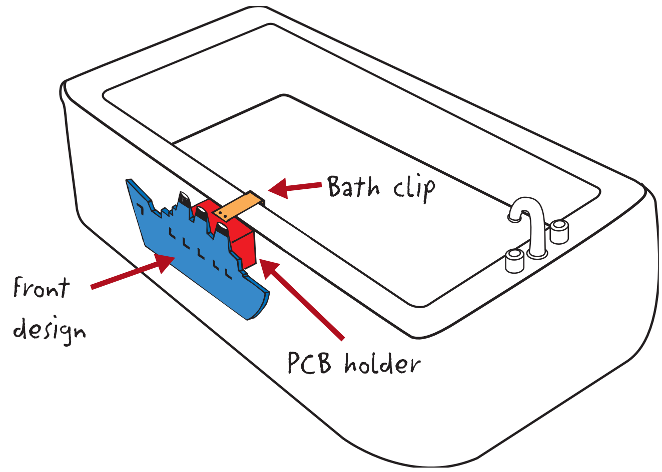


FIGURE 12.28: Your moisture sensor will fit on the bath like this.

Switch on

Table 12.7 is an example of a cutting list for a moisture sensor. In your design folio, complete a cutting list for your moisture sensor, using table 12.7 as a guide.

TABLE 12.7: Sample cutting list for a moisture sensor

No. of parts	Material	Width × length × thickness	Hardware/ decoration
2	Perspex — sides	80 mm × 80 mm × 3 mm	2 × nuts and bolts (4 mm width × 20 mm length) Electronic components as stated earlier
2	Perspex — sides	80 mm × 80 mm × 3 mm	
2	Perspex — top and base	80 mm × 46 mm × 3 mm	
1	Perspex — inside top	74 mm × 34 mm × 3 mm	
1	Perspex — front design	150 mm × 150 mm × 3 mm	
1	Perspex — bath clip	25 mm × 500 mm × 3 mm	
1	PCB	50 mm × 50 mm × 2 mm	
2	Copper tracking	5 mm × 500 mm × 0.5 mm	

Design process: COMMUNICATION

Final sketches and working drawings

See chapter 2, pages 44–6.

Choose one design and produce concept sketches and working drawings for your design. These will help you to plan in your mind and on paper what the moisture sensor will look like and identify any problems that may arise. Often an excellent design idea cannot be made because of unavailable resources or insufficient time to complete the project.

Promotion

Prepare a PowerPoint presentation of your ideas for your moisture sensor and present it to the class. Explain how you arrived at your final choice.

Design process: EXPERIMENTATION AND TESTING

Model making

See chapter 2, page 46.

When designing and making your product, it helps to construct a pattern, template or model (prototype) to evaluate your moisture sensor and see what it will look like. This could be done by hand or on a computer in a computer-aided design (CAD) or computer paint program.

The circuit could be prototyped on a breadboard or on Veroboard. When experimenting and testing, you need to:

- test material properties (refer to 12.1 Materials)
- test construction techniques (refer to 12.2 Tools and techniques).

Look again at the rules for basic safety in chapter 2, pages 51–5.

Safety

Note: The level of electricity in the moisture sensor you are making and other 9 V operated products will not cause injury if put in contact with water.

Design process: SAFETY AND RISK MANAGEMENT

General rules for working with control technologies

- Water and electricity don't mix. **Never** bring mains electricity and water into contact with each other.
- Remember that any fumes, including those from solder or heated perspex, are dangerous and should not be inhaled.
- Always assume tools using heat, such as soldering irons or strip heaters, are hot and handle with appropriate care.
- When working with adhesives, take care with storage and use.

Some safety rules that apply specifically to aspects of control technologies are stated throughout this chapter. Observe them!

Design process: PRODUCTION

Materials

You will need to use different types of materials to make your moisture sensor. You may change the given sizes for the perspex casing to suit your design. The design of the front is your main chance to personalise your moisture sensor.

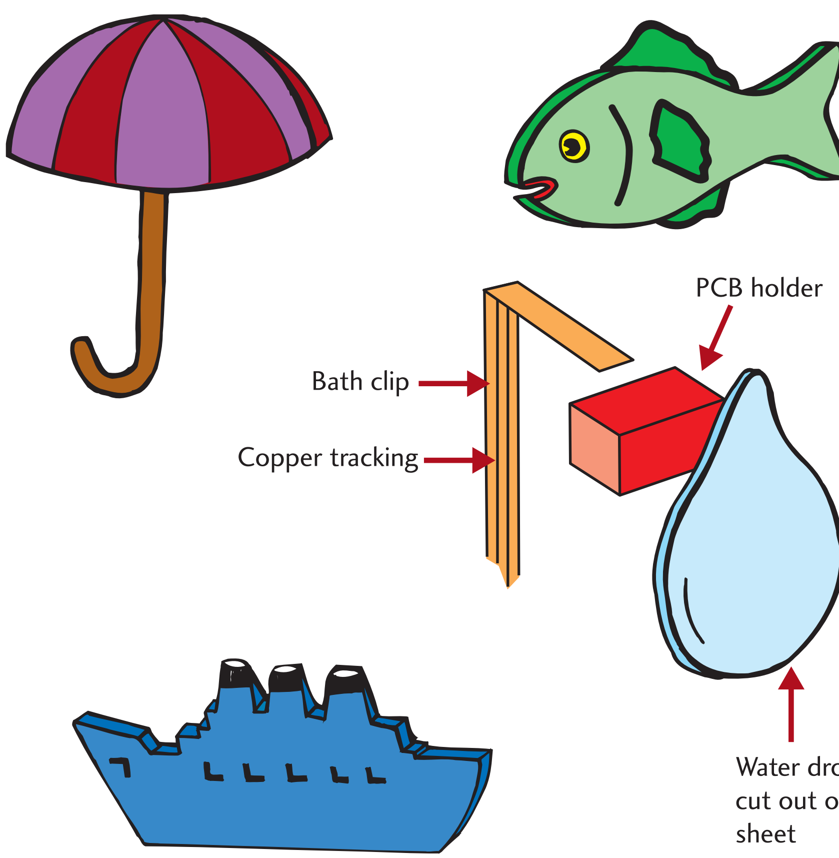


FIGURE 12.29: Examples of designs for the front of the moisture sensor

Tip

This circuit can be easily modified to detect a lack of moisture in a plant pot. The product would tell you when the plant needs more water. Simply swap the position of the probes with the preset resistor. You could experiment on a breadboard.

See the tools and techniques sections in chapters 3 and 5.

Safety

WARNING: A bandsaw is a high risk tool and **must not** be used by Years 7–8 students without teacher supervision.

Tools and techniques

Cutting tools

You will need to use cutting tools to cut the perspex into the shape for the front design and to cut perspex pieces that will enclose the PCB. You will also need to drill holes in the perspex for the bolts.

COPING SAW: A hand tool for cutting perspex into shape, using a template.

BANDSAW: This machine saw can also be used to cut perspex.

CORDLESS DRILL: Used to drill holes in perspex for the bolts. Place masking tape over the area of perspex you are drilling to minimise cracking. Only gentle pressure should be applied on the drill, again, to minimise cracking.

Finishing tools

Once you have cut out the moisture sensor pieces, you must finish the edges before you go on.

Moulding and heating tools

STRIP HEATER: This is used to heat and bend perspex sheet along straight lines or into right angles.

See chapter 5, pages 121–3, for more information on the finishing process.

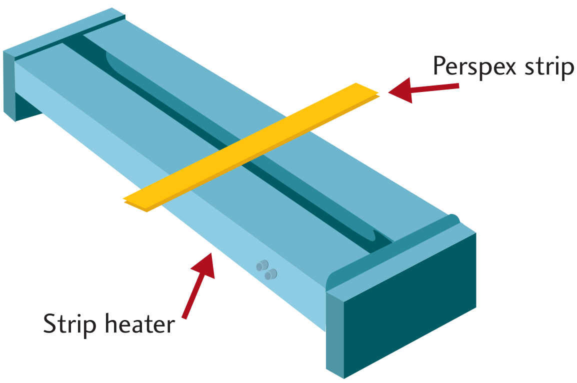


FIGURE 12.30: A strip heater is used to bend perspex.

See chapter 5, pages 123–4, for more information on the bending process.

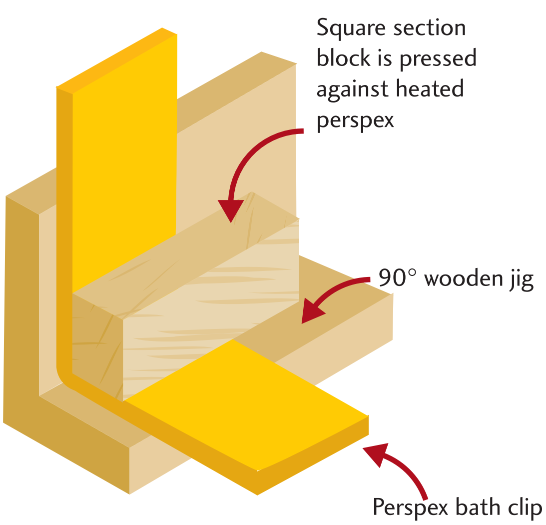


FIGURE 12.31: Bending the perspex into a right angle

Safety

Always wear dry, industrial, leather gloves when heating perspex on a strip heater.

See chapter 5, page 125.

Adhesives

There are two ways to join perspex together: with mechanical fastenings or glues.

TABLE 12.8: Joining techniques for the moisture sensor

Moisture sensor component	Joining material
Perspex to perspex	Acrylic cement/perspex cement
Bath clip to perspex PCB holder	Nuts and bolts
Copper tracking to bath clip	Self-adhesive strips or contact adhesive

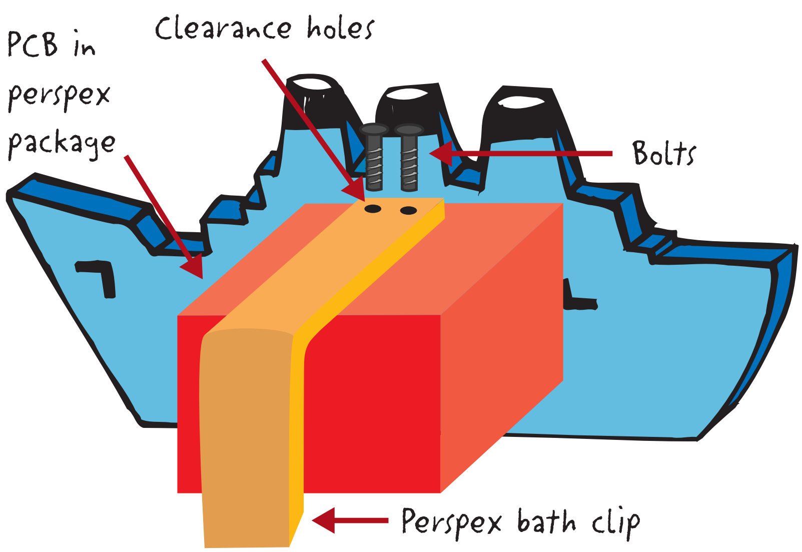


FIGURE 12.32: Drill clearance holes and then bolt the clip to the PCB holder.

Safety

Observe the following safety guidelines.

- Take extreme care when dealing with adhesives.
- Always work under teacher supervision.
- Always read the directions on the bottle or the tube.
- Work in a well-ventilated area and wear a mask. This is important to prevent giddiness and fainting. Most adhesives give off toxic gases and, if inhaled, will cause damage and/or are carcinogenic (can cause cancer).
- If any solvents, glues, or adhesives come in contact with your skin, wash the affected area immediately.
- Store substances according to the recommended safety advice.

Switch on

1. Instead of joining the separate pieces of perspex to create a PCB holder, how could you produce a PCB holder using perspex sheets and a strip heater?
2. Identify three safety rules that need to be followed when using adhesives. Explain why the rules are necessary.
3. Why is it important to have a good contact between the copper tracking, nuts and bolts and the actual PCB circuit? What would happen if this contact were broken?

4. Another way of making a case to hold the PCB is to vacuum form a plastic shape. Investigate this method of production. Ask your teacher to explain the process. Design a new suitable casing for your moisture sensor.
5. Design a poster to warn against the dangers of mixing water and electricity.
6. Use the Internet to search for more information about moisture sensors — for example, the products used to detect moisture in greenhouses or those used by people with a vision impairment to help them in the kitchen.

Design process: FINAL EVALUATION

Test the product

Evaluate your moisture sensor regularly during the production process. When it is finished, you are ready for the final evaluation. This means making sure the moisture sensor is fixed securely to the side of the bath and that it detects the water level.

Professional, peer and self-evaluations

Ask your teacher, your classmates and yourself the following questions — the answers will be your final evaluation of the moisture sensor and the project.

1. Is the product easy to use in the given environment?
2. Is the design safe to use?
3. Did you use the most suitable materials, tools and techniques?
4. If you were to make your moisture sensor again, what changes/improvements would you make?
5. Did you enjoy this unit of work? Why or why not?

Design process checklist

ONLINE RESOURCE BANK

Go to the Online Resource Bank at www.jaconline.com.au/switchedontech and click on the Design Process Checklist. Use the checklist questions to self-evaluate your project and to help you finalise your design folio.

You can also find more ideas for design projects at the Online Resource Bank.

Index

L

M

N

O

P